Abstracts of Technical Presentations

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Key Note Address

How Do We Get to: *"One Lagoon - One Community - One Voice"*? The Role of Science

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The scientist's role in society is changing. While public support of scientific research and the value of science in society remain high, the general public and policy makers may not understand the scientific process nor appreciate the complexities of ecosystem functions, stressors, and long-term ecosystem management. This is especially true when addressing concepts associated with uncertainty and scientific debate.

For the Indian River Lagoon, the removal of communication barriers among citizens, policy makers, and the scientific community represents a connected leadership opportunity. The creation of the IRL Council (a special district of the State of Florida), transfer of the Indian River Lagoon National Estuary Program (IRL NEP) to the IRL Council, and restructuring of the IRL NEP Management Conference provide a historic moment to build a citizen-, stakeholder- and science-driven coalition to work across all 5-counties and over 47 municipalities to engender IRL restoration and stewardship. The newly envisioned IRL NEP Management Conference provides the framework for scientists to become more proactive and strategic in cross-disciplinary knowledge sharing within the scientific community and with citizens, stakeholders, and policy makers. Dr. De Freese will share preliminary thoughts and proposed pathways to achieve the "*One Lagoon – One Community – One Voice*" vision for the IRL NEP.

Contributed Papers (Oral and Poster Presentations)

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

Connecting IRL Users with Data – New Directions for Advancing Research and Management

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Proper management, conservation and scientific advancement regarding abiotic and biotic compartments of the Indian River Lagoon (IRL) system are not possible without critical data points. A recent workshop built on results from a region-wide survey of federal, state, and local agencies as well as academia, non-profit entities, and the private sector, revealed what data are available and what new pathways will allow more effective data sharing and dissemination to end users. Water quality data were the most available and shared, while more complex biological and physical oceanography data were least available and less shared. Although the temporal structure of IRL data collection ranged from real-time to archival/multi-year, the most frequently used or needed by end users were monthly or archival/multi-year data. Types of end users of IRL data varied greatly and this diversity exemplifies the increased need for more effective data flow via new portals and innovative sharing techniques.

Maternal Transfer of Organochlorine Contaminants in the Pseudo-placental Scalloped Hammerhead Shark

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Sharks have a propensity to accumulate high contaminant concentrations, especially in species that occupy upper trophic levels. Organochlorine contaminants (OCs), including PCBs and chlorinated pesticides, can be used as environmental tracers in marine ecosystems. We measured OCs in livers of scalloped hammerheads from U.S. Atlantic waters, including near-term pregnant females and their embryos. This is the first study to demonstrate that hammerheads are exposed to substantial amounts of toxic contaminants prior to birth and document maternal transfer in a pseudo-placental shark species. Exposure to high levels of OCs may impair health of juveniles. Combined with their mobility, the propensity of upper trophic-level sharks to bioaccumulate contaminants may represent a substantial biovector by which legacy OCs may be further distributed throughout the coastal marine environment on regional and global scales. Our continued research in the Indian River Lagoon and adjacent waters will expand on these aspects and explore the adverse effects these contaminants have on the health of fish populations.

Punch-Drunk: Extreme Hits to the IRL

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Over the past few decades, the Indian River Lagoon (IRL) has endured chronic anthropogenic and natural stresses. The system has been absorbing these increased stresses for the most part with built-in "shock absorbers." Starting in 2008, however, the IRL endured several extreme hits in a very short time resulting in rapid and drastic changes to its physiochemical and biological conditions. Some of these extreme events immediately preceded and coincided with the 2011 Super Bloom and 2012 Brown Tide bloom. Did these extreme events factor into the superbloom? Additional hits have occurred since those major

bloom events. Are the unprecedented changes recently observed in the IRL resulting from a system in recovery or a system still in distress? Are these extremes a signal to an ecological regime shift? Accounting for these events and understanding how the system responds will be a key in future management.

From Gardens to Reefs: Methods for Reintroducing Eastern Oysters to Brevard County

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Within the first two years of the Brevard Zoo and Brevard County oyster gardening project, over 950 residents volunteered to become oyster gardeners and were trained through educational workshops. Citizen scientists grew oysters from spat in suspended habitats off their dock for 6-9 months. Gardener data were used to select three pilot reef locations in Brevard County. Live oysters were collected from gardeners and deployed at pilot reef sites in Port St. John, Merritt Island, and Melbourne Beach. University of Central Florida has been monitoring replicate reefs at each location to quantify success. Success metrics include survival of gardened oysters, natural recruitment, and increases in shell length over time. Abiotic data (salinity, water and air temperatures, wind speed) have also been collected. The data will determine if moving eastern oysters to new locations in the Indian River Lagoon within Brevard County is an effective method of natural water quality improvement.

Assessing the Influence of Predation on Mangrove Prop Root Residing Species Diversity along the Latitudinal Gradient

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The ecological biodiversity latitudinal gradient pattern is one of higher biodiversity in the lower latitudinal gradients and that biodiversity decreases with an increase in latitude. A field experiment was done to study the impact of predation on the species diversity of the mangrove prop root community. This field experiment focused on the difference between treatment types where selected predators have or have not been excluded. By assessing the influence of predation on the mangrove prop root communities, a control factor for the pattern of latitudinal biodiversity can be tested.

Florida Atlantic Coast Telemetry (FACT) Array: A Working Partnership

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The Florida Atlantic Coast Telemetry (FACT) Array is a collaborative partnership of researchers from 24 different organizations using passive acoustic telemetry to document site fidelity, habitat preferences, seasonal migration patterns, and reproductive strategies of valuable sportfish, sharks, and marine turtles. FACT partners have found that by bundling resources, they can leverage a smaller investment to track highly mobile animals beyond a study area typically restrained in scale by funds and manpower. Partners have access to a network of 480 receivers deployed along a continuum of habitats from freshwater rivers to offshore reefs that covers ~1100 km of coastline from the Dry Tortugas, Florida to South Carolina and

extends to the Bahamas. Presently, 49 species, (25 covered by Fisheries Management Plans and five covered by the Endangered Species Act) have been tagged with 2736 tags in which 1767 tags are still active.

Vibrio Bacteria in Florida Waterways: Myth Busters and Safety Tips

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Vibrio bacteria are responsible for 80,000 illnesses and 100 deaths in the United States annually, with the majority of cases reported from Florida. Infections are linked to estuarine environments and are acquired through contaminated seafood or aquatic injuries. Under certain circumstances these infections can be serious, however their incidence is rare considering the millions of people that participate in aquatic activities and consume local seafood each year. Recently misinformation, including the term "flesh eating bacteria", has caused alarm among the local community. Our goal is to bridge the gap between researchers, medical providers, media personnel and Lagoon users by busting common myths and providing important safety information. Our outreach addresses topics including where *Vibrio* are commonly found, who is at risk and how infections occur, as well as prevention tips from first aid to fish handling and seafood preparation. Educational materials featured in this presentation are located at http://www.fau.edu/hboi/mbbr/vibrio.php.

Refining Total Maximum Daily Loads (TMDLs) Adopted for the Indian River Lagoon

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To implement the Federal Clean Water Act locally, the Florida Department of Environmental Protection adopted Nitrogen and Phosphorus Total Maximum Daily Loads (TMDLs) in 2009 for most of the Indian River Lagoon (IRL). Basin Management Action Plans (BMAPs) to implement TMDLs for the Banana River, North IRL and Central IRL were adopted in early 2013. During TMDL and BMAP development, local governments shared concerns regarding the age, quality, degrees of freedom, spatial accuracy and temporal resolution of data used to develop IRL TMDLs. A consortium of eighteen local, state and federal interests jointly funded a research team to refine IRL TMDLs using data sets and computational power that were not available during initial TMDL development. Available data were analyzed and a new geo-spatial load-estimating model was built for the IRL. Seagrass targets were updated using a reference condition approach and refined nutrient load thresholds were determined from load-response relationships.

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

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Soft-sediment communities are important indicators of water quality and are useful in monitoring the overall health of a particular system. Species found within these communities (polychaetes, bivalves, amphipods, etc.) are relatively immobile, have short life spans, and rapid turnover rates making them ideal for long term monitoring. As part of the St. Johns River Water Management District's IRL Algal

Bloom Investigation project, benthic grab samples have been collected quarterly at 27 sites spanning nearly 100 km within the Indian River, Banana River, and Mosquito Lagoon. The project was designed as a way to develop a baseline dataset over space and time of species abundance and diversity within the IRL. This dataset will be useful for comparisons throughout the IRL during future stressful conditions including potential outbreaks of harmful algal blooms. Data being presented are on the preliminary analysis of changes in diversity, abundance, community structure, and species dominance.

