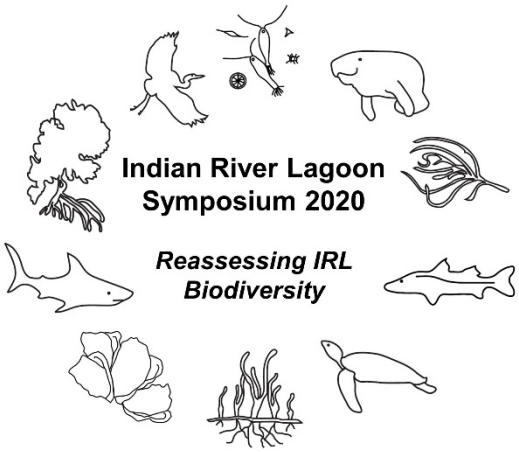
Abstracts of Technical Presentations



Johnson Education Center
FAU Harbor Branch
Fort Pierce, Florida

February 13-14, 2020

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Key Note Addresses

The Indian River Lagoon Species Inventory 25 Years Later: Improving a Unique Biological Resource

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The Indian River Lagoon Species Inventory (IRLSI) was developed into an online resource by the Smithsonian Marine Station in 1999, making the original inventory produced after the 1994 conference on *Biodiversity of the Indian River Lagoon* widely accessible to scientists, resource managers and citizens. With a growing database of over 3,500 taxa and 500 species reports, habitat descriptions and stewardship advice, the IRLSI remains the most comprehensive single resource for information on the biodiversity and ecological significance of the IRL system. Through a partnership with the IRL National Estuary Program (IRLNEP), the IRLSI is undergoing significant changes to modernize the platform, improve the visitor experience and allow faster expansion of the inventory using data gathered by experts working throughout the IRL. This talk will discuss the project's history, upcoming renovation plans and ways that stakeholders can help the expansion through contributions of images, occurrence data, genetic barcodes and more.

Maintaining a Biodiverse Gateway to the Universe: Long-Term Ecological Monitoring and Management at the Kennedy Space Center, Florida

Douglas M. Scheidt, Carlton R. Hall, David R. Breininger, Eric A. Reyier, Jane A. Provancha, Paul A. Schmalzer, Russell H. Lowers, Geoffrey M. Carter, Donna M. Oddy, Tammy E. Foster, Brean W. Duncan, M. Rebecca Bolt, Eric D. Stolen, Resa R. Cancro, Bonnie J. Ahr, Ronald Schaub, Danny K. Hunt, Christopher D. Schumann, Stephanie A. Legare, Timothy J. Kozusko, Stephanie K. Weiss, and Brenton D. Back
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The Kennedy Space Center (KSC) encompasses 57,430 hectares of uplands, wetlands, coastal dunes, and portions of the Indian River Lagoon, and is adjacent to nearshore habitats. Over 1,000 plant, 115 fish, 315 bird, 65 amphibian and reptile, and 25 mammal species have been identified, including 61 federal and state-listed threatened and endangered plant and animal species. There are more federally protected species on KSC than any other continental federal property. Stewardship and management of this complex and diverse ecosystem is shared by NASA, Merritt Island NWR and Canaveral National Seashore. Early monitoring focused on broad scale impacts of rocket launches on the landscape. In 1983, monitoring shifted focus to impacts on state and federally listed species and associated habitats. In 1990, a wildlife vulnerability and biodiversity index was developed which prioritized keystone, indicator and target species, and habitats into categories which, if managed properly would benefit the overall biodiversity.

Contributed Papers (Oral and Poster Presentations)
(The presenting author is the first author, unless indicated by underlining.)

The Diversity of Elasmobranchs (Sharks and Rays) in Florida's Indian River Lagoon
Matthew J. Ajemian, Grace Roskar, Michael P. McCallister, and Adam M. Schaefer
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The IRL has historically supported high ichthyofaunal diversity due to its vast latitudinal breadth and habitat heterogeneity. This perspective is biased to bony fishes, for which there is considerable long-term monitoring data, while information on cartilaginous fishes such as elasmobranchs (sharks and rays) has been lacking or inconsistent. In 2016, we initiated a comprehensive fishery-independent survey to characterize elasmobranch diversity, abundance, and population health in the IRL and adjacent waters. Since the survey's inception we have collected over 1,000 individuals from Titusville to St. Lucie Inlet, comprising at least 22 total species. Additionally, multiple smalltooth sawfish (*Pristis pectinata*) and young-of-the-year sandbar shark (*Carcharhinus plumbeus*) have been encountered in the southern region, potentially indicative of recovery in these heavily impacted species. The presence of these species and life stages suggests a relatively diverse community of elasmobranchs is still associated with the IRL, and multiple species continue to utilize it as a nursery.

Influence of Water Quality and Culverts on Mangrove Invertebrate Communities in the Coastal Oaks Preserve
Marina Arnold[1,3], Stephanie Buell[2,3], Paityn Johnston[1,3], Anjaleahmae Leviste[1,3], and Marisa Stipanich[1,3]
[1]Sebastian River High School, Sebastian, FL; [2]Vero Beach High School, Vero Beach, FL; [3]Junior Scientists Program

The Coastal Oaks Preserve (COP) is made up of multiple natural Florida habitats including mangroves, which are home to a variety of invertebrates. In the COP there are culverts which are used to control water movement between the Indian River Lagoon and the wetlands. At existing and newly installed culverts, and control sites we measured water quality (salinity, temperature, dissolved oxygen, and pH) and changes in invertebrate communities on collection plates weekly. Species composition varied among sites, but water quality was not found to be a contributing factor to growth on the plates. The monitoring of these plates will help understand and improve the COP's mangrove invertebrate communities.

Natural Language Processing Using Deep Learning for the Indian River Lagoon Algal Bloom Report Analysis
Manit Bhusal, Ashim Ghimire, Juan Calderon, and Hyun J. Cho
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Human languages and written texts reflect the sentiment, intention, and understanding of the context by the speakers and writers. Natural Language Processing (NLP), an area within Artificial Intelligence, with deep learning is used to analyze large sets of text data. NLP techniques were applied to the articles on the Indian River Lagoon algal blooms for automated depiction of a coherent, concise, and fluent summary of selected articles either from peer-reviewed research journals or from newspapers. Abstraction-based method of text summarization is applied by using a recurrent neural network as Long Short-Term Memory (LSTM) to overcome the grammar inconsistencies of the extractive method and to make predictions based on time series. Text mining was initially used to extract the most relevant sentences from the articles; the sentences are then fed into the LSTM for the more concise summary of the text.

Stoichiometry of Nutrient Fluxes in Sediments

Iulia Bibire, Austin Fox, Tyler Provoncha, Abigail Gering, and Maria Fernanda Hernandez Garcia
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The cause of harmful algal blooms is a prominent topic of study worldwide and although many theories suggesting causes for their particular spatial and temporal appearances have been proposed, definitive conclusions have yet to be drawn. One thing that can be agreed on is that the availability of nutrients is one of the most important factors that limit algal growth. Shifts in the ratios of nitrogen to phosphorous can influence algal bloom community composition and influence the harmfulness of the blooms. These ratios can further be used to infer the processes occurring within the system. With this in mind, the nutrient flux ratios were analyzed for different sediments throughout the northern and central IRL. In sandy sediments, O:N ratios were typically >20 and O:P ratios >300 suggesting that denitrification occurs in sandy sediment throughout the lagoon.

Planktonic Signatures of Marine Invertebrate Diversity in the Fort Pierce Inlet and Beyond

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Marine invertebrate larvae provide genetic links among populations of benthic adult stages, with strong potential to alter species ranges through new opportunities for food, reproduction, habitat and climate. Yet we know very little about the development, anatomy, identity or dispersal of larval forms within the IRL, along the Atlantic coast, and beyond. The absence of such knowledge is remarkable, considering that larvae have critical roles in the establishment and maintenance of marine biodiversity. Accordingly, a project is underway to characterize larval marine invertebrates in the Fort Pierce Inlet (FPI) and Florida Current through live imaging, confocal microscopy and DNA analyses. Currently, 1170 larval COI barcode samples are being sequenced, 16 bulk plankton metabarcode (COI, 18S V1-2) libraries are in preparation, and ~7800 digital images are captured. For the FPI, we are initiating the first local diversity baseline of planktonic invertebrate larvae, the most common developmental pathway across the Metazoa.

Exploring the Microbial Diversity of the Indian River Lagoon

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The Indian River Lagoon (IRL) is considered one of the most biodiverse estuaries in North America, but there is currently no published data on its microbiome. The microbiome data presented here is from four surface water samplings over a period of two years across nine sites in the IRL and St. Lucie Estuary (SLE). There are statistically significant changes in the microbiome between the IRL and SLE as well as seasonally. The environmental variables that most influenced these changes in the microbiomes between samples were salinity and temperature in both seasons. The third most influential variable was turbidity in the wet seasons and dissolved oxygen in the dry seasons. Many microbes are more abundant in one estuary or season versus another. For example, the freshwater-associated Burkholderiaceae family occurs more frequently in the wet seasons of the SLE, whereas the diverse Rhodobacteraceae family is more frequent in the dry seasons of the IRL. This initial study fills the knowledge gap on the IRL microbiome and serves as an important baseline for possible future changes due to human impacts.

Analyzing Water Quality in Natural Ponds during Wetland Restoration

Grace Britt[1,2], Melissa Dioguardi[1,2], Carson Fillizola[1,2], and Colton Fillizola[1,2]
[1]Vero Beach High School, Vero Beach, FL; [2]Junior Scientists Program

The objective of this study was to investigate the short-term effects of artificial wetlands on water quality in the Coastal Oaks Preserve, managed by the Indian River Land Trust. Seven sites were sampled from September to December 2019 in small natural ponds to determine nutrients (nitrogen and phosphorus), pH, salinity, dissolved oxygen (DO), temperature, water color, and *Enterococcus* (fecal indicator bacteria). Patterns of water quality and *Enterococcus* were evaluated. Dissolved oxygen and pH had similar patterns and were influenced by the presence of thick mats of duckweed. Nutrient levels declined though time due to decreased run off. High *Enterococcus* counts were a cause of possible concern that might be resolved with microbial source tacking. This research revealed the short-term effects of excavation and created a baseline for future stages of restoration in the Coastal Oaks Preserve.

Food Web Effects of Eutrophication in the Indian River Lagoon

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Eutrophication, particularly nitrogen enrichment, has the potential to alter estuarine food webs through enrichment of primary producers. These primary producers, including seagrass, phytoplankton, and macroalgae, represent the base of the food web, therefore shifts in their distribution, abundance, or nutrition have the potential to cause bottom-up effects in the Indian River Lagoon (IRL) food web. This has been observed in temperate regions but has not been well studied in the IRL. As such, to better understand the status of the IRL, primary producers (phytoplankton, macroalgae), primary consumers (shrimp, oysters, mussels, etc.), and secondary consumers (crabs) were collected in the IRL for analysis of stable nitrogen isotope values ($\delta^{15}N$). At each location, $\delta^{15}N$ values were compared between trophic levels and related to water quality to reveal the potential effects of eutrophication on IRL food webs. These data will be insightful to better understanding bottom-up effects of eutrophication in the IRL.

