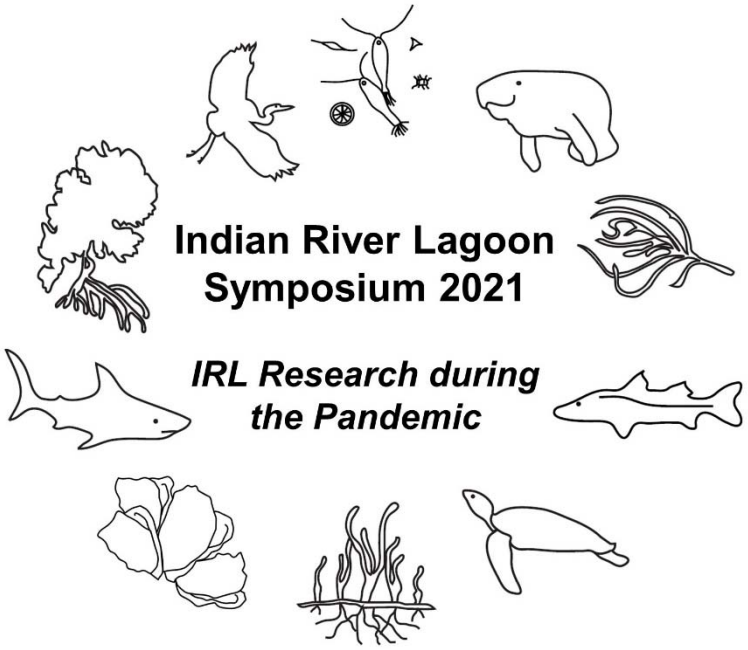
Abstracts of Presentations



February 18-19, 2021

Sponsored by:

HARBOR BRANCH OCEANOGRAPHIC INSTITUTE
FOUNDATION

Love Your Lagoon®

ONE LAGOON

Key Note Address

A 23-year View of Algal Blooms in the Northern Indian River Lagoon: Cyclical Patterns and a Regime Shift

Edward J. Phlips[1], Susan Badylak[1], Natalie G. Nelson[2], Lauren M. Hall[3], Charles Jacoby[3], Margaret A. Lasi[3], Jean C. Lockwood[1], and Janice Miller[3]
[1]University of Florida, Gainesville, FL; [2]North Carolina State University, Raleigh, NC; [3]St. Johns River Water Management District, Palatka, FL
Contact email: phlips@ufl.edu

This presentation examines the character of phytoplankton blooms in the northern Indian River Lagoon. The results of a 23-year study (1997-2020) provide evidence for multiple types of variability in bloom activity, including cyclical patterns, stochastic events and most prominently a regime shift in composition and intensity. Cyclical patterns (e.g., El Niño/La Niña periods) and stochastic events (e.g., tropical storms) were often linked to rainfall levels, which in turn impacted nutrient concentrations in the water column and the timing and intensity of blooms. In 2011, a major change occurred in the character of blooms, with a dramatic increase in peak biomass levels of blooms and the appearance of new dominant taxa, including the brown tide species *Aureoumbra lagunensis* and other nanoplanktonic species. Results of quantitative analyses reveal system behavior indicative of a regime shift. The shift coincided with widespread losses of the seagrass community and drift algae biomass. A combination of exceptionally low water temperatures in the winter of 2010/2011, hypersaline conditions associated with drought conditions, and high light attenuation caused by blooms appear to have contributed to the widespread and protracted decline in seagrass and drift macroalgal communities in the lagoon, leading to shifts in internal and external nutrient sources toward phytoplankton, resulting in more intense blooms in the post-2010 period than in earlier years.

Contributed Papers (Oral and Poster Presentations)

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

Tracking an Ongoing Novel Cyanobacterium Bloom in the Indian River Lagoon during the Summer and Fall of 2020

Stephanie Keller Abbe, Karen Henschen, Laura Markley, Célia Villac, Eric Muhlbach, Charles Tilney, Autumn Biddle, Richard Paperno, and Katherine Hubbard
Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL
Contact email: stephanie.kellerabbe@myfwc.com

A bloom of an unidentified nano-sized cyanobacterium was observed in August through December 2020, causing greenish water discoloration in the northern Indian River Lagoon (IRL). Microscopy-based detection revealed concentrations of $>10^6$ cells/mL in the northern and central Indian River, Banana River, and Mosquito Lagoon. Bloom concentrations ($2x10^5$ cells/mL) were first observed in the northern Indian River and Banana River and have persisted there longer than in other IRL basins. Ongoing inspection of archived samples, however, suggests this taxon has been in the system since at least mid-June. Cells are round to oblong (~3-4µm x 5µm), often dividing so two or more cells line up in a chain. Live cells indicate an elongated aerotope that becomes inconspicuous upon preservation with Lugol's solution. Flow cytometry confirmed that this cyanobacterium has low chlorophyll *a* and high phycocyanin-like fluorescence. Further identification efforts are based on cell ultrastructure, pigments, and 16S rRNA gene sequencing.

Expansion and Reduction of Estuarine Fish Species in a Changing Subtropical Estuary

Douglas H. Adams[1], Dwayne Edwards[1], Jacob Schneider[1], and Adam R. Searles[2]
[1]Florida Fish & Wildlife Conservation Commission, Melbourne, FL; [2]Nature Coast Biological Station, University of Florida, Cedar Key, FL
Contact email: doug.adams@myfwc.com

Recent and ongoing changes in habitats, climate, and water quality have influenced the abundance and distribution of sparids and other fish species within the Indian River Lagoon system. Concurrently, the Florida Fish and Wildlife Conservation Commission – Fisheries-Independent Monitoring program (FWRI-FIM) has confirmed recent hybridization between Sea Bream (*Archosargus rhomboidalis*) and Sheepshead (*A. probatocephalus*) in the Indian River Lagoon. Analysis of FWRI-FIM data indicates significant abundance increases and a northward range expansion of Sea Bream, with a potential concomitant decrease in relative abundance of Sheepshead within the system during recent years. The relative abundance of adult or fully-recruited Sheepshead in the northern Indian River Lagoon has decreased since 2016, with the lowest abundance of the past 22 years observed in 2019. This study will investigate these population dynamics and related habitat issues in detail.

Do Sponge Communities Reflect a Biome Transition Zone in the Indian River Lagoon?

Greer Babbe[1], Maria Cristina Diaz[1], Iris Segura-Garcia[1,2], John Reed[1], and Andia Chaves-Fonnegra[1,3]
[1]Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL; [2]Smithsonian Marine Station, Fort Pierce, FL; [3]Florida Atlantic University, Jupiter, FL
Contact emails: gbabbe2020@fau.edu, andia.chaves@fau.edu

The Indian River Lagoon (IRL) is a regional-scale ecotone that comprises a transition zone between the temperate and subtropical biomes on Florida's east coast. Although rich in species and habitats, little is known about the diversity and biogeographic patterns of sponges (Porifera) in this lagoon. Sponges play essential ecological roles as habitat and food for commercial fish, crustaceans and mollusks, and can improve water quality. This study aimed to describe the sponge communities across the IRL and determine if the expected two-faunal regimes (temperate and subtropical) overlap. We used the presence/absence of

68 morpho-species of sponges collected from 25 sites to evaluate species composition and distribution. Five environmental parameters are included in statistical analyses to assess habitat types and possible transition zones. This study constitutes a baseline to understand the contribution of sponges to benthic habitats in the IRL and future species' range shifts due to climate change.

Restore Lagoon Inflow Research: Abiotic Determinants of IRL Fish Community Structure

Jesse Blanchard[1], Ralph Turingan[2], and Austin Anderson[2]
[1]FISH Consulting LLC, Melbourne FL; [2]Florida Institute of Technology, Melbourne, FL
Contact email: turingan@fit.edu

The Restoring Lagoon Inflow (RLI) project, funded by the State of Florida, is investigating the feasibility of enhanced seawater exchange as a viable complement to ongoing restoration activities. The Fish Team is tasked with exploring the possible impacts of increased oceanic inflow on the IRL fish community. In Phase I, we used multivariate analyses of the long-term Fish and Wildlife Research Institute's Fisheries Independent Monitoring (FWRI-FIM) program dataset to determine which water-quality parameters drive spatiotemporal variation in fish community structure and population-specific abundances in the Northern IRL, and within specific sites of interest to RLI. These analyses showed that variations in dissolved oxygen, salinity, and temperature have correlated with variation in fish-community-structure and abundances. In Phase II, we are developing predictive models for key fish-community parameters as a consequence of change in levels of dissolved oxygen, salinity, and temperature to further evaluate the feasibility of enhancing seawater exchange for restoration.

Identifying Population Structure of the Gulf pipefish, *Syngnathus scovelli*, across Florida

Malia L. Boudreau, Gillian Báez, and Michelle R. Gaither
University of Central Florida, Orlando, FL
Contact emails: mboudreau2019@knights.ucf.edu, michelle.gaither@ucf.edu

The Gulf pipefish is an interesting species in which to study population structure, as they can tolerate a wide range of salinity, have low motility, exhibit a male-brooding mating strategy, and lack a dispersal larval stage. Furthermore, the coastal and estuary systems that these fish inhabit are in an increasing state of change due to environmental shifts, climate change, and anthropogenic effects. Here we propose to use DNA sequencing of the mitochondrial cytochrome c oxidase subunit 1 (CO1) barcoding gene to analyze population structure of Gulf pipefish around Florida, including in the Indian River Lagoon. Samples were obtained through collaborators at DISL, FWC, and NOAA. Preliminary sequence data allows us to identify genetic structure between populations, to estimate migration rates around the state and to better understand the level of gene flow among pipefish populations.

Revealing Fine-scale Behavior of Bull Sharks in the Indian River Lagoon

Lauran R. Brewster, Michael P. McCallister, and Matthew J. Ajemian
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: lbrewster@fau.edu

As predators, sharks can influence the equilibrium of an ecosystem, often occupying high trophic levels and maintaining ecological balance through direct and indirect effects. Portions of the Indian River Lagoon support young bull sharks (*Carcharhinus leucas*), but little is known about the fine-scale behavior of this species during this critical life stage and how it is affected by the dynamic environment of this estuary. We have developed a pop-up tag package to attach to juvenile bull sharks that allows monitoring of: space use (via an acoustic transmitter), activity (via body movement and orientation recorded by an accelerometer and magnetometer), depth and temperature. Overall, we hope to use these data to understand the activity of the species over varying temporal scales and in relation to major environmental perturbations such as harmful algal blooms, which have become increasingly common in the IRL over recent decades.

