Abstracts of Technical Presentations

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Key Note Address

Indian River Lagoon Symposium 2015 – Lessons, Challenges, and Opportunities

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The Indian River Lagoon (IRL) system is a prominent geomorphic feature on Florida's east coast extending 156 miles from Ponce de Leon Inlet south to Jupiter Inlet. Located in a zone where tropical and temperate climates meet the Lagoon is one of the most bio-diverse ecosystems in North America. For the purposes of characterization and management the Lagoon and its watersheds, there are six segments; Mosquito Lagoon, Banana River, North Indian River, North Central Indian River, South Central Indian River, and South Indian River, each different but all part of the Indian River Lagoon system.

Population in the IRL region increased from 45,000 in 1950 to well over 1,000,000 today and the Lagoon watershed increased from 865 square miles to over 1,900 square miles, with up to 60% of the drainage basin now comprised of an artificially extended watershed. Water and sediment quality have degraded due to point and non-point source pollution loadings and dramatic drainage alterations and flood control management of stormwater runoff. Natural wetlands have been impounded with severe habitat loss of mangroves and seagrasses.

We have recognized the values of the Lagoon and applied designations such as State Aquatic Preserves, Outstanding Florida Waters, and Estuary of National Significance. But the Lagoon's response is difficult to evaluate as is not static but ever changing in response to the natural fluctuations over time and to the human-induced influences which are more extreme. The Lagoon is continuously teaching us about the natural ecosystem values and the lessons learned can be life changing. As we seek to understand the ways of the Lagoon, there are significant challenges, increasing in number over time, challenges to overcome so we might better manage our activities to preserve or restore the values of the Lagoon. The opportunities for us to take action are there and may allow the Indian River Lagoon to be itself, opportunities for us to live in harmony with the Indian River Lagoon ecosystem.

Contributed Papers (Oral and Poster Presentations)

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

Pilot Oyster Reefs in Brevard County – From Oyster Gardening to Reef Deployment

Lacie Anderson[1], Sammy Anderson[2], Virginia Barker[3], Paul Sacks[1], Jody Palmer[2], and Linda Walters[1]

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In November 2014, after 6-9 months of oyster gardening, gardeners brought their live oysters to one of 3 pilot reef sites in Brevard County. Sites include Nicol Park (Port St John), Scout Island (Melbourne Beach), and along a Merritt Island impoundment near Rotary Park. To determine oyster success, oyster morphometric data were collected. In 2015, this data will be compared to 5 additional reef treatments (control = no shell; oyster restoration mats; bagged clean shell, spat on shell, or adult oysters collected in spring). Initial data suggest that oysters can grow very well in Brevard County. Natural recruitment also occurred in many areas. Measured oysters ranged in size from 0.6 to 12.6 cm.

Community-based Oyster Gardening, Monitoring and Restoration in the Indian River Lagoon, Florida

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Brevard Zoo, in partnership with Brevard County, launched an oyster gardening program in January 2014 to study the survivability of oysters in the Indian River Lagoon. Over the first 10 months of the project, nearly 800 residents volunteered to become oyster gardeners and were trained through educational workshops. These citizen scientists grow oysters from spat in suspended habitats off their dock for 6-9 months. Weekly data collection provides information regarding size of oysters, competition and predation, as well as natural recruitment and is inputted into an online database for analysis. Gardener data was used for site selection decisions for three pilot reefs in Brevard County. In November, over 60,000 live oysters were collected from gardeners and outplanted as one treatment at these pilot reef sites in Port St. John, Merritt Island and Melbourne Beach. Four additional reef treatments will be constructed in spring of 2015 and monitored for success.

Interactions between Foundation Species and Their Critical Role in Structuring Mangrove Ecosystems

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The overall goal of this research is to investigate the effects that primary foundation species and secondary foundation have on associate sessile species diversity and community structure in the intertidal zone. This will be achieved in three objectives that will be tested along a latitudinal gradient that extends from Key West to the Indian River Lagoon. Objective 1 will determine the potential for interactions between mangroves and the secondary foundation species using a broad scale survey of occurrence of species as well as measure growth and recruitment of secondary foundation species. Objective 2 will use a field experiment to test the effects of the structure of

the mangrove trees on the diversity of the secondary foundation species, associate sessile species, and the community structure. Objective 3 will use a field survey and field experiment to test interactions between foundation species and the effects on the associate sessile species.

Pathogenic *Vibrio* Bacteria in the Indian River Lagoon and their Potential Threat to Human Health

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Vibrios are emerging pathogens responsible for 80,000 illnesses and 100 deaths in the United States annually. Infections are directly linked to the marine environment and are acquired through contaminated seafood or aquatic injuries. Florida has the highest national incidence of vibriosis, with 20% of its cases reported from the Indian River Lagoon region. This is the first systematic study of *Vibrio vulnificus, V. parahaemolyticus*, and *V. cholerae* in the Lagoon, with the goal of understanding how, when, and where humans may encounter them in the environment. Using a combination of cultivation and molecular techniques, we have detected these pathogens in sediment, water, fish, and shellfish collected from a series of sites since the spring of 2014. Preliminary findings suggest an important health concern and will be used to inform the public and medical care providers of these hazards to improve recreational safety.

Examination of the use of Floating Individuals of *Halodule wrightii* for Restoration

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This exploration of using floating individuals of *Halodule wrightii* has provided very encouraging results. Floating individuals were collected in the Indian River Lagoon around the area of Fort Pierce, FL in the spring of 2014 and planted in a former dredge hole west of Fort Pierce Inlet. 32 individuals were attached to 25 cm x 25 cm biodegradable mesh for each of 30 plots distributed with 2 plots to each block. 66.66% of these plots survived over the 6 months that the experiment took place. The average area covered by the seagrass tripled by week 17. At that point, the seagrass was cut back to maintain the integrity of the experiment, and by week 25 there was double the area covered by seagrass compared to what was originally planted. This method can provide a more environmentally friendly alternative to traditional transplanting.

Effect of Invasive Species on the Soil Chemistry of the Coastal Oaks Preserve

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Invasive species like Australian pines and Brazilian peppers populate land near the Indian River Lagoon, including the Costal Oaks Preserve in Vero Beach. Based on the observation that there was limited ground coverage around invasive trees, we hypothesized that invasive species alter the soil, pushing out the native species and creating a homogenous landscape. Three random soil samples were taken within a meter of various trees. Ground cover was examined, and the girth of the tree recorded. The soil samples were taken back to the lab and tested for pH, humus, nitrate, phosphate, potassium, magnesium, and calcium. Results show that these species do affect the soil they inhabit, for example changing pH, nitrate, and other nutrients. Invasive species outcompete native plants, which could in return affect the biodiversity and ecosystem services.

Dolphin-Vessel Collisions: What Have We Learned and What Can We Do to Minimize Future Impacts?

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Scientists at Harbor Branch's Oceanographic Institute (HBOI) previously established vessel collisions as a threat to dolphins in the Indian River. Photo-Identification (Photo-ID) data collected between 1996 and 2006 indicated that at least 6% of the identifiable animals possessed injuries consistent with vessel impacts (Bechdel et al. 2009). Since the results were published, the HBOI Photo-ID team has continued to collect evidence of animals suffering from vessel impacts. Therefore, it is time to readdress the issues and analyze the following pertinent questions. What changes have been made since 2009 to reduce the number of dolphin-vessel impacts? Have reduced boating speed limits been established and enforced and have they been effective in achieving goals? Have boater education programs increased awareness and affected the number of reported collisions? These issues will be addressed in 2015.