Effect of Rainfall on the Levels of Fecal Coliform in the Coastal Oaks Preserve

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According to the EPA, the presence of *Enterococcus* and *Escherichia coli* fecal coliforms is the best way to indicate health risks for recreational activities in salt and freshwater respectively. We collected weekly water samples at eight different sites along a salinity gradient in the Coastal Oaks Preserve (COP) in Vero Beach, Florida. In the lab, we performed dilution series with two different media, mEI and MI. Our team observed high variability both within the different sample sites and throughout the study period. Our data showed a strong correlation between rainfall and fecal coliform within all eight sites. Due to the health risks associated with high levels of fecal coliform, surface waters at COP should not be used recreationally following heavy rainfall by people with a compromised immune system.

Microbial Diversity in the Indian River Lagoon

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The Indian River Lagoon (IRL) is considered one of the most diverse estuaries in North America. However, one of its largest communities, microbes, remains unexplored. This study aims to fill this knowledge gap by investigating the sediment bacterial and archaeal populations and their functions, as well as the effects of natural and anthropogenic stressors. Initially, we will conduct a baseline study to determine how the populations change in response to natural spatial and temporal variations such as salinity gradients. There are numerous anthropogenic perturbations that may affect an enclosed shallow lagoon such as the IRL. These include the input of nutrients and heavy metals from urban, industrial, and agricultural land usage as well as harbors. Understanding how microbial communities change over time in response to stressors is necessary since they play a crucial role in biogeochemical cycling of nutrients. Microbes also have the bioremediation potential to break down pollutants.

A Snapshot of Phytoplankton Communities along the Indian River Lagoon and the Okeechobee Waterway

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The Indian River Lagoon Estuary is linked by man-made canals and locks to the Caloosahatchee Estuary. The Okeechobee Waterway runs through the center of Florida via Lake Okeechobee. A study was designed to monitor the phytoplankton community across the waterway as it relates to changing environmental conditions. Thirteen test sites were established to represent different bodies of water; salinity, dissolved oxygen and temperature, as well as the phytoplankton community were measured at each site. The phytoplankton community was characterized in terms of density, diversity, richness and evenness. While there was no clear correlation between overall phytoplankton community and water

quality, the presence and abundance of individual species represents the differing habitats along the Okeechobee waterway.

The Importance of Sediment-Water Exchanges and Internal Nutrient Loading to System-Level Biogeochemical Attributes of the St. Lucie Estuary

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Biogeochemical cycling in estuaries is influenced by exchanges across the upland, atmospheric, oceanic, and sediment boundaries. Exchange rates at the sediment-water boundary are often the most difficult to ascertain. Quantification of estuarine responses to external nutrient loading requires knowledge of internal processes. This study measured rates of dissolved exchanges across the sediment-water interface in the St. Lucie Estuary (SLE) in both dry and wet seasons. Approximately 50 benthic cores (15.2 cm) were incubated under light and dark conditions in both February and July. Changes in nitrogen, phosphorus, and oxygen concentrations in the overlying water were used to calculate exchange rates. The rates were evaluated along gradients of salinity and submarine light, and, spatially interpolated to estimate system-level internal loading. Results suggest that low submarine light and high sediment organic content render the sediment-water interface a source of nutrients to the water column of the SLE.

Crustacean Mesograzers Influence Algal Epiphyte Loading in a Subtropical Seagrass Meadow

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Seagrasses are productive marine plants that provide key ecosystem services such as carbon storage and nutrient cycling. Unfortunately, seagrasses are declining globally, with a reported 30% loss in areal coverage since the late 1800s. While we have a basic understanding of some of the mechanisms driving seagrass loss (eutrophication and overfishing), we have a limited understanding of how these pressures interact to alter overall functioning. We present the results of a study that examined the combined effects of increased nutrient supply and decreased meso- and macrograzer abundance on the structure of a subtropical seagrass meadow in the Indian River Lagoon. Our results demonstrate that while nutrient loading had minor effects, reductions in crustacean amphipods elicited a marked increase in epiphytic algal loads, which can negatively impact seagrass growth over extended periods. These results highlight the important role that small consumers play in promoting the health and resilience of these systems.

Determining Factors that Influence Smooth Cordgrass (*Spartina alterniflora* Loisel) Transplant Success in Community-Based Living Shoreline Projects

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Efforts to mitigate shoreline erosion have incorporated the cultivation and transplantation of smooth cordgrass, *Spartina alterniflora,* as part of "living shoreline" projects. Assessments of these transplants at several sites have shown that survival is variable after a year (10%-93%). Lower survival has been attributed to environmental variables such as dislodgement by wave energy, and transplant shock due to salinity changes from cultivation to estuarine conditions is also suspected. To improve living shoreline projects, we examined the effects of cultivation salinity (0 ppt and 15 ppt) on transplantation success, and

the success of biodegradable mats (Jute-mesh, 10 individuals per m^2) in facilitating reestablishment of new transplants facing wave forces. *S. alterniflora* individuals were grown under salinity treatments for 12 weeks, and monitored after transplantation for 12 weeks at two sites in the IRL. Changes in aboveground height, number of new shoots, new shoot heights, and survival rates were used to determine transplant success.

The Effect of the Retention Pond on Water Quality in the Coastal Oaks Preserve's DOT Canal

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The Coastal Oaks Preserve (COP), located in Vero Beach, Florida, is bisected by a Florida Department of Transportation (FDOT) drainage canal which historically transported stormwater from US Hwy 1 directly east to the Indian River Lagoon. Surface water in the FDOT canal may have an adverse impact on the Preserve's ecosystems as well as the Lagoon. In the last year a nearby retention pond was constructed in which runoff from Route 1 was collected and then flowed into the DOT canal. The purpose of the study was to compare last year's water quality data to this year's. Weekly samples were collected both years, starting in October and ending in January. The water quality parameters measured include: dissolved oxygen, salinity, pH, temperature, color, and nutrients (inorganic nitrogen and phosphorus). Overall water quality varies from site to site. The analysis of the water quality between years will determine the effectiveness of storm water treatment prior to discharge into coastal wetlands and the Lagoon and how the runoff impacts the FDOT canal and the Lagoon ecosystem.

Using Passive Integrated Transponder Tags to Track the Emigration of Juvenile Snook and Tarpon That Were Previously Trapped in a Mosquito Control Impoundment

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The Florida Institute of Technology, Bonefish and Tarpon Trust, and Indian River Land Trust are partnering to examine the effects of mosquito impoundment management on juvenile sportfish. The Bee Gum impoundment in Vero Beach has remained virtually unconnected to the Indian River Lagoon for some time. In spite of this, young sportfish found their way in. The lack of connectivity makes it difficult for them to leave this nursery habitat. Using PIT tags and continuous antennas, we are monitoring their emigration through a recently opened culvert. We will correlate this movement with several parameters to determine when connectivity is most beneficial. This may allow managers to limit mosquito and facilitate sportfish production.

Natural Recruitment of the Red Mangrove: Sediment Type as a Limiting Factor in Root Structure Development

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Red mangroves (*Rhizophora mangle*) play a significant role in shoreline stabilization and have been utilized as part of numerous IRL restoration projects. In Canaveral National Seashore, *R. mangle* has been used to stabilize ancient shell middens. Transplanted *R. mangle* have high survival but limited natural recruitment has occurred. To better determine the impact of sediment composition and grain size on root structure and natural recruitment success, a replicated experiment was run at the University of Central Florida greenhouse. We used treatments of varying sediment composition, similar to that found at shell middens, and planted with propagules from Canaveral National Seashore. Preliminary analysis based on

leaf size and number show grain size does have an impact on growth, and possibly on survival. Final analysis will assist in determining successful placement of mangrove seedlings and if natural recruitment is a viable option at shell midden sites.

The Indian River Lagoon Shoreline Restoration Project: Project Monitoring for Better Shoreline Management

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The Indian River Lagoon (IRL) Shoreline Restoration Project (SRP) was created in 1995 in order to re-establish and maintain the mangrove fringe along shorelines of the IRL while also promoting community involvement and environmental awareness. Since 1995 the IRL SRP's goal has remained steady, yet the methods in which restoration is carried out have evolved in order to maximize effectiveness. For example, the SRP has shifted into a saltmarsh vegetation based method due to their ability to establish and spread quickly as well as allow for natural recruitment of mangroves. Also, in efforts to better protect plantings, oyster reefs have been added to projects. Monitoring research has shifted towards a more quantitative approach to track projects survivorship and densities with the aim to effectively inform future SRP endeavors.