Primary Producer Shifts in the Northern Indian River Lagoon and Banana River during COVID

Rachel A. Brewton, Diana Baladi, and Brian E. Lapointe
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: brewtonr@fau.edu

Shifts in the distribution and abundance of primary producers, including seagrass, phytoplankton, and macroalgae, could lead to bottom-up ecological effects in the Indian River Lagoon (IRL). To better understand the ecological implications of blooms of the rhizophytic macroalgae *Caulerpa prolifera*, monitoring of water quality and community composition of macroinvertebrates began in the northern IRL and Banana River in March 2020. The sites surveyed had high water clarity, extensive *C. prolifera* cover, and supported dense macroinvertebrate populations. After the initial monitoring event, COVID concerns lead to a temporary cease in fieldwork. When these sites were revisited in November 2020, water clarity was minimal, there was little evidence of the widespread *C. prolifera* blooms, and few macroinvertebrates were collected. Although the progressive changes in dominant primary producers were not captured due to COVID, these events provide a "snapshot" of how these shifts affect the ecology of the IRL.

Noninvasive Collection of Dolphin Dorsal Fin Images in the Indian River Lagoon Using Trail Cameras

Steve Burton, Brittany Baldrica, Brooke Davis, Madison Hahn, Megan Hoffman, Lydia Moreland, Annie Page-Karjian, and Wendy Marks
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: sburto10@fau.edu

The Marine Mammal Stranding and Population Assessment Team at Florida Atlantic University's Harbor Branch Oceanographic Institute is testing a noninvasive way to collect dolphin dorsal fin images using motion-activated trail cameras attached to dock moorings. The dorsal fin images collected will allow us to better understand dolphin habitat use in the areas of the Indian River Lagoon that are not surveyed during boat-based dolphin photo identification surveys. This approach provides novel temporal data (daily/annually) for these lesser-documented habitats. When high quality images are obtained, dolphins with distinctive fins may be identified to further understand an individual's known range.

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

Brianna V. Cahill[1], Kim Bassos-Hull[2], Carlos A. Santamaria[3], Christelle Bouchard[3], Lisa A. Hoopes[4], and Matthew J. Ajemian[1]
[1]Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL; [2]Mote Marine Laboratory, Sarasota, FL; [3]University of South Florida Sarasota-Manatee, Sarasota, FL; [4]Georgia Aquarium, Atlanta, GA
Contact email: bcahill2019@fau.edu

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) depended on location, but a comprehensive analysis of whitespotted 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.

Canopy-flow Interactions in Mosquito Lagoon: A Review of Recent Work on Eastern Oyster (*Crassostrea virginica*) Reefs and Shallow Shoal Grass (*Halodule wrightii*) Fringes

David Cannon[1], Kelly Kibler[1], Vasilis Kitsikoudis[2], Linda Walters[1], and Stephen Medeiros[3]
[1]University of Central Florida, Orlando, FL; [2]University of Twente, Enschede, The Netherlands; [3]Embry-Riddle Aeronautical University, Daytona Beach, FL
Contact email: david.cannon@ucf.edu

Biological canopies, including seagrasses, oyster reefs, and mangrove roots, are ubiquitous features of Indian River Lagoon, and understanding how they interact with the surrounding flow is important for both ecosystem modelling and restoration design. In this work, we describe the results of several recent studies on canopy-flow interactions in Mosquito Lagoon, including in situ investigations of mean flow and turbulence in intertidal eastern oyster (*Crassostrea virginica*) reefs and shallow shoal grass (*Halodule wrightii*) fringes. Studies on restored (x4), intact, and degraded oyster reefs showed that properly restored reefs reach hydrodynamic similarity with historically healthy reefs within 6 m of restoration, an important result for coastal managers looking to restore lost ecosystem services associated with live reefs. Results for submerged seagrass canopies highlighted the importance of spatial heterogeneity on flow steering and turbulence, with analysis suggesting that declining seagrass densities may lead to dramatic changes in nearshore hydrodynamics.

Phytoplankton Blooms in a Shallow Subtropical Estuary and the Potential Role of Silica

Amanda Capuano, Austin Fox, and Kevin Johnson
Florida Institute of Technology, Melbourne, FL
Contact email: acapuano2018@my.fit.edu

Estuarine diatoms are a dominant phytoplankton group for which silica is an essential nutrient. It has been hypothesized that, as the proportion of silica to other water column nutrients decreases with eutrophication, diatom proportions may also decrease. This was investigated by conducting weekly to biweekly sampling in the Indian River Lagoon (IRL) and Banana River Lagoon (BRL) from late September to mid-November 2020. Water quality data, whole water samples for flow cytometry, syringe-filtered water samples for nutrient analysis, and plankton tows were collected at each sampling event and location. Results of the flow cytometer and nutrient analyses indicate increasing non-diatom cell counts, including cyanobacteria, when Si:N ratios are high. Cyanobacteria are a common harmful bloom taxon in the Northern IRL. Phytoplankton data collection is ongoing. Thus far, there are no significant temporal changes in bloom densities.

The HBOI-FAU Sponge Cell Culture Collection: A Frozen Bank of Indian River Lagoon Sponge Cells for Habitat Restoration and Biotechnology Applications

Megan Conkling and Shirley A. Pomponi
Harbor Branch Oceanographic Institute, Florida Atlantic University, Fort Pierce, FL
Contact email: mconkli2@fau.edu

Sponges (Phylum Porifera) are diverse components of most marine ecosystems and a prolific source of chemicals with potential human health applications. We have established methods to cryopreserve sponge cells, developed the first marine invertebrate (sponge) cell lines, and created a frozen biobank of sponge cells that can be used as a repository for sponge biodiversity, as well as to support future research in habitat restoration and biotechnology applications. After an extensive survey of the Indian River Lagoon (IRL) we were able to cryopreserve sponge cells from 65 IRL sponges (>25 species, 16 families, and 7 orders). Exceptionally rapid cell division rates (one- to four-fold increase in cell number in 48 hours) occur in ~20% of the sponges. Research continues with optimization of nutrient media for the IRL species and development of methods for culture scale-up. This HBOI-FAU Sponge Cell Culture Collection is the first biobank of living marine sponge cells.

A Survey of Bird Abundance and Diversity in Mosquito Lagoon

Jessica Copertino, Jacob Hromyak, Paul Sacks, and Linda Walters
University of Central Florida, Department of Biology, Orlando, FL
Contact email: jessica.copertino@knights.ucf.edu

Birds provide many ecological functions and ecosystem services and can be indicators of ecosystem health. Mosquito Lagoon (ML) is home to a variety of resident and migratory bird species, including over a dozen listed on FWC's Imperiled Species List; however, there has been little research on birds in ML. In this study, we used photographic observations from December 2018-November 2020 to evaluate the abundance and diversity of the avian community in ML. We counted over 20,000 birds, identified 67 unique taxa, assessed seasonal variations, and evaluated the use of various habitat features by specific taxa. We identified several threatened species that were indicators for habitat features within ML. American oystercatcher was one indicator for live oyster reefs and Reddish egret was an indicator for mangroves. Our goal is to provide baseline information on the bird community in ML in order to better assess the impacts of future environmental changes.

How Efficient Are Oysters at Excreting Microplastics?

Casey Craig[1], Linda Walters[1], Jessy Wayles[2], Tess Sailor-Tines[2], Emily Dark[3], Kirk Fusco[3], Vincent Encomio[4,5], David Fox Jr[1], and Lei Zhai[1]
[1]University of Central Florida, Orlando, FL; [2]Marine Discovery Center, New Smyrna Beach, FL; [3]Indian River Lagoon Aquatic Preserves/Florida Department of Environmental Protection, Fort Pierce, FL; [4]University of Florida/Florida Sea Grant, Stuart, FL; [5]Florida Oceanographic Society, Stuart, FL
Contact email: craig.casey2015@knights.ucf.edu

Plastic pollution is a substantial and pervasive global threat commonly ingested by biota. Microplastics (MP), plastics smaller than 5 mm, were documented in unusually high abundances in the eastern oyster *Crassostrea virginica* from Mosquito Lagoon. While this confirms *C. virginica* can ingest MP, it is still unknown if these organisms accumulate and/or excrete MP. To this end, we developed a study to determine excretion efficiency in this bivalve. Live individuals were collected from the IRL, placed into flow-through chambers, and feces and pseudofeces were separately collected. Oysters were chemically digested, and MP extracted via filtration. MP were present in feces, pseudofeces, and oyster tissue suggesting MP are cycling through oysters. Results indicate *C. virginica* excrete 53.5% of MP they ingest, at a rate of 1 microplastic every 2 hours through feces, and 1 microplastic every 4 hours through pseudofeces.

Restore Lagoon Inflow Research: IRL Benthic Communities

Sean Crowley and Kevin B. Johnson
Florida Institute of Technology, Melbourne, FL
Contact email: crowleys2013@my.fit.edu

It has been proposed that adding coastal ocean water to the Indian River Lagoon (IRL) might improve sediment and water quality. If implemented as a pilot project, impacts on biological communities must be monitored and evaluated. We are characterizing and monitoring seagrass, drift algae, and benthic infauna communities within the IRL. The dominant seagrass species near proposed inflow sites is the shoal grass *Halodule wrightii*. 36 key species of benthic infauna have been identified from 6 phyla, with overall infaunal densities ranging from 622-112,610 organisms m^{-2}. Species include the amphipods (*Americhelidium americanum, Ampelisca abdita, Cerapus tubularis*), polychaetes (*Alitta succinea, Ctenodrilus serratus, Pectinaria gouldii*), bivalves (*Mulinia lateralis, Parastarte triquetra*), gastropods (*Acteocina canaliculata, Phrontis vibex*), foraminifera (*Ammonia parkinsoniana*), and tanaids (*Hargeria rapax, Leptochelia dubia*). Baseline monitoring allows identification of vulnerable, dominant, and absent species. Continued monitoring during a pilot inflow project could document shifting community composition and help identify key environmental parameters.

Influences of Boating Activity on Abundance, Biodiversity and Behaviors of Wading Bird Species on Oyster Reef Habitats

Melanie Dallavalle, Paul Sacks, and Linda Walters
University of Central Florida, Orlando, FL
Contact email: melaniedallavalle@knights.ucf.edu

The Indian River Lagoon and adjacent St. John's River account for 25% of Florida's wading bird population. In this important region, we deployed wildlife trail cameras to: 1) observe behaviors of birds on intertidal oyster reefs during day and night hours, and 2) determine if birds on reefs were negatively impacted by boating activities. Research occurred in Mosquito Lagoon in summer 2020. Ten motion-activated wildlife cameras were positioned on reefs for 6 weeks. Eleven species (837 observations) were recorded, with the most (40%) on restored reefs. Visits lasted from <1 to 134 minutes, with great blue heron spending the most time on reefs. Nine species were only observed during daylight, while 2 were observed at all hours. Bird behaviors included foraging (31.3%), resting (22.7%), and stalking prey (32.9%). Great blue heron departed reefs when exposed to boating activity, while willet and white ibis exhibited changes in behaviors in response to motorized boats.

www.irlon.org: A Data Portal for the Indian River Lagoon Observatory Network of Environmental Sensors (IRLON)

Kristen S. Davis, Bryan Botson, and M. Dennis Hanisak
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: ksande14@fau.edu

The IRLON data portal, www.irlon.org, launched in August 2020 to increase the utility of IRLON data streams by facilitating how users can better understand the data being generated in terms of health of the Indian River Lagoon (IRL). The data portal provides reference points for key water quality parameters, including comparisons to historical data at each station and indicators of water quality stress (e.g., low dissolved oxygen levels, phytoplankton blooms). IRLON data also automatically undergo data quality testing with protocols developed by QARTOD (Quality Assurance/Quality Control of Real Time Oceanographic Data) developed by the Integrated Ocean Observing System (IOOS); IRLON data users are able to access all raw data, or those that pass all QARTOD screening. All current and historical IRLON data are available for visualization and download in a variety of formats including machine-to-machine data ingestion in a GeoJSON format.

