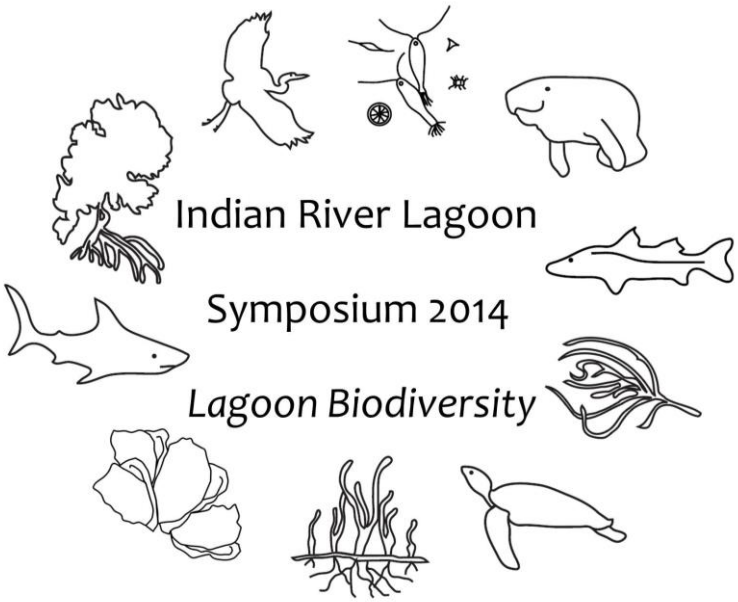
Abstracts of Technical Presentations



Johnson Education Center
FAU Harbor Branch, Fort Pierce, Florida

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Key Note Address

Spatial Heterogeneity: A Driver of Biodiversity in the IRL

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The Indian River Lagoon (IRL) is not a uniform bowl of heterogeneous water. Rather, it is closer to the opposite. A couple examples: (a) Fishes in the north are of primarily temperate origin, versus tropical origin in the south. These two areas are 2 degrees of latitude apart and separated by a major biogeographic transition, the Cape. (b) Discharges from Lake Okeechobee have no effect on Banana River or Mosquito Lagoon – with poor flushing and the large spatial separation, these north and south parts of the IRL behave almost as separate, independent systems. Huge variation also occurs on very local scales, even a few meters. Plus, there is a huge diversity of shorelines, sediment types, salinity, water quality, flushing rates, tides, temperature, closeness to inlets, and especially vegetated habitats – mangrove forests, marsh, seagrass, and macroalgae. Diversity, especially habitat diversity, is not adequately measured simply as a list. Even the same habitat type varies by location (meters to hundreds of kilometers), adjacent habitat, and time. Any given square meter is different than every other of the 900 million square meters in the Lagoon, and the same square meter is different from season to season and year to year.

Contributed Papers (Oral and Poster Presentations)

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

The Effect of Dikes on Fiddler Crab Populations in the Indian River Lagoon Wetlands

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In the 1950s, the wetlands bordering much of the Indian River Lagoon were impounded for mosquito control. This study aims to determine how the abundance and distribution of crab populations in the Coastal Oaks Preserve, Vero Beach, were affected by mosquito impoundment construction. We are sampling along an elevation gradient, using a steel core (40 cm in diameter and 25 cm deep) to determine the boundaries of each sample. Before collecting each sample, we count the number of burrows and record sediment characteristics. We then collect the top 10 cm of sediment from each core and sort for crabs through each sample by hand. Initial results indicate that burrows and crabs are generally more plentiful near the shoreline of the Lagoon, while inadequate water supply seems to limit crab populations near the dike road. This project demonstrates how human interference hinders the ecological function of the Indian River Lagoon.

Persistent Organic Pollutants in the Indian River Lagoon: Stingrays and Sharks as Monitoring Tools

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Persistent organic pollutants (POPs) present in abiotic and biotic compartments of the Indian River Lagoon (IRL) system have not been extensively studied. Initial analyses suggest that some POPs, such as polychlorinated biphenyls (PCBs), in marine biota from the IRL can be at concentrations high enough to potentially cause negative effects on immune and reproductive systems. We examined an array of POPs (e.g. PCBs, DDT and its metabolites, chlordane compounds) in Atlantic stingrays and shark species from the IRL. Juvenile bull sharks typically contained higher concentrations of POPs compared to Atlantic stingrays. Given their widespread distribution, benthic feeding ecology, low trophic-level, limited movement patterns, and relatively small home range, the Atlantic stingray may serve as a key indicator species for POPs in estuarine waters of the southeastern U.S. Our initial POPs results suggest that certain habitats in the IRL (e.g., coastal estuarine rivers) continue to retain legacy contaminants (e.g., PCBs) and may also harbor emerging contaminants.

Benthic Habitat Mapping in the Indian River Lagoon, Florida Using Hyperspectral Imager for the Costal Ocean

Deya Banisakher[1], Hyun Jung Cho[1], Deepak Mishra[2], and Lori Morris[3]
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The Hyperspectral Imager for the Coastal Ocean (HICO) is a satellite hyperspectral sensor with a high signal-to-noise ratio that can facilitate benthic habitat mapping. Benthic classification using satellite data has been proven to be an efficient method for evaluating spatially continuous benthic coverage. Spectral differentiation between seagrass and macroalgae is made convoluted

because the 'red absorption' and the 'Near InfraRed reflectance' by the plants decrease as water depth increases. We obtained HICO images for our study site, the Indian River Lagoon, along with areal imagery and ground truth data. We have developed two new methods for benthic vegetation classification, $Slope_{RED}$ and $Slope_{NIR}$, and evaluated their performance with conventional unsupervised Iterative Self-Organizing Data Algorithm and supervised Spectral Angle Mapping. The results demonstrate more dependable accuracies for the $Slope_{RED}$ and the $Slope_{NIR}$ algorithms when compared with conventional algorithms. The slope algorithms improved benthic mapping and classification.

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

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Vibrio bacteria 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 study is the first to document the presence of *V. vulnificus, V. parahaemolyticus* and *V. cholerae* in the Lagoon, creating a baseline for future monitoring. A combination of cultivation and molecular techniques will be used to evaluate local hotspots, seasonality, source associations and virulence. Preliminary findings suggest an important health concern for recreational users, specifically fishermen. Broader impacts include educating the public, medical care providers, and managing agencies of potential hazards in order to promote awareness, prevent exposure and reduce illness.