Assessing Wading Bird Disturbance by Boat Traffic on Oyster Reefs in Mosquito Lagoon Using Video Observation

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Mosquito Lagoon is frequented by both wading birds and people. Birds rely on the lagoon for shelter, food, and reproduction, while people frequent the lagoon for recreation. This confluence of use offers an opportunity to study wading bird responses to anthropogenic disturbances such as boat traffic. Our project goal is to determine if boating activity disrupts wading birds, especially when foraging on oyster reefs. To investigate this, we used motion-activated cameras placed on living, dead, and restored oyster reefs in Mosquito Lagoon to observe bird behaviors as well as boat activity. We sought to identify instances of bird behavior disruption and to quantify the amount of boat traffic, wave energy, noise, and the level of disruption it poses to birds (behavior change, leave reef). Understanding wading bird behavior on oyster reefs and how boat traffic affects it can help us understand the factors driving wading bird distribution in the lagoon.

A Comprehensive Diet Description for the Whitespotted Eagle Ray (*Aetobatus narinari*) in Florida Coastal Waters

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The whitespotted eagle ray (*Aetobatus narinari*) is a highly mobile marine batoid found in warm-temperate to tropical western Atlantic waters. Previous work suggests variation in whitespotted eagle ray diet (i.e., gastropod vs. bivalve dominance) depends on location, but a comprehensive analysis of spotted eagle rays in protected Florida coastal waters has not yet been conducted. To address this data gap, whitespotted eagle rays were sampled for stomach contents in both the IRL and Sarasota Bay, Florida. Prey items are being analyzed using traditional visual identification and molecular barcoding techniques. Additionally, stable isotope samples were taken via blood and muscle biopsies to determine trophic position (^{15}N) and source of primary production (^{13}C). While sampling and analyses are ongoing, these data will provide important information on the trophic role of this state-protected species and identify potential interactions occurring between whitespotted eagle rays and hard clam production and restoration activities.

Monitoring Fish and Water Quality in Historic versus New Culverts at the Coastal Oaks Preserve

Marc Calloway[1,3], Thabet Hasan[2,3], Preslie Heins[2,3], Haylee Jones[2,3], and Keegan McCollom[2,3]
[1]Sebastian River High School, Sebastian, FL; [2]Vero Beach High School, Vero Beach, FL; [3]Junior Scientist Program

The Indian River Land Trust invested in the addition of new culverts—cylinders connecting the lagoon to the impounded wetlands—to the Coastal Oaks Preserve (COP). These were installed to inaugurate the flow of fish between the lagoon and the impoundments and improve the water quality in the COP. Every week, we deployed fish traps into two culvert, one historic and one new. After six hours, we identified and counted any fish caught in these traps. We downloaded HOBOs that measured salinity, dissolved oxygen, and water depth every 15 minutes. After 10 weeks of data collection, there was no significant difference on water quality of the two culverts. More fish were caught and greater diversity observed in the historic culvert supporting our hypothesis that fish exhibit homing abilities.

Impacts of Oyster Reef Restoration on Infaunal and Bird Communities in Mosquito Lagoon

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Mosquito Lagoon (ML) is home to many threatened bird species. Oyster reef (*Crassostrea virginica*) restoration in ML has been successful in terms of oyster metrics, but little is known about the impact of restoration on foraging habitat provision for birds. Infaunal invertebrates in reef sediments are an important food source for estuarine birds. The primary goals of this study are to determine if and when infaunal abundances reach those of natural reefs, and if bird abundances and behaviors on restored reefs reach those of natural reefs. Data suggests that within 6 months post-restoration the infaunal abundance on restored and live reefs were statistically similar. The first 2 years of bird survey data do not suggest a statistically significant difference in foraging behavior between reef types, but it does appear that some bird families show preference for certain reef types. We continue to monitor these reefs as they change over time.

Microplastic Cycling: Are Eastern Oysters, *Crassostrea virginica*, Capable of Excreting Microplastics?
Casey Craig[1], Linda Walters[1], Jessy Wayles[2], Emily Dark[3], Kirk Fusco[3], Vincent Encomio[4,5], David Fox Jr.[6], and Lei Zhai[6]
[1]University of Central Florida, Orlando, FL; [2]Marine Discovery Center, New Smyrna Beach, FL; [3]Florida Department of Environmental Protection, Indian River Lagoon Aquatic Preserves, Fort Pierce, FL; [4]UF/IFAS FL Sea Grant, Stuart, FL; [5]Florida Oceanographic Society, Stuart, FL, [6]University of Central Florida, Orlando, FL
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Microplastics (MP), plastics less than 5 mm in size, are pervasive globally and commonly ingested by biota. MP were documented in unusually high abundances in the eastern oyster *Crassostrea virginica* from Mosquito Lagoon, the northernmost portion of the Indian River Lagoon (IRL). While this confirms *C. virginica* can ingest MP, it is still unknown if these organisms can excrete MP. To this end, we developed a study to determine if *C. virginica* is capable of excreting MP through feces and/or pseudofeces. Live individuals were collected from north, central, and south regions of the IRL and placed into a running-water bivalve filtration tank, where feces and pseudofeces could be separately collected. MP were present in both feces and pseudofeces, suggesting MP are cycling in this system. Results indicate *C. virginica* are excreting 1 microplastic every 2 hours through feces, and 1 microplastic every 4 hours through pseudofeces.

A Proposed Study of Organic Sediment Impacts on Seagrasses and their Association with Benthic Infauna
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Nutrient pollution in Florida's Indian River Lagoon (IRL) degrades water quality and promotes accumulation of fine-grained organic-rich sediment. One consequence of eutrophic conditions is the reduction of seagrass. Seagrasses are a vital component of coastal ecosystems, providing shelter, serving as nurseries, stabilizing sediments, acting as a CO_2 sink, and being a food source. This proposal addresses seagrass associations with organic sediments and infaunal communities within the IRL. It is hypothesized that reduced seagrass coverage will yield lower infaunal abundances and diversity, and drive changes in community composition. Secondly, it is hypothesized that seagrass coverage is likely to decrease with increasing sediment organic matter content. PERMANOVA indicates statistical differences in infaunal community composition with varying seagrass coverage ($p<0.005$). Simper analysis reveals this difference is likely due to two dominant species, *Leptochelia dubia* and *Parastarte triquetra*. Knowledge of these associations may help to further understanding of ecosystem dynamics within a degraded ecosystem.

Indian River Lagoon Biodiversity: Looking Back Four Decades and Thinking Ahead to 2030 with Consideration for a Question Posed by the Late Dr. Kerry B. Clark: "Are Our Sea Slugs Slipping Away?"
Duane E. De Freese
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The Indian River Lagoon Comprehensive Conservation and Management Plan – Looking Ahead to 2030 (adopted by the IRL Council and IRLNEP in August 2019) identified biodiversity as one of 32 vital signs for a healthy lagoon. The CCMP ranked biodiversity as a "Level 2-Serious Concern: Condition threatens long-term prognosis for lagoon health. Trend is unfavorable or uncertain. Favorable outcome is not expected without strategic intervention and long-term stewardship." The CCMP acknowledged the complexity associated with development of appropriate indicators and targets to effectively evaluate the status and trends of this vital sign. This presentation will address some challenges, needs and opportunities by looking back to published work of the author and the late Kerry B. Clark associated with IRL biodiversity and sea slugs.

Use of Trophic Structure to Evaluate Ecosystem Services of Estuarine Habitat Restoration
Melinda Donnelly, Suzanne Connor, Jessica Copertino, Giovanna McClenachan, and Michelle Shaffer
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Loss of ecosystem engineers creates cascading effects through communities, resulting in losses of biodiversity and services. Oysters and mangroves are important ecosystem engineers in estuaries and various methods have been used for restoration. Post-restoration monitoring tends to focus on increases in targeted species, assuming other species will return once ecosystem engineers are present. However, evaluations of additional abiotic and biotic metrics are needed to evaluate restoration value related to ecosystem services. We will present a framework for incorporating trophic interactions into success metrics for two types of habitat restoration in Indian River Lagoon: oyster restoration and living shoreline stabilization. Post-restoration monitoring was conducted by an interdisciplinary team of scientists, from the base of food chain to apex predators and interactive effects of changes in hydrological properties and nutrient fluxes. This data will evaluate development of food webs post-restoration and connect to human communities through support of fisheries and ecotourism.

Developing an Approach to Utilize UAS Derived Multi-Spectral Imagery to Estimating Chlorophyll in the Indian River Lagoon, FL
Aaron Duecaster[1] and Laurent Cherubin[2]
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The Indian River Lagoon is one of the many coastal ecosystems that have experienced the negative consequences of harmful algal blooms (HABs) multiple times in the last decade. It is believed that increased nutrient loading from human activity is the primary reason, but no published study has been able to link the HAB events to a specific cause. High resolution remote sensing methods for studying ecosystems allows researchers a more synoptic view of the status of an environment over in-situ measurements. Unmanned aerial systems have been applied to land surveying, but less so to aquatic systems. This project aims to provide a workflow to direct georeference high resolution multi-spectral imagery and predict chlorophyll in the IRL to improve HAB prediction, monitoring networks, and accurately assessing water quality.

Assessing Density and Diversity of Oyster Reef Resident Fishes Following Habitat Restoration
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Oyster reefs are essential fish habitat, creating complex structure that provides shelter, forage, and spawning substrate for fishes. Demersal fishes, such as gobies and blennies, are closely associated with oyster reef habitat, and are categorized as reef residents. However, little is understood about how the restoration of oyster reef habitat impacts the resident fish community. To address this knowledge gap, biotic data were collected in Mosquito Lagoon at eight newly restored oyster reefs over a two-year period. Changes in diversity and density of resident fishes at restored and control oyster reefs were assessed to quantify changes following restoration. Preliminary data suggests that the three most common fish at dead reefs are the Code goby, Naked goby, and Clown goby while the three most common fish at live and restored reefs are the Darter goby, Naked goby, and Code goby. The Darter goby's presence at restored sites has increased over time.

Decision-Making Strategies from a Public Perspective: Three Areas in Need of Special Attention in the Indian River Lagoon

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The purpose of the study is to analyze the decision-making process of individuals within a focus group asked to choose three specific places in the Indian River Lagoon that should receive special attention or resources for future decision making. Understanding the group's strategies could provide insight or application to the fields of citizen science and community involvement to further develop programs encouraging the public to become more involved in conservation and restoration efforts. The themes and categories were determined by reviewing transcribed interviews manually. In addition to clarifying the question, major strategic themes were choosing densely populated or developed areas, locations of recreational importance to the public, and choosing the whole lagoon due to the inability to select only one spot of significance. Including the local citizens in restoration planning and efforts could provide benefits to bridging the gap between research and the public.