Biodiversity of Sponges in the Indian River Lagoon (IRL), Florida

Maria Cristina Díaz[1], Greer Babbe[1], Iris Segura-Garcia[1,3], Juliet Ruggiero[1], Holly Sweat[3], Megan Conkling[1], John Reed[1], Andia Chaves-Fonnegra[1, 2], and Shirley Pomponi[1]
[1]Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL; [2]Florida Atlantic University, Jupiter, FL; [3]Smithsonian Marine Station, Fort Pierce, FL
Contact e-mail: taxochica@gmail.com

A team of scientists and students is evaluating biodiversity, habitats, genetics, phylogeny, and cell culture/biobanking of IRL sponges (Phylum Porifera). A total of 261 sponge specimens were collected from July to September 2020 at 25 sites that span the length of the IRL (251 km). A total of 68 morphospecies have been identified from 174 samples studied to date. These preliminary results have increased the species richness of IRL sponges from 48 to 76. Most species belong to the Class Demospongiae (74 species) and two species are of the Class Calcarea. Twenty-eight species and three genera (*Amorphinopsis*, *Chondrosia*, and *Spongia*) constitute new IRL records. Ten species are either new to science or undescribed morphological variants of known species (5 *Haliclona*, 1 *Chalinula*, 3 *Ircinia*, and 1 *Terpios* species). The most speciose orders are Haplosclerida (20) and Dictyoceratida (9), which reflects taxonomic affinities with mangrove lagoons and seagrass sponge fauna from the Tropical Western Atlantic.

Test of Biodegradable Alternatives to Plastics Used in Living Shoreline Stabilization in Mosquito Lagoon

Melinda Donnelly[1], Annie Roddenberry[2], Paul Sacks[1], Linda Walters[1], and Jessy Wayles[3]
[1]University of Central Florida, Orlando, FL; [2]Florida Fish and Wildlife Conservation Commission, New Smyrna Beach, FL; [3] Marine Discovery Center, New Smyrna Beach, FL
Contact email: melinda.donnelly@ucf.edu

Microplastic research shows the need to reduce plastic inputs into estuaries, prompting the development of non-plastic materials for use in living shorelines as wavebreaks. We designed a small-scale experiment to compare retention, oyster recruitment, and erosion reduction of five non-plastic materials to plastic shell bags in Canaveral National Seashore (Mosquito Lagoon) in June 2020. Non-plastic materials for wavebreaks included tables made of concrete infused jute (Sandbar Oyster Company), BESE^{TM} potato starch gabions, metal gabions, oyster CORE modules (UF Whitney Lab), and concrete blocks. All materials remained in place after four months, except for BESE^{TM} potato starch gabions (structure failure within one week). Oyster recruitment was observed after four months in low abundances (0 to 4 oysters/0.25m^2, shell height = 5 to 25 mm) on the tables, CORE modules, concrete blocks, and traditional shell bags. On-going monitoring will provide comparisons of oyster survival and growth and erosion rates among non-plastic materials.

Resident Fishes as Higher Trophic Level Indicators of Oyster Reef Restoration Success

Katie E. Durham, Dakota M. Lewis, Linda J. Walters, and Geoffrey S. Cook
University of Central Florida, Orlando, FL
Contact email: katieed@Knights.ucf.edu

In the Indian River Lagoon oyster reefs serve as essential fish habitat, providing refugia and foraging opportunities for fishes. Oyster reef restoration success is often assessed by quantifying oyster metrics but infrequently accounts for the responses of higher trophic level species. To address this knowledge gap, the response of reef resident fishes (gobies, blennies) is compared with standard metrics of oyster restoration success. Using lift nets and seines, natural and restored reefs were sampled over a two-year period within Mosquito Lagoon. Results suggest reef restoration was successful as evidenced by an increase in live oyster abundance and reef thickness over time, and an increase in reef resident total abundance. Both reef resident species richness and abundance displayed significant seasonal variation. These results highlight the benefits of oyster reef restoration on the resident fish community, whose increased population provides a prey base for economically and ecologically important higher trophic level sportfish.

Restore Lagoon Inflow Research: eDNA-Based Biodiversity Assessment

Jeff Eble[1], Kyle Heffner[1], Girish Kumar[2], and Michelle Gaither[2]
[1]Florida Institute of Technology, Melbourne, FL; [2]University of Central Florida, Orlando, FL
Contact email: jeble@fit.edu

To provide information on species occurrence and diversity within the Indian River Lagoon (IRL), environmental DNA (eDNA) sampling was coupled with next-generation DNA sequencing to allow simultaneous detection of a taxonomically diverse set of species. This work is intended to provide a better understanding of the current state of the IRL system in support of an ongoing investigation of whether controlled water exchanges can be implemented to improve lagoon water quality, without negative impacts on biological resources. A combined 130 water samples were collected and analyzed for the presence of trace eDNA to (1) optimize field and laboratory protocols for eDNA-based biodiversity monitoring, (2) increase occurrence records for IRL fishes and invertebrates, and (3) characterize species richness and distinctiveness to establish baseline biodiversity indices to assess ecosystem level responses to management actions.

The Bull Shark, *Carcharhinus leucas,* as a Sentinel Species for Harmful Algal Bloom Toxins in the Indian River Lagoon, Florida

Michelle L. Edwards, Michael McCallister, Adam M. Schaefer, and Matthew J. Ajemian
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: edwardsm2019@fau.edu

Florida's Indian River Lagoon (IRL) has experienced large-scale harmful algal blooms (HABs) of potentially toxic species almost annually since the early 2000s. Sentinel, or indicator, species can provide an integrative picture of contaminants in the environment and may be useful to understanding the presence of HAB toxins in the IRL. This study aims to evaluate presence of toxins in the IRL by using the bull shark (*Carcharhinus leucas*) as a sentinel species. Baseline concentrations of toxins were assessed from samples collected from 50 sharks between Brevard and Martin counties from 2018–2020. Ultra-performance liquid chromatography/tandem mass spectrometry (UPLC-MS/MS) was used to measure HAB toxins in shark stomach contents, plasma and liver. Analysis of samples demonstrated the presence of multiple toxins (microcystins, brevetoxins, domoic acid, and okadaic acid) in the tissues of bull sharks. This study will provide valuable information on background presence of multiple HAB toxins in this iconic estuary.

Lessons Learned from a Student Based Seagrass Restoration Project during COVID

Olivia Escandell[1], Robert Virnstein[2], Jake Zehnder[1], and Callie Shaffer[1]
[1]Brevard Zoo, Melbourne, FL; [2]Seagrass Ecosystems Analysts, Gainesville, FL
Contact email: oescandell@brevardzoo.org

As part of Brevard Zoo's Grasses in Classes Program, nursery tanks were outfitted for grow out of shoal grass (*Halodule wrightii*) in two Brevard County High School classrooms. In spring 2020, 48 square meters of nursery-raised shoal grass was planted on the eastern shore of the Indian River Lagoon along a conservation property in Melbourne Beach, FL. Shoalgrass fragments were planted using two methods: by-hand and by-hand secured with biodegradable bamboo staples. High school students volunteered to conduct monitoring of seagrass plantings throughout the summer. Growth of shoal grass fragments was observed using both planting methods. Results demonstrated that simple planting methods make it possible for volunteers to contribute to small-scale seagrass restoration.

Environmental DNA Analysis of Forage Fish Diversity and Distribution in the Indian River Lagoon

Emily Farrell, Girish Kumar, and Michelle R. Gaither
University of Central Florida, Orlando, FL
Contact email: emilyfarrell@knights.ucf.edu

The Indian River Lagoon is one of the most species rich estuaries in the U.S., providing habitat to over 400 species of fish including critical forage fishes, such as menhaden, anchovy, and sardines, and their predators. FWC conducts monthly seine surveys in the IRL, which provide the basis for most fisheries resource management and conservation decisions in the region. However, many key species are systematically overlooked by these surveys due to gear bias. Environmental DNA (eDNA) – DNA passively shed by aquatic organisms into the water column – is a new approach that shows great promise for monitoring of fishery species while avoiding many of the biases and challenges of traditional methods. This ongoing study aims to fill the forage fish data gap by utilizing eDNA metabarcoding to conduct a survey of these species in the IRL and create a rapid and cost-effective survey toolkit complimenting existing survey efforts.

Restoration Methods for a Successful Mangrove Living Shoreline in Mosquito Lagoon
Rebecca Fillyaw, Kelly Kibler, Melinda Donnelly, and Linda Walters
University of Central Florida, Orlando, FL
Contact email: emilyfarrell@knights.ucf.edu

A red mangrove living shoreline was deployed to identify the initial mangrove size needed to survive in a shallow, subtropical estuary, and isolate the cause of observed mortalities. Treatment groups included 5 replicates of seedlings (1 year), transitionals (2 years), adults (3-4 years), a mixture of the age groups, and no mangroves, both with and without an oyster shellbag breakwater. Survival was monitored monthly for one year (June 2019-June 2020). Average survival was 29% for seedlings, 51% for transitionals, 77% for adults, and 41% for the mixed age groups. The majority of the mortalities occurred during the annual high water season (September to December), indicating that flood stress was a major influencer. Breakwater presence increased total average mangrove survival by 26%, indicating wave energy magnified the impact of flooding stress.

Hydrodynamic Impact of Boat Wakes to Shoreline Ecotones
Gabriela Ford, Iris Peterson, Kelly M. Kibler, and David Cannon
University of Central Florida, Orlando, FL
Contact email: gabrielaford1512@knights.ucf.edu

Understanding the relationship between boat traffic and shoreline degradation is important to characterize shoreline stability. In this study, we investigate the potential for boat wakes to erode shorelines. The hydrodynamic signature and sediment transport potential of boat wakes generated 50-200 m from the shoreline of Mosquito Lagoon were compared to ambient conditions (tidal current and wind-driven waves). Findings suggest that far offshore boat traffic may have potential to induce shoreline sediment erosion. As compared to ambient conditions, wakes generated 50 m to 200 m from shore were characterized by 91% greater significant wave heights, delivered 98% greater energy to the shoreline, and increased bed shear by 86%. Average wake height did not depreciate with distance from shore. Furthermore, wakes generated further from shore were associated with the greatest bed shear stress and delivered more cumulative energy to shorelines as compared to those generated closer to shore.