Evaluating the Impacts of an Unusual Rain Event in the Indian River Lagoon and St. Lucie Estuary Using the Indian River Lagoon Observatory Network of Environmental Sensors (IRLON)

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IRLON is composed of nine stations equipped with Land/Ocean Biogeochemical Observatory (LOBO) units and weather stations that provide real-time, high-accuracy and high-resolution water quality and meteorological data in the Indian River Lagoon (IRL) and St. Lucie Estuary (SLE) through a publically available website. An unusual week-long rain event in September 2015 resulted in large, but varied, rainfall accumulations throughout the network. At all stations, CDOM, chlorophyll *a*, and phosphate increased as salinity decreased; however, the rate of change varied and was largely influenced by increased discharges from the St. Sebastian River and the relief canals in Vero Beach into the IRL and from the C-23, C-24 and C-44 canals into the SLE. Interestingly, the effect of increased nutrients on chlorophyll *a* was variable, with only three stations, all found in the IRL, having concentrations >10 µg/L. Continuous monitoring by IRLON is essential to capture episodic events and provide real-time data to managers facilitating evaluation and improvement of management actions.

Preventing Introductions to Sustain Healthy Ecosystems: Establish Eradication Protocols for a Popular Aquarium Seaweed

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Since the costly invasion of *Caulerpa taxifolia* along the Californian, Mediterranean, and Australian coasts, 50% of surveyed aquarium hobbyists have switched to using *Chaetomorpha linum* has as their primary alga in salt-water tanks. When compared, however, *C. taxifolia* and *Chaetomorpha* have many similarities, including broad environmental tolerances, high nutrient uptake rates, and the ability to survive and reproduce from tiny fragments. Previous studies have focused on physical ways to eliminate unwanted *Chaetomorpha* (e.g. boiling, freezing, etc.), and found acetic acid as the only effective eradication method. This study tested a wide range of commercial-grade acetic acid concentrations and

exposure times to find the minimum dose needed to cause 100% mortality within 24 hours. While four percent acetic acid met these criteria, we additionally found that commercially available vinegar (4-6% acetic acid) is a convenient and effective resource for aquarium hobbyists to responsibly dispose of excess algae and prevent future invasions.

The Indian River Lagoon Species Inventory: Promoting Awareness; Fostering Collaboration

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The newly designed and reformatted IRL Species Inventory website was successfully launched in October, 2015, effectively improving access to authoritative information on all aspects of IRL biodiversity including species taxonomy and narratives, habitat descriptions, practical information for IRL citizenry and IRL photo galleries. The website is utilized by a diverse audience. User groups include research scientists, resource managers, educators and the general public. The expansion and updating of the IRL Species Inventory is an ongoing process. In addition to taxonomically updating the over 3500 documented species on the website, other recent accomplishments include a downloadable, searchable database and bibliography as well as an article on climate change relative to the IRL. Plans are now underway to incorporate species narrative content into the new format. Future directions for inventory expansion include increasing the number of listed species by collaborating with IRL researchers and to update selected species reports.

Potential Competition between the Invasive Mussel, *Mytella charruana,* and the Eastern Oyster, *Crassostrea virginica,* in the Mosquito Lagoon

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Invasive species can have negative effects on local biodiversity by outcompeting native species. The invasive mussel, *Mytella charruana,* was first documented in Mosquito Lagoon in 2004 and has been reappearing ever since. In order to determine feeding competition between these mussels and the native eastern oyster, *Crassostrea virginica*, three methods were used: in situ filter feeding experiment, bacterial feeding assay, and stable isotope analysis. The in situ experiment indicated that mussels were better competitors for food than oysters, although the feeding efficiencies were similar. Mussels were more effective at removing bacteria from the water than oysters. Stable isotope analysis results demonstrated that these species have overlapping functional niches. Combined, these analyses suggest that mussels and oysters share the same ecological niche, and that there is a potential for *M. charuanna* to outcompete *C. virginica* in this system.

Comparison of Abiotic and Biotic Factors between Restored, Natural, and Altered Shorelines in Mosquito Lagoon

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Hard-armoring of estuarine shorelines is a major threat to biodiversity as it decreases critical habitat used by a diverse assemblage of terrestrial and aquatic species. An alternative to hard-armoring is the use of living shoreline methodology, a type of biomimicry to stabilize shoreline and restore intertidal habitat. In February 2014, we began a two-year study using BACIPS design to compare abiotic characteristics (slope, water depth, soil moisture, and substrate temperature) and community structure (plants, invertebrates, nekton, and birds) at four types of shorelines: 1) before and after stabilization using oyster

bags and wetland plants; 2) natural shorelines; 3) seawalls; and 4) rip-rap. Our results documented decreased rates of erosion and increased intertidal habitat following living shoreline stabilization. We found significant variation in both community structure and abiotic characteristics between shoreline types. Shorelines armored with seawalls had less diversity and abundance of fishes, crustaceans, and birds compared to other shoreline types.

The Northern Estuaries Resource Recovery Program: A Pilot Program to Restore Oyster and Seagrass Habitats in the St. Lucie River/Southern Indian River Lagoon and Caloosahatchee River

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The Northern Estuaries (St. Lucie River/southern Indian River Lagoon and the Caloosahatchee River) have received tremendous volumes of freshwater discharges from Lake Okeechobee, resulting in major losses of critical estuarine habitats such as oyster reefs and seagrass beds. To address these losses, the Northern Estuaries Resource Recovery (NERR) program was initiated in 2014 by the state of Florida to replace oyster and SAV resources that were lost due to the high volume 2013 discharges. Program objectives are to address recovery and build resiliency in these resources to reduce the impacts of future discharge events, and provide infrastructure that will establish a continuing restoration program. Components of the NERR program include a remote setting facility for producing spat-on-shell for oyster restoration and a seagrass nursery to create planting units from wrack-collected seagrass fragments. Community-based restoration is also an integral component of the program, involving volunteers in both oyster and seagrass restoration.

Shifting Baselines: Has the Productivity and Nutrient Content of *Sargassum* Changed over the Past Three Decades?

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Beginning in 2011 unprecedented blooms of *Sargassum* began washing ashore in the Caribbean, closing many beaches and creating concern in countries that are dependent upon their tourism-driven economies. This project explores the cause of these blooms and hypothesizes that they are driven by nutrient enrichment. We are testing this theory by measuring the productivity and nutrient content of plants from 2015-2016 and comparing these data to a similar study done in the 1980s. Preliminary results support our hypothesis, indicating a significant increase in the %N and N:P ratio. Through the use of Pulse Amplitude Modulated (PAM) fluorometry and the traditional light/dark bottle method we will determine if the productivity of *Sargassum* has followed a positive trend similar to the nutrient content. A better understanding of what is causing these blooms may help mitigate future mass strandings.

Identifying Controls on Fluxes of Dissolved Nitrogen from Sediments in the Northern Indian River Lagoon

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Fluxes of dissolved nitrogen, essentially all as ammonium ions, from “muck” sediments into the northern Indian River Lagoon (IRL) averaged 18 ± 17 metric tons per square kilometer per year. Internal releases of nitrogen occur mainly from fine-grained, organic-rich sediments that comprise at least 10% of the sediments in the northern IRL; the total sediment flux of >400 metric tons of nitrogen per year is greater than external inputs of nitrogen. Seasonal and laboratory-induced changes in temperature from 16-30˚C

yielded 3-fold increases in ammonium flux. Spatially, ammonium fluxes varied by >20-fold in response to differences in the physical and chemical composition of the sediment, including sediment porosity, organic carbon and total nitrogen content and the C/N ratio. Our growing dataset and more recent identification of controls on variable nitrogen fluxes provide opportunities for us to assist lagoon managers as they prioritize sites for dredging, restoration and remediation efforts.

Nom Nom on the POM: Filter Feeders in the Indian River Lagoon and their Role in Particulate Organic Matter Removal and Algal Bloom Mitigation

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As a complement to the IRL Algal Blooms Investigation (IRLABI), we are investigating the trophic diversity of filter feeders and assessing whether these organisms mitigate blooms via top-down control. Isotope surveys show substantial variation in the $\delta^{13}C$ and $\delta^{15}N$ values of different filter feeders, suggesting these organisms have unique functional roles in the IRL. The barnacle *Amphibalanus eburneus* was the dominant filter-feeding organism in the IRL; $\delta^{13}C$ and $\delta^{15}N$ values of *A. eburneus* were variable across sites and were correlated to the $\delta^{13}C$ and $\delta^{15}N$ values of particulate organic matter (POM), indicating that *A. eburneus* feeds on general sources of POM at each site. Finally, bivalve species fed isotopically (^{13}C and ^{15}N) labeled cells of algal bloom species became enriched in ^{13}C and ^{15}N, providing evidence for the assimilation of algal-derived nutrients. Together these data highlight the importance of filter feeder diversity in particle removal and potential algal bloom mitigation in the IRL.

Understanding the Feeding Behavior of Oysters (*Crassotrea virginica*) and Hard Clams (*Mercenaria mercenaria*) in the Indian River Lagoon

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In 2011, the Indian River Lagoon (IRL) had a dense phytoplankton bloom that had long-lasting negative effects. To investigate whether oysters and hard clams would be good candidates for algal bloom mitigation or could be used for bio-extraction, we conducted in situ filter-feeding experiments in each of the three sublagoons of the IRL: Indian River, Mosquito Lagoon and Banana River. Feeding experiments showed that oysters had higher clearance rates and filtration rates than clams. In addition, oysters were more effective at pre-sorting inorganic matter from the water column, thereby increasing their organic matter ingestion and the overall efficiency of their feeding process. Because total particulate matter in the water column of the IRL is strongly correlated with inorganic matter content like silt, organisms that are inefficient at presorting may be unable to thrive. Because of this, we do not recommend using hard clams for bioremediation purposes in the IRL.

