Abstracts of Presentations

Indian River Lagoon Symposium 2012

The Indian River Lagoon – Looking Forward

Johnson Education Center

HBOI-FAU

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Key Note Address

Historical Biodiversity of the Indian River Lagoon: A Restoration Goal

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Interdisciplinary quantitative studies of estuarine biota of east central Florida began fifty-seven years ago in 1955 with the work of scientists at the Florida Medical Entomological Laboratory in Vero Beach. These investigators focused vegetation, insects, invertebrates, fish and birds inhabiting coastal hammocks and wetlands. During this period nearly all of the tidal wetlands of central Florida's Indian River Lagoon were impounded for mosquito control causing significant impact on wetland invertebrate, fish and bird populations.

Forty years ago, in 1971, another interdisciplinary group of scientists began comprehensive exploratory and quantitative fish research in freshwater tributaries, tidal and impounded wetlands, seagrass, nearshore reef formations, continental shelf sand, mud and reef communities and deep slope habitats. This work eventually became a major part of the Indian River Coastal Zone Study (IRCZS), a ten-year interdisciplinary ecological study funded by the Harbor Branch Foundation and the Smithsonian Institution. During this period over one hundred scientists conducted collaborative interdisciplinary studies from the continental shelf to tidal wetlands along 225 coastal kilometers. Many new species were described in the process in addition to hundreds of new biogeographic records. This set the basis for describing a rich and previously unrecognized center of estuarine biodiversity for the United States. The IRCZS revealed exceptionally high local floral and faunal biodiversity, particularly, in the southern half of the estuary and coastal reef habitats. This work produced detailed quantitative data used to document the unique biotic communities of the Indian River Lagoon.

Ecological studies continue to this day with emphasis on biological assemblages associated with oyster reefs, wetland and mangrove forest ecosystems, seagrass habitats, coral reefs, individual species life histories/ecology and freshwater tributaries. These studies have documented species extirpation, substantial habitat and water quality decline, increase in fish disease incidence, toxic algal blooms and extraordinary population explosions in exotic species. These impacts have been particularly damaging in the southern half of the Lagoon that coincidentally supports the highest local aquatic biodiversity. These declines are directly associated with extraordinary increases (500%) in resident human populations and their demands on aquatic resources, such as freshwater management, increased pollutant loading, fisheries (recreational and commercial), and beach sand deposition.

A variety of ecosystem restoration programs have demonstrated that these deleterious impacts are not permanent and can be remediated or reversed in many instances. New technologies and techniques will also allow investigators to examine real-time dynamics in these ecosystems and, therefore predict natural variation as well as human influence on our rich regional biota.

Contributed Papers (Oral and Poster Presentations)

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

Why Should Policymakers Continue to "Invest" in Grants?

Amy Adams
Cape Canaveral Scientific, Inc. Melbourne Beach, FL

Grants …The term evokes images of government administrators discussing contractual agreements and financial spreadsheets. It also brings to mind the possibilities of solving problems and reaching for new discoveries that can make life easier. For elected officials, it offers collaborative prospects to stimulate growth. Although everyone understands the importance of grant funding at a conceptual level, policymakers may ask: Why should they "invest" in or pursue grant? There are three reasons: (1) The entity's investment leverages larger federal or state grants; (2) As a teaching mode for training college students, grants are a critical part of workforce development for high-value jobs; (3) Grants provide the foundation for innovations that lead to new commercial products, and jobs. This presentation will explore the reasons and highlight how funding for Indian River Lagoon projects has been used.

Bull Sharks in the Indian River Lagoon: A 30-Year Synthesis

Douglas H. Adams[1] and Tobey H. Curtis[2]
[1]Florida Fish and Wildlife Conservation Commission, Melbourne, FL; [2]National Marine Fisheries Service, Gloucester, MA.