Restore Lagoon Inflow Research: Biogeochemical Responses to Ocean Inflow, Would Inflow Promote Lower Concentrations of Nitrogen and Phosphorus in the IRL?
Austin L. Fox, Abbey Gering, Iulia Bibire, Tyler Provoncha, and Stacey Fox
Florida Institute of Technology, Melbourne, FL
Contact email: afox@fit.edu

The quantities of nitrogen (N) and phosphorus (P) that would be directly discharged from the lagoon via ocean inflow were calculated based on a pumping rate of 5 m^3/sec and concentrations of N and P in lagoon versus seawater. Overall, we calculated the net removal of ~50 tons of N and 5-10 tons of P per year from the lagoon. Preliminary field and laboratory data and experiments suggest that inflow of cooler, clearer seawater would likely promote decreased nutrient fluxes and oxygen consumption of Indian River Lagoon sediments. These small changes to internal nutrient cycling could have large impacts when applied to 100s of square kilometers of lagoon bottom, possibly preventing tons of N and P from entering the lagoon each year from internal sources. From a simply nutrient perspective, these data suggest that ocean inflow is worth continued consideration as part of a multifaceted approach to lagoon restoration.

eDNA: The New Frontier in Biomonitoring
Michelle R. Gaither
University of Central Florida, Orlando, FL
Contact email: michelle.gaither@ucf.edu

The use of environmental DNA (eDNA) in studies on aquatic systems has exploded over the past decade. Defined broadly, aquatic eDNA is any genetic material that has been extracted from a water sample and includes free floating DNA to microscopic organisms. Scientists and managers from state and federal offices and academic institutions are pushing the exploration of these new approaches in the hope that they will allow us to address important science and management questions by offering an efficient means to census marine life. Offering the ability to target single taxa or work across multiple trophic levels, eDNA is likely to revolution how we assess biodiversity. Here I will evaluate the use of this exciting tool, talk about the work in our lab to optimize protocols for use in the IRL, and discuss the future direction of eDNA in biomonitoring.

Decreasing Nutrient Concentrations in the Indian River Lagoon, FL with One Isolated Bottle Cap at a Time
Abigail Gering, Austin Fox, and Stacey Fox
Florida Institute of Technology, Melbourne, FL
Contact email: geringa2016@my.fit.edu

The efficacy of various denitrification media and treatment processes were evaluated for their potential to remove nitrogen from lagoon water. Although several media were effective, the success of plastic bioballs yielded an idea; rather than increasing the demand of plastics, how about repurposing plastic bottle caps as media in our laboratory flow-through system? To date, the treatment system with managed environmental conditions has yielded a >80% reduction in ammonium concentrations in as little as 8 hours and >70% reductions in total dissolved nitrogen (TDN). These data illustrate that bottle caps could function as a relatively inexpensive and way to lower nutrient concentrations in natural systems, and similar treatment systems could be reproduced in remote and underserved areas.

A Biological Assessment of Living Docks throughout the Indian River Lagoon
Morgan Gilligan, Robert Weaver, and Kelli Hunsucker
Florida Institute of Technology, Melbourne, FL
Contact email: mgilligan2019@my.fit.edu

Due to anthropogenic activities, oysters in the Indian River Lagoon (IRL) have declined. An ecological solution to restore oyster populations have been the introduction of restoration mats through a program called Living Docks. Working with local communities and citizen scientists, these oyster mats are secured to dock pilings to attract oyster larvae as well as other filtering organisms to help improve local water clarity. Nine Living Docks, located throughout the northern IRL, were assessed for the presence of benthic organisms and to calculate the impact these communities are having on the water quality. Community assessment of the docks showed a difference in diversity and oyster abundance among locations. A 48-hour filtration experiment was conducted to further test how the different benthic communities impact water quality conditions. Analysis of chlorophyll *a* concentrations and turbidity will demonstrate filtration capacity of four dock communities selected from Cape Canaveral to Sebastian.

Testing Alternative Nitrogen-Reducing Media under Conventional Septic System Drainfields

Anthony Gubler, Virginia Barker, Matthew Badolato, and Terry Williamson
Brevard County Natural Resources Management, Melbourne, FL
Contact email: anthony.gubler@brevardfl.gov

There are approximately fifty-thousand conventional drainfields within the Indian River Lagoon (IRL) watershed in Brevard County that can't be reached by sewer for budgetary reasons. These systems contribute nearly 20% of the nitrogen loading to the IRL. As an alternative to costly aerobic treatment septic systems, the Florida Department of Health (FDOH) passed rules allowing for new In-ground Nitrogen-Reducing Biofilter (INRB) septic systems that use wood chips as the nitrogen-reducing media. Concerned about the decomposition of wood chips, Brevard County partnered with the FDOH to test alternative media; the first being Bold & Gold Wastewater Media. Six INRB drainfields were installed to be sampled quarterly and analyzed for nutrient reductions. Brevard County funded the project with money from the Save Our Indian River Lagoon program.

IRLON 2.0: Emerging Environmental Issues in the Indian River Lagoon

M. Dennis Hanisak and Kristen S. Davis
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: dhanisak@fau.edu

The Indian River Lagoon Observatory Network of Environmental Sensors (IRLON) is an estuarine observation network launched with a single site in 2013 and expanded into 10 sites in the south central Indian River Lagoon (IRL) and St. Lucie Estuary. IRLON enables researchers to track environmental changes in the IRL system; assist resource and planning managers to make informed decisions; model and correlate environmental data to biological, chemical and physical phenomena; and contribute to education and public outreach on the lagoon. In 2020, new technical capabilities will enhance IRLON to address emerging threats (harmful algal blooms and coastal acidification) to the IRL, and three new sites will expand observations into the northern IRL system. These high frequency, continuous observatory data enable better quantification and modeling of relationships between environmental factors and biological processes in estuaries, such as the IRL with tremendous climate-related interannual variability.

Underutilized Potential of Small-Scale Oyster Reef Restoration Units as Habitat for Invertebrates

Jillian Hanley[1,2] and Rachel Harris[1,2]
[1]Florida Atlantic University, Jupiter FL; [2]Loxahatchee River District, Jupiter FL
Contact email: jhanley2015@fau.edu

Oyster reefs play vital roles in an estuary's health by filtering the water and by serving as nurseries for many aquatic animals. The objective of this research was to investigate habitat use of smaller macroinvertebrates on restored oyster reefs. Small-scale (approx. 10 cm^3) cage (bagged shell) and string (hanging shell) oyster cultch units were deployed on two restored oyster reefs in the Loxahatchee River Estuary for one year. Fauna inhabiting the units were monitored monthly, identified to the lowest practical taxonomic level, and categorized into functional groups based on feeding mode, living position, and mobility. Results showed similar abundance, richness, and diversity of functional groups in cage and string units. These findings suggest that even small-scale oyster reef restorations, such as individual 'vertical oyster gardens' (i.e., string units), add valuable habitat for smaller organisms. This provides additional options for small-scale restoration efforts.

Testing Alternative Oyster Restoration Materials in the Indian River Lagoon

Jenny Hansen[1], Adam Klingenberg[2], Jake Zehnder[2], Terry Williamson[1], and Virginia Barker[1]
[1]Brevard County Natural Resources Management, Viera, FL; [2]Brevard Zoo, Melbourne, FL
Contact email: jenny.hansen@brevardfl.gov

Brevard County and Brevard Zoo have partnered to investigate non-plastic materials for oyster recruitment potential, longevity in the system, and ability as a substrate to support oyster reef development. Breakdown of plastics in marine environments has become a significant issue. To reduce the use of UV stabilized plastic mesh bags for securing benthic structure, three locations were chosen to test seven material treatments. Modules were hung from docks and consist of multiple configurations of cement, oyster shell, and natural materials (COREs, JR-CSA/Prisms, Oyster Balls), as well as two gauges of galvanized steel gabions, and controls (Naltex™ bags). Monitoring of degradation, fouling, and oyster recruitment and growth will occur quarterly. Piloting of new materials on constructed oyster bars has also begun. Data collected will build on current efforts in material development in nearby environments, while ensuring they will meet site-specific constraints of the mid-reaches of the Indian River Lagoon.

Boring Sponges on Oyster Reefs: Distance from Boating Channels and Impact on Boring Damage

Katherine Harris and Linda Walters
University of Central Florida, Orlando, FL
Contact email: k.harris@knights.ucf.edu

The boring sponge (*Cliona celata*) weakens oyster shells, boring holes through shells making them susceptible to breakage. As a subtidal species, boring sponges are mainly found on reef edges. However, extensive boring damage from the sponge is common on higher, intertidal portions of oyster reefs in Mosquito Lagoon, Florida. Recreational boating in this area is known to displace oysters, leading to dead margins of bleached shell. Boat wakes may break bored oyster clusters and roll clusters higher on the reef, allowing sponge to spread through contact with other shells. It was hypothesized that distance from boating channels in Mosquito Lagoon impacts the amount of boring damage on oyster reefs, with reefs closer to boating channels having increased boring damage. A sponge survey completed in summer 2017 was utilized in GIS to measure distances from reefs to nearby boating channels. Results suggest farther distances from boating channels decreases the amount of boring damage on restored oyster reefs.

Developing a 3D Hydrodynamic Model for Mosquito Lagoon: Using a Present-Day Model to Investigate Future and Deep-Time Changes in Hydrodynamics

Angelo Hernandez, Christopher Hagglund, Kelly Kibler, David Cannon, and Sarah Barber
University of Central Florida, Orlando, FL
Contact email: ahernandezalmeida@knights.ucf.edu

A detailed hydrodynamic model able to predict water level and flow velocity has been created for Mosquito Lagoon. The model, created using Delft 3D Flexible Mesh software, is driven by tidal water level changes and wind, with a water level boundary condition implemented at Haulover Canal. A high-resolution modeling domain mesh was created to realistically simulate flows in the complex estuarine habitat, with special attention given to the lagoon's unique morphology and ecology (e.g., mangrove islands, oyster reefs, spoil islands, sandbars). Following model calibration and validation with observed data, the model will be capable of representing present-day hydrodynamic conditions in the lagoon. In collaboration with geologists and archaeologists, we will modify the present-day model to hindcast conditions through deep time, allowing us to analyze historical trends and relevant temporal changes. This deep-time analysis will help us understand the hydrodynamic history of Mosquito Lagoon, with applications for present-day and future management.