Water Correction Model for Improved Benthic Mapping

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Benthic mapping accuracy would be improved by applying well calibrated water correction models. Our study goal is to calibrate and validate our water correction algorithm using satellite Hyperspectral Imager for the Coastal Ocean (HICO) data to improve benthic mapping for Indian River Lagoon. We have continued laboratory and field experimental approach to model the depth-variant absorption and scattering of components of optical properties in shallow coastal waters. The absorption and scattering values will be incorporated into a radiative transfer model to estimate the energy propagation through a water column at varying concentrations and combinations of the optical components. Our calibrated algorithm will be used to extract the upwelling benthic reflectance from the reflectance at top-of-the water, which will greatly enhance the accuracy of benthic mapping in shallow coastal marine environments. After spectral adjustments and validation, the algorithms will be implemented into HICO data for validation.

Use of Floating Individuals of *Halodule wrightii* for Restoration

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Normal methods of transplantation involve the removal of individuals from healthy seagrass beds and planting them elsewhere, causing collateral damage to the donor bed. By collecting floating individuals and using them as a material for transplantation, the collateral damage can be avoided.

By using biodegradable mesh as a base, there is no need to reclaim materials after the process is done. Using individuals collected in Fall 2013 and Spring 2014, I will plant individuals of *Halodule wrightii* at two sites near Fort Pierce Inlet. This will answer the questions of whether or not floating individuals of *H. wrightii* can be used for restoration efforts and if time spent in tanks and location makes a difference?

Avian Diversity at MC-2: One of the Most Important Bird Nesting Sites in the Indian River Lagoon

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MC-2 is a 1.2 acre (~0.5 ha) island in the IRL near Sewall's Point in eastern Martin County. Bird monitoring conducted as a component of a grant-funded shoreline stabilization project produced over 8,400 records of 46 species, including year-round inhabitants, winter residents, summer residents, and migrants. Successful nesting was documented for 15 species, including wood storks, brown pelicans, oystercatchers, various species of herons and egrets and the first documented nesting of roseate spoonbills in Martin County. Other notable observations included photo-documentation of several individual birds that had been banded in other areas of Florida and along the U.S. east coast, nesting by double-crested cormorants during 12 consecutive months, the presence of magnificent frigatebirds, Egyptian geese and one observation of four flamingos. As a result of recurring human-related disturbance, MC-2 is currently being considered for designation by the Florida Fish and Wildlife Conservation Commission as a Critical Wildlife Area.

Seasonal Carbon, Nitrogen, and Phosphorus Dynamics in the St. Lucie Estuary with Variable Inflows from 2002-2008

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Interactions among geomorphology, circulation, and biogeochemical cycling determine estuary responses to external nutrient loading. The goal of this study was to assess carbon (C), nitrogen (N), and phosphorus (P) dynamics in the St. Lucie Estuary (SLE) using nutrient budgets. Seasonal budgets for water, salt, and dissolved inorganic nitrogen and phosphorus (DIN and DIP) were generated from 2002-2008. Water column concentrations declined as the net cycling of C, N, and P approached zero with reduced inflow and flushing times > 10 days. Estuarine DIN concentrations increased with watershed DIN loading as denitrification did not offer a pathway of N loss to the atmosphere. Net primary production increased significantly with external DIP loading including a bloom of *Microcystis aeruginosa* following hurricane-induced DIP loading in 2005. Watershed management plans should consider variations in DIN and DIP loading with inflow relative to internal material cycling in both dry and wet seasons.

Using a Community-Based Social Marketing Approach for Ecosystem Protection in the Indian River Lagoon

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Recreational boating activity is threatening the habitats and biodiversity of the Indian River Lagoon. Keystone species (oysters, seagrasses, mangroves) in the area have been negatively impacted by boat propellers, boat strikes, and boat wakes that can erode shorelines and dislodge oysters. In collaboration with social scientists, we are testing a community-based social marketing (CBSM) program to increase voluntary ecologically responsible recreational boating. Eco-sensitive zones in Mosquito Lagoon warranting better protection have been identified, and a smart phone navigational application is being developed to assist boaters in identifying these zones. Boating activity and shoreline erosion are being recorded at highly impacted and ecologically-stable control sites before and after the CBSM program. We will analyze any changes in boater activity, erosion, reef death, or propeller scarring following the CBSM program to determine its effectiveness in protecting the estuary from negative human impacts.

Water Quality and Seagrass Coverage in the Indian River Lagoon South

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Seagrasses are an important valued ecosystem resource in the Southern Indian River Lagoon (SIRL) and the distribution and abundance are closely related to water quality. Using boosted regression trees, relationships between seagrass coverage and water quality were examined using data collected in 5 segments in the Southern Indian River Lagoon during summers from 2000-2012. Water quality parameters analyzed were salinity, color, turbidity, chlorophyll *a* (Chl *a*), secchi disk depth (SSD), and nutrient concentrations [total nitrogen (TN) and total phosphorus (TP)]. Results showed that TN, TP and turbidity were more important factors influencing seagrass coverage relative to salinity, color, Chl *a* and SSD during the study period. This is likely due to co-occurrence of higher seagrass coverage with higher TN and TP concentrations in the north segments (22 and 23) and with lower turbidity in the south segment (26), respectively. The different associations suggest that the suite of water quality parameters that influence seagrass coverage may vary spatially along the SIRL. Additional analysis will be conducted to test this hypothesis.

Indian River Lagoon Observatory: Lessons Learned from Real-time Water Quality Monitoring in a Highly Productive, Dynamic Environment

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Two Land/Ocean Biogeochemical Observatory (LOBO) units were deployed on June 11, 2013 to provide real-time, high-accuracy and high-resolution water quality/weather data through a dedicated interactive website. Following 6 months of LOBO deployment, we better understand both the challenges and advantages associated with real-time monitoring. The biggest challenge facing water quality monitoring in the highly productive the Lagoon is biofouling, however real-time data acquisition allows immediate response to bad data events driven by biofouling. Continuous monitoring by the LOBO successfully allows the capture of dynamic events such as cold fronts and high rainfall in a near-real time capacity that is typically missed with discrete

sampling. Together, the mitigation of biofouling effects as well as high-frequency data acquisition will provide scientists of various disciplines from many organizations the ability to better quantify and model relationships between environmental factors and biological processes in the Lagoon.

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.