We examined bull sharks, *Carcharhinus leucas*, in the Indian River Lagoon (IRL) and adjacent shelf waters during the 30-year period 1975–2005 with regard to seasonal distribution, size structure, and habitat associations (n=555 sharks). The IRL was dominated by young-of-the-year (age-0) and juvenile bull sharks, which were most abundant during spring, summer, and autumn. Sharks were most often associated with freshwater creeks, power plant outfalls, ocean inlets, and seagrass habitats (temperatures >20ºC, salinities of 10-30‰, dissolved oxygen of 4-7 mg/L). Juvenile bull sharks were found in waters with higher mean salinities than were age-0 sharks. Multiple stressors in the IRL influence shark abundance, distribution and health. Although the IRL is one of the most important bull shark nursery areas on the U.S. Atlantic coast, catch-per-unit-effort data indicate that abundance decreases with increasing latitude within and north of the IRL, suggesting that the IRL is the northern limit of functional nursery habitat for this species in the northwest Atlantic Ocean.

Effects of Mercury on Florida Marine Fishes: Current Research and Future Directions

Douglas H. Adams[1], Christian Sonne[2], and Nil Basu[3]
[1]Florida Fish and Wildlife Conservation Commission, Melbourne, FL; [2]Aarhus University, Roskilde, Denmark; [3]University of Michigan, Ann Arbor, MI

Marine fishes in Florida can accumulate high concentrations of mercury, though its effects on fish health are not well understood. We used quantifiable pathological and biochemical indicators to explore mercury-associated differences in fish from the Indian River Lagoon (IRL) and the Florida Keys-Florida Bay-Everglades region (South Florida). Mercury in spotted seatrout (*Cynoscion nebulosus*) from South Florida was significantly higher than those from IRL. The distribution of mercury among tissues followed the same trend in both areas. The majority of blood-plasma parameters examined were significantly lower, and liver/kidney lesions were more prominent in South Florida. Neurochemical analyses showed that brain N-methyl-D-aspartic acid (NMDA) receptors were significantly less in fish from South Florida than from IRL, the first association between mercury exposure and reduced NMDA receptors in fish. These findings provide compelling evidence that elevated mercury causes quantifiable pathological and biochemical changes that influences marine fish health. Future efforts would benefit from expansion to other contaminant types (e.g., PCBs, PBDEs) and inclusion of other biota in the IRL and other systems.

Electrosensory Capabilities of the Bull Shark, *Carcharhinus leucas*

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Electroreception is an important sensory component that allows sharks to interact with their environment through the detection of electrical stimuli. Because transmission of electric signals depends on the conductivity of the water, this sense is affected by fluctuations in salinity. The bull shark is unique in its ability to tolerate a wide range of salinities and utilizes the Indian River Lagoon as a nursery ground. This study aims to describe how the capabilities of this sense change when it encounters various saline environments. Behavioral assays to quantify sensitivity to weakly electric fields will be conducted in fresh, brackish and salt water. Gel from the electrosensory organ will also be extracted at each salinity treatment to determine if its biochemical properties change to compensate for reduced water conductivities. This will provide an understanding of how this system functions and may be impacted by natural and anthropogenic changes in water parameters.

Need for Updating the TMDL for the IRL

Virginia Barker
Brevard County Office of Natural Resource Management, Viera, FL

In order to implement the Federal Clean Water Act, the Florida Department of Environmental Protection adopted Total Maximum Daily Loads (TMDLs) for most of the Indian River Lagoon (IRL) and is currently working with local governments to develop Basin Management Action Plans (BMAP) for the Banana River, North IRL and Central IRL. Local governments have concerns regarding the quality, robusticity, and resolution of old input data used to develop TMDL mandates for Nitrogen and Phosphorus load reductions. Greater confidence in quantifying necessary pollution load reductions and allocating responsibility between jurisdictions is needed for government stakeholders to commit to very costly stormwater treatment projects. A consortium of eighteen local, state and federal interests are funding an update and refinement of IRL TMDLs using data sets and computational power that were not available during initial TMDL development. This presentation will focus on the status of TMDL refinement for the IRL.