Exposure to Multiple Algal Toxins among Young Bull Sharks, *Carcharhinus leucas,* in Florida's Indian River Lagoon

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Harmful algal blooms (HABs) have increased in frequency in Florida's Indian River Lagoon (IRL) over the past century. A thorough understanding of the effects of HAB toxins on the IRL ecosystem is critical to mitigate risks; however, managers face challenges from a lack of information. This study aims to evaluate potential effects of HABs on the IRL using the bull shark (*Carcharhinus leucas*) as a sentinel species. Baseline concentrations were assessed from shark tissue samples collected in Fall 2018 and Spring 2019 from a standardized fishery-independent survey. Liquid chromatography-mass spectrometry was used to measure HAB toxins in shark stomach contents, plasma and liver. Analysis of samples has demonstrated the presence of multiple toxins (microcystins, brevetoxins, domoic acid, and okadaic acid) in the tissues of bull sharks during non-bloom periods. This ongoing study will provide valuable data on exposure and trophic transfer of multiple HAB toxins in this iconic estuary.

Developing an eDNA Tool for Monitoring Populations of the Dwarf Seahorse (*Hippocampus zosterae*)

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The Dwarf Seahorse was highly impacted by the 2012 Deepwater Horizon disaster oil spill in the Gulf of Mexico. The Dwarf Seahorse was proposed to be on the endangered species list but was not finalized to deficient data. The Gaither lab has designed a species-specific primer that verifies the presence or absence of the dwarf seahorse (*Hippocampus zosterae*) to be utilized through eDNA (environmental DNA) detection. eDNA Primer creation was tested with ND4, D-Loop and 12S genetic markers. We found the most reliable marker for *H. zosterae* and used for the primer was D-Loop. We created this primer to test the presence and absence of *H. zosterae* to fill a void of evidence of this species population size.

Identifying Factors That Impact the Success of *Rhizophora mangle* Living Shorelines

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Translocated *Rhizophora mangle* can experience mortality due to environmental factors including erosion, wave energy, and submersion. Due to their larger size and protection from wave energy, living shorelines with older *R. mangle* and shell bags should have a higher level of plant survival compared to younger *R. mangle* with no shell bags. An experimental living shoreline was established consisting of five *R. mangle* treatment groups (seedlings; seedlings transitioning to adulthood; adults; mixture of seedling, transitioning, and adult mangroves; and no mangroves) combined with the presence or absence of oyster shell bags. These *R. mangle* will be monitored for survival every month for a year. At three months, 27 of the total 640 *R. mangle* have experienced mortality with no significant differences among treatment groups. Since deploying shell bags and older *R. mangle* increases the cost of restoration, it is important to identify if these factors are crucial for living shoreline success.

Is Sediment Aeration an Effective Strategy for Muck Management in the IRL?

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Dredging is presently the only generally accepted method for muck removal from the IRL. The apparent success of sediment aeration in Florida lakes and other locations, coupled with local public interest in finding cheaper and more convenient means for muck management have spurred an interest in carrying out an aeration study of IRL muck. The efficacy of aeration using micrometer- and nanometer-sized bubbles has been evaluated in residential canals in the IRL system. Overall, no significant decrease in the volume of muck has yet been identified. Nevertheless, when oxygen was successfully delivered to the sediments, benthic nitrogen fluxes decreased by nearly 2-fold and phosphorus fluxes were also lower under oxic conditions.

On a Wing and a Prayer: Seeking New Nesting Habitats for Beach-Nesting Birds

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Florida has four species of state-listed “Threatened” beach-nesting birds: the American oystercatcher, snowy plover, least tern, and black skimmer. These birds nest on sandy shorelines, shell hash, spoil islands, and gravel rooftops. Rooftop nesting resulting from coastal habitat development has supported bird colonies for years. Every year, gravel rooftops used for nesting are being demolished or replaced with non-gravel alternatives. These newly constructed rooftops are unsuitable for nesting. With beaches dominated by humans and waterfront development, and fewer gravel rooftops available every nesting season, the final frontier for nesting may be spoil islands and other undisturbed shorelines. Around the Indian River Lagoon, dredge-material spoil islands have provided American oystercatcher and least tern nesting habitat. Spoil islands host the undisturbed sandy spits and beaches desired by these beach-nesters, and with some work, we could create and protect more of these suitable habitats.

Spatial Variation of Sediment Oxygen Demand in a Subtropical Estuary, the Indian River Lagoon, FL
Abigail Gering, Austin Fox, Stacey Fox, Iulia Bibire, Tyler Provoncha, and Maria Fernanda Hernandez Garcia
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The oxygen demand of sediments and particles were examined spatially in the Indian River Lagoon using *in situ* darkened benthic chambers and blank chambers for particles. This subtropical system experiences periodic episodes of hypoxia in the water column that have led to major fish kills and decreased biodiversity. Variations in sediment oxygen demand (SOD) followed patterns for sediment composition (e.g., water and organic matter content). To date, the overall average demand of oxygen from the sandy sediments is 0.04 ± 0.02 mg/cm^2/hr. Based on these data, the sediments use about 2.5 times more oxygen than suspended particles in a typical one-meter deep section of the lagoon. These data illustrate that the sediments and particles could use the oxygen that is integrated in the water column in as little as 48 hours of dark conditions.

Cathodically Protected Steel as a Replacement for Plastic in Oyster Reef Restoration Methods
Morgan Gilligan, Kelli Hunsucker, Afanasy Melnikov, Harrison Gardner, Robert Weaver, and Geoffrey Swain
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Oyster reefs provide beneficial ecosystem development which contributes to coastal robustness. Many oyster restoration efforts currently employ the use of plastic. An alternative to the plastic is the use of cathodically protected steel. To test this concept, steel mats were compared to traditional plastic mats to determine which had a greater rate of recruitment. The steel mats have an electrical current that cathodically protects them from corrosion. In turn, a chemical reaction occurs to form a carbonate chalk, which may be more favorable to oyster growth. Data was gathered over the course of three months at three locations along the Indian River Lagoon: Port Canaveral, Grant, and Melbourne Beach. Data collection consisted of photos, current and potential measurements, and environmental data (salinity, pH, temperature). The results indicate that steel mats are favorable for oyster settlement and are critical in generating positive impacts in the IRL.

Regional Fish Biodiversity Changes from 1955 to 2020: Which Species Were Here? Which Are Missing? Why?
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Thousands of fish collections using over one hundred different techniques made in various habitats on the continental shelf and Indian River Lagoon, Ponce de Leon Inlet to Jupiter Inlet began in March 1955. Greatest regional biodiversity was documented from inshore reef formations at depths <10 m and seagrass within the Lagoon during the Indian River Coastal Zone Study, a collaborative integrated Harbor Branch Foundation/Smithsonian Institution research program, 1973-1985. Over 800 fish species were captured in the region, including the continental shelf, over 400 from the Lagoon proper. This exceeded by 100 species total species from other Florida estuaries, particularly the Gulf coast from Florida to Perdido Bays. Indigenous species were in the families: Centropomidae, Sciaenidae, Haemulidae, Gerridae, Dactyloscopidae, Benniidae, Labrisomidae, Eleotridae, Gobiidae. Species were described as new un-described species, often limited to this region of Florida. Unfortunately, there has been a major decline in regional fish species; some are now endangered.

Scar Pattern Types and Regionalization on Florida Manatees (*Trichechus manatus latirostris*) Observed at Harbor Branch Oceanographic Institute in Florida

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The Manatee Observation Project was created in 2009 to document and photograph the manatees visiting HBOI. An analysis of photographs of 146 manatees that visited HBOI showed that a majority of the injuries sustained were caused by boats. Overall, 97% of the manatees had at least one propeller injury and 31% of the manatees had at least one skeg injury. Other non-boat related injuries documented in the images included cold stress and entanglement injuries. This study looked at the prevalence of scars by anatomical region, the cause of injury, and compared injury locations between male and female manatees.

Cytotoxicity Assessment of Samples Collected Along the Indian River Lagoon

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This project of the Florida Center for Coastal and Human Health was initiated to detect toxic compounds in the IRL. Water samples were collected from twenty sites in the wet and dry seasons. Organic extracts were prepared and assayed against a panel of cell lines to detect cytotoxic agents. The panel includes OATP1 A2 and OATP1 B1 Transporto™ cells to detect compounds requiring active transport; HepG2 cells to detect hepatotoxins not requiring active transport; the SH-SY5Y human neuroblastoma cell line to measure neurotoxicity; the Vero cell line to detect renal cell toxicity and sheep red blood cells to measure effects on hemolysis and hemagglutination. Results of the cytotoxicity screening will be presented.

Macroalgal Biodiversity of the Indian River Lagoon

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Healthy macrophyte communities are a high priority in managing the Indian River Lagoon (IRL). While the importance of seagrasses is widely recognized, there has been remarkably little research on IRL macroalgae. Given the IRL's rapidly changing environments, it is essential to establish a macroalgal biodiversity inventory and baseline. Intensive sampling of habitats throughout the IRL resulted in the publication of *Submersed Plants of the Indian River Lagoon* by Littler, Littler, and Hanisak (2008), the first comprehensive floristic field guide for IRL use by researchers, educators, resource managers, and general public. The IRL macroalgal flora consists of ~229 species, dominated by Rhodophyta (117 species), Chlorophyta (64 species), and Phaeophyceae (39 species). The field guide identified a number of range extensions into the IRL and new records for Florida and the Western Atlantic. An adequate knowledge of the biodiversity of macroalgae is a necessary requirement to better understand their ecology and management.

Data-Model Fusion as a Tool for Addressing Research Questions and Setting Management Goals

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In the past decades the quantity and diversity of measurements performed within studies addressing ecology-oriented research questions has exploded, providing new – and often underexplored – opportunities for data syntheses and development of process-based mathematical models. Process-based models reflect the theoretical knowledge about an ecosystem and are an important tool for evaluating its state, as well as projecting its responses to environmental change. Within the data-model fusion framework, observations can be used to evaluate models, update them, or develop new model formulations, which reflect changes in the state of knowledge. In this talk I will show the examples of data-model fusion application to develop and improve process-based models in ecology, as well as outline the potential applications for the Indian River Lagoon ecosystem.

Microalgal Diversity in the IRL System: How Little We Know

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The diversity of microalgae and related protists in the Indian River Lagoon system is closely tied to microbial loop processes. The scant evidence available suggests that primary production can be equivalent to, or exceed, that of seagrasses and seaweeds, yet alpha diversity of the species involved is poorly known. Environmental parameters modifying this diversity (possibly >2000 species) are many, and often overlooked. Of particular concern are the 70+ species that potentially can cause harmful algal blooms.