Dietary Preference and Gill Raker Morphology of *Albula* sp. cf. *vulpes* in the Indian River Lagoon, FL

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Bonefishes support very valuable recreational fisheries in the Florida Keys, Bahamas, Caribbean Islands, and around the Gulf of Mexico. Recent genetic research has shown that the well-known *Albula vulpes* is actually a multi-species complex. In fall 2012, large numbers of juvenile bonefish were found for the first time in the middle Indian River Lagoon, far north of their typical habitat. Genetic analysis identified these fish as the as-yet undescribed *Albula* sp. cf. *vulpes*. Gut content analyses of the juvenile *Albula* sp. cf. *vulpes* from the Indian River Lagoon showed that these 29-105 mm juveniles fed primarily on harpacticoid copepods and opportunistically on larger invertebrates such as mysids. Gill raker morphology is unusual and not indicative of winnowing. Hypotheses about the reason for the occurrence of juvenile bonefish outside their traditional habitat include natural recruitment variability, variation in thermal regimes, and loss of seagrass in the Indian River Lagoon.

Florida Oceanographic Oyster Restoration Education

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School children helping with Eastern Oyster (*Crassostrea virginica*) restoration is not a new concept. Along the east coast of the United States there are many restoration activities that involve students. However the scientific concepts behind those activities are not always part of those programs. The Florida Oceanographic Oyster Restoration Education grant (FL.O.O.R.Ed) allowed the collaboration between the research department and the education department to develop curricula that were in alignment with Florida's Next Generation Sunshine State

Standards for Science Grades 9-12. The grant included classroom and field time for monitoring the environmental conditions of reefs. Eight standards of moderate cognitive complexity and seven standards of high cognitive complexity were written into the curricula illustrating the basic principles of the animal kingdoms, community and population influences and the significance of environmental, genetic and political factors. Student comprehension of the standards increased in both the spring semester and the fall semester.

Taxonomic Descriptions of Novel Cyanobacteria with Ecological and Biomedical Relevance in the Indian River Lagoon

Niclas Engene and Valerie J. Paul
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Cyanobacteria seasonally form extensive blooms in the Indian River Lagoon (IRL) that produce potent and biologically active secondary metabolites. Many of these bioactive molecules can be hazardous for humans and the natural environment, while others have promising pharmaceutical and other biotechnology applications. In our efforts to provide taxonomic clarity, we show that several of the most prevalent cyanobacteria in the IRL, in fact, represent novel genera. Here we characterize and compare the ecology, morphology, evolutionary history, and secondary metabolism of these new taxonomic groups. We will also discuss some of our efforts to develop high-throughput, rapid, and robust chemotaxonomic and genetic screening methods that can be used to efficiently detect, predict, and monitor potential hazardous toxin-producing strains of cyanobacteria. These taxonomic descriptions and identification methods are essential for efficient monitoring, predicting, and controlling harmful cyanobacterial blooms in the IRL and Southern Florida.

After the Blooms: Is Seagrass Recovery in the Indian River Lagoon Recruitment Limited?

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Two years after catastrophic seagrass losses due to the 2011 Superbloom, some sites have begun to recover, but large areas of the Lagoon show no recovery, despite seemingly adequate water quality for growth. In July 2013, we established experimental plots at three sites to determine if seagrass recruitment might be limiting recovery. We surprisingly discovered that a major impediment to recolonization at two sites (near Pineda Causeway and Turkey Creek) may be grazing; plugs not protected by cages were rapidly grazed. At our third site (Wabasso), grazing was not significant. With caging, survival rate at all sites has been 100% to date, although cages have begun to negatively impact survival and growth. Our initial results suggest that, in the absence of grazing pressure, environmental conditions present at all three sites are favorable for seagrass recovery. Of course, we do not know how the transplants will fare over the winter …!

The Indian River County Junior Scientists Fellows Program: Research by the Next Generation to Preserve Our Natural Resources for All Generations

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Our two organizations have formed a unique partnership to fully engage high school students in the research and care of the environmentally sensitive 185-acre Coastal Oaks Preserve acquired by the Indian River Land Trust in 2011. We launched a pilot project in October 2013 with an initial cohort of 13 student Fellows in grades 10-12 from Indian River County's three public high schools (Vero Beach, Sebastian, Indian River Charter). A team of scientists and educators is sharing their expertise about problems facing our Lagoon and mentoring the research conducted by the students. They have begun team projects that will provide scientific information needed for conservation management of the Lagoon and its sensitive shoreline habitats. We seek to develop a long-lasting network of young people with authentic scientific research experiences in lagoon environmental management that will result in the next generation having capabilities to make wise decisions for the Lagoon's resources.

Toxic Microalgae in the IRL: Impending Doom or False Menace?

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Of the probable thousand microalgal species in the Indian River Lagoon system, about 10% have potential to inhibit, exclude, or kill marine life in various ways. But there are at least 30 microalgae in the Indian River Lagoon that are potentially harmful to humans, and are known to cause problems elsewhere. Some of these species produce toxins that may be fatal. So far, examples of human illness have been very minimal. Reasons why this is so are environmental, genetic, and may include a bit of luck.

Land Use Changes in the St. Sebastian River Watershed: A 25-Year Comparison

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In recent years, harmful algal blooms, seagrass loss, fish kills, marine mammal mortalities, and general eutrophication have plagued the Indian River Lagoon (IRL). Two primary sources of nutrient enrichment, stormwater runoff and groundwater inputs, are directly tied to watershed land use. Despite the 1995 establishment of St. Sebastian River Preserve State Park, which currently comprises 22% of the watershed directly adjacent to the river, some of the highest nutrient levels in the IRL have been documented near the mouth of this system. Landsat 5 TM images and post-classification change detections were used to identify land use changes between 1986 and 2011 that may contribute to increased nutrient inputs to the IRL. Results indicate a total of 65% land cover change over the 25-year period and 59% increase in urban areas, primarily along the South Prong of the St. Sebastian River, 35% increase in agriculture, and 33% decrease in natural lands.

IRL Update and Review of Upcoming Efforts

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Since the 2011 superbloom, much of the Indian River Lagoon has experienced a series of phytoplankton blooms and adverse effects on seagrasses. Significant loss of seagrasses was documented, some recovery has been noted, and significant reaches remain bare. In response to these events, the St. Johns Water Management District has launched the Indian River Lagoon Protection Initiative, which has at its core the Indian River Lagoon Algal Blooms Investigation. Ongoing and future efforts include sampling and experiments to better understand "bottom-up" stimulation of phytoplankton blooms by nutrients, especially nutrient cycling and nutrient inputs from sediment and groundwater, and "top-down" control of phytoplankton blooms by grazers ranging from microzooplankton to infauna and epifauna.