The Impact of Crown Conch, *Melongena corona*, on the Eastern Oyster, *Crassostrea virginica*, in Mosquito Lagoon, Florida

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Oyster harvesters throughout Florida have complained that crown conch, *Melongena corona*, are in competition with them for oysters, and have led to a large decline in intertidal oyster populations. In 2014, we conducted surveys of 15 randomly chosen oyster reefs to determine conch densities in Mosquito Lagoon. In addition to surveys, we initiated two experiments to examine feeding preferences and movement of crown conch. Our results indicate conch selectively forage on oysters with similar shell lengths, move a mean of 6.35 meters in 24 hours, and are rarely encountered in cold months. Due to their low density of 5.15×10^{-3} conch/m^2, it is not likely that crown conch are a significant predator, able to alter oyster population densities in Mosquito Lagoon. Our data can benefit others when planning management regulations on oyster harvesting and conservation efforts in Mosquito Lagoon.

Utilizing Volunteers to Rescue a Dolphin Trapped in a Shallow Water Lagoon

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Volunteers are crucial to the smooth operations of most marine mammal rescue centers and marine animal parks. All volunteers of the Harbor Branch Oceanographic Institute Marine Mammal Research and Conservation Program (MMRC) are trained in the following areas: lab safety, zoonotic diseases, cleaning protocols, necropsies, educational outreach, handling marine mammals and behavioral observations. This presentation describes a National Marine Fisheries Service (NMFS) approved intervention to capture and release a dolphin (*Tursiops truncatus*) trapped in a shallow lagoon utilizing MMRC volunteers, a few marine mammal trainers and nearby residents. Methods include use of proven health assessment capture and restraint protocols to facilitate a well expedited rescue to safely return the dolphin back into the Indian River Lagoon (IRL).

Quantifying the Effects of Boat Wakes on Intertidal Oyster Reefs in Mosquito Lagoon

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Concerns about negative impacts of recreational boating in the Indian River Lagoon have guided our research on the impacts of boat wakes on oyster reefs (*Crassostrea virginica*) in Mosquito Lagoon (ML). There has been a 24% loss of oyster habitat in ML since 1943. There is correlative evidence that this is a result of boat wakes, yet no studies to date have confirmed dead reefs can be a direct result of boat wakes. Therefore, we ran controlled boat passes to determine what wake heights are generated at oyster reefs in ML. These results were utilized in experiments at FIT's wave tank to observe oyster movement and sediment erosion. Data was analyzed using model selection and regression analysis. We have shown that wake heights as small as 2 cm are capable of dislodging and moving oysters. These results can help implement boating policies, contributing to conservation of this important ecosystem engineer.

Responses of Tropical Seagrass Meadows (*Thalassia testudinum*) to Experimental Manipulations of Nutrient Supply and Grazer Abundance

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Seagrass meadows are productive marine habitats that provide key ecosystem services such as carbon storage, nutrient cycling and sediment stabilization. Seagrasses are declining globally, with a reported 30% decline in areal coverage since the late 1800s. While we have a basic understanding of some of the mechanisms driving seagrass loss (overfishing, physical disturbance, and eutrophication), we have a poor understanding of how these pressures interact to alter the structure of seagrass meadows across large spatial scales, particularly within tropical environments. We present the results of a study that examined the relative effects of increased nutrient supply and decreased meso- and macrograzer abundance on the structure and function of seagrass meadows (*Thalassia testudinum*) at several locations across the Caribbean and one location within the Indian River Lagoon, FL. Our results demonstrate that in certain regions, large macrograzers can play a key role towards regulating seagrass responses to increased nutrient loading.

A Two-Season Experiment Determining Effective Cultivation Methods for the Marsh Cordgrass *Spartina alterniflora* for Transplantation Success

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Recent efforts to restore coastal shorelines have incorporated transplantation of the marsh cordgrass *Spartina alterniflora*. To improve transplantation success, a more effective greenhouse cultivation method was sought to result in higher belowground biomass, more new shoots, and increased survival rates. During the spring and fall of 2014, 240 *S. alterniflora* transplant units were treated with nutrients (nitrogen, N+P, phosphorus, control) at one of two salinities (0, 30 ppt) in a full factorial design and cultivated for six weeks. There was no statistical difference in belowground biomass between treatments in spring 2014. Despite this, nitrogen-treated plants observed higher survival rates than phosphorus-treated and control plants. Plants grown in freshwater also had significantly higher survival rates and more new shoots than those grown in

saltwater. Fall data is currently being analyzed, but our results suggest that growing *S. alterniflora* in freshwater with the addition of nitrogen is the best of our tested methods.

Lurking Nutrients: The Unaccounted Reality Learned from the 2011 Superbloom
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Drift macroalgae (DMA) is one of the three major autotrophic communities in the IRL that assimilate and cycle nutrients. DMA extends important nutrient cycling and habitat functions into deeper water that seagrass provides in the shallows. Studies sponsored by St. Johns River Water Management District indicate that in many lagoon locations, DMA is the most dominant benthic macrophyte, often contributing more biomass than seagrass and epiphytes combined. The amount of stored nutrients in benthic macrophyte may be equivalent to that received annually from external sources. Therefore, it was the unusually high amount of DMA loss and lack of nutrient uptake that is hypothesized to have help initiate and prolonged the unprecedented phytoplankton (super) bloom of 2011. This paper will explore potential triggers for the DMA loss and its potential importance in the nutrient budget of the IRL.

Fetch Climatology over the Indian River Lagoon: An Investigation of the Frequency of Significant Wind Exposure Events since 1979
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Significant wind exposure events (SWEE) can impact water levels and increase wave heights in the Indian River Lagoon (IRL). In turn, this can affect the transport of sediments and nutrients in the IRL, as well as the health of vegetation such as seagrasses. In this presentation, we use data from numerical model analyses over a thirty year period to investigate the frequency of high impact wind events over the IRL. Fetch maps are generated to sort the wind events into three principle categories for which the wind direction (fetch) is oriented along the major axis of the lagoon including: 1) high wind events, 2) long duration wind events, and 3) a combination of the two. The data are mined for the temporal frequency of SWEEs (e.g., return period) in an effort to better understand and predict the IRL's response.

Demersal Copepod Survival in the Immediate Proximity of IRL Muck Sediments
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It is generally thought that animals and plants cannot live in the organic muck that has been accumulating in the Indian River Lagoon. This study observes the effects of muck on survival of the demersal copepod *Pseudodiaptomus pelagicus*. Copepods were kept for 24 hours in permeable chambers lying directly on muck sediments, in muck-tainted seawater, and under muck-free control conditions. Copepod survivorship and recovery was fair under all conditions, and there were no significant differences detected between the treatments and the control. Future plans include characterizing the influence of muck sediments on the chemistry of boundary layer water in an experimental aquarium and comparing those conditions to a natural estuarine seafloor where muck predominates.

Oyster Restoration Programming in the Indian River Lagoon Estuary, Florida: A Multi-faceted Initiative Focused on Community-based Environmental Stewardship

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In recent years, an unfortunate synergy of coastal development, canalization, boating, agricultural runoff, and nonpoint source pollution have resulted in a significant decline in water quality and benthic habitats in the Indian River Lagoon. Oyster coverage that was historically present in the lagoon and its estuaries has declined by more than 75 percent. In response to the dramatic decline in oyster reefs in the lagoon, county governments and non-governmental organizations have initiated a suite of community-based oyster restoration programs that have received significant public attention, participation, and recognition. Despite their differences in methods and protocols, all of these programs share components dedicated to youth education, public outreach, and instilling environmental stewardship. This poster summarizes these activities, compares method, and highlights successful programs that engage citizen-scientists and youth groups.

Presence of the Invasive Lionfish (*Pterois* spp.) in the Indian River Lagoon: Implications for Control and Management

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In this study we examined the presence of lionfish in the Indian River Lagoon to address estuarine use through ontogeny. We examined known distribution in the IRL using the USGS Non-indigenous Aquatic Species (NAS) website, demographics (sizes and reproductive capacity) and use of mangroves. We also examined lionfish diet in the IRL. The wide range of sizes, sexually capable adults and fidelity to mangroves suggest that lionfish do not necessarily exhibit an ontogenetic shift offshore. These findings indicate the ability of the IRL to serve as a suitable ecosystem for lionfish throughout their life cycle. Furthermore, lionfish have been reported in the IRL since 2008 as far as 14 km from inlets. The ecological and economic value of the IRL and other estuaries warrants the development of strategic removal efforts and consistent monitoring. Lionfish presence in the IRL signifies their threat to southern temperate, subtropical, and tropical estuarine systems.