The Dynamics within the IRL Seagrass Beds

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The St Johns River Water Management District has been monitoring seagrass beds in Florida's Indian River Lagoon system using two methods – Photo-interpretation of aerial photographs and 98 fixed seagrass transects. Both methods detect spatial and temporal changes in seagrass depth distribution, but transects detect species abundance and diversity. Prior to the Superbloom, monthly transect monitoring showed seasonal trends in percent cover throughout the year, but these trends and peaks differ amongst

sites, months, and years. Following the Superbloom, losses of seagrass were catastrophic in some regions and almost undetectable in others. However, the loss of species diversity was Lagoon-wide, and possibly the most devastating. Recovery of the system has been slow and appears to be as wide-ranging as the losses were both spatially and temporally.

Seagrass Fish Assemblages in Martin County: A Vulnerable National Treasure

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Quantitative and qualitative collections made with 3.2-mm mesh seines from 1974 to 2015 between St. Lucie Inlet and Jensen Beach indicate changes in fish assemblage composition with proximity to the Atlantic Ocean. Seagrass presence and species composition apparently also influence fish assemblage composition with major loss of seagrass habitat from 2004 to 2006 within the Indian River Lagoon within 1-5 miles of St. Lucie Inlet. Certain fish families known to routinely associate with seagrass habitats north of Martin County do not do so at this southern latitude, while other stenothermic tropical species are abundant at this southern latitude, but not elsewhere in the Indian River Lagoon. Seagrass fish collections in Martin County indicate that the fauna at this location is the richest within the Indian River Lagoon. This is a unique national center of biodiversity in need of recognition and protection by local, regional, state and federal entities.

Reality of Climate Change: What Does Archaeology Have to Offer?

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Jupiter Inlet I is a complex archaeological site situated between the Atlantic coast and the Loxahatchee River within the southern extent of the Indian River Lagoon. Research has demonstrated that the human inhabitants of this site have utilized the productive resources of the lagoon for the past several thousand years. Moreover, the paleoenvironmental data based upon the analysis of the oyster remains from this site have indicated a rise in salinity over the past millennia. The long-term goal of this type of research could incorporate a multi-disciplinary approach to further analyze locally derived climate data for a comprehensive understanding of our ever-changing coastal landscapes due to sea level fluctuations. Conclusions based on such research will help facilitate discussion regarding the implications of climate change and sea level rise with the general public and governmental officials alike.

Seagrass Recovery in the Indian River Lagoon: The Tortoise or the Hare

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For over twenty years, the St. Johns River Water Management District has monitored seagrass beds in the Indian River Lagoon using a multi-scale approach. Methods used include lagoon-wide seagrass mapping, biannual and monthly seagrass transects, and water quality sampling. Investigation of this data shows fine-scale changes in seagrass cover, shifts in species composition, changes in algal cover, and edge of bed responses to water quality. A closer look at several seagrass transects, monitored monthly, shows that the rate of recovery following wide-spread algal blooms in 2011 and 2012 has varied site-by-site. These differences illustrate the importance of monitoring at a high spatial and temporal frequency to accurately capture seagrass recovery in the IRL.

Development of a Seagrass Nursery for Restoration of Seagrass in the Indian River Lagoon

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We have launched a project to develop the initial infrastructure and technical capabilities to successfully cultivate and transplant seagrass as part of a collaborative effort to restore seagrass in the IRL. The initiative is based on our previous experience with seagrass cultivation, as well as a recent seagrass restoration feasibility study in partnership with the St. Johns River Water Management District. That effort concluded that the limited seagrass recovery following its catastrophic loss due to the 2011 "Superbloom" in the IRL is lack of available recruits (vegetative fragments and seeds) rather than environmental factors. Our initial effort focuses on *Halodule wrightii* in a closed-system, land-based tank system. Our innovative nursery approach to seagrass restoration and creation could play a significant role in the re-establishment of seagrass habitat, one of the most valuable communities in the marine environment, and improve the management of this vital IRL resource.

Patterns and Distributions of Post-mortem Evidence of Cetacean Interactions with Sharks among Coastal and Estuarine Communities

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Cetaceans and sharks likely interact through predation and competition, specifically in estuarine environments. This study analyzed the frequency and occurrence of shark bite wounds among stranded cetaceans along Florida's east coast from the Atlantic Ocean and Indian River Lagoon. Cetaceans had significant differences between geographical zones ($p=0.01$), shark species ($p<0.01$), and ante versus post mortem bites ($p=0.01$). Oceanic animals had the highest prevalence of interactions from cookie cutter sharks in the middle zone while estuarine animals had the highest prevalence from carcharhinid sharks in the northernmost zone. Sharks displayed significant differences between geographical zones ($p=0.02$) and between the bodies of water ($p<0.01$), with cookie cutter sharks most prevalent in the middle zone in the Atlantic Ocean and carcharhinds most prevalent in the southernmost zone of the IRL. These results demonstrated that cetaceans are susceptible to predation and scavenging from sharks, and that predation varies based on location and environment.

Evidence of Sewage-Driven Eutrophication in the St. Lucie Estuary and Nearshore Reefs: A Science-Based Management Approach

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The St. Lucie Estuary (SLE) is a heavily impacted system absorbing the deleterious effects of prolonged, high-volume releases, stormwater runoff, and local septic tank contributions. To address these management concerns, HBOI-FAU partnered with Martin County to conduct a watershed study designed to document the interactions between onsite sewage treatment and disposal systems (OSTDS), groundwater, and surface water in the SLE and nearshore reefs. Results from ground and surface waters consistently suggested significant watershed contributions of nitrogen and phosphorus, primarily from OSTDS. Stable nitrogen isotopes in macroalgae and phytoplankton "bio-observatories" and presence of the artificial sweetener sucralose provided additional evidence of OSTDS contamination that extended out to the nearshore reefs. These results are being directly used by Martin County to make science-based management decisions that ultimately have the ability to reduce nutrient loading and, therefore, improve water quality conditions in the SLE, Indian River Lagoon, and along adjacent nearshore reefs.

Out of Africa: First Records for the Americas for Several Species of Ciliates

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Ciliates are unicellular eukaryotic organisms that play an important role in microbial loops and food webs. The biodiversity and biogeography of many ciliates is an understudied area within microbial ecology. Some species once thought to be endemic to a restricted geographical area have been shown to have wider distributions when sampling efforts are increased. Many distinct tropical ciliate species were originally documented in Africa, but have remained unseen elsewhere. These ciliates are known only from drawings with little ecological information and no photographic record existing. We record here novel observations of several tropical ciliates discovered thriving in Florida, USA. Our findings include: the first record outside of Africa; the first record for Americas; the first photomicrographs of several tropical species; and the first report of the ecology for these species. Such studies are important for understanding global biodiversity, tropical ecology, and the dispersal of microorganisms.

Organic Sediment Characteristics and Benthic Infaunal Diversity in the Indian River Lagoon

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Fine-Grained Organic-Rich Sediments (FGORS) may indicate an anthropogenically eutrophic estuarine ecosystem. This study examines a range of FGOR sediments while analyzing the diversity of benthic infauna found within. It is hypothesized that, as FGORS' organic content increases, biodiversity of metazoan infauna will decrease. Infauna were collected using a Petite Ponar grab at 16 locations (n=3) from May 2015 to present. Metazoa were counted and identified via stereomicroscopy. Major taxa and representative species (density ±1SE) include annelids (e.g., *Diopatra sp.,* $2.9x10^3$ $\pm1.05x10^3$ m^{-2} in September), molluscs (e.g., *Acteocina canaliculata,* $3.9x10^3$ $\pm1.5x10^3$ m^{-2} in October), and arthropods (e.g., *Peratocytheridea setipunctata*, $3.3x10^3$ $\pm2.07x10^3$ m^{-2} in September). The Shannon-Wiener Diversity Index for infaunal communities ranged from 0 to 2.3 with 12 species in the most diverse sample. Biodiversity and abundances are being checked for correlations with FGORS conditions (water content, % organics, and % silts/clays).

The Living Dock

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Benthic organisms such as oysters, sponges, barnacles and tunicates are filter feeders, which have the potential to significantly improve local water quality. A pilot project was conducted to test the efficacy of creating a 'Living Dock' by growing such filter feeders at a location along the Indian River Lagoon. Two different methods (oyster mats and oyster bags) were tested for their ability to recruit oysters and other benthic organisms, as well as the effort required for long-term maintenance. Eighteen oyster mats were wrapped around dock pilings and eighteen oyster bags were hung between pilings of the same dock. After one year of immersion, healthy populations of barnacles, sponges, algae, bryozoans, and tunicates were found growing on both the bags and the mats. During that same time period, live oysters were also found growing on both mats and bags, with a maximum of 63 live oysters in one bag.