Genetic Connectivity among Red Mangrove (*Rhizophora mangle* L.) Populations in the Caribbean Sea and Florida

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The red mangrove, *Rhizophora mangle* L., produces large propagules capable of dispersal over long distances in estuarine and/or oceanic waters. During the Last Glacial Maximum, *R. mangle* was restricted to equatorial regions; however, as temperatures increased and sea level rose this species expanded poleward and populations were reestablished throughout the Caribbean and on the Florida peninsula. Utilizing molecular markers, our research suggests that Florida was most likely recolonized by propagules from populations along the Caribbean mainland and not from Caribbean island sources. Gene flow appears to be more frequent to the east coast of Florida and, therefore, these mangroves possess a greater level of genetic diversity when compared to their counterparts in west and south coast populations. These findings provide a broad perspective as to which *R. mangle* populations in Florida may be at a greater genetic disadvantage if stochastic changes occur, especially in light of potential future climatic changes.

Coral and Zooxanthellae Responses to Seasonal Fluctuations and Freshwater Discharge

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The coral reef habitat at St. Lucie Reef persists despite environmental instability from Lake Okeechobee discharges, summer upwelling, and seasonality. Examining the symbiotic algae, zooxanthellae, that reside in corals can provide insight to overall coral physiology during stress events. Two dominant corals at St. Lucie Reef, *Montastraea cavernosa* and *Pseudodiploria clivosa*, were collected over a year and a half, representative of wet (discharge) and dry (non-discharge) seasons. Zooxanthellae were isolated from each coral fragment from four sites along the reef. Responses to light levels synchronized with photochemical efficiency were quantified via cell density and chlorophyll measurements. Both coral species varied in the amount of

zooxanthellae harbored as well as chlorophyll concentrations. Although morphological differences exist between coral species, these coral colonies appear to have similar photosynthetic capacities under variable water conditions. Elucidating the genotypes of zooxanthellae within host species will provide evidence for potential variation underlying observed physiological differences.

Mesozooplankton Populations in the Northern Indian River Lagoon, Florida
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With the search for the causes of the 2011 superbloom still underway, ongoing monitoring of zooplankton populations is being conducted as part of a larger study working to identify the connections between the zooplankton populations in the Indian River Lagoon (IRL) system and their top-down regulation of the problematic phytoplankton populations. Sampling of zooplankton occurs every two weeks at 3 sites along with 2 additional sites every 6 weeks in the Northern IRL which correspond to sites monitored for phytoplankton populations. One way the changes in composition and abundance of zooplankton are being measured is through the settled volumes of zooplankton. This preliminary data serves as a general gauge to the abundance of zooplankton allowing for greater temporal and spatial monitoring.

IRLscience.com, Bringing Together Scientists, Teachers, Students, Legislators, and the Public to be Better Informed about Issues Affecting Our Indian River Lagoon
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This talk will update the symposium on the progress of IRLscience.org. During previous Indian River Lagoon symposiums, attendees expressed a common concern regarding the lack of communication about research and activities occurring within the IRL among user groups. Irlscience.com seeks to condense information about active research and activities occurring in the lagoon from multiple groups into a single site. Current research activities and findings will be synthesized into language easily understood by nonscientists. The site also includes a community calendar where lectures and events around Florida that have a lagoon focus can easily be viewed by the public. The website is seeking participants to share their research and education materials.

Blue Crab Population in Peril in the Indian River Lagoon System: Survival of the Fittest?
Jesse Martin
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In this report, population data suggests *Callinectes bocourti* is dominating *C. sapidus*' native habitat in Goat Creek in current water conditions that may promote the decline and disappearance of *C. sapidus* (and to a lesser degree, *C. similis*) in local waters.

Investigations into Multispecies Mortality Events in the Indian River Lagoon (IRL)
Jan H. Landsberg and Martine de Wit
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Over the past year, FWC researchers and partners have responded to elevated mortalities of manatees and brown pelicans in the IRL. These events followed a dramatic reduction of seagrass

in the area due to long-term, non-toxic phytoplankton blooms. Manatee deaths of unknown cause were first recorded in July 2012, and reached catastrophic numbers by late winter of 2013 when an Unusual Mortality Event (UME) was declared. Until December 2013, at least 117 manatee deaths that fit the UME case definition were recorded. Manatee carcasses were in good nutritional condition with full gastrointestinal tracts, with no apparent cause of death. In contrast, pelicans were emaciated and appeared chronically sick. The two-month long pelican event from February-April 2013 included at least 250 birds. Investigations into the cause of both events and any possible relation with the environmental changes or the bottlenose dolphin UME (NOAA and partners) in the IRL are ongoing.

Impacts of On-Site Sewage Disposal Systems on Urbanized Canals and Tidal Creeks in Southeast Florida

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Effluent from on-site sewage disposal systems (OSDS) is generally known to impact groundwaters and surface waters with nitrogen and other contaminants, but little research has quantified this problem in urbanized tidal creeks along the Indian River Lagoon (IRL). A study conducted from 1994 to 1995 assessed the effects of OSDS on contamination of groundwaters in Jupiter River Estates and surface waters of Jupiter Creek and the Southwest Fork of the Loxahatchee River, which flows into the Southern IRL. The results demonstrate that high densities of OSDS have the potential to be a significant source of nitrogen and contaminant loading to the IRL. These results prompted a similar study along the relief canals and St. Sebastian River in Indian River County that also suggests that OSDS are contributing to high nutrient loadings in that region of the IRL.

Glycosidic Toxins Isolated from the Red Alga *Gracilaria tikvahiae* May Be Linked to Mass Manatee Mortalities in the Indian River Lagoon

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Since 2011, the northern Indian River Lagoon (IRL) has experienced unprecedented, and likely nutrient-driven, harmful algal blooms responsible for the loss of over 47,000 acres of seagrass habitat. In turn, other aquatic plants and macroalgae, including *Gracilaria tikvahiae*, favor the nutrient-rich conditions and are able to flourish. Along with the decline in seagrass coverage, the recent unusual mass mortality of manatees exemplifies the worsening health of the IRL. While the cause of the high mortality rates is still undetermined, it appears there may be an unusual suspect. Preliminary results have identified glycosidic toxins in the common red alga *G. tikvahiae* collected from the Banana River during the spring and summer of 2013. The presence of these toxins may have damaging implications for a system with already compromised health and their consumption may be linked to the record number of manatee deaths in Brevard County in 2013.

Temporal Variation of Benthic Communities and Water Quality Data at the FIT Static Immersion Test Platform North of Sebastian Inlet in the Indian River Lagoon, Florida

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Recruitment and progression in benthic communities are affected by variations in environmental parameters. This study examines monthly variances in water quality and recruitment of benthic organisms on 30 x 30 cm PVC panels at the FIT static immersion test platform 5 km north of Sebastian Inlet. Data have been collected since June 2009 and trends have been observed between water quality changes and benthic community structure. Understanding the effects of water quality on recruitment is important for identifying indicator species and the ecological assessment of the Indian River Lagoon.