The Distribution of Seagrass Species Adjacent to the Coastal Oaks Preserve

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Understanding and mapping the seagrass community adjacent to the Coastal Oaks Preserve, Vero Beach, will provide a basis for future studies of the interactions between the Preserve and the Indian River Lagoon. Following the methods of the lagoon-wide monitoring program developed by the St. Johns River Water Management District, we established eight transects spaced 200 m apart and perpendicular to the shore. Along each transect, we are recording the seagrass species present, percent cover, canopy height, shoot count, and water depth every 10 m. The most abundant species are *Halodule wrightii, Thalassia testudinum,* and *Syringodium filiforme.* As depth increases, the abundance of *T. testudinum* increases. This baseline will allow the identification of positive or negative consequences of future management actions to seagrasses in the Lagoon.

Biodiversity of Natural and Altered Shorelines in Mosquito Lagoon

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Living shorelines are becoming recognized and promoted throughout the United States as a cost-effective type of ecological engineering to make coastal areas more resilient. A commonly cited benefit of living shorelines is support of higher levels of biodiversity, for species from both estuarine and terrestrial environments, compared to hard-armored shorelines. In March 2014, we began a two-year study using a BACIPS design to compare abiotic characteristics and community structure at four types of shorelines: 1) shorelines stabilized using living shoreline techniques; 2) natural shorelines; 3) seawalls; and 4) rip-rap. Preliminary data suggest natural shorelines had higher diversity of fishes, crustaceans, and birds compared to hard-armored shorelines. Abiotic conditions were also different for hard-armored shorelines compared to natural shorelines, particularly for temperature and shoreline slope. Living shoreline stabilization occurred in July 2014 at Seminole Rest (Mosquito Lagoon) and on-going monitoring will allow us to compare diversity to natural and altered shorelines.

Do Irregular Sample Sizes Affect Benthic Species Abundance in Field Samples?

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The Indian River Lagoon (IRL) is one of the most diverse estuarine systems in the United States. However, little is known about the diversity of the IRL's infaunal communities. To better understand the infaunal community composition in the IRL quarterly sampling is done by the Marine Ecology Lab at the Smithsonian Marine Station. Infaunal species were obtained using a ponar grab sampler; sediment grabs were sieved in the field and then preserved in formalin. The samples are then brought to the lab for sampling and identification. After sorting sedimentary material was dried and weighed and will be compared with species abundance to determine any relationships. This experiment will determine if there is any connection between the type of sediment found and the abundance and dominance of benthic, infaunal species within the IRL.

Fine-grained, Organic-rich Sediments (a.k.a. Muck): A Major Source of Dissolved Nitrogen and Phosphorus to the Northern Indian River Lagoon

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Releases of dissolved nitrogen and phosphorus from muck sediments have been determined using (1) interstitial water chemistry, (2) laboratory incubations, and (3) *in situ* chambers. Fluxes of nitrogen, essentially all as ammonium ions, and phosphorus, essentially as orthophosphate ions, averaged 10 ± 5 and 1.5 ± 1 metric tons, respectively, per square kilometer of muck per year. Spatially, fluxes of ammonium ions ranged from <1 to >20 metric tons per square kilometer per year in response to differences in muck composition. Calculated releases of dissolved nitrogen and phosphorus from muck sediments of ~300 and 40 metric tons per year, respectively, in the northern IRL basin (north of Melbourne Causeway) are approximately equal to or greater than external inputs of nitrogen and phosphorus from stormwater runoff. Spatial variability in nutrient fluxes and the variable composition of muck may provide opportunities to prioritize dredging, restoration, and remediation efforts.

Sources and Fate of Particulate Organic Matter within the Indian River Lagoon: Using Stable Isotopes to Investigate the Role of Epifaunal Communities in Particulate Removal

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Phytoplankton blooms have increased in occurrence and severity in the Indian River Lagoon (IRL) in recent years. While these blooms have long been ascribed to increased nutrient loading, there are likely multiple, complex factors driving their proliferation. As a complement to the IRLABI epifaunal monitoring program, we are testing the hypothesis that members of the epifaunal community may mitigate these blooms by top-down control. The role of epifaunal communities in particulate removal was assessed at geographically disparate sites throughout the IRL by collecting water samples for particulate organic matter (POM) and common resident epifaunal organisms for C and N stable isotope analysis ($\delta^{13}C$ and $\delta^{15}N$). By comparing the isotope values of this potential source of organic matter to those of common macroinvertebrate consumers, we hope to elucidate organisms that are capable of exerting top-down control on phytoplankton within the IRL.

Biology and Conservation Status of the Florida East Coast Diamondback Terrapin (*Malaclemys terrapin tequesta*) in the Indian River Lagoon System

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Malaclemys terrapin is the only turtle species occupying exclusively brackish and estuarine coastal habitat. Its seven subspecies occupy a narrow coastal range from Massachusetts through Texas, and while *M.t. tequesta* has one of the largest subspecies ranges – from at least Volusia County to Miami – it is the least understood subspecies. Diamondback terrapins were hunted nearly to extinction in the early 1900s, and despite continuing losses in crab pots and anecdotal observations of low population size and spotty distribution, State law provides little protection for *M.t. tequesta* other than a possession limit of two animals. This presentation will examine the current state of knowledge of *M.t. tequesta* including its conservation status, and will make a case for inclusion of this important vertebrate species in IRL restoration plans. As a benthic-feeding, year-round IRL resident and a potential sentinel species for lagoon health, *M.t. tequesta* deserves particular consideration for conservation.

Paleoenvironmental Reconstruction at the Jupiter Inlet I Site: An Archaeomalacological Approach

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Growing concerns about the future of the Indian River Lagoon have called for an interdisciplinary approach. For several decades, archaeologists have studied the utilization of marine, estuarine, and riverine resources by Florida's prehistoric people. Looking into the past to see how the prehistoric people adapted to their changing environments helps to lend insight into the effects on human and non-human populations. My research aims to reconstruct the environmental habitat zones present at the Jupiter Inlet I Site at the time of occupation based upon the molluscan species identified. Furthermore, I will show preliminary data from archaeological excavations in order to

determine whether there are changes in the kinds and quantities of molluscan species through time.

Continuous Water Quality Monitoring in the Indian River Lagoon

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Traditionally, the Indian River Lagoon water quality monitoring performed by SJRWMD has been accomplished through monthly grab samples analyzed in a laboratory. Monthly monitoring, while valuable for long-term trends, may miss events of short duration. Large rainfall events are drivers of water quality variability, affecting nutrient concentrations. These episodic influxes of nutrients to the IRL system are readily metabolized by phytoplankton and macroalgae and can be missed in monthly sampling regimes. Continuous monitoring may provide insight to the short-term variation of nutrients in the IRL. Nitrate and phosphate sensors are deployed in conjunction with a multi-parameter sonde measuring temperature, dissolved oxygen, conductivity, pH, chlorophyll *a* and fDOM. This high temporal resolution data may aid scientists in their understanding of these nutrient variations and how they may impact phytoplankton blooms, as well as provide data that may facilitate better calibration of water quality models.