Genetic Analysis of Bottlenose Dolphin (*Tursiops truncatus*) Community Structure within Estuarine and Coastal Communities of Eastern Florida

Sarah E. Bechdel,[1] Marthajane Caldwell[2], Marilyn Mazzoil[1], Megan Stolen[3],Wendy Noke Durden[3], Teresa Mazza[3], Stephen D. McCulloch[1], Gregory D. Bossart[4], and Greg O'Corry-Crowe[1]
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Over the past decade, photo-identification and genetic studies on bottlenose dolphins (*Tursiops truncatus*) along the Atlantic coast and within the connected estuaries of eastern Florida have been used to define discrete management stocks. Sighting data and social affiliations suggest limited movement between IRL estuarine communities and adjacent coastal populations. We conducted genetic analysis (n=375) to determine if mixing could be detected between: 1) estuarine (Jacksonville and IRL) verses coastal populations, 2) the two estuarine stocks (Jacksonville vs. IRL), and 3) within and among all five estuarine communities. Using the mitochondrial DNA (mtDNA) control region, we found significant ($p \leq 0.05$) differences between estuarine verses coastal dolphins (Fst=0.09) and between the two estuarine stocks (Fst=0.49). Structure was also detected among communities within stocks (Fst=0.00-0.68). Our results to date concur with recent sighting data of movement between the Jacksonville stock and the IRL estuary stock.

Septic Tanks: Are They Significant Sources of Nutrient and Bacterial Loading to the IRL?

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The overall importance of septic tanks or on-site treatment and disposal systems (OSTDS) to the nutrient and bacterial contamination of the IRL has been an unresolved question for many years. In view of the high numbers of OSTDS and the poor site conditions often existing in the IRL watershed, four Florida Tech studies were funded in the last six years by three different agencies to directly determine the importance of OSTDS contamination to the IRL and its tributaries. These studies were all very similar and involved the seasonal collection of groundwater and surface water quality and hydrologic data. In each study, groundwater samples were collected at each site from piezometers and pushpoint samplers at transect locations adjacent to and down-gradient from the septic tank drainfield to the edge of adjacent surface water bodies. Our collective data indicate that while OSTDS can contribute nutrients to the IRL under certain worst case site condition scenarios, properly functioning (not failing) OSTDS are not the "smoking gun" that many have predicted and do not appear to be a significant source of nutrients or fecal coliform bacteria.

Restoring Oyster Reefs in the Mosquito Lagoon

Anne Birch[1], Stephanie Garvis[2], Jody Palmer[3], Linda Walters[2], and Paul Sacks[2]
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Oyster reefs are the engines of an estuary, providing ecosystem services that support a diverse assemblage of species, including humans. Like coral reefs, oyster reefs have significantly declined globally, including in the Mosquito Lagoon. The Mosquito Lagoon oyster reef restoration project was initiated in 2005 to restore reefs damaged from boat wakes by applying a science-based methodology that involves and educates the community and explores solutions to address the cause of the problem. Fifty reefs have been restored since restoration began in 2007. Annual monitoring shows that the methodology works; oyster mats have similar numbers of live oysters as natural reference reefs. Extrapolating the data collected to all restored reefs (25,978 mats), our project has provided substrate for 2,062,653 live oysters. Support from partner agencies, organizations, and corporations coupled with community involvement are integral to the project's success. Detailed monitoring data and community involvement stories will be presented.

Phase-Shift in the Density of Co-occurring Native and Non-native Fish Species in the Indian River Lagoon: Evidence for Species Interactions?

Jesse R. Blanchard[1], Ralph G. Turingan[1], and Richard Paperno[2]
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This study is designed to examine historical data collected by the Florida Fish and Wildlife Conservation Commission and to establish patterns of inter-annual variation in the density of co-occurring native and non-native fishes. This retrospective analysis serves as the basis for designing a series of manipulative experiments to determine how invasive species affect the ecology and evolution of native fish populations in the invaded ecosystem, such as the Indian River Lagoon. Inter-annual variation in the density of co-occurring native and non-native fishes is apparent. Annual fish densities of some non-native fishes declined when densities of co-occurring cichlids increased. CCA revealed that density of Cichlidae is a strong correlate of densities of these non-native fishes. It is hypothesized that this pattern has been shaped by direct or indirect interactions between these native and non-native fishes. This hypothesis will be tested in future manipulative experiments.