Infaunal Molluscan Abundance and Diversity in Relation to pH and Temperature in the Indian River Lagoon

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Environmental stressors like pH and temperature fluctuations can impact development, growth and mortality rates of calcifying and non-calcifying benthic invertebrates. Evidence suggests a rise in temperature of 2.5 to 4 °C and a decline in ocean pH up to 0.5 units by year 2100 (Davis 2013). Calcifying organisms like mollusks show tolerance variability in relation to both factors, as demonstrated by differences in their shell growth and hatching rates (Shirayama 2005). Although estuarine mollusks can tolerate daily pH and temperature fluctuations, long-term changes can affect their fitness and subsequent diversity. The relationship between pH, temperature and infaunal molluscan abundance and diversity in the Indian River Lagoon system is assessed using 15 years of quarterly monitoring data.

Diamondback Terrapins in the Southern Indian River Lagoon

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Studies in the early 1980s reported a large population of terrapins in the northern IRL, but by 1993 this population was shown to be experiencing a severe decline. Brevard Zoo and Florida Fish and Wildlife Conservation Commission are studying populations in the northern Indian River Lagoon (IRL) system, but very little is known about terrapin populations further south along Florida's east coast. Our goal for this project is to increase the knowledge base on diamondback terrapins in southeastern Florida. We are conducting searches for terrapins in the southern IRL. Within the IRL system, terrapin movement and habitat utilization will be monitored using acoustic telemetry. We will be collecting genetic material for an ongoing range-wide genetics survey, diet will be determined using fecal samples, and fecundity will be examined in these far-south populations. This data will enable us to establish much-needed baseline information on current terrapin populations in southeastern Florida.

Living Shorelines, Lessons Learned and Patterns Uncovered in Their Implementation as Tools for Citizen Science and Runoff Mitigation

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The Indian River Lagoon (IRL) faces various sources of eutrophication, including non-point source runoff emanating from waterfront properties. The problem is multifaceted, and this project sought to evaluate whether the semi-active involvement of IRL citizens can provide a novel avenue of increasing community awareness and simultaneously aid in mitigating runoff pollution levels. Waterfront homes and retention ponds dominated by turfgrass in the Mosquito Lagoon watershed were converted to homes boasting a living-shoreline of native vegetation. The converted living shorelines provided an avenue to study the efficacy of native vegetation to sequester nutrients in surface run-off over a 2-year period. Furthermore, the living shorelines provided an anchor to study the community's knowledge on eutrophication issues via various workshops. This presentation will be focused on broad patterns of public education, the shorelines' efficacy in nutrient sequestration, as well as the strengths and weaknesses of directly involving the IRL community in active research.

Mineral Accretion: An Environmentally Friendly Alternative to Plastic for Oyster Restoration

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This research is investigating the use of a cathodically protected steel to replace plastic as the base material for oyster restoration. Electricity is supplied (via a solar panel) to the steel mesh to prevent corrosion and cause a rise in the local pH. This causes calcium and magnesium ions to combine with bicarbonate and hydroxide ions and precipitate as $CaCO_3$or $Mg(OH)_2$ on the steel surface (mineral accretion). In order to determine the efficacy of using steel mats for oyster restoration in the Indian River Lagoon, a two-phase experiment was designed to 1) determine the optimal steel and mesh size needed for oyster restoration and 2) determine if steel mats are as effective at promoting the growth of oysters and as traditional plastic mats. This short presentation will describe the results from side-by-side comparisons *in situ* of steel mats with plastic mats at three test sites.

Habitat Differences in Epifaunal Community Diversity within the Indian River Lagoon

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The MarineGEO program at the Smithsonian Marine Station has been monitoring biodiversity in all major habitats in the IRL. An overlooked group that compose a large fraction of biodiversity are those inhabiting hard substrata (i.e., fouling species). For the past 3 years, we have deployed fouling panels at 15 sites comprised of 5 different habitats: seagrass, mangroves, unvegetated, oyster reefs, and artificial structures. The goals of the project are to establish a baseline of community composition and development, monitor interannual changes, examine habitat differences, and monitor for non-natives. We utilize this data to examine mechanistic causes of differences in biodiversity in habitats by manipulating consumer access to communities. We found that diversity is highest in artificial habitats though a larger proportion of non-natives were found here as well. Consumers were also found to be important in structuring communities in different habitats, altering the direction of community development and species diversity. Our work highlights the utility of studying under-represented groups and illustrates the importance of including experiments to inform causal mechanisms of changes in species diversity.

Development of a Biogeochemical Model for Understanding Nutrient Cycles and Phytoplankton Blooms in the Northern Indian River Lagoon

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In the last decade, the northern Indian River Lagoon has experienced several major events including unprecedented phytoplankton blooms, seagrass die-off, fish kills, and mammal mortalities. To elucidate the fundamental dynamics of nutrient cycles and phytoplankton blooms, we developed an idealized NPZD biogeochemical model. The model targets central Mosquito Lagoon, and it includes 3 types of nutrients (N, P, Si), phytoplankton (5 groups), zooplankton (2 groups), bacteria, and organic matter. We used an idealized spatial configuration with zero-dimensions, two-layers (water column and sediment), and no horizontal transport or external nutrient inputs. The model is driven by observed physical parameters, including temperature, salinity, photosynthetically available radiation, and vertical mixing (estimated from wind speed). The model has been tested with available data, including long-term datasets for nutrients and phytoplankton. Some preliminary results will be presented and discussed.

Benthic Foraging Fish Prey Selectivity in Dredged Sediments

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Seagrasses are nursery habitat for fishes and benthic invertebrates in the Indian River Lagoon (IRL), an estuary impaired with accumulation of organic sediment. IRL fish known to feed on invertebrates (crustaceans, mollusks and polychaetes) include Mojarra (*Eucinostomus* spp.) and Red Drum (*Sciaenops ocellatus*). Environmental dredging in Turkey Creek is intended to remove harmful sediments and restore benthic habitat, which likely impacts benthic invertebrate populations and, indirectly, their predators. To examine the impact of dredging on benthic trophic relationships, fish gut contents collected via seining in Turkey Creek were compared to available prey before and after dredging. The composition and abundances of consumed vs. available prey have been compared via Ivlev's selection index. Results suggest that the predators change their diets and selectivity as a result of environmental dredging.

Patterns of Recovery and Loss: Southern Indian River Lagoon Seagrass 2005-2017

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Aerial maps of Indian River Lagoon seagrass to track acreage are produced every two years in a partnership between the South Florida and St. John's River Water Management Districts. The goal is to capture large-scale seagrass spatial distribution and total footprint. Images from April 2017 observed a total of 7,606 acres in Southern IRL, a 26% loss from 2015. This was greater than the ~2,000-acre decline observed from 2009-2011 (9,353 to 7,407 acres). Following 2011, substantial recovery was observed such that by 2015, the total seagrass footprint along SIRL was 10,294 acres, close to that determined by 1943 aerial photographs. From 2005 to 2017, two cycles of recovery (within 4 years) and loss of recovered acreage (within 2 years) have been observed. Examining these patterns with long-term trends in environmental data may help to discern what specific conditions or combinations thereof facilitated seagrass recovery and which facilitated loss.

Hydrodynamic Thresholds of Shoreline 'Ecosystem Engineers' and Their Application to Successful Restoration

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This project has developed ecological thresholds in wave energy for mangrove and oyster. These'ecosystem engineer' species are commonly utilized in living shoreline restoration in Florida. However, design of successful stabilization methods for eroding shoreline can be challenging, as designs must be robust to each site's prevailing hydrodynamic conditions. Understanding the capacity of key shoreline species to resist erosion represents a persistent scientific knowledge gap. Combining high-resolution field survey data from Mosquito and northern Indian River Lagoon with long-term wave modeling, we identify ecological thresholds in wave distributions, within which mangrove and oyster may survive. Use of mangrove and oyster to restore shorelines where wave energy is above the ecological threshold should be avoided. This information will assist managers in directing successful shoreline stabilization projects and is transferable to other regions with mangrove and oyster.

Oyster Mapping in the St. Lucie Estuary to Support Everglades Restoration

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The REstoration, COordination, VERification (RECOVER) Program, the science arm of the Comprehensive Everglades Restoration Plan (CERP), aims to regularly update maps of ecological indicator species in support of ecological modeling, and planning and evaluation of CERP projects. The most recent map of oysters (*Crassostrea virginica*) in the St. Lucie Estuary (SLE) was conducted in 2010, and an update was set as a high-priority task for 2019. A remote sensing survey was conducted using side-scan sonar and multibeam system to generate ultra-high-definition images of 2,705 acres of submerged habitat. Ground-truthing at approximately 1 site per 9-10 acres deployed a 0.25 m^2 quadrat and used a rapid visual assessment protocol to collect information on oyster habitat, e.g. live/dead percentages and structure type. The updated oyster map will be applied to oyster habitat suitability index models, interim restoration goals, and long-term tracking of oyster distribution following CERP project implementation to inform adaptive management.

Connecting the Community with the Indian River Lagoon through Public Outreach Efforts

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FAU Harbor Branch engages nearly 10,000 people each year through a wide array of outreach programming, and the institute's graduate students play a critical role in these efforts. Over the last year, three students worked to develop targeted projects that advance public education. The first project developed a survey to gauge the general public's familiarity with the Indian River Lagoon and factors that impact it. The second project created a series of hands-on activities and demonstrations. The third project established a display at the Ocean Discovery Visitors Center to showcase sea turtle research and conservation efforts. The goal of this work was to improve environmental literacy and the awareness of critical research.

Optimization of Aquatic Environmental DNA Capture, Preservation and Extraction Methods

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Environmental DNA (eDNA) approaches are becoming widely applied, and yet there is there is little consensus across studies on methods for eDNA capture, storage, and extraction. To understand how protocol biases affect biodiversity assessments, we compared five most commonly used extraction methods on clear and turbid water samples collected from Indian River Lagoon. We also tested the effectiveness of extraction protocols on the removal of PCR inhibitors. Moreover, we are testing effect of different filter pore sizes (0.2, 1.0 and 3.0 µm) on biodiversity assessment and the effectiveness of benzalkonium chloride (at a final concentration of 0.01%) as a preservative for the water samples at room temperature over a period of seven days. Our preliminary data revealed the highest PCR inhibition in samples extracted with phenol-chloroform-isoamylalcohol method while overall the most consistent and high quality DNA was obtained with DNeasy Kit.