Diamondback Terrapins in the Central Indian River Lagoon: What We Know Now

Jeffrey Herr[1], Isabella Martin[1], David Torres[1], Emily Dark[2], and Jon A. Moore[1]
[1]Florida Atlantic University, Jupiter, FL; [2]Florida Department of Environmental Protection-Indian River Lagoon Aquatic Preserves, Fort Pierce, FL
Contact email: jherr2013@fau.edu

The diamondback terrapin, *Malaclemys terrapin*, is an elusive estuarine turtle found along the east coast of the United States. Diamondback terrapins were *the* turtle soup turtle, and suffered from over-fishing. Despite some recovery, populations continue to decline across their range. The eastern Florida diamondback terrapin, *M. t. tequesta*, is an understudied subspecies. The goal of this study is to increase the knowledgebase on *M. t. tequesta*, focusing on their movement, blood chemistry, and diet. Terrapins are captured in the central Indian River Lagoon, and blood and fecal samples are taken for analysis. Terrapins are fitted with a VEMCO V9 acoustic transmitter, and passively tracked by a receiver array surrounding the study site, as well as in collaboration with FACT. Our hope is that with a larger knowledgebase on this subspecies, conservation efforts will be better able to protect the species as a whole.

The One Lagoon Monitoring Plan: Connecting Monitoring to the Lagoon's Vital Signs

David Heuberger and M. Dennis Hanisak
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: dheuberger@fau.edu

Monitoring the water quality, sediment, and biological resources of the Indian River Lagoon is important not only to determine the current condition of the estuary but also to ascertain the effectiveness of restoration. The Indian River Lagoon National Estuarine Program (IRLNEP) is developing the One Lagoon Monitoring Plan: A Comprehensive, Coordinated, and Integrated IRL Monitoring Plan. This resulting comprehensive lagoon-wide monitoring plan will identify existing assets, gaps in data or analyses, emerging needs and opportunities, and specific recommendations for action. The developing monitoring plan connects to three categories of "Vital Signs" (Habitat Quality, Water Quality, and Living Resources) in IRLNEP's Comprehensive Conservation and Management Plan (CCMP). Long-term outcomes of the monitoring plan include creation of a monitoring database; modeling to distribute useful and useable interpretations and predictions to larger groups of users; and ultimately a healthy IRL due to improved design, implementation, adaptation, and accountability for many individual actions.

Modeling the Ventilation and Connectivity in the Indian River Lagoon

Mingshun Jiang and Ash Brereton
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: abrereton@fau.edu

A high-resolution hydrodynamic model based on the Regional Ocean Modeling System (ROMS) for the Indian River Lagoon (IRL) has been developed and calibrated with available *in situ* data (temperature, salinity, sea level and tides). Preliminary results indicate: 1) strong coastal transport driven by the Gulf Stream, which leads to a significant gradient of water level between the lagoon (high) and coastal areas (low); 2) seasonal precipitation and evaporation significantly affect both the water level and salinity in the three northern basins, which in turn influence the lagoon ventilation through sea level and density gradients, respectively; finally 3) the intercoastal waterway provides a path for the lagoon ventilation, suggesting its importance to the water quality and ecosystem health in the IRL.

Development of a Coupled Hydrodynamic-biogeochemical-*Microcystis* Model for the St. Lucie Estuary, FL

Mingshun Jiang, Brian Lapointe, Malcolm McFarland, Ash Brereton, Rachel Brewton, Dennis Hanisak, and Nicole Stockley
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: jiangm@fau.edu

A three-dimensional (3-D) hydrodynamic-biogeochemical model based on the regional ocean modeling system (ROMS) has been developed for understanding the water quality and *Microcystis* blooms in the St. Lucie estuary, and the impacts of freshwater inputs from Lake Okeechobee. The biogeochemical model is an NPZD functional group model that simulates nitrogen cycle and phytoplankton blooms. A one-year (2018) simulation has been completed and validated against h available *in situ* data. A Lagrangian individual-based model (IBM) of *Microcystis* cells has been developed and coupled with the 3-D model. The IBM considers cell growth death and diel vertical migration (which is controlled by light cues). The results indicate that vertical migration provides several advantages for *Microcystis* blooms: 1) more light; 2) spreading over larger areas; and 3) reducing exposure to salty waters. The results also point to the potential hotspots of *Microcystis* blooms during different winds and flow conditions

Connecting the Community with the Indian River Lagoon through Public Education

Skyler Klingshirn, Madeleine Arencibia, and Gabby Barbarite
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: gbarbari@fau.edu

FAU Harbor Branch offers a variety of public outreach programs and events that reach over 35,000 people each year. Here, we highlight three graduate student-led projects that were designed to educate diverse audiences, both in-person and remotely. The first project established a display at the Ocean Discovery Visitors Center to showcase sea turtle research and conservation efforts. The second project used social media to share research updates and reach broader audiences. The third project focused on the development of a marine science activity book for children ages 8 to 12. The goal of this work is to improve environmental literacy, increase awareness of important research and inspire future scientists.

Applying an Ensemble Modeling Approach to Understand Shifts in an Estuarine Fish Community Following a Large Fish Kill in the Indian River Lagoon

Dakota M. Lewis[1], Kevin A. Thompson[2], Tim C. MacDonald[2], and Geoffrey S. Cook[1]
[1]University of Central Florida, Orlando, FL; [2]Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL
Contact email: dlewis4@knights.ucf.edu

To explore the relationships among environmental disturbances, sport fish, and forage fish communities, this study examines a non-toxic brown algal bloom (*Aureoumbra lagunensis*) occurring from December 2015 through March 2016 in Banana River, FL. An ensemble modelling approach was used to explore shifts in the relationships between bloom dynamics, water quality, forage fish community dynamics, and sport fish community dynamics. The algal bloom crashed over a three-day period in March 2016 and resulted in a fish kill when dissolved oxygen concentrations dropped below hypoxic levels (DO <2mg/L). The bloom and subsequent fish kill led to shifts in both forage and sport fish community dynamics, and their relationships when compared to non-disturbed years. Large alterations in community dynamics and relationships following a disturbance event suggest both forage and sport fish communities, food webs, and trophic dynamics may be at increasing risk of crossing ecological thresholds as algal blooms become more common in coastal ecosystems.

The State of the Indian River Lagoon Technical Report: Opportunities and Challenges

Claudia Listopad[1], Duane De Freese[2], Danielle Huffner[1], and Zach Leibowitz[1]
[1]Applied Ecology, Inc., Indialantic, FL; [2] Indian River Lagoon National Estuary Program, Sebastian, FL
Contact email: dhuffner@appliedecologyinc.com

In 2019, the Indian River Lagoon National Estuary Program (IRLNEP) contracted with Applied Ecology Inc. to develop the State of the Indian River Lagoon Technical Report. This report will assess system-wide stressors, describe trends in the Lagoon's conditions, and community responses to these threats. To successfully identify, integrate, and synthetize the data needed for the technical report, AEI has established interdisciplinary steering and technical advisory committees and applied a well-established ecological conceptual framework. This presentation will summarize the efforts Applied Ecology, Inc. has performed up to-date, as well as the challenges COVID-19 has presented towards a facilitated integrative approach to this project. Once completed, the Technical Report will provide the information for resource managers to plan and evaluate management decisions and to guide scientific efforts to fill identified data gaps.

Characteristics of Wastewater Contaminated Groundwater in the Indian River Lagoon

Claudia Listopad[1], Leesa Souto[2], Virginia Barker[3], and Andrew Kamerosky[1]
[1]Applied Ecology, Inc., Indialantic, FL; [2]Marine Resources Council, Palm Bay, FL; [3]Brevard County Natural Resources Management, Viera, FL
Contact email: akamerosky@appliedecologyinc.com

In 2016, Marine Resources Council with the partnership of Brevard County and Applied Ecology, initiated a Legislative funded groundwater research project to better understand nutrient sources and concentrations in groundwater reaching the IRL. The project installed 45 groundwater monitoring wells in 11 communities serviced by different wastewater treatments and three natural areas to compare nutrient concentrations. Monitoring and reporting efforts have since been extended and supported by Brevard County's Save our Indian River Lagoon Sales Tax. After almost 3 years of monitoring and well over 1000 samples, this presentation will provide some key highlights. Both monitored septic and reclaimed irrigation communities had similarly high total nitrogen concentrations. Septic system neighborhoods were identified to have elevated organic nitrogen and phosphate, while reclaimed water irrigation neighborhoods had elevated inorganic nitrogen. The data collected can guide wastewater retrofit projects and assist in updating nutrient pollutant load estimates to the IRL.

Restored Coastal Habitat in the Indian River Lagoon Can Reel in Juvenile Sportfish

Jennifer M. Loch, Geoffrey S. Cook, and Linda J. Walters
University of Central Florida, Orlando, FL
Contact email: jloch@knights.ucf.edu

Declining coastal habitats in the Indian River Lagoon have impacted economically important fisheries, resulting in dedicated oyster reef and shoreline restoration projects. These restored habitats can theoretically enhance predator populations, but this is understudied. To assess the impact of habitat restoration on juvenile sportfish populations and communities, we measured sportfish abundance, diversity and composition using seines in a Before-After-Control-Impact experiment. Juvenile sportfish abundance was variable over time but were collectively higher on restored oyster reefs compared to controls and were similar between control and restored shorelines, which was influenced by biotic features of the restored habitats, prey abundance and distance to Ponce Inlet. Sportfish diversity demonstrated similar trends, with differing community composition between oyster reefs and living shorelines. These data suggest restored habitat supports sportfish populations and site selection may influence its success in fisheries enhancement, knowledge which can help resource managers better utilize habitat restoration to sustain fish populations.

Proposed Study to Understand the Pollution Historical Changes and Application of Meiofauna Bioindicators in Banana River Lagoon

Michael Martínez-Colón[1], Fajemila Olugbenga[2], and María A. Alves-Martins[3]
[1]Florida A&M University, Tallahassee, FL; [2]Osun State University, Osogbo, Nigeria; [3]Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil
Contact email: michael.martinez@famu.edu

Numerous studies assessing the spatial distribution of pollutants in estuarine and lagoonal environments have been used to establish environmental health conditions. These studies rely on current environmental settings to establish base-line conditions for current and future management. In the Banana River Lagoon, a two-meter core will be studied to determine its reference conditions (pre-impact and pre-management) by understanding the temporal variability of pollutants (heavy metals) and the use of benthic foraminifera (meiofauna) to assess the historical changes in environmental health. The overall scope of this recent ongoing collaborative project is to describe, understand, and compare the effects of historical changes of sediment quality conditions with the implementation of the Foram-AMBI (*f*AMBI) index as a long-term and cost-effective biomonitoring tool for environmental health assessment.