Does Plant Density Influence Growth of *Spartina alterniflora* and *Rhizophora mangle*? A Competition Study

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Plants compete for nutrients and light in order to optimize growth and success. In order to assess plant competition between species commonly used in living shoreline stabilization, we studied growth of *Spartina alterniflora* and *Rhizophora mangle* when grown in varying density combinations. In the UCF greenhouse, *Spartina alterniflora* and *Rhizophora mangle* were planted into 53L plastic pools using purchased topsoil. There were 3 treatments, 4, 6, or 12 total plants, with each treatment having an equal number of *Spartina alterniflora* and *Rhizophora mangle.* The plants were kept submerged 5 cm above soil level, in water sampled from Indian River Lagoon. Plant height was measured weekly in order to monitor growth in different abundances. We found no significant differences in plant growth between treatments. This information is valuable for living shoreline stabilization in that planting *Spartina alterniflora* and *Rhizophora mangle* in high densities may not increase negative effects of competition.

Fauna Utilizing the Seagrass Adjacent to the Coastal Oaks Preserve

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Prior to this project the Junior Scientists Fellows Program mapped seagrass beds in the Indian River Lagoon close to the Coastal Oaks Preserve. This year we collected, identified, and measured fauna at deep and shallow sites along two transects. Dip nets with a mesh of 1-mm^2 were used to gather organisms within replicate 1-m^2 throw traps, also with a 1-mm^2 mesh. We noticed that the most common organisms found were *Penaeus duorarum* (pink shrimp) along with juvenile *Callinectes sapidus* (blue crab) and *Morula nodulosa* (blackberry snail). This project demonstrates the key role that seagrass beds play as habitats for diverse juvenile organisms in the Indian River Lagoon. With continued sampling of this baseline data, stronger trends may present themselves.

Virtual Outreach at Florida Oceanographic Society – Sharing Educational and Scientific Topics across Regions (SEASTAR)

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Supplementing formal classroom lessons with interactive, hands-on field activities is a critical component of successful primary and secondary-level STEM education. Unfortunately, it has become increasingly difficult for teachers to incorporate educational field trips into their curriculum. To help bring real-world science into the classroom, Florida Oceanographic Society has developed a low-cost virtual outreach program. The SEASTAR program uses Skype and a 4G tablet to stream live, interactive lessons about coastal ecology and conservation into schools around the country, reaching 796 middle and high school students during spring of 2015. The program allows "virtual visits" to Florida Oceanographic's Coastal Center for students who would otherwise be unable to join us in person due to financial, geographic, or scheduling constraints. While many virtual outreach programs rely on high-cost equipment to stream programming, our simplified approach has proven incredibly successful, and represents a viable solution for bringing your work into the classroom remotely.

Is Functional Trait Variation in East Florida Red Mangrove (*Rhizophora mangle*) a Product of Genetic Differences or Phenotypic Plasticity?

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Species distributional shifts are one consequence of climate change. An example is mangrove expansion into temperate salt marsh worldwide. Persistence at and further expansion past range edges are dependent on the ability to adapt to local environmental conditions, such as cold stress that is thought to limit mangrove distributions. Local adaptive responses are the result of either trait evolution or phenotypic plasticity. We found that three red mangrove (*Rhizophora mangle* L.) populations along East Florida vary significantly at plant functional traits (e.g. leaf size, specific leaf area (SLA)) and are genetically distinct (F_{ST} = 0.10, P < 0.0001). Range edge *R. mangle* possessed smaller leaves and reduced SLA, consistent with leaves better-suited for colder temperatures. At present, a common-garden experiment is underway to assess whether this variation in functional traits is due to genetic differences or phenotypic plasticity.

Social Science Survey of Oyster Gardening Program Participants in Brevard County, Florida

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Oyster gardening programs have been implemented in Brevard County, Florida to promote coastal conservation and restoration through education and outreach in the communities adjacent to the Indian River Lagoon (IRL). In order to evaluate participants' understanding and perception of ecological processes and whether these inform their conservation activism, 303 participants were surveyed on three major topics: 1) ecological problems in the IRL; 2) biology and ecosystem function of oysters; and 3) their confidence in the oyster gardening program. Participants perceived that water pollution is the greatest threat to the IRL, and most had some knowledge of oyster biology and ecology. However, participants' knowledge of the ecosystem function of oysters was relatively low compared to their confidence in the effectiveness of oyster gardening. These and additional survey analyses can inform coastal conservation outreach and education programs regarding what factors encourage community participation and positive perception of conservation activities in the IRL.

Copepod Communities of the Northern Indian River Lagoon System

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Copepod populations in the northern Indian River Lagoon (NIRL) system are being followed to 1) determine environmental factors driving copepod community composition, and to 2) identify copepods acting as top-down phytoplankton regulators. Replicated mesozooplankton samples have been collected fortnightly at six sites distributed in the NIRL, Mosquito Lagoon (ML), and Banana River (BR) from 2013-present. *Acartia tonsa*, *Oithona colcarva*, and *Parvocalanus crassirostris* dominate the copepod community. The highest and lowest average densities for *A. tonsa* are in the NIRL at Cocoa ($4.8x10^4 \pm 2.1x10^4$ m^{-3}) and Titusville ($4.0x10^3 \pm 1.1x10^3$ m^{-3}), respectively. From November 2013 to October 2014, an increasing trend in abundance was seen for *A. tonsa* in the southern BR ($p = 0.003$), and for all species in the NIRL and ML ($p \leq 0.038$). An overall decreasing trend in salinity ($p \leq 0.042$) may have influenced copepod population patterns. This and other potential environmental and biological drivers impacting copepod communities will be discussed.

Wave Energy Distribution on Restored Shorelines versus Unrestored Shorelines

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Living shoreline restoration is an important research topic, especially in the state of Florida and along the coast of the United States. One area of this research that has yet to be heavily explored is how wave energy affects sediment erosion at sites that have been restored. Starting in May 2015, we began a seven month study at Indian River Lagoon where wave energy reduction at each of five restoration sites was observed. We used a video method to record wave heights before and after waves encountered various materials used for restoration- oyster bags, oyster mats, red mangroves, and spartina. The data clearly demonstrate that restoration materials significantly decrease incoming wave energy at restored sites as compared to unrestored sites ($p<0.001$ for all). Future studies on this topic and on the effects of restoration to nearshore hydraulics will provide us with the best method of shoreline restoration.

Integrating Continuous Ammonium Measurements with Real-Time LOBO Monitoring in Florida's Indian River Lagoon

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Most Indian River Lagoon (IRL) water quality monitoring efforts rely on grab samples, which have limited value in observing dynamic stormwater-driven processes. In response, FAU/Harbor Branch developed a LOBO (Land-Ocean Biogeochemical Observatory) network in the IRL to measure temperature, salinity, dissolved oxygen, turbidity, colored dissolved organic matter, chlorophyll *a*, nitrate, and phosphate. To link storm events and IRL water quality, an autonomous batch analyzer was deployed adjacent to a LOBO during the 2013 wet season. High ammonium concentrations (up to 10 µM) were associated with high rainfall, which lessened as the precipitation decreased. Pulses of ammonium were repeatedly followed by increased chlorophyll *a* concentrations (up to 8 µg/l), whereas no such temporal relationship occurred for nitrate. The ammonium pulses followed sharp decreases in conductivity, demonstrating the importance of stormwater in driving ammonium-enrichment and phytoplankton blooms in the IRL.

Algal Bloom Update for the Northern and North-Central Indian River Lagoon

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Algal blooms have continued to occur in the northern and north-central Indian River Lagoon system following the major blooms of 2011 and 2012. Spatiotemporal variations in phytoplankton composition and biomass were elucidated by combining data from on-going, long-term sampling of water quality and phytoplankton with statistical analysis of reflectances captured in readily available Landsat images. A focus will be placed on events occurring in 2015, notably a persistent and intense bloom of picoplanktonic and nanoplanktonic algae in southern Mosquito Lagoon, and patchy, but intense summer blooms of *Pyrodinium bahamense* extending between Cocoa and Titusville.

Six Years of Barnacles: A Sign of a Recovering Indian River Lagoon?

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Monthly sessile invertebrate recruitment along with hourly water quality measurements have been monitored at the Florida Institute of Technology static immersion test platform since June 2009. This site is located 5 km north of Sebastian Inlet on the east side of the IRL. Biodiversity and recruitment have changed significantly during this time. There have been multiple "extreme" events throughout the IRL since 2009 including: cold spells, phytoplankton blooms, seagrass die offs, and marine fauna mortality events. Sessile invertebrates provide important insight into changes in the IRL because many of the adult forms cannot escape adverse impacts. At this site, barnacles not only tell an interesting story, but also may shed some light on the health of the IRL.