Effects of Land Use on Nitrogen and Phosphorus Inputs to the Indian River Lagoon

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Urban and residential land uses in the Indian River Lagoon (IRL) watershed contribute sewage and fertilizers to stormwater runoff, resulting in increased nitrogen (N) and phosphorous (P) loadings that can fuel harmful algal blooms. The goal of this project is to quantify dissolved concentrations of ammonium, nitrate and soluble reactive P in storm water from agricultural, natural, and urban land uses adjacent to seven of the canals and tributaries within the IRL watershed. Preliminary results based on water samples taken at the beginning, middle and end of storm events at 10 sample points suggest initial spikes of soluble reactive P, nitrate and ammonia in storm water runoff. These results represent the first attempt to characterize nutrient concentrations of stormwater among various tributaries and land uses on the IRL.

Phototaxis of Copepods in Relation to Derived Habitat

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We are testing the phototactic responses of a variety of copepods from different ancestries and habitats. Three of four species that we have selected are found in the India River Lagoon. Our *Derived Sensitivity Hypothesis (DSH)* states that the sensitivity of copepod photoresponses should match both the available light spectrum and the light intensity in their habitats. Pelagic and demersal copepods from the orders of Harpacticoida and Calanoida are being chosen to examine photoresponses under different light conditions. According to the *DSH*, pelagic copepods living near the surface should have positive phototaxis and respond to a broad range of color spectra (wavelengths); demersal copepods may exhibit negative photoresponses or respond to a relatively narrow range of wavelengths. By testing copepods from the orders Harpacticoida and Calanoida, groups that have adapted to largely different habitats, it is hoped that the role of evolutionary history can be contrasted with that of the modern, or derived, habitat.

Expansion of the Shoreline Restoration Project: Incorporating Oyster Reef Restoration to Protect Sensitive Shorelines and Increase Biodiversity within the Indian River Lagoon

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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. Over the course of eighteen years, planting techniques have shifted into what is now the saltmarsh vegetation based method used to naturally recruit all three species of mangroves found in Florida, transforming the area into a mangrove dominated shoreline. Taking a more holistic approach, the SRP has recently incorporated oyster reef creation into the existing methodology of shoreline restoration. The goal is to use oyster reefs to increase the stability of eroding shorelines and offer protection to newly planted project sites. Oyster reefs will also provide suitable substrate for oyster spat, encouraging spat to settle onto the reef; helping to recruit and enhance local biodiversity. While the IRL Shoreline Restoration Projects' goal remains the same, the method with which restoration is carried out continues to evolve.

Effects of Brown Tide on Eastern Oyster Recruitment in Mosquito Lagoon

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Blooms of *Aureoumbra lagunensis* have caused numerous fish kills and significant seagrass loss in the Indian River Lagoon, prompting many to become concerned about the status of the IRL's intertidal oyster reefs. The reefs comprised of the Eastern oyster (*Crassostrea virginica*) provide many important services to the ecosystem including habitat for many commercially important fishes, erosion protection, and water filtration. To determine oyster recruitment patterns before, during and after the 2013 brown tide, data were collected monthly from 10 oyster reefs located within Canaveral National Seashore boundaries. Results show that oyster recruitment occurred continuously from April through December 2013. July had the lowest mean recruitment at 76 $\pm$ 48 live oysters / m^2, while October had the highest mean recruitment at 392 $\pm$ 168 live oysters / m^2. We are continuing to collect monthly data on this important topic.

Making Lemonade from Ecological Lemons: Isolating Anticancer Compounds from Bloom-Forming Cyanobacteria

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Cyanobacteria (blue-green algae) produce a diverse suite of secondary metabolites which are utilized for chemical defense and competitive interactions. The proliferation of marine cyanobacteria in degraded coastal habitats is generally attributed to the effects of climate change and anthropogenic increases in nutrient availability. Specifically, here in the Indian River Lagoon (IRL) cyanobacteria can form extensive blooms that can persist for months and negatively impact the ecosystem services provided by the estuary. However, while cyanobacteria pose an ecological threat to the health of the IRL, they have also been found to be a prolific source of novel compounds which are potentially useful in designing new pharmaceuticals. Using field collections, laboratory culturing, chemical isolation and bioactivity assays, we are in the early stages of characterizing novel compounds with potential anticancer properties.

Brevard Oyster Partnership for the Indian River Lagoon (Oyster PIRL): Brevard Residents Will Help Restore Our Lagoon by Raising Native Eastern Oysters along Their Waterfronts

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Brevard Zoo is partnering with Brevard County to lead a community based oyster restoration project that will engage County residents living along the Indian River Lagoon. Participating residents will hang predator exclusion modules from their docks and raise oysters from highly vulnerable baby spat to thick-shelled young adults. On a bi-weekly basis, participants will collect information on oyster recruitment, growth rates and survivability and enter their data into a website organized by Brevard Zoo staff and volunteers. Their oyster data will help identify areas where large scale oyster reefs (to be populated by the young adult oysters raised by program) will both thrive and improve lagoon water quality.

The Indian River Lagoon Species Inventory: Promoting Biodiversity for Two Decades

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The Indian River Lagoon (IRL) Species Inventory is an online database (www.sms.si.edu/irlspec) documenting IRL's biodiversity. It is utilized by resource managers, educational groups, as well as the general public. The initial inventory, compiled in 1994, affirmed claims that the IRL was one of the most biologically diverse estuarine systems in the United States and more importantly allowed for better understanding of this unique ecosystem as well as for the development of more relevant management plans. The Smithsonian Marine Station became the repository for the inventory in 1997 overseeing its expansion to include a taxonomic listing of over 3,500 documented species, over 440 species narratives and descriptions of ecologically and commercially significant groups as well as IRL habitats. The website also includes a wealth of information for IRL citizens to improve understanding and encourage stewardship of this vulnerable ecosystem. As new scientific information becomes available, we plan to continue with the development and public promotion of the IRL Species Inventory, particularly at this critical time in the lagoon's history. It will take collaborative, coordinated efforts between the scientific community and the general public to achieve sustainability of the Indian River Lagoon. It is our hope that the IRL Species Inventory will help in this endeavor.