***Phascolion cryptum*: A Model for Molecular Studies of Life History Diversity in the IRL**

Michael J. Boyle and Mary E. Rice
Smithsonian Marine Station, Fort Pierce, FL

The Life Histories Program of the Smithsonian Marine Station has been investigating the biology of invertebrates within the IRL for the past 40 years. Of special interest is the comparative development of life history diversity within Sipuncula, a phylum of nonsegmented, coelomate marine worms. We are currently investigating developmental morphogenesis of the direct-developer, *Phascolion cryptum*, which inhabits discarded gastropod shells within seagrass beds throughout the estuary. After one week of development, the gut and other juvenile organ systems are functional, unlike sipunculans with indirect development that exhibit distinct larval stages. Here, we present confocal micrographs of organogenesis, and the expression patterns of genes that may have a role in gut formation, including *Parahox* genes and several other developmental regulatory transcripts, *foxA*, *brachyury*, and *wingless*. *P. cryptum* represents one of several experimental models for comparative studies on the molecular and developmental evolution of species-specific invertebrate life histories found within the IRL.

Use of Proven Capture and Release Methods to Disentangle a Dolphin Calf from Recreational Fishing Gear

Steve P. Burton, Juli D. Goldstein, and Stephen D. McCulloch
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL

This presentation describes a NMFS approved intervention to capture and release a dolphin mother/calf pair (*Tursiops truncatus*) to remove life-threatening fishing gear, and to further treat and evaluate a dolphin calf in the Indian River Lagoon, FL. Methods include use of proven health assessment capture and restraint protocols utilized to facilitate a well expedited and efficient means to relieve anthropogenic stressors. Dolphin calf was successfully disentangled on three occasions (January 2011, May 2011 and July 2011) and presently remains gear-free. The pattern of repeated entanglement suggests the need to develop a suitable action plan, including post-release monitoring and development of regional education/outreach regarding responsible use and disposal of monofilament fishing gear.

The 2011 Indian River Lagoon "Superbloom" and Research Approach for Evaluation

Robert Chamberlain[1], Joel Steward[1], Charles Jacoby[1], Margaret Lasi[1], Whitney Green[1], and Robert Virnstein[2]
[1]St. Johns River Water Management District, Palatka, FL; [2]Seagrass Ecosystems Analysts, Palatka, FL

A phytoplankton bloom of unprecedented concentration began in early 2011 and continues to persist. This "superbloom" appears to have originated in Banana River, spread to northern IRL, and then extended its spatial coverage north and south to southern Mosquito Lagoon and the Rockedge vicinity, respectively. Peak chl-*a* concentrations have exceeded 100 µg/L; greater than five times the 95th percentile of historical values. In association with this superbloom, seagrass coverage has drastically declined, with many areas suffering >50% reduction, including a complete loss at some District transect sites. A consortium of scientists from a variety of disciplines has been assembled to document and investigate the bloom, its potential causes, current impacts, and possible continuing effects. This poster will present some preliminary aerial and graphical depictions of the superbloom and seagrass decline, identify the participating scientists, and describe the consortium's developing investigative approach in an effort to attract cooperative contributions.

Use of a Spoil Island for Seagrass and Mangrove Mitigation in the Indian River Lagoon

Dave R. Clark, L.R. Ellis, T.Z. Osborne, A.G. Rozin, and J. Beal
Inwater Research Group, Jensen Beach, FL

St. Lucie County bridge and road construction impacts to mangroves and seagrasses resulted in the need for eight combined acres of restored seagrass and mangrove habitat in the Indian River Lagoon Estuarine system. In 2005, a spoil island in Ft. Pierce (SL-15) was recontoured to provide the mitigation acreage. *Rhizophora mangle* and *Spartina alterniflora* were planted on intertidal elevations; subtidal elevations were open to natural recruitment of seagrasses. After success criteria were met (80% mangrove survivorship and 10% seagrass coverage after five years), management of the island was subsequently released to the Florida Department of Environmental Protection. Restoration success suggests that spoil islands in the Indian River Lagoon can be utilized for future mitigation sites.