Fish Diversity and Abundance within the Coastal Oaks Preserve

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Certain species of fish are essential to the diversity, productivity, and economic importance of the Indian River Lagoon (IRL). We hypothesized that adjacent mosquito impoundments connected to the IRL are a crucial asset to certain species of fish. Our team is monitoring the number of fishes swimming in and out of the exchange culverts connecting the Lagoon and the mosquito impoundments of the Coastal Oaks Preserve. Each week our team deployed a culvert trap for approximately 6-7 hours. During the last two years (October through January), some species, such as mosquito fish, juvenile snook, sailfin molly, puffer fish, and fat sleepers were observed both years. New species we are observing this year include striped mullet, marsh killifish, pipe fish, mangrove snapper, grunt, blackbotched pompano, and black grouper. The number and species of fish caught have differed between the last two years. There are many factors that may affect the number and type of fish documented. Not only are these fish important to the IRL ecosystem, but they also are important to the local community and state economy.

Temperature Sexual Dependency of the American Alligator at the Kennedy Space Center

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American alligator nesting efforts and the resulting neonates will affect future generations of alligator populations as a whole over time. Since alligators are temperature sexual determinant animals, nesting temperatures within wild alligator nests will dictate the sexes of upcoming populations throughout time. With global warming and sea level rise soon upon us, the type of strata that the alligators are using to build nests, locations, and weather patterns all become involved in the overall determination of what sex the alligators are producing each year with their nesting activity.

The Never Ending Assays: Will Bivalves Eat Algal Blooms in the Indian River Lagoon?

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In 2011, there was a massive bloom of microalgae in the northern Indian River Lagoon causing a significant loss of seagrass coverage. Very little is known about how to prevent these events but they can potentially be controlled with natural grazers such as filter feeding organisms. Therefore, over the course of several experiments, we investigated grazing effects of four native bivalve species from the lagoon when feeding on four species of microalgae that bloomed in the IRL plus one control alga. Each of the laboratory feeding experiment was conducted over four day periods and clearance rates were estimated for the first and last exposure. Most blooming species were consumed by the bivalves within normal ranges. The assays indicate that oysters are the most effective bivalve at consuming the different microalgae; therefore, increasing the numbers of oysters in the lagoon could be helpful in controlling future bloom events.

A Murky Situation: Effects of Brown Tide Harmful Algal Blooms Caused by *Aureoumbra lagunensis* on the Eastern Oyster *Crassostrea virginica*

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Harmful algal blooms caused by the marine microalga *Aureoumbra lagunensis* have been associated with fish kills as well as the loss of seagrass and benthic invertebrates in New York, Texas, and the Indian River Lagoon. This project investigated responses of *Crassostrea virginica* to *A. lagunensis* and high salinities that occurred in conjunction with blooms. Monitoring of *C. virginica* within Mosquito Lagoon indicated depressed oyster recruitment was associated with blooms of *A. lagunensis*. To uncouple any negative effects of *A. lagunensis* from high salinity, laboratory flume oyster settlement trials were carried out under moderate (25 PSU) and high (40 PSU) salinities. Additionally, four-week survival and growth of oysters was tracked following acute, one-week exposure to *A. lagunensis* and subsequent transplantation to the field. Findings suggest that negative effects at settlement and post-settlement experienced by oysters during brown tides were attributed to both high salinity and *A. lagunensis*.

Blue Crab Population in Peril in the IRL: Will Invasive Blue Crab Species Tolerate or Select Polluted Habitats More Often Than Native *Callinectes* Species?

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This research investigated the behavior and responses of blue crabs exposed to impaired water quality habitats that mimic the type of pollutants known to be present in the Indian River Lagoon. Additionally, the abundance and diversity of *Callinectes* species in Goat Creek, an IRL tributary in Valkaria, during August 2015 – early January 2016 was recorded as part of a 5 year continuation study on *Callinectes* populations in the IRL. Crabs were caught using traps baited with chicken or fish and left undisturbed for 20-28 hours. Data on crab species, carapace width, spine length, gender, presence/absence of unusual markings or legs/claws, weight/mass and, individual recapture data, were recorded before the crabs were tested on their preferences and tolerances in different simulated polluted water conditions before releasing crabs back into the creek unharmed. Air temperature, water temperature, pH, dissolved oxygen, water clarity, and depth of the trap were also recorded.

Pathogenic *Vibrio* Bacteria in Mangrove Snapper Meat

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Vibrio bacteria are responsible for 76% of all seafood illnesses in the United States, most are mild and caused by *V. parahaemolyticus;* however 95% of all seafood related deaths are attributed to *V. vulnificus*. These pathogens are found throughout the environment and in processed seafood, but little is known about their natural presence in fish meat. This study focused on Mangrove Snapper, a popular foodfish in the Indian River Lagoon, to determine potential *Vibrio* reservoirs as well as the effects of contamination and temperature abuse. We found that these bacteria are not present in fish meat and only appear after contamination from fileting or handling. Additionally, temperature can greatly impact *Vibrio* densities and should be closely monitored when preparing fish. Future research should focus on the effects of heat and ice on toxins produced by *Vibrio,* with special regard to the safety of consuming temperature abused seafood.

Mangrove-Insect Interactions in Mosquito Lagoon

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To determine if and how frequently mangrove species in Mosquito Lagoon are effected by insects, a field survey was developed to assess possible impacts on red, black, and white mangroves at three shoreline stabilization sites (Eldora House, Fellers House, and Turtle Mound). Twenty randomly selected trees of each species along the shoreline at each site were tagged along specific branches. All leaves on tagged branches were counted and categorized into six common insect interactions. Some effected leaves fell under more than one category: curling, bite marks, punctured leaf, scaly, cocoon, and undamaged. We identified the insects involved in each type of interaction and also recorded any flowering/seed production on these branches. Combined, this data will enable managers and scientists to better understand mangrove-insect interactions, especially in light of climate change.

Variation in the Trophic Diversity of the Barnacle *Amphibalanus eburneus* over Time and Space in the Indian River Lagoon

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Phytoplankton blooms have increased in occurrence and severity within the Indian River Lagoon (IRL) in recent years, with a “superbloom” in 2011 that had long-lasting negative impacts on these ecosystems. As part of an ongoing epifaunal monitoring program within the IRL Algal Blooms Investigation (IRLABI), we are investigating how the trophic diversity of a dominant filter feeder, the barnacle *Amphibalanus eburneus*, changes over time and space. Stable isotope analysis of *A. eburneus* tissue revealed significant differences in the $\delta^{13}C$ and $\delta^{15}N$ values both between seasons and across sites, suggesting that the diet of *A. eburneus* is variable over time and space. The $\delta^{13}C$ and $\delta^{15}N$ values of *A. eburneus* were correlated to the isotope values of bulk particulate organic matter (POM), suggesting that *A. eburneus* consumes general sources of POM available at each site.

A Survey of Nitrogen Fixation in the Northern Indian River Lagoon, Florida

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Increasing eutrophication and harmful algae blooms in the northern Indian River Lagoon (IRL) has led to an investigation of potential nutrient sources. This research aims to address the seasonal and spatial importance of the water-column, benthic vegetation, and IRL sediments to supplying new nitrogen (N) to the IRL via N_2 fixation. Water-column fixation was tested from samples collected between September 2014 and November 2015. Results showed a significant temporal effect as well as a significant interaction between month and light treatment. This may suggest higher heterotrophic bacterial contributions over winter months compared to photosynthetic N_2 fixers that are more active with higher temperatures. Preliminary data for benthic vegetation showed that epiphytic coverage of seagrasses and macroalgae act as an additional site for N_2 fixation activity. Overall, results from this research indicate that N_2 fixation may be a potentially important process in supplying new N the IRL.

Monitoring Changes in Fish Community Composition Relative to the Occurrence of an Extended Algal Bloom/Seagrass Die-off Event: Where Are We Now?

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A series of large phytoplankton blooms (superbloom) beginning in early 2011 triggered habitat changes, most notably a loss of seagrass, which occurred throughout much of the Indian River Lagoon system. In April 2013, the FWC-FWRI increased its existing fisheries-independent sampling in the IRL to assess the status of fish populations (abundance, distribution, and species diversity), to compare these data with conditions prior to the superbloom. Multivariate analyses of these data indicate there were significant differences in community metrics among the pre/post and bloom years. Relative abundance of small-bodied/cryptic species and juveniles of several sciaenids declined during the bloom year. In contrast, sub-adult and adult relative abundance of these sciaenid species increased during the superbloom year, followed by a decrease (post-bloom). A mixed response from planktivorous taxa was observed. Some taxa (e.g., Spotted Seatrout, Pinfish) may have compensated for the loss of seagrass habitat by utilizing tributaries in the affected area.