Chlorophyll *a* 'Blooms' and Water Quality in the Indian River Lagoon System from Jupiter to Ponce Inlets: Using Long-term Monitoring Data from SJRWMD and SFWMD to Test Alternative Causal Hypotheses by Structural Equation Modeling

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Testing cause-and-effect is usually the realm of experiments. Often in complex, multivariate real world field ecology, controlled experiments cannot be done at the proper spatial or temporal scales necessary to properly address the questions. Further they are limited in numbers of variables that can be used by logistics. However, structural equation modeling can test alternative proposed multivariate hypotheses formulated *a priori* as directed graphs or path diagrams. I used SEM to test hypotheses about what affects trajectories and rates of change of Chl-*a* using

>13,000 data points (1990-2013) from 76 water quality stations ranging from Jupiter Inlet northward to Ponce Inlet. Analyses showed that (among other things) the driving nutrients changed not only spatially in the IRL but also with Chl-*a* concentration, that feedbacks existed between Chl-*a* and light penetration, that total nitrogen varied with distance from inlets, and that Chl-*a* and temperature were strong drivers of dissolved oxygen.

A Comparison of Two Commonly Used Oyster Reef Restoration Methods

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Two commonly used methods for oyster reef restoration are mesh bags filled with shell (shell bags) or mats with oyster shell directly affixed to them (oyster mats). Differences in reef architecture inherent in these two approaches might result in differences in oyster reef metrics and thus, potentially reef function and ecosystem services. We compared community metrics between shell bag and oyster mat reefs. One m^2 shell bag and oyster mat reefs were placed side-by-side at an upstream and downstream site within the St. Lucie River. Despite adverse water quality conditions and a short time period (two weeks) of reef colonization, patterns of abundance varied significantly between reef types. In general, total abundance of organisms, and numbers of amphipods and mud crabs were significantly greater ($p<0.05$) on oyster mats. Differences in colonization of reef types may be due to physical differences in reef structure (interstitial space, sedimentation, reef height, etc.).

The Ghost of Fouling Communities Past: The Effect of Original Community on Subsequent Fouling after Cleaning and Transplant

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Biofouling on ships has been linked to the spread of invasive species which has been identified as one of the gravest threats to environmental health and biodiversity. Previous research suggested that fouling community composition and quantity on biocide coatings was modified by prior fouling settlement. This experiment was designed to determine how preconditioning affected the rate and composition of re-fouling of cleaned panels after a transplant was performed. A series of 10 x 20 cm panels were placed at three locations in Florida (Ponce Inlet, Sebastian Inlet and Port of Miami) which were characterized by distinct fouling communities. Fouling community composition and coverage were characterized at bimonthly intervals both before and after transplantation. The original fouling community affected the subsequent fouling composition and recolonization by specific organisms. The community level effects were short-term but specific responses lasted up to 14 months post-transplant.

Evaluating Salinity Targets for Protecting Seagrass in the St. Lucie Estuary and Adjacent Indian River Lagoon

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The St. Lucie Estuary (SLE) “salinity envelope” was established under the Indian River Lagoon Surface Water Improvement and Management Program to protect oysters and seagrass. The envelope is achieved when salinity is between 12 and 20 psu at the US1 Bridge, which results in salinities typically being greater than 20 psu in downstream seagrass beds. Salinity and seagrass

data (2008 – 2013) were used to evaluate the appropriateness of the envelope for protecting seagrass. Seagrass percent occurrence typically declined when salinity fell below the envelope with recovery occurring when salinities were within or above the envelope. In 2010/2011, salinity exceeded the envelope's upper limit for over 8 months and then rapidly declined. Even though salinity remained within seagrass tolerance ranges during this decline, seagrass percent occurrence decreased. Maintaining salinity within the envelope would prevent steep salinity declines and result in favorable salinities suggesting the envelope is appropriate for protecting seagrass.

Monitoring Changes in Fish Community Composition Relative to the Occurrence of an Extended Algal Bloom Event and the Associated Loss of Seagrass Habitat

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A massive phytoplankton bloom (superbloom) and subsequent loss of seagrass occurred throughout much of the Indian River Lagoon (IRL) system in early 2011 prompting a multi-agency effort to understand and monitor the impacts to the lagoon ecosystem. An increase in effort was initiated to assess the current status of fish populations in northern IRL sub-basins, to compare these data with conditions prior to the recent bloom events, and to analyze trends in relative abundance. In general, species diversity and richness during the bloom year were below the long-term average; however, both indicators have improved in the two years following the bloom. Multivariate analyses indicate there were significant differences in community metrics among the pre-bloom, bloom, and post-bloom years. A trend analysis indicated evidence of a decline in abundance that began prior to the bloom. Continued data collection will help to characterize these trends in more detail.

Assessment of Benthic Mapping using Hydroacoustic, Aerial, and Satellite Sensor Data

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Remote sensing of benthic features has used aerial imagery, hydroacoustic data, and satellite imagery. Each method has its own advantages and limitations in benthic mapping. The purpose of this study is to find the most effective depths for each method in benthic vegetation mapping in Indian River Lagoon. We compared performances of Biosonics DTX Echosounder hydroacoustic data with Hyperspectral Imager for Coastal Ocean satellite data at varying depth classes by calculating classification accuracy against ground truth data. We predict that the accuracy of optical surveying methods will decrease with increased depth, and vice versa for hydroacoustic methods. Using this information, we will develop a model that demonstrates the depth at which the accuracy of each method crosses over. The model will be used to combine the three types of data to create a benthic classification map of the IRL with improved accuracy.

Mangroves on the Move: How Important is Flotation Time and Light Availability?

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Global climate change events are driving the expansion of mangroves into salt marsh habitat around the world. We examined the role of propagule flotation time and light availability on establishment and productivity of *Avicennia germinans* and *Laguncularia racemosa.* Propagules were collected along a latitudinal gradient on the east coast of Florida and were grown under two light levels (sun and shade) after being floated in seawater for varying lengths of time (0, 1, 2, 3, 4 weeks). Site, flotation time and light availability all significantly affected growth of the mangrove species. *A. germinans* and *L. racemosa* propagules initially established better in the shade yet fared better in full sun. Sun and shade establishment began to decline in both species after propagules had floated for 4 weeks. Understanding the factors mediating mangrove establishment and productivity gives insight into the mechanisms behind their poleward range expansion and helps forecast the future range of this important ecosystem.

Shift in Fine-scale Habitat Use by Foraging Manatees after Unprecedented Seagrass Loss in the Northern Indian River Lagoon

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The USGS Sirenia Project is cooperating with the Florida Fish and Wildlife Conservation Commission (FWC) and the St. Johns River Water Management District (SJRWMD) to characterize Florida manatee winter use of and effects on seagrass beds in the northern Indian River Lagoon. We analyzed fine-scale use of seagrass beds by manatees before and during the unprecedented algal blooms and associated reduction in seagrass coverage in the IRL using manatee GPS tracking data from FWC, seagrass transect data from SJRWMD, and on-site tracking, seagrass, bathymetric, and ecological data from USGS. After the substantial loss of seagrass, manatees foraged in increasingly shallower waters as the deeper portions of seagrass beds progressively disappeared through light loss.