Indian River Lagoon Observatory: Real-time Water Quality Data Network for Research, Education, and Outreach

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The goal of the Indian River Lagoon Observatory (IRLO) is to investigate ecological relationships in the Indian River Lagoon (IRL) and how they are impacted by natural and human-induced stressors. An important IRLO component is a network of advanced observing stations. We are deploying a network of 10 Land/Ocean Biogeochemical Observatories (LOBOs) in the IRL and St. Lucie Estuary to provide real-time, high-accuracy, and high-resolution water quality data through an interactive website. Continuous, high-resolution measurements are being made for: temperature, conductivity, depth, turbidity, current speed and direction, chromophoric dissolved organic matter, nitrate, phosphate, dissolved oxygen, pH, and chlorophyll a. These reliable, continuous observatory data will enable better quantification and modeling of relationships between environmental factors and biological processes in the IRL and enable scientists, managers, educators, students, and the public to directly observe long-term ecosystem changes and those driven by events, such as freshwater discharges, droughts, storms, and algal blooms.

δ^{13}C Evidence of Light-limited Growth of *Thalassia testudinum* in the Indian River Lagoon

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In recent years, unprecedented harmful algal blooms (HABs) in the Indian River Lagoon (IRL) have culminated in the extensive loss of seagrass habitat. Seagrass distribution is directly related to light availability, a parameter that can be estimated by evaluating the stable carbon isotope composition of seagrass blades. Lighter (more negative) carbon isotope values equate to increasingly eutrophic or light-limiting conditions when compared to the heavier (more positive)

values. In 2014, $\delta^{13}C$ and light attenuation were used to document light-limited growth in turtle grass (*Thalassia testudinum*) along both latitudinal (Sebastian to Jupiter) and depth (exposed to 3.4 m) gradients with a reference site in the Florida Keys. Lighter $\delta^{13}C$ values and higher attenuation in the north (Indian River/St. Lucie) suggest more light-limited growth conditions than in the south (Martin/Palm Beach). Ultimately, carbon isotope research can provide additional insight into how eutrophication and HABs may impact the physiology of IRL seagrasses.

On the Biogeography of the Giant Free-living Ciliated Protozoon *Loxodes rex*, an Alleged Endemic Ciliate, with First Recording in the Americas

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As the foundations of foodwebs, protozoa are an important factor in the success of an ecologic system. Unfortunately, these organisms are often overlooked and research in the Americas is lacking. Recent samplings conducted in freshwater canals and ponds within the Indian River Lagoon watershed have revealed *Loxodes rex*, an alleged endemic ciliate species. Originally described as endemic to Tropical Africa, *L. rex* has been considered a prime candidate for proof of microbial endemism. Our studies have shown this giant, fragile cell to be thriving in tropical South Florida. Our observations are novel, and include both the first record of occurrence for the Americas and the first high quality in vivo images for this charismatic species.

Constructing a High-Resolution Fetch Map of the Indian River Lagoon to Verify the Accuracy of Relative Exposure Index over the Lagoon

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Relative Exposure Index (REI) is a metric that approximates annually averaged wave exposure over a body of water using fetch information along with climatological wind speeds and directions. Since its introduction into literature thirty years ago, there appears to be no direct study of how the REI compares to an average of the actual wave exposure. In this presentation, we discuss the construction of a high-resolution (500 m) map of both direct and effective fetch over the Indian River Lagoon (IRL) at a ten degree wind-direction resolution. Using this map, thirty years of analysis data from the Climate Forecast System Reanalysis and the North American Regional Reanalysis, and fifteen years of wind observations from the Automated Surface Observing System, the actual wave exposure is calculated eight times per day and then averaged over the time scale of the study in order to compare it to the REI over the IRL.

Benthic Habitat Mapping in Indian River Lagoon using Hyperspectral Imager for the Coastal Oceans (HICO) Data

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The Water Correction Model that we developed serves as a versatile imaging tool for benthic mapping. The model and tool allows the users to perform water correction to hyperspectral satellite data, such as that obtained from the Hyperspectral Imager for the Coastal Oceans (HICO) that was used in this study to survey seagrass and other substrates in Indian River Lagoon. This

tool functions to allow the users to perform water correction of remotely sensed reflection data by selecting pixels of different substrate types and the same substrate types under water at a given depth. The algorithm uses the samples from the HICO data or from the actual physical site to calculate the water absorption and water reflection to reconstruct the distorted reflection data of the benthic substrate.

Epifaunal Communities within the Northern Indian River Lagoon: Methodology, Initial Trends, and Future Directions

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In general, the epifaunal diversity within the Indian River Lagoon is poorly known. There is currently a need to develop simple but effective methods to monitor communities along a large enough spatial scale to detect real changes that co-occur with seasonality and fluctuations in lagoon health. With increases in shoreline hardening, hard substrate is becoming more dominant and therefore, it is important to include this into the trophic dynamics of the IRL. Of particular concern are the deleterious effects of phytoplankton blooms in the IRL and what response epifaunal communities have to these including potential mitigation through top-down control. As part of the IRLABI, we have identified 27 sites within the Mosquito Lagoon, Banana River, and northern IRL in which quarterly monitoring has begun and will continue for the next several years. This, coupled with experiments, should allow us to identify effects on communities from blooms or other environmental changes.

Harmful Algal Bloom Detection Methods for the Indian River Lagoon through the Hyperspectral Imager for the Coastal Oceans (HICO)

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The research goal is to detect and map spatial distribution of the 2013 phytoplankton blooms in Indian River Lagoon (IRL), FL using the satellite Hyperspectral Imager for Coastal Oceans (HICO) data. Due to harmful algal blooms that have plagued the lagoon since 2011, a technique for early algal bloom detection is necessary. Satellite images help provide full coverage of temporal and spatial images of study areas. The algal signals are being studied using both field and HICO data acquired in October 2013 to detect and map spatial distribution of the blooms. A protocol will be prepared detailing the process of how to apply the detection model and generate algae distribution maps. The end product will be supervised classification maps indicating the spatial distribution of Chlorophyll *a* concentrations which is an indirect measurement of phytoplankton. This will assist with the monitoring of phytoplankton blooms in the future of the IRL.

Genetic Diversity of the Red Mangrove (*Rhizophora mangle* L.) in Florida: Contrasting Patterns in the Northern and Southern Indian River Lagoon

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Florida mangroves are expanding past their historical range limits into areas previously dominated by salt marsh. The introduction of these mangrove foundation species can have extensive ecological impacts. Measuring genetic diversity within populations of these expanding mangroves offers insight into potential associated community diversity and resilience to environmental changes. We quantified neutral genetic diversity within red mangrove (*Rhizophora mangle* L.) populations along this species' contemporary distributional range in Florida. East Florida red mangroves, including those at the leading edge, are generally more genetically diverse than those from West Florida. On the east coast, genetic diversity is associated with proximity to inlets, leading to greater diversity in the southern than northern Indian River Lagoon (IRL). Future shoreline restoration projects in the IRL should consider collecting mangrove propagules from multiple areas adjacent to inlets to capture a potentially greater array of genetic diversity.

Tunicates as a Potential Bioremediator of the Brown Tide Alga *Aureoumbra lagunensis* in the Indian River Lagoon

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Filtration rates of the pleated tunicate *Styela plicata* were measured in order to determine its use as a potential bioremediator of the brown tide pelagophyte *Aureoumbra lagunensis*, a bloom which caused heavy impacts to north Indian River Lagoon in 2012 and 2013. Filtration rates were calculated for water containing cultures of *A. lagunensis* compared to filtration rates when exposed to a control species (*Isochrysis* sp. (clone T-Iso)) at cell concentrations of 5.0×10^5 cells mL^{-1} $individual^{-1}$ for both species, which replicates approximate algal bloom concentrations. The calculated hourly filtration rates and the average filtration rates over the experimental period for individual tunicates were significantly slower in the *A. lagunensis* treatments when compared to the control ($p < 0.0001$). These results are consistent with previous studies on clearance rates of bivalves exposed to *A. lagunensis*, and speaks to the breadth of brown tide effects on a variety of IRL species.