Microbial Source Tracking in the Indian River Lagoon: Assessment of Fecal Pollution

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Fecal indicator bacteria (FIB), which include enterococci and coliforms, are part of the natural assemblage of microorganisms found in the intestines of warm-blooded animals. Microbial source tracking (MST) techniques allow for the identification of specific sources of fecal indicator bacteria in the environment. In this study, water and sediment samples from several different sites of varying water quality throughout the Indian River Lagoon are collected bi-monthly for analyses. Classical cultivation methods allow for the enumeration of FIB colony forming units, while both conventional and quantitative polymerase chain reactions (PCR) are used to detect host-associated bacterial genetic markers for humans and cattle. We aim to assess potential impacts of anthropogenic pollution and agricultural runoff in order to make predictions for human and ecosystem health, as well as improve local water quality monitoring and management strategies.

The Effects of Grain Size Distribution on Red Mangrove, *Rhizophora mangle*, Root Structure

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The goal of this project is to determine the role of sediment grain size distribution played red mangrove (*Rhizophora mangle)* seedlings' root development at two locations in Canaveral National Seashore. We sampled at Turtle Mound shell midden and a saltmarsh adjacent to Feller's House Field Station. A total of eight samples were taken from Turtle Mound. Five samples contained mangroves less than 1 year old and sediment, and three were sediment-only samples. A total of nine samples were taken from Feller's House marsh with five being juvenile mangroves plus sediment and four consisting of only sediment. Morphometric measurements were taken of each mangrove immediately after sampling and the sediment was processed using standard wet and dry sieving techniques. Results show that mangrove recruitment is associated with finer grain sizes. Mangroves growing in finer sediments also showed significant increases in rootlet development.

Marine Turtles in the Northern Indian River Lagoon – What's Up?

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Kennedy Space Center's (KSC) Ecological Program includes a variety of long term monitoring studies that support NASA in environmental compliance, NEPA decisions, and insight for ecosystem service questions. Marine turtles residing in the lagoons around KSC have been monitored intermittently since 1975, after evidence that the lagoon provided developmental habitat for at least one species. Tracking demography of these relatively large marine vertebrates enables an ecological "pulse-check" for KSC, this region of the IRL, as well as a comparison to other developmental habitats. The last 20 years of surveys combined with recent stranding events and collaborative regional databases have yielded interesting insights into the status and site fidelity of these animals.

Seagrass Mapping from Aerial Photography – Southern Indian River Lagoon Addressing Photointerpretation Challenges

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Southern Indian River Lagoon seagrass distribution is mapped every two to three years from aerial imagery. Datasets from 1999 – 2013 were evaluated to identify persistent seagrass (mapped in all years) and fluctuating seagrass (mapped in at least one but not all years). Field inspections found fluctuating seagrass tended to be deeper than persistent seagrass and often supported diminutive seagrass species (*Halophila spp.*) and/or macroalgae (including dense *Caulerpa prolifera*). Comparison of bathymetric and seagrass data confirmed depths were greater in fluctuating seagrass polygons (mean = 1.2 meters) than persistent polygons (mean = 0.8 meters). Photointerpretation in deeper areas may be compromised by water clarity and made more difficult when canopy is short. Because the fluctuating seagrass areas offer the biggest challenges in interpreting map results, South Florida Water Management District scientists inspected representative locations within the fluctuating seagrass areas in conjunction with 2015 imagery acquisition.

Temporal Trends in Prevalence of Disease and Specific Disorders among IRL Dolphins in the Health and Environmental Risk Assessment Program (2003 to 2015)

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Longitudinal health surveillance of apex species provides insight into both the health of the wildlife and the environment they inhabit. Evaluating disease prevalence over temporal scales is essential and can reflect changes in the ecosystem. The Dolphin Health and Environmental Risk Assessment project has produced valuable data on a variety of infectious diseases and the population health of Atlantic bottlenose dolphins in Florida's Indian River Lagoon from 2003 to 2012. The prevalence of lobomycosis, pappilloma and pox lesions, dolphin morbillivirus, eastern equine encephalitis, venezuelan equine encephalitis and west nile virus were not significantly different across sampling periods. Temporal variation in the prevalence was observed with increases in the prevalence of, western equine encephalitis with decrease of *Chlamydia psittace* positive tests were observed. However, no clear temporal pattern was found among all pathogens. Analysis of overall health status and disease state data did not reveal any significant temporal trends, which suggests that the diseases are not emerging health threats but rather demonstrates the endemic nature of multiple pathogens within the IRL dolphin population. Continued surveillance is necessary to determine the impacts of changing environmental conditions on marine mammal health and the ecosystem at large.

Kennedy Space Center: Launching Land Management for Future Generations

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Kennedy Space Center, occupies 140,000 acres of uplands, wetlands, coastal dune and estuarine waters in the northern portion of the Indian River Lagoon. Only six percent of this area is actually used for space related activities, the remainder of these habitats are managed by Merritt Island National Wildlife Refuge and Canaveral National Seashore. KSC established the Ecological Program in 1982 in response to NEPA, ESA, and other federal and state regulations with an emphasis on launch effects. The program has evolved to include research on other facilities management concerns. These include; 1) special concern species such as; Florida Scrub-Jay, wading birds, waterfowl, manatees, sea turtles and fisheries, 2) fire ecology including habitat impacts, biogeochemistry and controlled burning, 3) emerging contaminants effects on wildlife, ecosystems and humans, 4) projected climate change impacts on infrastructure, operations, and natural resources, and 5) incorporation of Ecosystem Services into the NEPA decision making process.

A Shell Midden's Story: Investigating How Multiple Factors Affect the Lack of *Rhizophora mangle* Propagule Recruitment at Stabilized Shorelines along Turtle Mound

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Rhizophora mangle plays an essential role in erosion prevention along Florida's coastlines. We monitored the natural retention and recruitment of *R. mangle* propagules following living shoreline stabilization at Turtle Mound Historic shell midden in Canaveral National Seashore. We recorded morphometric data on *R. mangle* propagules and seedlings at 3 types of shorelines (stabilized, intact, damaged) and released 486

tagged *R. mangle* propagules among the three sites. *R. mangle* propagule recruitment at the stabilized shoreline was minimal. Only 26 tagged propagules were recovered during this study. We hypothesized limited propagule recruitment at stabilized shorelines was influenced by wave energy or differences in substrate. Additional studies found wave energy was not different between stabilized shorelines and intact shorelines; there was, however, a significant difference in grain sizes between the 3 shoreline types. On-going experimental trials will show the degree of influence large shells in sediment at shell middens have on propagule recruitment.

Assessing the Ecological Health of the Indian River Lagoon: Outcomes from the Science Assembly

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After the algae superblooms and catastrophic loss of marine life in the Indian River Lagoon in 2013, lagoon interests are wondering if the current indicators of ecological health are adequately measuring the system. Furthermore, community residents, policy-makers, and resource managers are asking if the lagoon is getting better or worse. Marine Resources Council (MRC) is leading a community effort to assess and grade the lagoon's ecological health. The Indian River Lagoon Report Card grades numerous indicators of ecological health while keeping the public engaged in continued discourse about the lagoon's condition. The Science Assembly workshop facilitated input from scientists and resource managers to define ecological health indicators and establish benchmarks. This presentation shares the outcomes of the Science Assembly.

Resilience of a Tropical Sport Fish Population (Common Snook) to a Severe Cold Event Varies across Five Estuaries in Southern Florida

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For species that are closely managed, understanding population resilience to environmental and anthropogenic disturbances can guide which suite of management actions are available to mitigate any impacts. During January 2010, an extreme cold event in South Florida caused widespread mortality of Common Snook, *Centropomus undecimalis*, a popular sport fish. Interpretation of trends using fishery-independent monitoring data in five South Florida estuaries showed that changes in catch rates of adult snook varied between no effects post event to large effects and 4 year recoveries. The reasons for the variation across estuaries are unknown, but are likely related to differences in estuary geomorphology and habitat availability, and differences in the proportions of behavior contingents that place snook in different areas of the estuary during winter. Emerging awareness of the presence of behavior contingents, identification of overwintering sites, and improvements of abundance indices in remote nursery habitats should provide a better understanding of population resilience to disturbance events for snook.

Leafy Lunch: The Effects of Leaf Herbivory on Established Seedlings of the White Mangrove

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The white mangrove (*Laguncularia racemosa*) is a crucial ecosystem engineer, providing habitat for many insects and crustaceans. In the wild, crustaceans such as *Aratus pisonii* and other organisms feed on mangrove leaves. This study aims to observe the effects of leaf herbivory on survival and growth of *L. racemosa* seedlings. All seedlings were cultivated from propagules planted in November 2014. On

February 3, 2015, seedlings were selected with four to eight leaves. Four treatments (25 replicates per treatment) were established to simulate different levels of herbivory: control (no leaves removed), low damage (25% of leaves removed), medium damage (50% of leaves removed), and high damage (100% of leaves removed). Each week of the experiment, data was collected on survival and leaf count, with height taken every four weeks of the twelve-week experimental run. Data from this study will help improve our understanding the effect of biotic interactions on *L. racemosa*.