Smithsonian Indian River Lagoon Species Inventory: Documenting and Barcoding Benthic Infauna

Andrew Meashaw, Iris Segura-García, Michelle Stephens, and L. Holly Sweat
Smithsonian Marine Station, Fort Pierce, FL
Contact email: akmeashaw@gmail.com

With changing conditions in the Indian River Lagoon (IRL) and Saint Lucie Estuary (SLE), understanding the effects of abiotic variables on biodiversity within these environments is imperative. Infauna are good indicators of these environmental changes, and thus have been monitored by the Smithsonian Marine Station in the IRL and SLE since 2005. Over 900 taxa from 16 phyla have been identified across 15 sites selected for their proximity to environmental stressors. In 2020, a voucher collection of these taxa was established to inform management practices and expand our knowledge of cryptic biodiversity in the estuaries. Over 200 specimens have been collected, photographed, and preserved to date. To further elucidate taxonomic identification, specimens were sequenced for the *COI* gene. This DNA barcode and voucher collection will continue to expand and will be shared with scientists, students, resource managers, and the public as part of the online IRL Species Inventory biodiversity database.

Determining the Regulation and Control of Saxitoxin Production in *Pyrodinium bahamense* in the Indian River Lagoon

Jackie L. Metz, Rachel L. Hedinger, Malcom McFarland, and Guojun Wang
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: guojunwang@fau.edu

As one of the most severe HAB toxins, saxitoxin is a global issue. While production of saxitoxins has been widely studied in cyanobacteria and *Alexandrium* dinoflagellates, little is known about its production in *Pyrodinium bahamense*, which unfortunately is the major saxitoxin producer in the IRL. Even less is known regarding why and when saxitoxins are produced. Thus, our research has been aimed to further characterize the biosynthesis of saxitoxin in *P. bahamense* through analysis of the transcription and related saxitoxin production using lab cultures of *P. bahamense* strains collected from the IRL. The final aim is to determine potential genetic regulators that control the production of saxitoxins in *P. bahamense* in the IRL.

Stable Isotope Analysis of an Invasive Crab Species, *Charybdis hellerii*, in the Indian River Lagoon
Justin Meyer and Geoffrey Cook
University of Central Florida, Orlando, FL
Contact email: justinmeyer35@knights.ucf.edu

Charybdis hellerii has been reported to be expanding its non-native range northward up the Indian River Lagoon. Competition between *Callinectes sapidus* and *C. hellerii* potentially poses a significant threat to fishing industries in the state of Florida and the southeast if *C. hellerii* populations continue to expand. In order to determine the extent of the threat the invasive crab poses, this study will use stable isotope analysis of muscle tissue from the crabs. The results of this study will describe the isotopic niche and competition for dietary resources between an invasive crab and its native economically valuable counterpart. Fundamental knowledge generated through this project will provide insight that can guide the development of more effective management strategies for monitoring and mitigating the ecological and economic impacts of *C. hellerii* in the IRL, Florida, and other coastal ecosystems should its northward spread continue.

Evolution of a Cyanobacteria Bloom in the Northern Indian River Lagoon in 2020
Tim Moore, Malcolm McFarland, and Nicole Stockley
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: mooret@fau.edu

In July 2020, an algal bloom of an unidentified cyanobacterium started to develop in the northern Indian River Lagoon. The bloom was bright green color to the eye, and spread into the adjacent Banana River and Mosquito Lagoon sub-systems in August. By early September, the bloom covered much of the northern Indian River Lagoon, and remained vibrant through November. The bloom started to show evidence of decline in late November, but continued longer in the Banana River and Mosquito Lagoon, incurring low oxygen levels and associated isolated fish kills. Using satellite data, buoy observations, and collected field measurements, we assembled an emerging view of how the bloom evolved, and speculate on the causes and the significance for the trophic network of the northern IRL

Effect of Biodegradable Materials on Oyster Reef Restoration and Biogeochemistry
Chelsea K. Nitsch[1], Joshua S. Sacks[2], Linda J. Walters[1], Paul E. Sacks[1], and Lisa G. Chambers[1]
[1]University of Central Florida, Orlando, FL; [2]University of Washington, Seattle, WA
Contact email: cnitsch@knights.ucf.edu

Oyster restoration mats produced with Vexar™ aquaculture mesh can enhance coastal ecosystem services but may also introduce plastics to the environment. An "eco-friendly" alternative is biodegradable (BESE-elements®) mats. This study investigates the ability of BESE material to support oyster reef restoration and its impact on biogeochemical cycling. Preliminary results suggest BESE material promotes oyster recruitment equivalent to traditional plastic mats, but fragmented BESE material does degrade (8-12% mass loss) after 12 months of field deployment. Findings also suggest BESE material can serve as a substrate for microbial respiration, increasing CO_2 production under lab conditions, and contribute to localized changes in sediment nutrient availability.

Leveraging Natural Selection for Restoration of Clam Populations and Water Quality in the Indian River Lagoon

Todd Z. Osborne[1,2], Jose Nunez[1], and Jeff Beal[3]
[1]University of Florida, St. Augustine, FL; [2]University of Florida, Gainesville, FL; [3]Ducks Unlimited, Fort Pierce, FL
Contact email: osbornet@ufl.edu

Hard clams (*Mercenaria mercenaria*) have historically been significant contributors to healthy water quality in the Indian River Lagoon (IRL) via filter-feeding that reduces turbidity from algae and detritus which in turn allows greater light penetration needed for seagrasses to grow. Furthermore, through bio-filtration, clams remove particulate organic nutrients from the water column depositing them in sediments, contributing to sediment consolidation and 'benthic-pelagic coupling' that further reinforces water quality and clarity. To date, we have successfully collected broodstock from impacted areas of the IRL, spawned and raised three million clams to out-plant size in nursery facilities and repatriated 2.35 million native hard clams to strategic locations in the northern IRL. Monitoring of clam growth and survival suggests that clams can withstand significantly degraded water quality. This work represents a unique collaborative effort between the University, state and local agencies, several conservation organizations, and the public.

DNA Sequencing from Home: Using a Portable DNA Sequencer to Monitor Eukaryotic Microorganisms in the Indian River Lagoon

Heidi J.T. Pagán, Tatiana Ferrer, and Greg O'Corry-Crowe
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: hpagan1@fau.edu

As part of the Florida Center for Coastal and Human Health, 18S eukaryotic community profiling was performed on water samples from Indian River Lagoon sites over the past two years. The portable handheld MinION device allowed us to minimize time in the lab after preparing the sample by then running the DNA sequencer at home. Taxonomic classification from this rapid response, long read technology identified several toxin producing species from harmful algal blooms, including *Aureoumbra lagunensis*, *Pseudo-nitzschia*, and *Pyrodinium bahemense*, as well as a predator species of *Microcystis aeruginosa*. Variation in seasonal and geographic distribution of these and other species were observed and may reveal species' interactions driving bloom formation and duration.

Validating Ultrasonography of Shoulder Fat Thickness as a Non-Invasive Technique for Estimating Body Condition in Green (*Chelonia mydas*) and Loggerhead (*Caretta caretta*) Sea Turtles

Marisa Pico[1], Justin R. Perrault[2], and Annie Page-Karjian[1]
[1]Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL; [2]Loggerhead Marinelife Center, Juno Beach, FL
Contact email: mpico2017@fau.edu

Body condition provides an important index for nutritional status assessment in wild animals and can be evaluated via subjective body condition scoring (BCS) and/or calculated body condition index (BCI; based on body length and mass). Body condition data collected during health assessments of 205 green (*Chelonia mydas*) and 96 loggerhead (*Caretta caretta*) sea turtles captured or stranded in Florida during 2001–2019 were analyzed to develop quartiles based on the relationship between BCI and BCS. Resulting reference quartiles for green turtles were: emaciated (BCS 1), 0.97 ± 0.08; thin (BCS 2), 1.22 ± 0.21; good (BCS 3), 1.31 ± 0.10; and robust (BCS 4), 1.39 ± 0.13. Resulting reference quartiles for loggerheads were: emaciated, 1.14 ± 0.13; thin, 1.27 ± 0.14; good, 1.41 ± 0.19; and robust, 1.44 ± 0.22. These data represent a useful reference to help biologists and clinicians interpret BCI scores resulting from sea turtle health assessments.

Continuously Monitoring Bottom Water Oxygen in Muck and Sand Sediments in the IRL

Tyler Provoncha, Austin Fox, Stacey Fox, Iulia Bibire, and Abigail Gering
Florida Institute of Technology, Melbourne, FL
Contact email: tprovoncha2018@my.fit.edu

In recent years, the IRL has suffered from a series of hypoxic events, leading to fish kills and changes 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. Muck deposits are known to further exacerbate hypoxic events when compared to sand sediments, with around a 3.6 mg/L average difference in DO, but little monitoring of bottom water hypoxia has been done to see what effect SOD and other factors impact sediments. Therefore, by monitoring bottom water dissolved oxygen in varying sediment compositions continuously, the impact of events such as fish kills can be shown, as well as long-term trends that drive oxygen dynamics in the IRL.

Redox Environment Controls on the Degradation of Harmful Organic Contaminants in Marine Sediment

Matthew Quinan[1], Michael Martinez-Colon[2], Christoph Aeppli[3], and Jordon Beckler[1]
[1]Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL; [2]Florida A&M University, Tallahassee, FL; [3]Bigelow Laboratory for Ocean Sciences, East Boothbay, ME
Contact email: mquinan2019@fau.edu

Understanding the degradation of harmful organic contaminants in marine and estuarine systems is paramount given their ubiquity throughout coastal ecosystems. Following deleterious events, such as an oil spill, benthic ecosystems are particularly at risk given subsequent deposition to the seafloor, e.g. as marine oil snow. However, the degree to which the composition of the sediment and microbial community present control the degradation of these compounds is poorly understood. To assess the rate and extent of hydrocarbon degradation as a function of the redox environment, Indian River Lagoon sediments were incubated in the Harbor Branch Sediment Incubation Laboratory with various mineralogical, microbial, and crude oil amendments. The addition of iron-coated sand significantly increased iron-reducing activity in the sediment, likely resulting in the accelerated degradation of petroleum hydrocarbons. Thus, hypoxia, due to poor water quality, and disruption of the riverine delivery of metal oxides may significantly decrease the resilience of the IRL.

Diversity and Distribution of Foraminifera in the Indian River Lagoon, Florida: An Updated Species Checklist

Susan L. Richardson
Florida Atlantic University, Jupiter, FL
Contact email: richards@fau.edu

A survey of the published and unpublished literature resulted in an updated checklist of the diversity and distribution of foraminiferans living in the Indian River Lagoon (IRL), Florida. A total of 159 species are recorded from all regions of the IRL (North Indian River, Banana River, North-Central Indian River, South-Central Indian River, South Indian River (including Hobe Sound and Jupiter Sound). Foraminiferans were found living in sandy sediments, in mangrove swamp sediments, as epiphytes on seagrass blades, associated with oyster reefs, and in the plankton. Of the 159 species recorded from the IRL, 155 are benthic species, one is a holoplanktonic species (*Globigerinoides ruber*), 2 are meroplanktonic (*Pseudotretomphalus atlanticus* and *Tretomphalus bulloides*), and one is tychoplanktonic (*Bolivina variabilis*). The highest diversity of foraminiferans occur in unvegetated or vegetated sandy sediments, with a total of 96 species recorded from sites located throughout all segments of the IRL.