Microscopic Meat-Eaters and Voracious Vegetarians: Temporal and Spatial Changes in Indian River Lagoon Mesozooplankton Communities

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Ongoing monitoring of plankton populations is being conducted to develop a better understanding of mesozooplankton population dynamics and community impacts. One objective is to assess the potential role of grazers during harmful microalgal blooms. A second objective is to examine the importance of temporally variable planktonic predators. The five study sites are in the Northern Indian River Lagoon (IRL) system where the 2011 IRL Superbloom occurred. Samples are collected fortnightly with replicate tows for each site. Communities are characterized through multivariate analysis of plankton and environmental data. Both spatial and temporal changes in the planktonic community have been observed, and these variations are to be compared against algal presence.

The Use of Pulse Amplitude Modulated (PAM) Fluorometry to Measure Nutrient Limitation in Indian River Lagoon Macroalgae

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Light limitation resulting from large macroalgal and phytoplankton blooms is currently thought to be a primary factor causing the recent seagrass die-off in the Indian River Lagoon. Nutrient enrichment is believed to be one of the primary causes of these blooms. This project will utilize pulse amplitude modulated (PAM) fluorometry and rapid light curves (RLC) to help determine if macroalgae are nutrient limited. PAM fluorometry and RLCs allow for *in situ* measurements of the photosynthetic ability of photosystem II (PSII) and coupled with nutrient dosing allows for rapid determination of nutrient effects on the photosynthetic mechanisms of macroalgae. A better understanding of what drives these macroalgal blooms will contribute to stronger conservation and management strategies within the IRL watersheds.

Water Quality and Algal Bloom Update for the Northern and Central Indian River Lagoon

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Since the major algal blooms of 2011/2012, water quality in the Indian River Lagoon (IRL) system has recovered to varying extents depending on the location and the specific water quality parameter. Using data collected by St. Johns River Water Management District's IRL monthly water quality monitoring program, we present a synoptic graphical overview of changing chlorophyll and nutrient concentrations, with emphasis on the results from the last 5 years (2010-2014).

Manatee Grazing Impacts on a Mixed Species Seagrass Bed in the Indian River Lagoon

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To test the effect of manatee grazing on a mixed species community of *Halodule wrightii* and *Syringodium filiforme*, we constructed two 12.8 x 12.8 m manatee exclosures in the northern Banana River, in an area typically grazed by manatees in the spring. Shoot counts, biomass, and species composition were sampled seasonally in the exclosures and two paired open plots of equal size between October 1990 and October 1994. *Syringodium* responded positively to release from manatee grazing pressure and gradually replaced *Halodule* in the exclosures. Our findings may be helpful to those interested in predicting seagrass recovery and manatee carrying capacity of repeatedly grazed seagrass beds.

My Brevard Yard: Creating Beautiful Lawns and Protecting Our Waterways

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My Brevard Yard (MBY), developed by the UF/IFAS Extension Brevard, is a creative approach to teach homeowners how to properly fertilize and irrigate their landscape. The My Brevard Yard program consists of a three-hour workshop that includes an overview of stormwater runoff and the Indian River Lagoon, a lesson on fertilizer science, and an introduction to irrigation systems. Participants receive a workbook that includes a worksheet that walks them through the steps of

calculating fertilizer amounts for their landscape. An innovative, hands-on approach is used to teach participants how to calibrate a fertilizer spreader, take a soil sample for testing, set irrigation clocks, and install a micro-irrigation system. At the end of the workshop the residents can sign up for the optional MBY home visit. The visit includes a check of the irrigation system, soil samples are collected for testing, and any landscape issues or concerns are addressed.

Fish Diversity and Abundance within the Coastal Oaks Preserve

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Certain species of fish are essential to the Indian River Lagoon. Our team is measuring the amount of fish coming in and out of the culverts connecting the Indian River Lagoon and the mosquito impoundments of the Coastal Oaks Preserve. We hypothesized that these impoundments are a crucial asset to certain species of fish. Each week our team is deploying a culvert trap for approximately 6-7 hours. To date we have seen species such as mosquito fish, sheepheads minnows, juvenile snook, sailfin molly, and goldspotted killifish. The highest number of fish caught was when the culverts were just opened in early October. There are many factors that may have a possible effect on the number of fish caught. Not only are these fish important to the ecosystem of the Indian River Lagoon, but they also are important to its economy.

Infaunal Communities within the Northern Indian River Lagoon

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Harmful algal blooms have become increasingly more common over the past few decades. These huge events have led to significant attention both from the general public and the academic world. Previous research has been concerned with the formation of these blooms but not on the community-level effects these blooms may have. In addition, little is known about how phytoplankton blooms are controlled in natural communities. As part of the IRL Algal Bloom Investigation (IRLABI) program funded by St. Johns River Water Management District, 27 sites within the northern IRL have been identified to sample and monitor the infaunal communities quarterly for the next several years. This sampling effort, combined with experiments should give an insight into how estuarine communities cope with harmful algae blooms or other environmental changes.

Effects of Land Use on Nitrogen and Phosphorus Inputs to the St Lucie Estuary

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Urban, agricultural and residential land uses in the St. Lucie watershed contribute sewage and fertilizers to stormwater runoff, resulting in increased nitrogen (N) and phosphorus (P) loadings that can fuel harmful algal blooms. However, the concentrations of N and P in stormwater, as well as the N:P ratio, are poorly understood. The goal of this project was to quantify dissolved concentrations of ammonium, nitrate, total N, soluble reactive P, and total P in stormwater from agricultural, natural, and urban land uses on the St Lucie Estuary watershed. Preliminary results based on water samples taken throughout storm events at 14 sample locations on the watershed

consistently show initial spikes of N and P, as well as the N:P ratio, in stormwater runoff at the beginning of a storm, followed by a downward trend in overall nutrient levels and ratios.

Spectral Photoresponses of Four Copepods with Consideration of Ancestry and Modern Habitat

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A comparative approach is used to test the Derived Sensitivity Hypothesis (DSH), which predicts that copepod phototaxis will reflect recently invaded, as opposed to ancestral, environments. Phototaxis experiments were conducted to determine the polarities and spectral responses for two species each of the Orders Calanoida and Harpacticoida. *Parvocalanus crassirostris* is a typical calanoid in that it lives in the water column, while *Pseudodiaptomus pelagicus,* an unusual calanoid, has a benthic association. In a similar comparison, *Tisbe biminiensis* is a typical, benthic-dwelling harpacticoid, while *Euterpina acutifrons*, also harpacticoid, lives in the water column. The polarity of phototaxis for all species, meaning their direction of movement relative to the light stimulus, was consistent with the DSH in that their responses are likely to sustain them in their respective habitats. On the other hand, spectral sensitivities, revealed as their preferred wavelengths of light, may persist as artifacts of ancestral preferences.

Engaging Our Future Generations through Service Learning by Adopting Mangroves for the Indian River Lagoon Shoreline Restoration Project

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The Indian River Lagoon (IRL) Shoreline Restoration Project (SRP) is dedicated to naturally restoring the shorelines of the IRL by replenishing the once mangrove dominated shoreline through volunteer driven plantings of the native red mangrove (*Rhizophora mangle*). In order to succeed with this endeavor, the IRL SRP recruits passionate volunteers of all ages to help raise and care for young red mangroves. Perhaps the most essential volunteers are those still in school; our future generations. It is through hands-on learning that students retain the most knowledge and can truly feel like they are making a difference. The mangrove adoption process begins with a brief presentation, followed by volunteers selecting a mangrove propagule of their own to nurture for many months to come, and concludes with the mangroves being planted along an eroding shoreline of the IRL. The goal of the SRP is to not only restore the shorelines of the IRL, but to also make a lasting impact on as many lives as possible, in hopes of shaping them into good environmental stewards of the community.

Does *Aureoumbra lagunensis* (Brown Tide) Negatively Affect Eastern Oysters (*Crassostrea virginica*)?