Characterization of Sea Turtles in the Southern Indian River Lagoon

Dave R. Clark, Cody R. Mott, Steve T. Weege, Jeffrey Guertin, Jeffrey A. Gomas, Michael J. Bresette, and Jonathan C. Gorham
Inwater Research Group, Jensen Beach, FL

The Indian River Lagoon system provides rich foraging grounds for threatened loggerhead (*Caretta caretta*) and endangered green (*Chelonia mydas*) sea turtles. Beginning in 1998 and continuing through 2007, Inwater Research Group (IRG) conducted an assessment of marine turtles in the southern Indian River Lagoon south of Fort Pierce Inlet at Jennings Cove. Over 250 turtles were captured here during the nine year study. Juvenile green turtles accounted for the majority of captures and more than half of all turtles had fibropapillomatosis. We compared these data from the Indian River Lagoon site to a more southern study site (Lake Worth Lagoon) as well as a nearby offshore location (St. Lucie Power Plant).

The Impact of Salt Marsh Presence on Mangrove Growth as Mitigated by Intertidal Depth in a Restored Site

Glenn Coldren, C. Edward Proffitt, Donna Devlin, and Kathryn Tiling
Florida Atlantic University at Harbor Branch Oceanographic Institute, Fort Pierce, FL

Diversity has been shown to be important to ecological function and productivity in a number of systems, but experimental demonstration has been sparse, especially in estuarine intertidal zones and in tropical to temperate transition zones where species pools may be greater. In the Indian River Lagoon salt marsh and mangrove species intermingle because climatic factors allow persistence of temperate and tropical species. To understand how these interactions may affect development of a restored wetland, we planted four salt marsh species (*Spartina alterniflora, Spartina patens, Sesuvium portulacastrum, Distichlis spicata*) into various species richness combinations (1,2,4) over a 24cm intertidal elevation gradient at a defoliated site, with one *Rhizophora mangle* planted into each plot. We have previously found that salt marsh species enhance the initial colonization of all three mangrove species. The effect on growth may differ by intertidal elevation and over time, with effects switching from strongly facilitative to strongly competitive.

The Indian River County "Quality of Life" Indicators Project

Graham L. Cox and Richard Baker
Pelican Island Audubon Society, Vero Beach, FL

Pelican Island Audubon Society, with the help of 23 advisors from all parts of the county, have started an innovative community-based process to survey and measure 'quality of life' indicators to guide Indian River County towards an environmentally, socially, and economically sustainable future. Indian River Lagoon plays a crucial part in the life of this county, so that water quality, ecosystem health and health of the lagoon fisheries are an obvious subset of indicators. The project will define a community vision, set goals and measure progress in these three dimensions of life in the county. With our advisors, key leaders and focus groups we have developed a preliminary list of 'quality of life' indicator topics. We have held eight community 'indicator work groups' to identify values and discuss indicator topics. More are planned. We have developed a web site and preliminary community survey. In due course we will establish an accessible community-wide database to periodically measure the three indicator categories and present the results to community leaders on a regular basis.

Seagrass Status along a Water Quality Gradient in the Central Indian River Lagoon, FL

Kristen S. Davis and M. Dennis Hanisak
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL

Seagrass plays a critical role in biological productivity and biodiversity of the Indian River Lagoon. Seagrass monitoring was conducted for 6 years (2005-2011) at 4-6 sites along a water quality gradient near Vero Beach and Fort Pierce. Visual assessments were made following lagoon-wide seagrass monitoring protocols (St. Johns River Water Management District). Sites ranged from near-monospecific beds of *Halodule wrightii* to more diverse, mixed communities of *H. wrightii*, *Syringodium filiforme*, and *Thalassia testudinum.* Seagrass cover was stable through 2009, despite significant interannual differences in water quality. Cover decreased at all sites from 2009 to 2011, consistent with a lagoon-wide seagrass decline. These data, coupled with concurrent high-frequency water quality monitoring, will provide a better understanding of seagrass ecosystems. This research also provides a baseline to assess changes in this critical resource following the planned reduction of freshwater inputs, recognized as the most significant human impacts on this estuary.