Groundwater – Surface Water Interactions in the North Fork of the St. Lucie Estuary

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The North Fork of the St Lucie River, a tributary of the Indian River Lagoon (IRL) experiences persistent water quality impairments. To understand a potential bacterial source to this system, the interactions of groundwater, surface waters, and septic systems were investigated in Port St. Lucie, Florida. Groundwater samples from wells installed near septic systems and surface water from adjacent canals were analyzed to assess concentrations of fecal indicator bacteria, dissolved nutrients, and chemical source tracers of human wastewater. Nitrogen stable isotopes ($\delta^{15}N$) were determined for both groundwater samples and canal macrophytes to identify nutrient sources. Multiple wells and the adjacent canals had significant levels of sucralose, high dissolved inorganic nitrogen, and the presence of fecal bacteria at greater than background levels. This suggests that a strategic septic-to-sewer program could improve water quality in the North Fork and help to moderate algal blooms and bacterial contamination in downstream IRL waters.

Nutrient Over-Enrichment and Brown Tide Result in Light Limitation of Seagrass Communities in the Indian River Lagoon

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Widespread seagrass losses occurred in the Indian River Lagoon (IRL) following unprecedented harmful algal blooms (HABs), including persistent brown tides (*Aureoumbra lagunensis*). Little is known about how biochemical factors, such as the elemental composition (C:N:P) and stable isotope signatures ($\delta^{13}C$, $\delta^{15}N$), of seagrasses within the IRL relate to coverage. Accordingly, we conducted a survey to better understand these relationships. Species distribution varied by location. *Halodule wrightii* was ubiquitous, whereas *Syringodium filiforme* was not found in the northernmost segments. *Thalassia testudinum* was only present in the two southernmost segments that had the lowest TDN and highest light availability (K_d). Blade %N and %P exceeded critical restoration values, especially in the northern segments. Elemental composition reflected high N-availability and seagrass species distributions were relatable to spatial trends in N and light limitation. For effective restoration, resource managers must reduce N-loading to the IRL to diminish HABs and increase light availability.

Water Quality Drivers of Microcystin and Saxitoxin Concentrations in the Indian River Lagoon: A Case Study from the Florida Center for Coastal and Human Health

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Harmful Algal Blooms occurrences have increased in the Indian River Lagoon (IRL), releasing toxins such as microcystin and saxitoxin. This study assessed toxin dynamics and their relationship with water quality. Data collected across the IRL included colored dissolved organic matter (CDOM), temperature, salinity, pH, dissolved oxygen, nitrate, phosphate, chlorophyll-*a*, and microcystin and saxitoxin concentrations. Microcystin was significantly higher in the Southern IRL, whereas saxitoxin was slightly higher in Northern IRL. Both toxins were significantly higher during the wet season. Microcystin showed significant correlations with CDOM (r= 0.81), temperature (r= 0.50), and salinity (r= -0.51), while saxitoxins were significantly correlated with nitrate (r= -0.37) and chlorophyll-*a* (r= 0.33). Multiple linear regressions models identified CDOM, chlorophyll, and DO as the optimal parameters explaining microcystin variability, and chlorophyll, temperature, and nitrate for saxitoxins. These results provide a baseline to understand potential drivers of IRL toxins dynamics and help manage and improve water quality.

Quantifying the Effects of Hypoxia and Fish Kills on Fish Community Diversity in the Indian River Lagoon

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Dissolved oxygen (DO) is decreasing in the global oceans. This decrease and related hypoxic events are frequently exacerbated by algal blooms in coastal systems, potentially resulting in fish kills. However, we lack an understanding of the response of fish communities to these disturbance events. Long-term environmental data suggest DO levels in the IRL are decreasing, which may result in more frequent hypoxic events. To address how the IRL fish community has changed in response to hypoxia-related fish kill events, here we integrate environmental and biotic data to model the correlative relationships among algal blooms, environmental parameters, and fish kills. The results are used to explore temporal shifts in fish community assemblages and diversity following these disturbances. Ultimately, the insight provided from these analyses can generate a more predictive understanding of fish kills in the IRL and identify more effective management strategies for mitigating these effects in complex coastal ecosystems.

Utilizing Wildlife Cameras for Organism Identification and Behavioral Analyses along Restored Shorelines in Canaveral National Seashore

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Living shoreline restoration utilizes natural materials to promote growth of native habitat. To monitor animal behavior that could influence the success of a living shoreline, ten wildlife cameras were placed along a new (June 2019) living shoreline restoration site in Canaveral National Seashore for five days per month to identify these animals and their behaviors. Activated by motion detection, the wildlife camera footage indicates minimal impact to the deployed mangroves and oyster shell bags. Birds (24 observed heron individuals) were the most frequently observed organisms at the shoreline and raccoons (55 observed individuals) were most frequently observed in the adjacent upland vegetation. Deer, feral hogs, bobcats, crabs, and humans have additionally been recorded. Cameras will be monitored through Summer 2020 to determine diversity and identification of organisms and their impact on stabilization efforts.

Assessing the Response of Mangrove Snapper (*Lutjanus griseus*) Trophic Dynamics to Oyster Reef Restoration in the Indian River Lagoon

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Declining oyster reefs in the Indian River Lagoon (IRL) have impacted economically important fisheries, resulting in dedicated oyster reef restoration projects. These restored habitats can theoretically enhance foraging opportunities for predators, but this is understudied. To assess the impact of habitat restoration on trophic interactions, we quantified gut contents and stable isotopic signatures of a common reef-associated sportfish species, Mangrove Snapper (*Lutjanus* griseus). *L. griseus* were captured in a Before-After-Control-Impact experiment and processed for gut content and tissue stable isotope analyses. *L. griseus* had fewer empty stomachs and consumed more fish at live oyster reefs compared to dead, with restored reefs intermediate to controls. Similarly, stable isotope composition of fish at live reefs demonstrate greater carbon enrichment compared to dead reefs, while restored reefs become more enriched over time. These results can be utilized to develop more effective restoration-based solutions to guide management and conservation of IRL sportfish.

Quantifying the Effects on Nekton Communities following Habitat Restoration in a Dynamic Coastal Estuary

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Globally coastal habitats are experiencing degradation, and this threatens critical ecosystem services such as shoreline stabilization, water filtration, and nursery grounds for marine fauna. To combat the loss of these ecosystem services, resource managers are actively restoring coastal habitat. This study compares samples collected from three reference sites, three previously restored sites, and six sites undergoing restoration. Restoration sites are impacted wetlands with high elevation mounds that are leveled to increase intertidal habitat, enabling recruitment of intertidal flora and fauna. Fyke nets are used to sample nekton foraging within the upper intertidal zone. To assess restoration success, nekton abundance, biomass, and diversity are quantified. Preliminary results suggest sites restored eight years prior have approximately twice the abundance of nekton and no differences in nekton community composition or biomass. This project provides new insight regarding the benefits of restoring coastal wetland elevation to maximize intertidal habitat, thereby positively impacting nekton communities.

Machine Learning Techniques Applied to Flow Cytometry and Flow Imaging Data to Assess Phytoplankton Community Dynamics in the Indian River Lagoon

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Flow cytometry and imaging in flow allow for efficient detection and enumeration of phytoplankton but produce large data sets that require substantial effort to analyze. We have applied machine learning algorithms to automate analyses and extract ecologically important information from these data sets collected in the Indian River Lagoon (IRL) and St. Lucie Estuary (SLE). Water samples were collected monthly since 2016 from 10 locations in the southern half of the IRL and SLE. Samples have been analyzed with a BD Accuri C6 flow cytometer and Fluid Imaging Technologies FlowCam. Environmental conditions are continuously monitored at these sites by the Indian River Lagoon Observatory Network of Environmental Sensors. Unsupervised machine learning techniques were used to cluster flow cytometry data while supervised convolutional neural networks have been trained to classify FlowCam images. Results show variation in phytoplankton community dynamics over seasonal time scales and in response to local environmental conditions.

Analytics of Textual Data Structures on Visualization in Meteorology

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Efficient analysis and visualization of meteorological big data is essential, but a challenging part in coastal research. My research is to understand the functions of visualization in meteorological data analyses through textual coding, mining, and annotation. The method started with stages of software supported tasks on textual data structures (sentences and references) from a selected seed scholarly article, “Visualization in Meteorology – A Survey of Techniques and Tools for Data Analysis Tasks”. The process results in datasets and interactive visualizations that support the performance of five content types including concept, fact, procedure, process, and principle. A total of 605 sentences were extracted and annotated for the presence of content knowledge in the five categories plus selected key words and their derivatives such as weather, climate, meteorology, visualization, technique, and tools. Groups of sentences were obtained using a 10-digit binary code model, which were further analyzed using conventional statistical methods.

Genetic Analysis of Indian River Lagoon Water Samples for Early Detection of Toxin Producing Organisms

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Harmful algal blooms (HABs) usually co-produce toxins such as microcystins, saxitoxins and domoic acid, which have been impacting public human and environmental health in the Indian River Lagoon (IRL). These toxins are produced by a group of genes, i.e., biosynthetic gene clusters, which encode a set of enzymes working together to produce the toxins. We hypothesized that understanding the production machinery of toxins could better monitor, predict, and prevent these events. As a part of the Florida Center for Coastal and Human Health (FCCHH) project, genetic analysis of IRL water samples was performed in the past year to detect multiple genes for two known IRL HAB toxins, microcystins and saxitoxins. Our results showed high levels of biosynthetic genes in the water samples and further confirm a good co-relationship between the level of genes and the amount of toxins in the water samples. These results indicated that genetic analysis of water samples for biosynthetic genes can be a useful tool for the detection of toxin-producing organisms. Our future work aims to optimize these methods, such as the utilization of RNA as an additional testing of water samples.

Indian River Lagoon Microbiota and Their Potential Roles in Harmful Algal Blooms

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Toxin production during harmful algal blooms (HAB) in the Indian River Lagoon (IRL) impacts both coastal and human health. The ability to predict toxic HAB would be pivotal to water management efforts. To this end, a better understanding of the key drivers of toxin production during IRL HAB is needed. This includes the microbial community dynamics present during toxin production. During 2018/2019, DNA was extracted and shotgun sequenced from 120 water samples collected from 20 sites along the IRL. Sequencing reads were pre-processed and assembled using a suite of bioinformatic tools and compared using a set of assembly metrics. From the best metagenomic assembly, sites were compared for differences in taxonomy and their potential impact on the production of toxins. These preliminary results will be combined with upcoming data from the Florida Center for Coastal and Human Health to conclude the key drivers in toxin biosynthesis during IRL HAB.

The Manatee Observation Project at Harbor Branch Oceanographic Institute, a Ten-Year Look at Manatee Photo-Identification

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The Manatee Project was started in 2009 to photograph and document the manatees visiting HBOI. Unlike many manatee surveys, which are typically conducted in the winter when manatees are aggregated in thermal refuges, the Manatee Project surveys visiting manatees throughout the year. This has resulted in the documentation of seasonal migrants in the fall and spring, as well as year-round "residents" of the IRL in all seasons. More than 500 distinctive individuals have been identified from our photo database of manatees at HBOI. Currently we have matched at least 118 manatees to the Manatee Individual Photo-identification System (MIPS) run by the U.S. Geological Survey's Biological Branch in Gainesville. The vast majority of our individuals matched to MIPS are from Florida's east coast population.