Vertebrate Impact on a Newly Deployed Shoreline Stabilization Project by Wildlife Camera Analysis

Julia Rifenberg, Jason Litwak, Linda Walters, and Rebecca Fillyaw
University of Central Florida, Orlando, FL
Contact email: rifenbergj@knights.ucf.edu

Living shoreline stabilization is a technique that utilizes plants and other natural elements to protect estuarine coasts. Research has provided minimal information about which vertebrate species utilize living shorelines post-deployment. Ten wildlife cameras were placed along a living shoreline site in Canaveral National Seashore to document which vertebrate species utilize a living shoreline and surrounding vegetation. This shoreline was stabilized with red mangroves (*Rhizophora mangle*) and eastern oyster (*Crassostrea virginica*) shell bags in June 2019. The cameras, activated by motion sensors, remained at the site for five days a month for seven months (September 2019 – March 2020) to identify vertebrates and their behaviors. Wildlife camera footage provided data on which vertebrate species visited the site, what behaviors were exhibited, and what impact the vertebrate species had on the stabilization materials. Results indicate that living shorelines provide habitat for many vertebrates (25 unique species) and these species do not negatively impact stabilization materials less than one-year post-deployment.

Using Deliberative Discussion Forums to Foster Solutions for IRL Water Quality and Community Well-Being

Carol Roberts[1], Linda Seals[1], Martha Monroe[2], Holly Abeels[3], Curtis Johnson[4], and Mandy Baily[2]
[1]University of Florida/IFAS Extension, Fort Pierce, FL; [2]University of Florida, Gainesville, FL; [3]University of Florida/IFAS Extension, Cocoa, FL; [4]Fort Pierce County Commission, Fort Pierce, FL
Contact email: mbaily@ufl.edu

CIVIC (Community Voices, Informed Choices), a University of Florida (UF) and Florida Agricultural and Mechanical University (FAMU) Extension Service program, conducted deliberative discussion forums in the Indian River Lagoon counties during 2020. These conversations were part of a larger framework that strives to include all voices and encourage participation in collectively solving community issues. CIVIC worked with Florida Sea Grant and the Indian River Lagoon Council to engage IRL residents in information sessions and facilitated dialogue of social, economic, and environmental concerns related to IRL water quality. Though typically these forums would have been in person, they were successfully held online due to pandemic concerns.

Multi-Disciplinary Research during the Pandemic: Reconstructing Human-Environment Interactions and Ecosystem Conditions of the Indian River Lagoon over Deep-Time

Jacklyn D. Rumberger[1], Sarah B. Barber[2], Joseph Donoghue[2], Peter Jacques[2], Seabird McKeon[2], Kristy Lewis[2], Melinda Donnelly[2], Kelly Kibler[2], Neil Duncan[2], Kitty F. Emery[3], and Nicole Cannarozzi[3]
[1]Washington State University, Pullman, WA; [2]University of Central Florida, Orlando, FL; [3]Florida Museum of Natural History, University of Florida, Gainesville, FL.
Contact email: jacklyn.rumberger@wsu.edu

In light of current global health concerns, our multi-disciplinary team of natural and social scientists is developing a diachronic model of human-environment interactions and ecosystem conditions in the Indian River Lagoon over the Common Era (AD 1 – 2021) that utilizes existing data sets. In this paper, we focus on pre-Hispanic lagoon usage reconstructed from archaeological fauna excavated in 2017 and 2018 from the Burns Site, located along the Banana River. We compare those data with historic records, phytolith and trace element records, existing site reports from the barrier island and around Mosquito Lagoon, and modern ecology data to understand how, where, and when lagoon use was organized and what species were targeted.

These preliminary results demonstrate strategic decision making in resource selection in response to environmental conditions that inform our understanding of human synergy with both cultural and climatic changes and offer lessons for the future of the IRL system.

Monitoring Success of Brevard County's Save Our Indian River Lagoon (SOIRL) Oyster Breakwaters

Paul E. Sacks[1], Melinda Donnelly[1], Linda Walters[1], Jenny Hansen[2], and Virginia Barker[2]
[1]University of Central Florida, Orlando, FL; [2] Brevard County Natural Resources Management, Viera, FL
Contact email: paul.sacks@ucf.edu

The University of Central Florida is conducting third-party monitoring of Brevard County SOIRL shoreline restoration/stabilization oyster breakwater projects to enable project managers to adaptively respond as data are acquired. Nine sites from Cocoa Beach to south of Melbourne Beach have been monitored for up to 2 years. Data are collected regularly on the survival of gardened oysters, if used to seed the oyster breakwaters, density of oyster recruitment and growth, and presence of potential predators and competitors. Results show that oyster recruitment and survival of gardened oysters is lowest in narrow canals in the Banana River and highest in the southern part of Brevard County along shorelines facing the open Indian River Lagoon. Also, where there are adequate larval supplies, recruitment can occur with or without gardened oysters.

Quantifying Trophic Competition between a Tropical Herbivorous Fish and Its Congener in the Indian River Lagoon, Florida

Adam R. Searles[1], Douglas H. Adams[2], Charles W. Martin[1], and Laura K. Reynolds[1]
[1]University of Florida, Gainesville, FL; [2]Florida Fish and Wildlife Conservation Commission, Melbourne, FL
Contact email: adamrosss@ufl.edu

Since 2014, a 49-fold increase in the abundance of the tropical herbivore, Sea Bream (*Archosargus rhomboidalis*), has been observed in the northern IRL. The recent proliferation of this species has the potential to impact communities by further exacerbating already severe seagrass losses in the northern IRL and increasing competition with its congener, Sheepshead (*A. probatocephalus*). To quantify grazing of Sea Bream on seagrass and trophic competition between the sparids, gut content analysis was conducted on Sea Bream and Sheepshead collected by FWC's Fisheries-Independent Monitoring program. Stomachs were excised and each content was identified to the lowest possible taxonomic level. Blotted wet weight and volume were recorded for each item. Analysis of wet weight data revealed no significant differences between diets, suggesting the potential for competitive interactions between them. Further work, including stable isotope analysis, is needed to fully elucidate trophic overlap between these congeners in the IRL.

Unlocking Sponge Biodiversity (Phylum Porifera) in the Indian River Lagoon, Florida, Using DNA Barcoding

Iris Segura-Garcia[1,2], Maria Cristina Díaz[2], Andia Chaves-Fonnegra[2,3], Shirley Pomponi[2], John Reed[2], and Holly Sweat[1]
[1]Smithsonian Marine Station, Fort Pierce, FL; [2]Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL; [3] Florida Atlantic University, Jupiter, FL.
Contact email: seguragarciai@si.edu

Sponge diversity in the Indian River Lagoon (IRL) is not well known. Only 16 species are listed in peer-reviewed publications. Furthermore, to our knowledge only 12 species have been successfully barcoded or taxonomically confirmed. The present study aims to contribute to the knowledge of sponge (Porifera) biodiversity in the IRL by adding new records, confirming previous ones, and identifying recently collected specimens, using a combination of morphological and DNA-barcoding approaches. A total of 261 samples were collected at 23 sites along the length of the IRL (251 km) from July to September 2020 and genotyped for the COI and 28s genes. Our results will allow the confirmation of certain taxonomic identifications and

will enhance our capability to distinguish species new to science, or first records for the IRL. This study will contribute a vast number of new DNA-barcode records, e.g., *Mycale angulosa* and *M. microsigmatosa,* in public databases.

***WeShore:* Connecting Homeowners, Contractors and Nature through Living Shorelines**

Marjorie M. Shropshire[1] and Vincent Encomio[2]
[1]University of Florida, Gainesville, FL; [2]Florida Sea Grant, Stuart, FL
Contact email: pucpuggy@bellsouth.net

Living shorelines have benefits for people and nature, however waterfront homeowners often lack information on how to proceed and may default to shoreline hardening, especially when confronted with contractors who may not recommend living shorelines as an option. The *WeShore* project explores homeowner barriers to taking action on living shoreline implementation, using a co-design and participatory framework to address concerns in context. Focusing on homeowners in Martin and St. Lucie Counties, *WeShore* is a prototype of an online pathway waterfront homeowners can follow to successfully achieve the goal of constructing a living shoreline. It connects and informs disparate groups—homeowners, restoration professionals and contractors—that might otherwise have difficulty coming together in a mutually beneficial collaboration. The outcome of the project will help homeowners by creating a one-stop online resource for living shoreline information focused on their particular needs and concerns.

Acute and Chronic Effects of Roundup QuickProTM (73.3% Glyphosate Salt) on *Halodule wrightii* and *Halophila johnsonii* Seagrass in Closed Tank Systems

Owen Silvera[1], Rachel J. Harris[1,2], and D. Albrey Arrington[2]
[1]Florida Atlantic University, Jupiter FL; [2]Loxahatchee River District, Jupiter FL
Contact email: owen.silvera@hotmail.com

Seagrasses are essential habitats for many species and provide critical ecosystem functions. Globally seagrasses are declining at an alarming rate. Locally, seagrass loss is concerning because of the magnitude of habitat loss as well as the uncertainty surrounding the mechanisms driving seagrass decline. We exposed two prevalent seagrasses in the IRL to the terrestrial herbicide Roundup QuikPRO™ (active ingredient 73% glyphosate) and quantified seagrass response over 53 days. Direct application of 112 mg glyphosate (15mL of 7.5 g/L) onto *Halodule wrightii* and *Halophila johnsonii*, simulating overspray during low tide, yielded persistent concentrations of 2.58 mg/L glyphosate after 13 days. Direct application had acute effects, but survivorship after 53 days was equivalent to control tanks. Indirect application of 125 mg/L glyphosate, with persistent concentrations of 83.4 mg/L glyphosate after 13 days, resulted in complete *H. johnsonii* mortality and nearly complete mortality of *H. wrightii*. Despite high-water solubility, glyphosate poses a measurable threat to seagrasses which warrants further study.

Rapid Response of Coastal Mangroves to Hydrological Restoration

Loraé T. Simpson[1], Erin McDevitt[2], Zachary Huges[3], Samantha C. Smith[1], and Jeff Beal[4]
[1]Florida Oceanographic Society, Stuart, FL; [2]Florida Fish and Wildlife Conservation Commission, Tequesta, FL; [3]Martin County Public Works, Stuart, FL; [4]Ducks Unlimited, Fort Pierce, FL
Contact email: lsimpson@floridaocean.org

Mangrove habitats have been shown to sequester huge amounts of carbon (C) relative to their spatial extent. In Stuart, Florida, the Jensen Beach Impoundment contains 61 ha of mangrove tidal swamp; however, in the aftermath of hurricane Irma, mass mortality of 22 ha took place due to high water levels and poor water quality. This resulted in the transformation and loss of approximately 1708 mg C from aboveground biomass. Restoration of the impoundment aims to restore the hydrology and connectivity of the system to the Indian River Lagoon, and to date, 267 mg C have been restored through natural recruitment. Restoration

projects that aim at rapid vegetation recovery through hydrological connection can increase the trajectory of habitat recovery, C sequestration, and climate change mitigation.