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Harmful algal blooms caused by the marine microalga *Aureoumbra lagunensis* were identified in Mosquito Lagoon (ML) in 2012 and 2013 in areas where intertidal oyster reefs, comprised of the eastern oyster (*Crassostrea virginica*), provide important ecosystem services including habitat for commercially important species, erosion protection, and water filtration. Ongoing monitoring of *C. virginica* indicates that depressed oyster recruitment may be associated with *A. lagunensis.* As

of November 2014, new blooms of *A. lagunensis* have not been reported for ML. 2014 recruitment for the month of May (month of peak *A. lagunensis* densities in 2013) increased by 300% from the previous year. To determine the effects of *A. lagunensis* on *C. virginica*, larval settlement during exposure to *A. lagunensis* will be tested using recirculating, raceway flumes. Additionally, growth and survival of juvenile *C. virginica* will be analyzed following acute, laboratory exposure to *A. lagunensis* and subsequent transplantation in the field.

Morphometric Comparisons in Stranded Bottlenose Dolphins from the Indian River Lagoon and Atlantic Coast, FL

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Post-mortem examinations of stranded marine mammals have been conducted on marine mammals by FAU Harbor Branch staff since 1999. The current study is the first quantitative assessment of body condition among Atlantic Bottlenose Dolphins (*Tursiops truncatus*) stranded along the eastern coast of Florida. Morphometric measurements were compared across age, gender, season, cause of death and residency (Indian River Lagoon or Atlantic Ocean). In addition to the comparative analysis, a secondary objective was to calculate age and gender specific morphometric reference ranges. Results highlight important differences in size by multiple parameters. The data may be used in future investigations in order to aid in age determination for stranded dolphins.

Blue Crab Population in Peril in the Indian River Lagoon: Trends in the Population (Abundance and Diversity) of *Callinectes* Crabs in the Goat Creek Region

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Callinectes sapidus is a keystone species in the Indian River Lagoon (IRL), serving as a vital decomposer and both a predator/ prey species. Locally, blue crabs are an important food source and industry. This research examined the abundance and diversity of *Callinectes* in Goat Creek, Kidd Creek and Trout Creek, IRL tributaries in Valkaria, Florida during September 2014 – early January 2015. Crab catch was evaluated from a total of 102 trials in Goat Creek, 58 trials in Kidd Creek, 37 trials in Trout Creek and 5 trials in the Sebastian Inlet area of the IRL. Three species of swimming crabs were caught, totaling 39 individuals; 14 *C. sapidus*, 8 *C. similis*, and 17 *C. bocourti.* Using mark-recapture population calculations, the estimated *Callinectes* population in the Goat Creek region of the IRL decreased in 2014 to only 156 from an estimated 218 crabs in 2013 and 682 crabs in 2010.

The "Best Places for Dolphins to Live" Index: Creating a Metric for Local Citizen and Government Involvement in Protecting IRL Dolphins

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Although dolphins are capable of long-range movements, those in the Indian River Lagoon demonstrate limited home ranges and lifetime site fidelity, forming distinct communities. Our goal is to develop a "Best Places for Dolphins to Live" index that ranks lagoon areas based on individual and population-level survivability and well-being profiles of resident dolphins. Essential to this task will be investigations of population data such as abundance, density, birth and death rates, and multifactorial data such as dolphin health, fisheries entanglements, vessel

strikes, water quality, seagrass beds, prey availability, and fish-tissue contaminants for the five counties surrounding the estuary. The profiles will be used to characterize localized impacts on dolphins and their habitats, identify habitat areas of concern and the targeted educational messages that may benefit them, and provide county agencies with dolphin demographics and risk analysis models for evaluation and development of policy.

The Manatee Project at Harbor Branch, a Five-Year Summary

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In 2009, the Manatee Project began systematically monitoring the manatees entering the ship channel, west basin, and small boats marina. Land-based observations and photo-identification methods were used to accrue data on the manatees. Over 300 individuals have now been photographed and given preliminary identifications. Photos of distinct individuals have been shared with the Manatee Individual Photo-identification System (MIPS) run by the USGS in Gainesville, FL. The manatees coming to Harbor Branch represent a mix of transient migrants that use the channel as a stopover during migration and resident manatees that are found in the channel in summer and winter. Numbers of individuals are much higher in the winter and the west basin appears to be a warm water refuge. Behavioral observations indicate the west basin and small boats marina are used for a number of purposes – primarily resting, warmth, feeding, drinking, and mating.

The Power of Partnerships: Working with Regional Partners and Local Citizens to Restore and Monitor the Northern Indian River Lagoon

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Projects based on cooperative partnerships through the Marine Discovery Center (MDC) engage residents and visitors in restoration and monitoring of the IRL. Partnering with non-profit organizations, state and federal agencies, biologists, university professors, students, and citizen scientists creates a dynamic combination of skills and specialties. Collaborations in Volusia County such as Adopt-An-Estuary and Project H_2O provide hands-on education, relevant data, and a unified message through multiple partner agencies. The Shuck and Share oyster recycling project is a successful partnership between Brevard Zoo, the University of Central Florida, and MDC to restore oyster beds in the IRL through education, outreach, and research. Volunteers use recycled shell from seafood restaurants to create oyster mats and bags for shoreline restoration, then help rebuild local reefs. Partnerships like these improve efficiency and sustainability, allow access to additional resources and expertise, increase capacity and accountability, and allow MDC and others to serve a broader community.

Seagrasses Guide to Surviving a Superbloom!

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Prior to a massive phytoplankton "superbloom" event in 2011, many of the seagrass beds in the IRL were close to achieving their deep edge depth targets established by St Johns River Water Management District in 2005. However, despite seagrass expansion into deeper water, there appeared to be a "thinning" of seagrass density within many beds during the past 10 years. A standard depth range between 0.4 and 0.8m was found to have the densest and most stable seagrass cover. This depth range, named the core dense zone (CDZ), allows for comparison between seagrass transects. Analysis of seagrass density within the CDZ determined this thinning was more prevalent in areas of higher interannual variability. Stable CDZ appeared to be the most important factor affecting seagrass resiliency during and after the superbloom. The seagrass beds with highly variable density, and/or a density level lower than a functional threshold, have suffered the most loss and have been the slowest to recover.

Application of Molecular and Flow-Cytometric Tools for Characterizing Pico- and Nano-Plankton Communities in the Indian River Lagoon

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The Indian River Lagoon (IRL) has recently experienced several "superblooms" of pico- and nano-plankton that are difficult to monitor using microscopy. Accordingly, we are working to generate tools to screen water samples for small size classes of phytoplankton with a focus on green-tide chlorophytes and the brown-tide pelagophyte *Aureoumbra lagunensis*, both new bloom-forming organisms in the IRL. Our primary objectives involve combining laboratory and field-based approaches to develop and refine molecular tools for detection of target taxa, and implementing these approaches in field monitoring. Community-based tools, including DNA fingerprinting and flow cytometry, have been used to show that changes in pico- and nano-plankton biomass and community composition occur in the IRL over space/time, and in field samples following 24-hour storage. This work is being used to inform field collection and laboratory processing procedures, ultimately increasing monitoring and event response capabilities.

Temporal and Spatial Variation in the Recruitment of Epifauna in the Indian River Lagoon

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The recruitment of sessile invertebrates has been monitored at two IRL sites in Fort Pierce since June 2004. At each site four 100 cm^2 PVC panels were exposed for 2 week periods. At the end of each period the panels were collected and replaced by clean panels. All species of attached invertebrates on the panels were identified and counted. Recruitment was found to occur throughout the year and the fauna at the different sites was similar. However, the abundances of recruits of most species varied significantly between the sites. Differences were consistent for most species with one site always having the higher abundance of recruits. Individual species exhibited different patterns of temporal variation from seasonal to random. We also have been using an individual-based spatially-explicit model to examine broader patterns of recruitment throughout the IRL.