Transport Pathways of Fresh Water Leaving the St. Lucie Estuary

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A numerical model was used to investigate transport pathways of St. Lucie Canal (SLC) water leaving the St. Lucie Estuary and exiting into the Atlantic Ocean. The objective was to determine the fraction that leaves directly through St. Lucie Inlet versus that moving northward through the southern part of Indian River Lagoon and leaving through Fort Pierce Inlet. One-year simulations from 1993 to 1996 suggest that approximately 91% leaves through St. Lucie Inlet, while 9% leaves through Fort Pierce Inlet. The concentration of SLC water decreases northward due to the diluting effect of tidal exchanges through Fort Pierce Inlet. At the midpoint between the two inlets, the concentration of SLC water is approximately one-third what it was in the vicinity of St.

Lucie Inlet. The concentration of SLC water leaving Fort Pierce Inlet is less than one-twentieth of what it was in the vicinity of St. Lucie Inlet.

Long-term Benthic Monitoring and the Effect of Freshwater Influx on Biodiversity in the Indian River Lagoon and St. Lucie Estuary

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Benthic communities are strong indicators of environmental health and are used in a variety of monitoring programs due to their quick response to environmental stressors. The long-term monitoring of these organisms not only depicts environmental trends, but also helps assess the overall health of an estuarine system and its response to anthropogenic impacts. Since 2005, the benthic infauna of the Saint Lucie Estuary (SLE) and the Southern Indian River Lagoon (SIRL) has been quantitatively monitored quarterly at 15 sites. The data indicates that overall biodiversity has a negative correlation to freshwater influx and areas within the SLE and SIRL are becoming ecologically degraded. With projected changes in freshwater discharge into the SLE and SIRL, it is important to continuously monitor these sites within the estuarine system in order to predict responses to environmental changes.

Model Evaluation of Potential Impact of Freshwater Release on the Southern Indian River Lagoon

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The three dimensional CH3D hydrodynamic model for the St. Lucie Estuary and Southern Indian River Lagoon was used to simulate freshwater release during the wet season. The hydrodynamic model was well calibrated, peer reviewed and applied successfully in the St. Lucie Estuary Water Reservation Project. In this study, a tracer with an initial concentration of 100% was released with the freshwater at the S-80 structure. The model was able to simulate the transport of the tracer including how much and how fast it could spread and penetrate into the Southern Indian River Lagoon. The percentages of the tracer transported into the Southern Indian River Lagoon and out of the St. Lucie Inlet were calculated. Sensitivity tests were performed to demonstrate the strength and duration of the release. Animation of the model results will be provided for this presentation.

Roughness-driven Diversity and Composition of Benthic Diatom Communities in the Indian River Lagoon

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Benthic diatoms are a major component of biofilms that form on surfaces submerged in marine environments. Roughness of the underlying substratum affects the settlement of both diatoms and subsequent macrofouling colonizers. This study reports the effects of roughness on diatom communities established in the Indian River Lagoon (IRL) on acrylic panels with a range of surface roughnesses. Smoother substrata exhibited higher cell density, species richness, and diversity. Twenty-three of 58 species were found either exclusively or more abundantly on the smooth surfaces compared to one or both roughened treatments. The results suggest a greater ability of benthic diatoms to recruit and colonize smooth surfaces, likely explained by a higher degree of contact between the cells and the surface. Because biofilm composition can alter larval

settlement in higher trophic level organisms, diatom diversity has the potential to also affect the diversity of macrofouling communities on variably rough surfaces throughout the IRL.

The Indian River Lagoon Research Institute: Integrating Scientists, Engineers, and Educators to Improve and Sustain Lagoon Health

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Today's problems in the Indian River Lagoon (IRL) have evolved through a complex set of interrelated issues that have led to the decline of lagoon health. The Indian River Lagoon Research Institute (IRLRI) was recently established at the Florida Institute of Technology with the mission to develop and implement sustainable solutions for the revitalization and maintenance of the IRL. A group of more than 20 faculty members with decades of scientific research experience in the IRL have come together to improve understanding and develop solutions in the following areas: muck and nutrients, lagoon flow, nutrient reduction, sediment loading, ecosystem recovery, policy and management, and engineering technologies. Part of the mission of the IRLRI also includes outreach and education to help the community and lagoon stakeholders understand the importance of IRL problems and their role in creating solutions. The IRLRI is striving to collaborate with numerous institutions and agencies along the lagoon with the common goal of improving the IRL system.

Estuarine Impacts on Coral Reef Health and Implications for Water Resource Management in Southeast Florida

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Effective management strategies are critical for conserving coral reef communities, particular in nearshore systems subject to increased human impacts. St. Lucie Reef in Southeast Florida is strongly influenced by freshwater discharges from the Indian River Lagoon, St. Lucie River, and its expanded watershed, including Lake Okeechobee. This study assesses the relative impacts of these discharges on coral health. For the dominant hard corals, *Montastraea cavernosa* and *Pseudodiploria clivosa*, relative health was quantified using both coral gene expression and bacterial community profiling of coral mucus. Corals exhibited variable expression of genes related to xenobiotics, pesticides, osmoregulatory stress, and symbiosis regulations. Coral mucus-associated bacterial communities were dominated by alpha- and gamma-proteobacteria, dynamic over time, and unique from bacterial communities found on conspecific corals in other Caribbean regions. Ongoing work will assess coral health and benthic community responses to changing watershed management and water quality resulting from the Comprehensive Everglades Restoration Plan.

Oyster Reef Restoration in Mosquito Lagoon: Long-Term Data and Successes

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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, 63 reefs (1.77 acres) have been restored with the assistance of over 33,000 volunteers. With an average of 472 live oysters m^{-2} on restored footprints as of 2013, seagrass can also be found adjacent to 37% of reefs. In 2012 and 2013, there were brown tide events in Mosquito Lagoon. Fortunately, these blooms did not kill all oysters as was reported in the press.

ADCIRC Forecast Model for the IRL

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A recent NWS COMET project resulted in the development of an ADCIRC based circulation/inundation model for the Brevard County portion of the IRL. Further development extended the Brevard County domain to include the entire IRL, with all 6 inlets (including Port Canaveral). A real-time forecasting system based on the ADCIRC model, has been predicting 3 day forecasts of circulation in the Lagoon based on the NAM forecast winds and pressure. Model output can be used to predict larvae transport, gauge flows between the basins, and determine the extent of vulnerability of certain regions along the lagoon to wind driven flooding. Results from the COMET project indicate that there are unique locations within each of the basins that act like nodes (water levels remain fairly constant even as the flow becomes significant), and other locations where the constricted flow causes significant piling of water on the upwind side.