Assessing the Remote Sensing Viability of Detecting Cyanobacteria in Lake Okeechobee and Other Lakes

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Lake Okeechobee is connected to the IRL and periodically discharges into the southern IRL. Discharge events have transported toxic cyanobacteria comprising *Microcystis* into the IRL during bloom periods. Although *Microcystis* is common to freshwaters, cells have been known to survive the brackish waters of the IRL and thus pose a potential health threat to animal life around the IRL. Detecting *Microcystis* in Lake Okeechobee is necessary for predicting when these organisms might be a potential threat to the IRL. Remote sensing is an observational tool that can be used to detect *Microcystis* in Lake Okeechobee. However, the performance metrics of remote sensing products in Lake Okeechobee are unknown. A necessary component of using satellite data for monitoring is the validation of derived water-leaving radiance products, and other bio-optical algorithms and products. In this study we examine the satellite performance compared to an automated field radiometer deployed in Lake Okeechobee.

Dynamic Diversity of Seagrass in the Indian River Lagoon

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The Indian River Lagoon harbors seven species of seagrass, making it an unusually diverse location at the global scale. Multiple factors influence the diversity of seagrass at different spatial and temporal scales. For example, only two species, *Halodule wrightii* and *Syringodium filiforme*, are present throughout the lagoon, and all seven species occurred along the same transect only once. Of the 97 fixed transects, 10 of the 15 with the highest species richness are found in the tidal influence of the four southern inlets. At the transect scale, the distribution of species ranges from monospecific stretches of *Halodule* to mixtures of up to five species. Typically, transects have monospecific stretches at their shallow and deep ends and mixtures between. Prior to the 2011 bloom, the lagoon-wide distribution of species remained relatively consistent, but the long-term effects of recent, extensive losses remain to be seen.

Utilizing Biodegradable Mats for Oyster Reef Restoration: Are there Biogeochemical Implications?

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Oyster reef restoration is a popular technique for enhancing coastal ecosystem services but can also introduce plastics to the environment. This study investigates how an "eco-friendly" alternative to plastic mats [biodegradable (BESE) mats created from potato chip waste] may alter biogeochemistry within restored reefs by serving as a nutrient source or substrate for microbial activity. A before-after-control-impact design was implemented on eight oyster reefs within Mosquito Lagoon, Florida: two restored with BESE mats, two restored with traditional plastic mats, two live/natural reef controls, and two dead reef controls. Sediment sampling (0-5 cm) occurred before restoration and at 1, 6, 9, and 12-months post restoration; samples were analyzed for bulk density, dissolved organic carbon, total nutrients (C, N, and P), and extractable nutrients (NH_4^+, NO_3^-, and PO_4^{3-}). Preliminary one-month post-restoration data indicates BESE mat sediments were similar to those beneath plastic mats but showed slightly higher NH_4^+ and organic matter content.

Harmful Algal Bloom-Associated Biotoxins and Health in Juvenile Green Turtles (*Chelonia mydas*) in Three Ecologically Disparate Foraging Grounds in Florida

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Sea turtles are at risk from harmful algal blooms (HABs) due to environmental degradation and possible negative health effects from exposure to HAB-associated biotoxins. Ultra-performance liquid chromatography-tandem mass spectrometry was used to detect 10 classes of HAB-associated biotoxins in samples from 42 juvenile green sea turtles (*Chelonia mydas*). Turtles were captured during non-HAB bloom periods at three sites: Florida's Big Bend, the Indian River Lagoon, and the Florida Keys. Serum samples from 23/42 (55%) and esophageal lavage samples from 4/9 (44%) turtles tested positive for biotoxins including domoic acid, microcystins, nodularin, lyngbyatoxin-A, and okadaic acid. Anatoxin-A, neosaxitoxin, saxitoxin, cylindrospermopsin, and brevetoxins were below detection limits in all samples. A negative linear relationship was observed between domoic acid concentrations and absolute heterophil counts (R^2=0.16, P=0.03), suggesting possible immunomodulation. Biotoxin concentrations were higher in esophageal lavage samples than serum, supporting forage consumption as the primary route of biotoxin exposure.

Fish Community Diversity in the Indian River Lagoon: 25 years of Changes and Challenges

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Analysis of over 20 years of fish community data from the State of Florida's long-term fisheries-independent monitoring program in the Indian River Lagoon indicates diversity metrics, abundance, and composition varies markedly over spatial and temporal scales. In general, the three lagoon basins (Mosquito Lagoon, Banana River, and Indian River) have communities that are characteristic of the dominant habitats within each (e.g., saltmarsh, hardened shorelines, mangrove, seagrass, oyster reef). Temporal variation in biodiversity reflects large-scale disturbances that have occurred over the past 20 years (e.g., algal blooms, seagrass losses, hurricanes, winter freezes) although the response by communities to these disturbances can vary in magnitude and duration.

Risks to Indian River Lagoon Biodiversity Caused by Climate Change

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The results of the Indian River Lagoon (IRL) Climate Change Vulnerability Assessment (2018) yielded 472 risks to the Action Plans of 13 key indicators or Vital Signs identified in the newly revised IRL Comprehensive Conservation and Management Plan. Of those, 160 occurred in the Living Resources category that includes Biodiversity (48), Species of Special Concern (63), Fisheries (52) and Invasive Species (45) vital signs. Based upon these results, nine "Climate Ready" Action Plans are proposed. All target anthropogenic pollutant loadings expected to increase in response to changing temperature, precipitation, storminess, pH, and sea level. All focus on reducing water quality impairment caused by septic, wastewater, and surface water systems. A majority of the other 'at risk' Vital Signs – including Biodiversity – are expected to benefit from the implementation of the nine Action Plans given all climate-related risks are interconnected by biological, chemical, and physical processes operating within the IRL watershed.

Validating Ultrasonography of Shoulder Fat Thickness as a Non-Invasive Technique for Estimating Body Condition in Green (*Chelonia mydas*)

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Body condition evaluation provides an important index for health assessment, foraging success, and reproductive success. In sea turtles, body condition is typically evaluated through subjective body condition scoring and a calculated body condition index (BCI) using the turtle's length and weight. BCI is more accurate, but requires weighing the turtle which can be difficult in field situations. One solution is using ultrasonography to provide a non-invasive proxy for body condition evaluation to be used in conjunction with visual assessment, morphometrics, and clinical blood data to objectively quantify health in sea turtles. The proposed research will validate ultrasonography as a proxy for body condition in green sea turtles. Ultrasonography-guided measurements of subcutaneous fat depth will be taken at four anatomic locations on both sides of the body. Summary statistics for each measurement will be reported, including mean, standard deviation, and range for repeated fat depth measures at each location.

Spatial Distribution of Oxygen in the Indian River Lagoon

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In recent years, the IRL has suffered from a series of hypoxic events, leading to fish kills and modifications to geochemical processes that regulate nutrient cycling within this system. While many of these events have been documented using real-time sensors, these sensors are typically located near the surface (0.5-1.0 m depth) and are likely to miss events that are limited to bottom water that can still influence benthic biota and geochemical processes. Vertical profiles and our bottom water sensors (10-30 cm above the sediments) have sometimes shown lower dissolved oxygen concentrations (often >50% lower) in bottom water compared to surface water, most notably near muck deposits. These new data capture differences between surface and bottom water and will help to identify the extent of hypoxia and to explain observed patterns for nutrient cycling in the IRL.

Prevalence and Intensity of *Perkinsus marinus* (Dermo) Infections in Oyster Populations in the St. Lucie Estuary

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The protozoan oyster parasite, *Perkinsus marinus* (Dermo), can have detrimental effects on eastern oyster populations living in environments with prolonged periods of high salinity and high temperatures. The St. Lucie Estuary often experiences these conditions during the summer months and as a result dermo prevalence in sampled oysters is high. Major weather events and subsequent fresh water inundations frequently lead to decreased salinities in the estuary. These low salinity conditions adversely affect oysters, especially during the hot summer months, often resulting in widespread oyster mortalities. Because the dermo parasite favors a high salinity/high temperature environment, its presence also declines following a low salinity event. However, once water quality conditions improve and oysters return, dermo prevalence increases as well. The extent and intensity of dermo infections following recovery depends on the salinity and temperature regime as well as the age of the sampled oysters.

A Reassessment of Epiphytic Foraminiferal Diversity in Jupiter Sound, Florida, Indian River Lagoon

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A reassessment of the epiphytic foraminiferal diversity in Jupiter Sound, Florida, was conducted in the fall of 2019. These results were compared to earlier assessments that were carried out in 2005 and 2001. The extent and composition of the seagrass meadow have changed considerably over the past 18 years. In 2001, the meadow was comprised predominantly of turtle grass (*T. testudinum*) with scattered patches of manatee grass (*S. filiforme*). In 2016, the bed was extensively overgrazed by variable urchins (*L. variegatus*), West Indian sea eggs (*T. ventricosus*), and queen conch (*L. gigas*). The site is also subject to heavy recreational use. Currently the meadow consists predominantly of manatee grass interspersed with patches of turtle grass, and the blades are heavily epiphytized by filamentous algae and cyanobacteria. The epiphytic foraminiferal assemblages show increased species diversity, both species richness and Shannon's H, compared to earlier studies, but exhibit drastically reduced population densities.

Temporal and Spatial Distribution of Saxitoxin in Bottlenose Dolphin Prey Species from the Indian River Lagoon

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The Indian River Lagoon (IRL) is frequently affected by harmful algal bloom (HAB) events, many of which produce natural toxins harmful to marine wildlife. The bottlenose dolphin (*Tursiops truncatus*) is a marine sentinel species critical to monitoring the ecosystem health of southeastern US coastal waters, and the presence of HAB toxins in a food web potentially shared by this species and humans may have significant public health impacts. We assessed the distribution and concentration of the HAB toxin saxitoxin in IRL waters, the food chain (prey fish) and ultimately in the resident dolphin populations. Here we present data on the concentration, spatial distribution and seasonality of the HAB toxin saxitoxin in finfish species known to be important in the IRL dolphin diet. These data will fill critical data gaps for this region where dolphins serve as an indicator species for understanding future health threat(s) to humans in the IRL.

Oral Histories: What We Learn Can Help Improve the Indian River Lagoon (IRL)

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Local anecdotal information can be combined with maps/photographs to document an estuary's ecological history. This information can then be used to help guide habitat restoration. In Mosquito Lagoon, intertidal oyster distributions dating back to 1943 have been published. In the central IRL, local accounts and commercial harvest records suggest historically dense oyster populations, however, oyster reefs are not visible in historic maps or photography. To remedy this, we are collecting oral histories of the IRL from long-term residents to record their knowledge and documents. Findings from talking to 56 residents include: 1) locals love to talk about the historic IRL; 2) surprisingly, most individuals knew exactly where adult oysters were abundant through the early 1980s; they recounted what wiped out local populations and when, 3) historically clear waters allowed subtidal oysters to grow 1-1.5 m below the water's surface, and 4) oysters provided free food for families with limited incomes.