Restoring Habitat for the Selfless Shellfish: Community-Based Restoration, Research and Monitoring of Intertidal Oyster Reefs in Mosquito Lagoon, FL

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Brevard Zoo partners with the University of Central Florida through a community-based restoration program to increase the number of live oysters (*Crassostrea viriginica*) in the Indian River Lagoon (IRL). Oysters offer unique ecological functions to the IRL system including filtration, habitat, food sources, and sediment stabilization. Impacts have been observed due to increased recreational boat activity through the formation of "dead margins," piles of disarticulated shells and sediment that has been carried toward the shore and exceed the mean high water line. Dead margins are leveled out to prepare for oyster restoration mats to be placed over to serve as building blocks for a reef offering suitable substrate for new oyster recruitment. Oyster restoration mats are constructed by volunteers and citizen scientists through public workshops, private events, and school visits. Continued success is exhibited by the acres of restored footprint area and exceeded goals in terms of oyster recruitment, habitat improvement, and community engagement.

Moving Oysters to Save the Indian River Lagoon: Assessing Growth Rate and Survival of *Crassostrea virginica* in New Location

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Mosquito Lagoon provides a well-established ecosystem for intertidal reefs of the eastern *Crassostrea virginica;* however, the number of reefs dramatically decreases at Eldora State House and further south. We investigated the possibility of survival and growth of eastern oysters in this transition zone (Eldora House) and approximately one mile south of this location (Castle Windy). During the project, 10 oyster mats with attached live oysters were transferred to each of these two locations. Additionally, ten new oyster mats were deployed at each site to measure larval recruitment. Survival was high at both sites (80%), all oysters grew, and there was no recruitment during the spring 2014 experiment. We suggest from this trial that *Crassostrea virginica* can be transported to new locations in the Mosquito Lagoon, deployed and be successful.

General Survey and Grazing Characteristics of Infauna and Epifauna in the Northern Indian River Lagoon System

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Major planktonic blooms of long duration (months) have become more frequent in the Northern IRL, with negative outcomes for species of commercial interest and species offering critical ecosystem services. The role of benthic infaunal and epibenthic species on the control of planktonic blooms is largely unknown. We are investigating the grazing characteristics of common infauna and epifauna species in the northern IRL as part of the St. Johns River Water Management District's IRL Algal Blooms Investigation (IRL-ABI). The aims of our project are to: 1) improve knowledge of infaunal and epifaunal grazers, and 2) improve an understanding of grazing pressure and its potential to act as a "top-down" control on phytoplankton blooms. This

sampling effort of infauna and epifauna combined with field and laboratory experiments should give insights into how estuarine communities cope with harmful algal blooms or other environmental changes.

Seahorse Roundup: Establishing a Genetic Baseline for the Lined Seahorse through Citizen Science

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The Vero Beach Marine Laboratory is working with local citizens and to map the genetic diversity of the lined seahorse (*Hippocampus erectus*), within the Indian River Lagoon (IRL). Small fin tissue samples have been collected and have undergone genetic analysis. This will allow us to get an overarching picture of the genetic diversity of seahorses, a species sensitive to ecological changes. The IRL underwent a massive loss in seagrass coverage since 2009, and has caused substantial shifts to the IRL communities. Since seahorses are highly dependent on seagrass beds, we hope that our genetic surveys can provide a measure of how the higher order taxa have been impacted by these shifts through the measures of genetic diversity and connectivity. Furthermore, this information is crucial to understanding the population genetic structure of the lined seahorse, and sets a baseline for further biological studies and conservation plans.

Florida Atlantic Coast Terrapin Team: Diamondback Terrapin Conservation through Partnerships, Citizen Participation, and Educational Outreach

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In partnership with Florida Department of Environmental Protection Indian River Lagoon Aquatic Preserves, Florida Institute of Technology, St. Johns River Water Management District, and other community partners, Brevard Zoo has utilized educational outreach and citizen participation in raising awareness about diamondback terrapins in the Indian River Lagoon. A successful citizen reporting program has helped focus research efforts and provided a better understanding of terrapins living in the Indian River Lagoon. Through the use of social media, posters, brochures, animal ambassador presentations, and other outreach methods the Florida Atlantic Coast Terrapin Team is educating the community on this unique turtle, its threats, and what individuals can do to help protect diamondback terrapins. This partnership serves as a resource for terrapin outreach on Florida's Atlantic coast and the program represents a model for future conservation projects in targeting other species, issues, or areas in need of attention.

Modeling the Flushing Response to the Construction of a Low Crested Weir Connecting the Banana River to Port Canaveral

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The purpose of this study is to determine the extent to which constructing a low crested weir adjacent to Port Canaveral can improve flushing in this region. Although Banana River has an outlet to the ocean through the Port Canaveral locks, the locks remain closed when there is no

passing vessel resulting in limited circulation, long flushing time and poor water quality. Recent high mortality events in the lagoon ecosystem can be linked to the decline in the water quality. ADCIRC 2DDI is used to simulate the hydrodynamic properties of the study area and determine the velocity field. Passive particles are placed in the Banana River, and their movement is tracked using LPTM. Flushing and residence time are then computed. Results indicate a significant improvement in tidal flushing in both the Banana River and the central Indian River Lagoon after the addition of the weir to the domain

Chronic Interstitial Pneumonia and Lobomycosis in a Stranded Indian River Lagoon Bottlenose Dolphin: A Case Study

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In August, 2014 FAU Harbor Branch recovered a deceased Atlantic Bottlenose Dolphin in the Indian River Lagoon. The female dolphin was a known IRL resident with ulcerative peduncle dermatitis later confirmed as lobomycosis. Goss findings included a thickened pericardial sac and multiple nodular lung lesions. Histopathological examination showed chronic-active interstitial pneumonia with fibrosis and pulmonary edema. Bacterial culture of lung was negative for growth of bacteria or fungi and fungal organisms were not identified histologically with special stains. Serological screening was negative for morbillivirus. Dolphins with lobomycosis exhibit severe impairment of adaptive immunity which could have been associated with the development of the pulmonary lesions. This case highlights many of the pathological manifestations of multiple diseases that are prevalent among resident dolphins within the IRL. The findings demonstrate potential links between dolphin health and environmental perturbations.

Propagule Trapping: A Field Study to Determine if Shoreline Restoration Facilitates Additional Recruitment of the Red Mangrove, *Rhizophora mangle*

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The purpose of this study is to monitor the successful recruitment of *Rhizophora mangle* propagules, along the restored shoreline of Turtle Mound National Historic Site in Canaveral National Seashore. To evaluate the success of *R. mangle* propagule recruitment on natural intact, natural damaged, and restored shorelines, I examined equivalent lengths of these three shoreline types. In the first part of the study, I recorded many variables affecting recruitment success rate such as propagule counts, lengths, and damage. In the second part of the study, distribution was monitored by GPS, tracking 243 tagged propagules dispersed between each site. The results showed that eroded sites have a significantly lower recruitment rate of propagules than non-eroded sites. The recruitment at the restored site was not as high as expected, possibly due to other variables such as the age of the site or the shell midden qualities of the site.

Effects of St. Lucie Estuarine Discharge Water and Temperature on Corals and their Symbionts

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Coral health declines have been linked to anthropogenic changes in water quality and temperature. This project will look at direct effects of estuarine discharge water on corals. St. Lucie Reef near Stuart, FL receives increased estuarine efflux resulting from South Florida watershed changes. This research will supplement existing *in-situ* monitoring on St. Lucie Reef with *ex-situ* experimental design to investigate the individual and interactive effects of estuarine discharge water and temperature on two coral species. Ambient and elevated temperatures (25°C and 30°C) and offshore versus discharge water collected from St. Lucie Inlet will be used. Light, salinity, and DO will be controlled across experimental treatments and replicates. Potential effects on corals will be evaluated through response variables including growth rate, coral stress gene expression, zooxanthellae density, and chlorophyll concentration. Experimental and *in-situ* data will support collaboration and data sharing with local agencies to inform South Florida's resource management policies.