Changes in the Abundance and Distribution of Benthic Mollusks in Polluted Sediments of a Shallow Subtropical Estuary

Rachael Stark and Kevin B. Johnson
Florida Institute of Technology, Melbourne, FL
Contact email: rstark2014@my.fit.edu

Eutrophication has resulted in the accumulation fine-grained, organic-rich sediments (muck) over a significant portion of the Indian River Lagoon (IRL). Environmental dredging has been employed to attempt to remove muck and restore benthic habitats. This study is assessing the effectiveness of environmental dredging by using mollusks as bioindicators and examining mollusk tolerances for polluted sediments. We hypothesize an inverse relationship of mollusk community and population indicators with sediment organic content, and that the removal of muck sediments via dredging will increase the biodiversity, species richness, and abundances of mollusks. Data were collected from March 2017 until October 2020 in the Mims region of the IRL. Generalized linear models indicate an increase in the abundance of mollusks one-year post dredging.

Improvements in *Microcystis* Quantification Using Sonication and Flow Cytometry

Nicole Stockley and Malcolm McFarland
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact e-mail: nstockley@fau.edu

The Indian River Lagoon has been significantly impacted by blooms of the toxic cyanobacteria *Microcystis* in recent years. Accurate measurements of algal biomass are critical to examining both the causes and effects of these recurrent blooms, including the role of water quality parameters like temperature and nutrients in initiating and prolonging blooms and the potential health effects for people and animals in contact with impacted waterways. However, *Microcystis* tends to form amorphous colonies that can range from dozens of cells to thousands and can have varying cell densities, complicating traditional microscopy cell count methods. Flow cytometry is a viable alternative to microscopy as single cells are within the detectable size range, but colonies are still an issue as they are generally too large to be measured. Sonication is examined as a technique to disaggregate *Microcystis* colonies to improve quantification of individual cells using flow cytometry.

Vegetation Husbandry: A Tool to Engage Volunteers in a COVID-19 World

Emily Surmont, Irene Arpayoglou, Kirk Fusco, Emily Dark, and Matthew Anderson
Indian River Lagoon Aquatic Preserves/Florida Department of Environmental Protection, Fort Pierce, FL
Contact email: emily.surmont@floridadep.gov

The COVID-19 pandemic has directly affected the ability of scientific outreach programs to engage the public in educational and volunteer opportunities. Despite challenging COVID-19 restrictions, the Indian River Lagoon Aquatic Preserves Shoreline Restoration Project has been able to engage students and the public through coastal vegetation husbandry. Information regarding shoreline habitat is provided, and participants engage in vegetation fostering for a designated time period. After the designated time period, plants are collected from participants for use in shoreline restoration. This vegetation husbandry initiative has sustained the project's education and outreach goals, while promoting safety by adhering to COVID-19 CDC guidelines, and could provide an enriching volunteer opportunity if adopted by other organizations.

Expanding Biodiversity: Continued Development of the Indian River Lagoon Species Inventory
L. Holly Sweat[1], Greer Babbe[2], Andia Chaves-Fonnegra[2], Megan Conkling[2], Maria Cristina Díaz[2], Andrew Measha[1], Shirley A. Pomponi[2], John Reed[2], Juliet Ruggiero[2], Michelle Stephens[1], and Iris Segura-García[1,2]
[1]Smithsonian Marine Station, Fort Pierce, FL; [2]Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: sweatl@si.edu

In 2019, the Smithsonian Marine Station (SMS) launched a revision of the Indian River Lagoon Species Inventory (IRLSI) through a renewed partnership with the Indian River Lagoon National Estuary Program. Information representing over 25 years of work by scientists and educators to highlight the biodiversity and complexity of the IRL was transferred to a new platform at irlspecies.org. Projects are now underway by scientists from SMS and FAU Harbor Branch Oceanographic Institute to explore the biodiversity of sponges and infaunal invertebrates, two groups that provide critical ecosystem services but are currently underrepresented on the IRLSI. Using morphological, DNA barcoding and genomics approaches, these studies are helping to quantify the richness of an estuary often regarded as one of the most biodiverse in the nation. This talk provides overviews of the projects and how they will be incorporated into the IRLSI for use by scientists, students, resource managers and the public.

Investigation of Survivin-targeting Marine Natural Products from the Indian River Lagoon
Kirstie R. Tandberg, Tara P. Pitts, Esther A. Guzmán, Priscilla L. Winder, Peter J. McCarthy, and Amy E. Wright
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL
Contact email: ktandberg2013@fau.edu

Eudistoma olivaceum is a colonial tunicate that occurs in the Indian River Lagoon. In prior work, a compound was isolated from the tunicate *E. olivaceum* that reduces the levels of survivin in both the A549 lung carcinoma and DLD-1 colorectal adenocarcinoma cell lines in an immunofluorescent imaging assay. Survivin is a protein that is upregulated in cancer cells and plays a critical role in the promotion of mitosis and inhibition of apoptosis facilitating growth of tumors. Compounds that reduce levels of survivin may provide novel chemotherapies for cancer. In the current project further experimentation was conducted to determine whether the compound acts on the transcriptional level to reduce survivin mRNA levels, as measured by qPCR, or acts on the post-translational level and increases the degradation rate of survivin protein compared to control, as measured in a western blot assay. Results from these experiments will be presented.

Microplastic Exposure in Pea Crabs from the Indian River Lagoon
Sophia Vermeulen, Casey Craig, and Linda Walters
University of Central Florida, Orlando, FL
Contact email: sophiavermeulen@knights.ucf.edu

Pea crabs, *Pinnotheres pisum*, parasitize a range of bivalve species, including the eastern oyster *Crassostrea virginica*. As plastic pollution continues to permeate ecosystems, microplastics (MP), plastic particles less than 5 mm have been documented in body tissue of *C. virginica* from Mosquito Lagoon. This study aimed to determine if pea crabs inside IRL oysters are exposed to the MP they ingest. Pea crabs were extracted from chemically digested oyster samples collected from the IRL, vacuum filtered to extract microplastics, and analyzed using microscopy. On average, there were 1.87 MP ± 0.22 per pea crab. Pea crab abundance varied by region, with southern oysters containing the highest abundances of pea crabs. There is no difference in MP abundance on pea crabs based on region of origin.

How Many Amphipods Can Dance on a Blade of Seagrass?

Robert Virnstein[1] and Patrick Dowling[2]
[1]Seagrass Ecosystems Analysts, Gainesville, FL; [2]Unknown whereabouts
Contact email: seagrass3@gmail.com

Amphipods were added to a bowl containing a single 5-cm long blade of *Thalassia testudinum* (turtle grass). Eventually, adding more amphipods resulted in no additional amphipods on the seagrass. This is considered saturation density. The maximum number was about 20 for *Cymadusa compta*. For moderately dense *Thalassia*, this density would extrapolate to a density of 300,000 per m^2, a density not found in nature. For *Elasmopus rapax*, the maximum number was about 16. When both species were added together, the larger *Elasmopus* displaced **all** the *Cymadusa*, physically kicking them off the blade (literally). Thus, in**tra**specific competition was low, but in**ter**specific competition was high. Density of amphipods is not limited by space available.

Replacement of Oyster Reefs by Mangroves: Unexpected Climate-Driven Ecosystem Shifts

Linda Walters[1], Giovanna McClenchan[1,2], and Megan Witt[1]
[1]University of Central Florida, Orlando; [2]Nichols State University, Thibodaux, LA

Increases in minimum air temperatures have facilitated poleward expansion of mangroves. Using aerial photographs and satellite imagery, we determined percent cover and number of mangrove patches on oyster reefs in Mosquito Lagoon over 74 years (1943-2017). There was an overall 103% increase in mangrove cover on live oyster reefs from 1943 (6.6%) to 2017 (13.4%), with a range of 0-76% cover on individual reefs. Between 1943 and 1984, the cover remained consistent (~7%), while between 1984 and 2017, mangrove colonization and growth increased rapidly with a 6% yr^{-1} increase in mangrove area on oyster reefs (198% increase). Site visits found at least one mature *Avicennia germinans* on each tracked mangrove reef, with large numbers of smaller *Rhizophora mangle*, suggesting the post-1984 mangrove increases were the result of increased *R. mangle* recruitment and survival. The lack of freezes could lead to an ecosystem shift of intertidal oyster reefs to mangrove islands.

Monitoring a Synechococcaceae Cyanobacteria Bloom in the Indian River Lagoon, FL

Connor J. Wong and Kevin B. Johnson
Florida Institute of Technology, Melbourne, FL
Contact email: cwong2016@my.fit.edu

A study monitoring the progression of a cyanobacteria bloom (possibly *Synechococcus* sp. or *Cyanobium* sp.) is being conducted (07/30/20 – Present) in the Indian River Lagoon (IRL) to determine spatial and temporal bloom dynamics. This study seeks to investigate the relationship between bottom-up bloom controllers (e.g., abiotic conditions) and bloom expansion or inhibition. Monitoring in the IRL Proper is ongoing at four sites distributed between Mims, Merritt Island, and Melbourne and at two sites in the Banana River Lagoon (North and South Merritt Island). Water samples are kept on ice and processed within hours of collection via flow cytometry (BD Accuri C6) to determine phytoplankton cell densities. Water quality data are collected simultaneously for cell count correlation analyses. Densities of cyanobacteria with phycocyanin range four orders of magnitude ($277 – 5.87x10^6 \pm 1.82x10^6$ cells mL^{-1}) and non-cyanobacteria densities range one of order magnitude ($3.7x10^4 – 9.15x10^5 \pm 1.7x10^5$ cells mL^{-1}).

Restoring Lagoon Inflow Update: Numerical Model Tests of Indian River Lagoon Anthropogenic Inflow Scenarios

Gary A. Zarillo
Florida Institute of Technology. Melbourne, FL
Contact email: zarillo@fit.edu

Historically exchanges between the coastal ocean and the Indian River Lagoon frequently occurred by storm surge over wash, temporary breachways across the barrier island system, and by long-lasting uncontrolled tidal inlets that migrated alongshore generating shoals now incorporated into the barrier island superstructure after inlets closure. In this study hypothetical exchanges of water from the coastal ocean into the IRL were investigated using the Environmental Fluid Dynamics Code, which is a 3D numerical hydrodynamic and transport model supported by the U.S. Environmental Protection Agency. Model results showed that pumping stations and water control structures placed at key locations could potentially enhance circulation and promote better circulation in IRL compartments that are currently poorly flushed. A second phase of this study will address the potential water quality benefits of water exchanges.