Lagoon Academy Homeschool: Connecting Homeschoolers to the Lagoon through Placed-Based and Hands-on Education

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Since September 2019, the Environmental Learning Center (ELC) has been offering monthly programs for homeschool students at its 64-acre lagoon island campus. Each month a different theme is presented that is connected to the Indian River Lagoon. Past focuses include lagoon ecosystems, water quality, and STEM based activities that help monitor the health and biodiversity of the lagoon. Engaging this cohort of youth in lagoon-focused learning may help to broaden the scope of students engaged in the lagoon and offers homeschool families ideas on how to connect other subject areas to their local environment.

Establishing an Algal Biodiversity Baseline to Monitor Florida's Waterways via Environmental DNA Sequencing

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Algae are known to exhibit tremendous crypticism and modern approaches using DNA sequencing generally unveil much unsuspected diversity. Such approach is generally critical to accurately resolve species identifications, and in spite of the ongoing algal crisis in Florida, very little is actually known about the biodiversity of algae found in the State's waterways. This strongly impedes the capacity of environmental agencies to efficiently monitor, track and detect phytoplankton species, including harmful algal bloom species. In the present study, we sequenced multiple samples collected from Florida's waterways in an effort to facilitate monitoring and ecological projects relying on environmental sequencing, such as investigating bloom dynamics in the Indian River Lagoon.

Studying the Public Health Impacts of Harmful Algal Bloom Exposure in Florida

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Florida has experienced multiple algal blooms in recent years. Blue-green and red-tide algal blooms have the potential to impact public health due to the production of toxins including brevetoxin and hepatotoxic microcystin (MC). However, data quantifying exposure and health outcomes in humans is sparse. The interdisciplinary team began research efforts during the 2016 algal bloom in the IRL and expanded efforts in 2018 to include direct assessments of human exposure. Ongoing epidemiological studies will be presented and future directions will be discussed.

Assessing the Impacts of Oyster Reef Restoration on Macroinvertebrate Community Assemblages in Mosquito Lagoon, Florida

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To better our understanding of the effects of oyster reef restoration on community diversity and assembly processes, it is critical to assess the response and potential recovery of ecosystem structure and function following restoration. To that end, four oyster reefs were restored during 2017 and 2018. Macroinvertebrate communities were sampled at these eight sites, along with eight control sites, four dead and four living oyster reefs. All sites were sampled with lift nets before restoration and for two years following restoration. PERMANOVA revealed significant differences in community composition at restored oyster reefs and live reefs before restoration, while dead reefs and restored reefs were not significantly different. However, one year after sampling, restored reef assemblages were not significantly different than assemblages on live reefs but were significantly different than those on dead oyster reefs. Subsequent canonical analysis of principle coordinates revealed *Eurypanopeus depressus* to be an indicator of restoration success.

Using Computer Programming to Automate Environmental Data Analyses

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The long-term collection of environmental and biological data is a critical part of analyzing ecological trends in the Indian River Lagoon. Since 2005, the Smithsonian Marine Station has collected replicated infaunal invertebrate samples quarterly from 15 sites, resulting in a lot of data. The ability to rapidly prepare this information would facilitate analyses, and this can be achieved via computer programming. Using the Python language, I have developed a program to automatically convert large datasets into simple, comprehensible formats. So far, this program has been used to visualize salinity, pH, species abundance and diversity from 2,655 samples across 855 sampling events. In the future, the program can be used to organize and display endless combinations of factors, helping to interpret results from these cumbersome datasets.

Spatiotemporal Changes in Phytoplankton Dynamics in the St. Lucie River Estuary (SLE)

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Phytoplankton play a significant role in primary production and food web dynamics of estuarine systems. Changes in phytoplankton biomass and community structure may occur due to several factors such as nutrient delivery from terrestrial freshwater flows and connectivity to highly developed watersheds. To better identify phytoplankton responses to environmental parameters and threshold inflows, phytoplankton collections and water quality analyses including chl *a* (a phytoplankton biomass proxy) were made at 10 stations in the SLE and C-44 canal from January to September 2019. Relative abundance of major phytoplankton classes varied along the estuary during this period. Results agreed with historical data that the North Fork has the highest average chl *a* concentration within the estuary. The greatest peak of chl *a* occurred in the North Fork in June when dinoflagellates dominated the phytoplankton community, and stratification and hypoxia near the bottom of the water column was recorded.

Grasses in Classes: Using Native Plants to Engage Students with Hands-on Restoration

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Brevard Zoo's Restore Our Shores (ROS) is a community-based program that umbrellas multiple projects focused on lagoon restoration and education that, since 2009, has helped gather over 58,000 volunteers into an active cohort of lagoon restoration advocates. One of the newest ROS projects, Grasses In Classes, engages students of all ages by providing free hands-on workshops focused on the importance of native plants. These students learn how to care for mangroves, marsh grasses (*Spartina)* and seagrasses, all of which will make their way back into the lagoon at living shoreline sites. The project also includes a pilot study for seagrass restoration, staff will collect floating seagrass fragments that students will grow in the classroom. These students will then have the opportunity to join the ROS team in the field for both the planting and monitoring of the seagrass, helping to pave the way for future seagrass restoration methodologies.

Evaluating Spatial-Temporal Trends of Indian River Lagoon Essential Fish Habitat, Forage Fish and Their Recreationally Important Predators

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Estuaries provide shelter, foraging, and spawning habitat for a variety of economically significant marine fish. Since 2010, perturbations in the form of harmful algal blooms have become a regular occurrence within the Indian River Lagoon (IRL) causing major seagrass die-offs and fish kills. Our objectives are to use fisheries-independent data to analyze diet composition for three predators (*Centropomus undecimalis*, *Cynoscion nebulosus*, and *Sciaenops ocellatus*) to develop a baseline of trophic interactions, evaluate spatial overlap of recreationally important predators and their prey (forage fish and invertebrates), and investigate the influence of seagrass (and other environmental parameters) on predator and prey distribution and abundance using spatial analyses. Ultimately, the results of this study will establish a baseline of trophic interactions and aid IRL fisheries managers and natural resources scientists in developing management strategies.

Preparing for Environmental Careers: An Immersive Internship Program for At-Risk High School Students

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During the summer of 2019, The Environmental Learning Center (ELC) hosted four at-risk high school students for a seven-week, paid, multi-disciplinary internship program. The program sought to expose these youth to a wide-range of environmental careers and issues, with a primary focus on the Indian River Lagoon. The ELC provided a supportive environment as well as mentorship from staff and community organizations to help interns better understand local environmental concerns, while also providing a supportive setting to develop needed workforce skills. The internship highlighted the importance of education and interpretation as a means to raise awareness of issues impacting the Indian River Lagoon and concluded with interns each creating interpretive projects for display at the ELC.

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

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Stony Coral Tissue Loss Disease (SCTLD) has spread from Florida throughout Caribbean coral reefs since 2014, with some reefs experiencing as high as 83% coral mortality. Through a collaborative research partnership, both antibiotic and chlorine intervention treatments have been field-tested in southeast Florida. To experimentally assess the effectiveness of these intervention treatments against SCTLD *in situ*, SCTLD-affected *Montastraea cavernosa* colonies were treated in April 2019 and have since been monitored using 3D modelling techniques to track lesion progression. Mucus samples were assessed with 16S amplicon sequencing to characterize the community makeup. *In situ* observations indicate that the antibiotic treatment is more effective for reducing the progression of disease lesions but does not prevent the development of new lesions. Further results from this project will elucidate how treatment impacts rate of healthy tissue loss and the diversity and abundance of different microbial groups in the coral surface mucus layer.

Fifteen Years of Benthic Infaunal Diversity and Composition throughout the Indian River Lagoon: A Comparison across Regions

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Benthic infauna are important indicators of water and sediment quality and are used in various estuarine monitoring programs to assess overall ecosystem health and follow long-term trends in community composition. Infaunal community changes can reflect a multitude of stressors, including eutrophication, hypoxia, climate change, overfishing, contamination and others. The Smithsonian Marine Station has catalogued benthic infaunal communities throughout the Indian River Lagoon (IRL), Mosquito Lagoon, and Banana River. Quarterly monitoring has been conducted in the southern IRL since 2005, the Central IRL from 2008-2011, and the Northern IRL, Mosquito Lagoon and Banana River from 2014-2016. With over 1.2 million individuals identified, this large compilation of data is being used to assess diversity and species composition across all five regions of the estuary. Results from this comparison will contribute to our understanding of the impacts caused by unique combinations of stressors plaguing different sections of the IRL system.

Comparison of Field and Laboratory Phytoplankton Pigment Fluorescence Measurements in the Indian River Lagoon

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Phytoplankton contain a variety of pigments that absorb light during photosynthesis. Each of these pigments has unique fluorescence spectra which can be used to quantify the amount of a given pigment in a sample. Since different phytoplankton types have different pigments and in varying ratios, the amount of pigment fluorescence in a sample can be used to determine the abundance of the various phytoplankton types. The measurements from multiple *in situ* pigment fluorescence sensors are compared to each other and to those from a bench top flow cytometer and extracted chlorophyll fluorescence to identify relationships between the different measurement methods. Fluorescent particle counts are compared to bulk fluorescence measurements to determine the relationship between pigment fluorescence and phytoplankton biomass.

Infaunal Invertebrate Diversity in the Indian River Lagoon System: 15 Years of Data and Counting

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Benthic infaunal invertebrate communities are a standard gauge of aquatic ecosystem health because these slow-moving organisms cannot escape acute environmental stress. The Smithsonian Marine Station has assessed the diversity and community composition of infauna throughout the Indian River Lagoon (IRL) system since 2005. The long-term dataset spans across algal blooms, inundations of freshwater and excess nutrients, seagrass losses and other strains on IRL health and productivity. This talk will introduce the full network of 179 benthic infaunal monitoring sites utilized over the past 15 years, discuss how these biological indicator communities have changed at key locations, and reflect on what we have learned about their diversity since the compilation of the first IRL species inventory 25 years ago.

Discovery of Survivin-Targeting Marine Natural Products from the Indian River Lagoon

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The goal of this project is to identify marine natural products that reduce survivin levels in cancer cells from an organism, *Eudistoma olivaceum*, which occurs in the Indian River Lagoon. Survivin is a protein that is upregulated in cancer cells and plays a critical role in the promotion of mitosis and inhibition of apoptosis. A fraction obtained from the extraction of an *E. olivaceum* sample was shown to significantly reduce the levels of survivin in both the A549 lung carcinoma and DLD-1 colorectal adenocarcinoma cell lines in an immunofluorescent imaging assay. This fraction was purified following bioassay guided fractionation using sequential liquid chromatographic steps to yield a series of compounds with varying levels of activity. Further experimentation will be conducted to gain insight into how the active compounds reduce survivin levels in the cancer cells. Progress towards the development of these assays will be presented on the poster.