Variation in Growth and Biomass Partitioning of *Rhizophora mangle* in Response to Flotation Time and Light Availability

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Mangroves are migrating northward and displacing salt marsh around the world due to a combination of biotic and abiotic factors. We hypothesized that propagule flotation time and light availability strongly influences initial seedling establishment and subsequent productivity of *Rhizophora mangle*. Propagules were collected on the east coast of Florida and floated in seawater for 0,1,2,3, or 4 weeks. Propagules were then planted and grown under two light levels (sun and shade) following pre-determined flotation times. Propagule establishment followed a polynomial curve; however, neither flotation nor light availability were significant factors. Propagule chlorophyll concentration, biomass, and leaf C:N decreased with flotation time and light availability significantly altered biomass allocation and leaf C:N. We suggest that *R. mangle* seedling productivity is driven in part by spatial and temporal factors. The most productive seedlings will float for short periods and establish in areas where they are not limited by light.

Do Porcelain Crabs Prefer Flow Generating Substrate from Oysters?

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The Indian River Lagoon (IRL) is one of the most diverse habitats of its kind but it is threatened as a result of human activities. One such threat consists of invasive species that are changing the ecosystem of the IRL. Porcelain crabs (*Petrolisthes* sp.) are an invasive, suspension feeding, anomuran crab that potentially compete with native filter feeders. These crabs are distributed worldwide and are often found in connection with organisms that generate flow (e.g.: sponges, oysters). However, habitat preferences have not been well studied in these crabs and it is not known if they preferentially choose flow generating substrates. This experiment will investigate habitat preferences of porcelain crabs on oyster reefs. Choice assays will be set up with clumps of

live oysters and cleaned shell hash to observe porcelain crab habitat preferences. This study will help determine if porcelain crabs preferentially choose habitat that generates flow.

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

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

"Tiger Stripe" Phenomena in Indian River Lagoon Dolphins

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An unknown skin abnormality, which we refer to as "tiger stripes", has been identified in IRL dolphins through photo-identification surveys; the condition is a form of scarring which presents as parallel dorsal-ventral stripes on the torso (body) of the dolphin. We suspect the "tiger stripes" may be indicative of rapid weight gain and loss such as pregnancy or illness resulting in emaciation, similar to human "stretch marks". If so, this condition could be utilized as a pre-mortem marker of emaciation in IRL dolphins and may be useful as a means of identifying precursor events to Unusual Mortality Events and others with a similar etiology, which are often distinguished by emaciated animals. We have completed a preliminary analysis of this condition with the objectives of (1) determining whether the condition is more prevalent in recently pregnant females, a marker of rapid weight gain/loss, and (2) examining the spatial and temporal distribution.

Model Based Estimate of Nutrient Budget for the St. Lucie Estuary

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Nutrient budgets have important implications for estuarine systems. A nutrient budget was developed for the St. Lucie Estuary using a three dimensional water quality model which simulates the transport and biogeochemical processes of nutrients. The model was calibrated with measured data collected over a 6-year period. Budgets were developed for total and inorganic forms of nitrogen and phosphorus. Both external and internal sources were considered in the

budget. The external sources include nutrient loads from major tributaries estimated with monitoring data at the structures (C-44, C-23, C-24 and Ten Mile Creek) and with a watershed model from the tidal basins. The internal sources representing exchanges of nutrients between sediment bed and the water column were simulated by the water quality model. Model results suggest that transport is a dominant factor in nutrient budget supporting on-going nutrient load reduction programs implemented in the watershed.

Bacterial Biofilms in the IRL: Invisible Influencers of Ecosystem Structure

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Bacteria are a dominant component of marine biofilms found on nearly all submerged surfaces. These microbes have the potential to shape benthic community structure by influencing larval settlement, recruitment success, and dispersal of benthic macroorganisms. The role of bacterial biofilms as possible ecosystem engineers is gaining attention, but little is known about benthic bacteria in the Indian River Lagoon. This study investigates bacterial biofilm composition, diversity, and variation between two IRL inlets, and details how biofilm transport between the two inlets affects microbial community structure. DNA analysis of IRL biofilms detected 24,351 OTUs. Up to 23% of all OTUs were unique among location groups. The presence of these unique taxa, and varying proportions of shared taxa, indicate that overall bacterial community composition can be distinct. The potential for bacterial biofilms to drive fouling community development, succession, and biological invasions will be discussed.

The Effects of On-site Sewage Treatment and Disposal Systems on Urbanized Canals and the St. Sebastian River in Indian River County, FL

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Effluent from on-site sewage treatment and disposal systems (OSTDS) is generally known to impact groundwaters and surface waters with nitrogen (N), phosphorus (P), fecal bacteria, and other contaminants, but little research has quantified this problem along the Central Indian River Lagoon (CIRL). This study assessed the effects of the 26,660 OSTDS, located in Indian River County, on the surface and groundwaters along three urbanized canals and the St. Sebastian River (SSR) that flow into the CIRL. Multiple lines of evidence were used to define the source of the nutrient loadings including using the artificial sweetener, sucralose, as an indicator of human sewage impact. Sucralose levels were correlated with elevated N concentrations found in surface waters and $\delta^{15}N$ levels found in macrophyte tissues. The results demonstrate that high densities of OSTDS have the potential to be a significant source of nitrogen and contaminant loading to the Indian River Lagoon.

Morphological diversity of *Halodule wrightii* genotypes of the Indian River Lagoon, Florida

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Intra-specific diversity of foundation species has important ecological consequences, particularly in communities where species diversity is low. Trait diversity of seagrass has been shown to confer resistance/resilience in response to disturbance events to affect habitat structure and long-term stability. First, we quantified morphological variation among genotypes of the seagrass

Halodule wrightii. We conducted a common garden experiment at the Florida Oceanographic Society (FOS; Stuart, Florida). From the Indian River Lagoon (IRL), Florida, we collected ~30 unique clones from six sites that varied in relative amount of seagrass loss as a result of the 2011 die-off events. These clones were grown in the same environment at the FOS for 11 weeks to identify if unique morphological traits were maintained between genotypes. Secondly, we are investigating if this morphological variation is related to potential loss/gain of genotypes during these die-off events by quantifying the genotypic diversity of *H. wrightii* in the IRL.

My 7th Grade Science Project: The Effect of Nutrients on the IRL

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This simple experiment illustrates what happens when nutrients are added to the IRL system and given sufficient time for phytoplankton to grow.

Oyster Reef Restoration in Mosquito Lagoon: 7 Years of Data and Success

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In Mosquito Lagoon, one of the primary threats to reefs of the intertidal oyster *Crassostrea virginica* is wakes from recreational boats. Wakes dislodge live clusters and tumble them into piles that extend above mean high water. Because the area is microtidal, the clusters do not roll back down and the oysters subsequently perish, with only bleached piles of disarticulated shells remaining. No-wake zones are unlikely to be developed for this popular fishing area, so restoration protocols were developed that could withstand intense boating activities. Since 2007, 68 reefs (2.01 acres) have been restored with the assistance of over 40,000 volunteers. With an average of over 700 live oysters m^{-2} on restored footprints, significant increases in live oyster numbers are also now documented surrounding these footprints. Restored reefs are able to increase in thickness to keep up with local sea level rise patterns.

Water Quality in the Coastal Oaks Preserve's DOT Canal and Neighboring Impoundments

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The Coastal Oaks Preserve located in Vero Beach contains a DOT canal that runs alongside multiple impoundments. Runoff from the highway flows into the canal and may have an adverse impact on the Preserve ecosystem as well as the Lagoon. The purpose of the study was to determine trends in water quality among the eight sites from the entrance of the property to near the mouth of the canal. Samples have been taken weekly, starting in October 2014. The water quality parameters measured include: dissolved oxygen, salinity, pH, temperature, color, presence of coliforms, and *E. coli*. Overall water quality varies from site to site. The data will be vital in the management of the Coastal Oaks Preserve and in determining how the DOT canal and impoundments impact the Lagoon ecosystem.