Indian River Lagoon Experiment 2012 (IRLEX2012): 3 Days of Water Quality and Inlet Surveys

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Following news of an emerging brown tide algal bloom in the northern Indian River Lagoon (IRL), researchers sought to gain insight into the surface water quality in the IRL, as well as the extent of algae coverage. Researchers covered a transect that started at Sebastian Inlet and followed a zig-zag path extending up through the Haulover Canal and into the Mosquito Lagoon. The system analyzed surface water for dissolved oxygen, pH, chlorophyll-*a*, salinity, temperature, turbidity, refined fuels, and CDOM. The data recorded evidence of the southern extent of the algae bloom, as well as distinct regions of elevated values for the measured parameters. Repeated surveys would identify the regions where values are consistently different from the rest of the lagoon system affecting the diversity of organisms. The near-synoptic nature of the comprehensive lagoon survey, conducted in ~7 hrs, allows researchers to obtain a better understanding of water quality in coastal lagoons.

St. Lucie Estuary Oyster Bed Water Quality Monitoring

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Oysters have been selected as an indicator species and have been monitored for the last eight years in the St Lucie Estuary as part of the RECOVER Monitoring and Assessment Plan (MAP) for the Comprehensive Everglades Restoration Plan (CERP). Oysters provide important habitat for numerous organisms and can filter up to 5 liters of water per hour. Salinity readings were

collected at a long-term established oyster bed in the Middle of the St. Lucie Estuary in order to detect the actual changes in salinity at the bed during various freshwater flow events. Data was collected during periods of both high and low salinity. The data collected this year and in previous years will be used to develop and calibrate a salinity regression model that compares salinity at the bed to the USGS recording station located at US1 (Roosevelt Bridge). The model will be used in the future to predict what the salinity conditions on the oyster bed will be based on US1 readings. This model will also guide water managers in decision making on releases to the estuary.

The Restorative Capabilities of *Ruppia maritima* and *Halodule wrightii* in the Indian River Lagoon

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Global seagrass bed biomass and species diversity have been reduced due to natural disasters, massive algal blooms, increases in coastal residencies and with industrialization. Much effort has been made recently to restore these coastal seagrass populations worldwide. Our project focuses on two species of seagrass, *Ruppia maritima* and *Halodule wrightii*, which naturally occur within the Indian River Lagoon (IRL) system. The goal of studying each species respectively is: (1) determine the best handling protocol for seeds and seedlings in the laboratory and to determine the effectiveness of seed/seedling propagation in the IRL. To date, nearly 2500 *R. maritima* seeds have been harvested and tested for the effects of stratification and storage on germination rates and viability. (2) Analyze the effect that season has on the establishment and effectiveness of transplanting activities. The *H. wrightii* study is a collaborative effort that will compare the findings from summer transplanting and winter transplanting.

Water Quality and Coliform Presence in DOT Canal

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A Department of Transportation (DOT) canal runs through the 185-acre Coastal Oaks Preserve, Vero Beach, from US1 to the Indian River Lagoon. The canal contains runoff from the highway and may have an adverse impact on the Preserve ecosystem as well as the Lagoon. The purpose of the study was to determine changes in water quality along the DOT canal from the entrance of the property to 10 meters out into the Lagoon. Samples have been taken weekly, starting in November 2013. The water quality parameters measured include: dissolved oxygen, salinity, pH, temperature, color, presence of coliforms, and *E. coli*. To date, rainfall appears to have a significant impact on the water quality from week to week. The quality improves the further locations are from US1. The data will be vital in the management of the Coastal Oaks Preserve and in determining how the DOT canal impacts the Lagoon ecosystem.

Adapting a Method to Detect and Quantify BMAA in Organisms from the Indian River Lagoon

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The cyanobacterial neurotoxin β-*N*-methylamino-L-alanine (BMAA) is an amino acid that has been implicated in a number of neurodegenerative diseases including Amyotrophic Lateral

Sclerosis (ALS), Parkinson's, and Alzheimer's. The identification and quantification of BMAA has been difficult since there are a number of structurally similar compounds. To distinguish between BMAA and its structural isomers, a derivative of BMAA was made using the Waters AccQ-Tag chemistry. A selective Liquid Chromatography-Mass Spectrometry (LC-MS) method to detect and quantify the BMAA derivative was adapted in order to screen for the presence of BMAA in organisms collected from the Indian River Lagoon.

Copper Release and Dispersion from an Indian River Lagoon Marina

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Water quality persists as a key concern with respect to the biological health and diversity of the Indian River Lagoon. A study carried out in Crane Creek and the adjacent lagoon showed that releases of potentially toxic dissolved Cu from antifouling paints accounted for >90% of the total dissolved Cu input to the creek. The maximum concentration of dissolved Cu in the creek, 2.2 μg/L, was ~16% above the U.S. EPA chronic value of 1.9 μg/L. Potential adverse impacts from Cu were likely reduced by uptake of dissolved Cu on suspended particles. Mass balance calculations and sediment data for Cu showed that one-third of the dissolved, anthropogenic Cu released from antifouling paint was transported from the creek to the lagoon whereas two-thirds of this Cu was deposited in creek sediments. Copper values for creek sediments were as high as ~200 μg/g, well above an Effects Range-Low of 70 μg/g.

The First Record of the Turtle Barnacle, *Chelonibia testudinaria*, on an Artificial Surface Mimicking a Slow Moving Ocean Vessel

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Barnacles are one of the most successful and ubiquitous colonizers of hard substrata in marine and brackish environments. In the Indian River Lagoon, barnacles commonly found on anthropogenic surfaces, in particular ship hulls, include: *Amphibalanus variegatus*, *A. amphitrite*, *A. eburneus*, and *Megabalanus coccopoma*. In 2012, the turtle barnacle, *Chelonibia testudinaria*, was found growing on a commercial silicone fouling release coating that had been applied to the surface of a rotating drum, which is used to test ship hull coatings at Port Canaveral. The test drum was rotating at about 1.03 m/s (2 knots) during the estimated time of *C. testudinaria* settlement. Although it has been speculated that the turtle barnacle has the potential to attach to ship hulls, it has not been observed previously, neither on ship hulls nor statically exposed ship hull coatings. We report for the first time the presence of several *C. testudinaria* on our dynamic test drum, which mimics a slow moving vessel.