Modeling Inundation and Residence Time of Saltwater in the Loxahatchee River Floodplain

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Floodplains are characterized by subtle topography in the form of surface depressions, hummocks and hammocks, which can considerably influence the delivery and distribution of water and constituents across the landscape. Presently, very few studies incorporate the topographic detail needed to resolve such features and, hence, their effects are not assessed. In this study, we incorporated a high resolution Lidar DEM into hydrodynamic and particle tracking simulations in Delft3D for a 0.04 km^2 tidally influenced floodplain of the Loxahatchee River to quantify the effects of microtopography on inundation and residence time (Rt). Simulations revealed flow divergence and convergence with the submergence/emergence of microtopography, and 70,000 m^3 of water remaining in surface depressions at the end of the ebb cycle. Residence times ranged from 0.99 to 1.4 days, increasing with distance from the river.

Florida's Panama Canal: Investigating the Link between Biofouling and Biofilms Transported through the Okeechobee Waterway

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Marine biofilms form on nearly all submerged surfaces, and they often influence the settlement of macrofoulers. Biofilms adhering to ship hulls may be carried thousands of miles, and effects on macrofoulers therefore have implications for bioinvasions. Freshwater shipping routes are less effective than previously thought at killing marine macrofoulers. However, no studies have examined how freshwater passageways affect the mortality of biofilm organisms such as diatoms. Persistence of coastal diatoms was investigated in biofilms developed on three modern ship hull coatings. Biofilms cultivated on opposite coasts of Florida were reciprocally transplanted through 165 km of freshwater in Florida's Okeechobee Waterway. Using a specially designed test vessel, panels were transported on the hull and in recirculating and flow-through live wells. Transport method affected diatom community composition, resulting in new biofilms that altered post-transport macrofouling. These results provide a fresh perspective on the role of shipping in the spread of invasive species.

Dry Season Surface Water Quality Changes in the St. Lucie Estuary with Periodic Lake Okeechobee Water Releases

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In 2015, the U.S. Army Corps released water from Lake Okeechobee to the St. Lucie Estuary (SLE) during the dry season to help lower lake levels in anticipation of the hurricane season. Six water quality surveys were conducted during these releases using a flow-through system that collected continuous data from the mouth of the estuary up to S80 and portions of the North Fork. These results were compared to

discrete water quality samples collected at fixed stations by the Smithsonian Marine Station prior to releases. Salinity, turbidity, and chlorophyll a concentrations varied with Lake water inflow. Salinity declined throughout the estuary with increased flow, even after flows were temporarily terminated. Turbidity increased greatly under higher flow conditions, while chlorophyll a concentrations increased after flows ceased. In addition, chlorophyll a concentration in the North Fork under higher flow conditions indicate that water was pushed up into the North Fork preventing outflow.

Morphology of *Halodule wrightii* Clones: Implications for Restoration

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Seagrass clonal diversity can have positive effects on community structure and function, including but not limited to resource use and biomass production. Morphological differences are measureable units of differences between clones, acting as a potential important indicator of clonal diversity. Enhanced diversity has important ecological consequences, where increasing diversity leads can lead to corresponding increases, for example, in productivity, growth, and resistance/resilience to disturbances. Therefore understanding the role of morphology in habitat-forming species (e.g., seagrasses) may play a twofold role in transplant success using increased morphological diversity as well as serving as a future measure of success. We conducted a series of common garden experiments to examine the morphological variation of individual clones of *Halodule wrightii*. These experiments demonstrate that individual clones maintain unique distinct traits under similar environmental conditions, thus using morphological diversity may be an effective method for improving diversity in seagrass restoration.

In the Wake of the Superbloom: Development and Validation of Integrated Technologies for Monitoring Green and Brown Tides in the Indian River Lagoon

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During 2011 and 2012, green and brown tides negatively affected established seagrass beds and seagrass-dependent fisheries and wildlife in the Indian River Lagoon (IRL). These blooms signified a potential shift in the size of bloom forming organisms, from microplankton (20-200µm) to nano- and pico-plankton (<20µm). These blooms of smaller cells, not easily identified/quantified by microscopy, presented a new monitoring challenge in the IRL. Accordingly, taxa-specific (q)PCR and flow cytometry assays were developed to resolve IRL bloom-forming taxa from morphologically similar nano- and pico-plankton. Assays specific to a chlorophyte dominant during the 2011 green tide or the pelagophyte dominant during the 2012 brown tide were successful at quantifying cellular and/or DNA targets across several orders of magnitude. *In silico* and/or lab-based testing utilized environmental and culture samples to further define and/or automate assay-specific classification strategies for target taxa in order to optimize IRL field detection and monitoring capabilities.

In the Wake of the Superbloom: Tracking Green and Brown Tides in the Indian River Lagoon with Integrated Technologies

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During 2011 and 2012, green and brown tides negatively affected established seagrass beds and seagrass-dependent fisheries and wildlife in the Indian River Lagoon (IRL). These blooms signified a potential shift in the size of bloom forming organisms, from microplankton (20-200µm) to nano- and pico-plankton (<20µm). These blooms of smaller cells, not easily identified/quantified by microscopy, presented a new monitoring challenge in the IRL. Accordingly, we developed and/or used taxa-specific probes for flow cytometry and qPCR to rapidly screen seawater samples collected from the IRL in 2015. Probe-based qPCR and flow cytometric estimates of cellular abundance—for a chlorophyte dominant during the green tide and the pelagophyte dominant during the brown tide—were significantly correlated with microscopy abundance. Both the chlorophyte and pelagophyte were detected throughout 2015, but rarely dominated IRL nano- or pico-plankton biomass, highlighting the utility of integrated monitoring technologies for resolving fine-scale taxonomic diversity within these size classes.

Update on Oyster Research in Mosquito Lagoon

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To better understand the current state of expansive intertidal reefs of the oyster *Crassostrea virginica* in Mosquito Lagoon, during the summer of 2015 we led a mapping program of all oyster reefs along Florida's east coast from Mosquito Lagoon northward. In total, we digitized 19,214 reefs, 13% of which were in Mosquito Lagoon waters. Of this total, 6.1% are dead reefs (8.9% dead in Mosquito Lagoon). To complement the mapping, we have ongoing monitoring of recruitment and participated in the first year of a multi-agency oyster condition assessment effort to compare reefs from the Georgia border through Mosquito Lagoon. Spatial and temporal statistical analyses will be used to determine patterns and problem locations in our estuaries.

"To Spawn or Not to Spawn? Evidence of Possible Skipped Spawning and Delayed Maturation by Florida East Coast Common Snook *Centropomus undecimalis*

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Current research demonstrates female common snook (*Centropomus undecimalis*) make multiple spawning migrations to and from inshore non-spawning areas and marine spawning aggregations within an annual reproductive cycle. To address the possibility that some fish may skip spawning—thus testing the current assumption that all females spawn annually—we used a combination of energetics, gonadal histology and acoustic telemetry data collected from 434 (energetics and gonads) and 271 (telemetry) individuals of Indian River Lagoon and connected waters from 2009 – 2014. A best fit General Linear Model (GLM) indicated total length and habitat (river, estuary, inlet or offshore) are significant predictors of Hepatosomatic Index (HSI). In all habitats non-vitellogenic fish during the spawning season had lower HSI and were smaller in size than vitellogenic fish. Similarly, telemetry demonstrated smaller fish were more likely to not participate in spawning related movements. The results suggest that some smaller females possibly undergo delayed maturation.

Benthic Foraminifera as Bioindicators of Environmental Conditions in the Indian River Lagoon

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Foraminifera can be environmental bioindicators in estuarine ecosystems. Indices have been proposed whereby resource managers can evaluate benthic environments as to their condition using the presence and abundance of foraminifera. To evaluate this indicator for the Indian River Lagoon (IRL) benthic ecosystem, the densities and distributions of foraminiferans are being measured in Turkey Creek (Palm Bay, Florida) and the nearby IRL. Spatial and temporal population patterns are being followed for comparison with key environmental parameters characterizing benthic sediments. *Ammonia parkinsoniana* is an abundant foraminiferan in this region of the IRL. Densities of large individuals (tests >500µm) range from 0 to 4,592 (n=3, SE +/- 20.4) m-2 in Turkey Creek sediments. Samples were collected from May to November 2015 with peak abundances occurring in May. This size class completely disappeared from all locations in September and October. *A. parkinsoniana* abundances are being checked for correlations with sediment components such as silt/clay, organic material, and water content.