Using Citizen Science to Monitor Seagrass in the Southern Indian River Lagoon

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In 2012 the Florida Oceanographic Society developed a citizen science based seagrass research program, "Florida Oceanographic Seagrass Training Education Restoration" (FOSTER), to educate and engage our local community through active research participation. One of the goals of FOSTER was to create a community effort to assess seagrass health in the Indian River Lagoon. Volunteer citizen scientists regularly participate in ongoing monthly seagrass surveys, where they measure seagrass species composition, occurrence, coverage, and height along established transects along the lagoon shoreline at the Florida Oceanographic Coastal Center. Their seagrass data has helped identify trends in seagrass losses and shifts in species composition in the Indian River Lagoon over the last six years.

Biodiversity of the Indian River Lagoon System: A Cautionary Tale from the Birds

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Prevailing dogma on IRL comparative biodiversity stems only from one claim about ichthyofauna and two about avifauna. The extensive network of bird-watchers, clarity of bird taxonomy, long history of the Christmas Bird Count (CBC), and burgeoning database on ebird.org make birds excellent for comparison. The 1985 claim that Merritt Island CBCs are often the "most speciose count" in the U.S. is unfounded. CBCs there in 1970-1985+ have never had the highest count; for CBC 2013 in Florida alone, it ranked 11th. The 1989 claim that IRL has "the most diverse avifauna in the United States" also is unfounded. Of 240 hotspots (>250 species) in coastal continental states on ebird.org, Merritt Island National Wildlife Refuge has 295 species; but 60 other sites list higher numbers.

Tracking the Lionfish Invasion across the Indian River Lagoon Using Environmental DNA

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The Indo-Pacific lionfish (*Pterois volitans* & *P. miles*) have been recorded within the Indian River Lagoon, but the extent of their distribution is not fully understood. There is no shortage of studies on the immense negative impact lionfish have on native populations: as ambush predators, many native fishes are not familiar with their hunting behavior. They are known to have a broad salinity tolerance that allows them to invade estuaries, further highlighting their threat to native populations in the Indian River Lagoon. Environmental DNA (eDNA) is genetic material shed into soil, water, or air. In this project we capture this DNA using cellulose filters and employ custom-designed species-specific lionfish primers to track their presence within the Indian River Lagoon.

What Might Seagrass Recovery Look Like? How Can We Help?

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Since 2009, the IRL has lost over half its seagrass. The loss was especially high in the north-central IRL—nearly 100% in some segments. The questions are whether seagrass might recover and what might recovery look like? Some possible scenarios include: a) no recovery from a phytoplankton-dominated system: b) decades-long recovery from rhizome spread of remaining seagrass; c) sporadic recruitment by seagrass fragments that grow into patches, then into beds; d) a few consecutive drought years with clear water, resulting in massive recruitment; e) macroalgae, both drift and attached, take up nutrients and stabilize sediments, paving the way for seagrass recovery; f) we plant many, many scattered patches that spread rapidly; and g) we spend a few billion dollars to greatly reduce nutrient loading, and the seagrass is not all eaten by turtles and manatees. Recovery will take time and luck.

The Effect of Sea Level Rise on the Retreat of *Sable palmetto* Hammocks in the Coastal Oaks Preserve

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Coastal forests are increasingly threatened by flooding from sea level rise as evident by forest retreat at the Coastal Oaks Preserve (COP). In this investigation, *Sable palmetto* hammocks at nine different sites were surveyed to determine the effects of sea level rise on forest structure. The hammocks were classified as healthy, intermediate, or decadent in replicate 400-m^2 quadrats by evaluating live and dead canopy, sub-canopy, trunkless palms, and seedlings. Elevation, groundwater salinity, soil properties, flooding, and increased hydroperiod all contributed to the health of the sable palms. These factors could be key indicators in determining locations and priorities of conservation efforts by the COP to preserve viable *Sable palmetto* forests for generations to come. Forest monitoring studies should focus on regeneration of sable palms in upland areas rather than on the health of the canopy trees.

Reassessing IRL Biodiversity: The Importance of Oysters in the Indian River Lagoon
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Oysters provide a variety of critical ecosystem services to estuaries around the globe. This includes providing habitat for recreationally and commercially important species; attenuating natural wave and boat wake energy that frequently translates into reduced shoreline erosion; and transferring nutrients, phytoplankton, and suspended solids to increase water clarity and light availability for submerged vegetation. In the Indian River Lagoon system, the eastern oyster *Crassostrea virginica* dominates the system in northern Mosquito Lagoon, while in the Banana and Indian Rivers, oyster reefs are currently limited in number and widely scattered. Historical and current issues that positively and negatively impact oysters throughout the IRL will be discussed in this presentation as well as ongoing oyster restoration efforts.

Evaluating Ecosystem Services of Intact Shorelines and Oyster Reefs in Indian River Lagoon: A Meta-Analysis of Hydrodynamics and Sediment Carbon Storage
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Ecosystem services of natural features in the Indian River Lagoon, such as wetland shoreline ecotones and oyster reefs, are valuable, yet difficult to quantify. To understand how valuable services are created in natural features, we evaluated hydrodynamic energy dissipation and carbon sequestration in reference-state, degraded, or restored shorelines and reefs. Velocity and wave heights were measured at vegetated sites, oyster reefs, and nearby channel sites in the Indian River Lagoon. Sediment samples were collected and surveying data were also recorded at these sites. This recorded data was used to calculate wave attenuation, velocity attenuation, percent organic matter, and grain-size distribution for each site. A meta-analysis among eight reefs and five shorelines was conducted to discern the processes by which natural features affect hydrodynamics and carbon storage in sediments. Understanding these important ecosystem services is integral to knowing how best to protect and restore ecosystems.

Does the Benthic Invertebrate Community Reflect Disturbances in the Central Indian River Lagoon?
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The Indian River Lagoon (IRL) is home to more than 4,300 species of plants and animals, making it one of the most diverse estuaries in North America. Benthic invertebrates play an important role within the lagoon ecosystem. These organisms are filter feeders, removing suspended particles from the water column and thus helping to improve water clarity and quality. The Center for Corrosion and Biofouling Control (Florida Institute of Technology) has been monitoring benthic invertebrate communities at a test site in the central lagoon since 2008. Organism abundance, temperature and salinity has also been recorded. In addition to natural disturbances (i.e., cold snaps and tropical cyclones), these organisms endure the declining health of the IRL. This presentation will explore the annual changes in benthic invertebrate community structure as well as responses to both natural and human induced disturbances in benthic invertebrate diversity and individual taxa.

Planning, Permitting, and Use of Native Wetland Plants in Coastal Stormwater Management Projects

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Urbanization causes changes to the hydrology of areas and increases amount of impervious surfaces; this often leads to increased runoff and pollutants discharged into natural waterbodies. To mitigate stormwater-driven pollution, a treatment wetland was constructed as a means to reduce nutrient and sediment loading into the Halifax River estuary. The treatment wetland system is designed to increase stormwater flow time and nutrient filtration through the constructed wetland planted with native plants in order to reduce nutrient and sediment loading into the Halifax River estuary. Water quality is assessed through measurements for total suspended solids (TSS), dissolved oxygen (DO), total Kjeldahl nitrogen (TKN), phosphate, ammonia (NH_3), and nitrate. The treatment wetland is expected to reduce TSS and nutrients entering into the Halifax River. Research outputs will be shared with the coastal community and municipal and state governments to enhance their ability to lessen their impact on storm-water pollution.

Empowering the Community to Build a State-of-the-Art Aquarium and Indian River Lagoon Conservation Center

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Brevard Zoo was created by a small group of people with a big dream: building a world-class zoo. One that would serve as a hub where the community could gather to learn about animals and nature. In the 25 years since the zoo opened, we have focused our mission on education and conservation with our recent efforts working to restore the Indian River Lagoon (IRL). This commitment to local conservation will be taken even further with the development of our Aquarium Project at Port Canaveral. Input is being gathered from scientists, educators, elected officials, and residents to craft the design and the scope of the project. A state-of-the-art aquarium would expand our reach in the community to educate and would increase our ability to tackle the threats facing the IRL. We can't wait to go on this journey and take you all with us!

Exploring the Driving Factors behind Mangrove Colonization of Oyster Reefs within Mosquito Lagoon

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Ecosystem shifts are extensive changes in the functions, structures and composition of a system. This study aims to uncover the possible driving factors of an ecosystem shift from oyster reef to mangrove forest within Mosquito Lagoon. The amount of mangrove area on oyster reefs doubled between 1943 and 2017, but not consistently across reefs. A space-for-time experiment was established in Summer 2018 with 23 reefs categorized into 3 groups by the percent of mangrove cover in 2017: low (0-5%), medium (6-45%), and high (46-100%). Data was collected on mangrove recruitment, survival, and growth, as well as live oyster density, in May 2018, January 2019 and July 2019. Mean growth values (height, diameter) were not statistically significant between groups. There was no significant relationship between survival rate and percent cover of mangrove area. This research can provide fundamental knowledge to coastal managers protecting and restoring the Indian River Lagoon.

Hematology and Plasma Biochemistry Baseline Reference Values of Free-Ranging Estuarine Elasmobranchs

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Elasmobranchs (sharks and rays) play an integral part in the marine ecosystem due to their role as predators; however, there is limited data on baseline values for basic clinical measures that are essential to monitoring population health among wild individuals. The primary objective of this study was to establish baseline hematology and plasma biochemistry of elasmobranchs in the southern Indian River Lagoon. Blood was collected from live animals captured in fishery-independent surveys in the south IRL. To date, samples have been analyzed from 18 different species, with a particular focus on bull sharks (n=97) and spotted eagle rays (n=27). Blood values were variable among species; however, initial results for bull sharks suggest similar values of multiple parameters (e.g., glucose, calcium, sodium) compared to captive counterparts. This data establishes baseline values that will be utilized for multiple ongoing studies designed to evaluate the dynamics of population health in IRL elasmobranchs.

Introduction to Restoring Lagoon Inflow Research Phase I

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Florida Tech faculty are exploring solutions for improving water quality in the Indian River Lagoon with a pilot project to investigate the impacts of allowing periodic ocean inflows. The project is not intended to support an artificial inlet or suggest a complete solution to restoring IRL water quality. Phase I will gather baseline data and modeling on existing water quality, biological parameters and hydrologic conditions at potential locations for future temporary permitted inflow test structures. Project objectives include (1) testing whether controlled water exchanges can be engineered to improve flushing and water quality without the negative impacts on littoral sediment budgets; (2) document baseline biological characteristics of the lagoon and coastal ocean in the vicinity of the proposed inflow locations; and (3) determine potential impacts to water quality that could result from direct dilution by seawater, changes to lagoon water residence time, and changes in geochemical cycling.