Macroalgae as Indicators of Phosphorus Limitation in the Indian River Lagoon, FL

David D. Debortoli, Ian R. Macleod, Laura W. Herren, and Brian E. Lapointe
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL

Macroalgae provide a useful ecological tool as indicators of phosphorus limitation and health of the economically important Indian River Lagoon (IRL). Increasing land drainage and urbanization has caused nutrient pollution throughout much of the estuary, but little is known regarding spatial variability of such anthropogenic impacts on the IRL. In the summer of 2011, the Harmful Algal Bloom Team at HBOI selected 21 sites covering the entire latitudinal extent of the lagoon and adjacent water bodies, including both relatively pristine and heavily populated areas. At each site, water quality parameters were measured and the two dominant species of benthic macroalgae were assayed for alkaline phosphatase activity as a measure of phosphorus limitation. Data analysis indicated a correlation between phosphorus limitation and coastal development. Algae in the northern less developed areas displayed greater phosphorus limitation compared to southern more developed areas. This study provides the first comprehensive spatial assessment of nutrient enrichment and eutrophication throughout the IRL, with implications for water management, urbanization, and development of nutrient standards.

Observational Study and Environmental Impact of *Lyngbya majuscula* in the Indian River Lagoon
Kimberly Lewis Demet, Lisa A. Kelly, Theresa Meickle, Jennifer Sneed, and Valerie Paul
Smithsonian Marine Station, Fort Pierce, FL

A persistent bloom of *Lyngbya majuscula*, which occurs on the seagrass flat near Little Jim Island in the Indian River Lagoon, was the focus of a six-week observational study in 2011. This bloom appeared to peak on May 17th and had mostly died off by June 7th. Samples of the bloom were extracted for testing in biological assays. The results of the sea urchin feeding assay with *Lytechinus varietgatus* and an anti-fungal assay with *Dendryphiella salina* indicated that secondary metabolites present in *L. majuscula* may inhibit the feeding rate of herbivores and the growth of fungi within the seagrass flat. An anti-microbial assay run with bacterial strains isolated from the observation site showed no growth inhibition.

Competition and Facilitation Interactions between Red Mangrove (*Rhizophora mangle*) and *Spartina alterniflora* in a Restored Site: Do Below Ground Responses Mirror Above Ground Responses?
Donna J. Devlin and C. Edward Proffitt
Florida Atlantic University at Harbor Branch Oceanographic Institute, Fort Pierce, FL

Herbaceous salt marsh species can act as both facilitators and competitors of red mangrove (*Rhizophora mangle*) seedlings, affecting seedling survival, growth and architecture. Previously in a greenhouse experiment, we found that artificial shading reduced both above and below ground biomass. In a field experiment, we found that based on above ground growth characteristics, the role of *Spartina* as a facilitator or competitor of *Rhizophora* can switch across an environmental gradient. In this study, we examine the above versus below ground growth characteristics of *Rhizophora* with and without *Spartina* neighbors in a field experiment in the Indian River Lagoon. We found that the above and below ground compartmentalization by *Rhizophora* did not always mirror each other; and that differences in growth and compartmentalization by *Rhizophora* in the presence/absence of *Spartina* cannot be explained by shading alone.

Plankton Ecology of the Indian River Lagoon
Nikki Dix
Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL

Zooplankton play a critical role in the ecological function of estuaries, mostly because of their place in the food web. Grazing activities structure the phytoplankton community and affect nutrient cycling. Zooplankton are also the main food source for many recreationally, commercially, and ecologically important fish species. In the Indian River Lagoon, an estuary of national significance, zooplankton are not well-understood. In this postdoctoral research project, zooplankton in the lagoon will be investigated using both observational and experimental methods. For one year, samples will be collected between Vero Beach and Fort Pierce on a monthly basis. The zooplankton community will be characterized microscopically and phytoplankton biomass will be quantified by measuring photosynthetic pigment concentrations. Grazing experiments will also be used to estimate the amount of primary production consumed by zooplankton, as well as how grazing rates change over space and time. Stay tuned…

Hydrological Restoration of Mosquito Impoundments in Mosquito Lagoon

Melinda Donnelly[1], William Greening[2], Linda Walters[1], and Ronald E. Brockmeyer[3], [1]University of Central Florida, Orlando, FL; [2]Volusia County Mosquito Control, New Smyrna Beach; [3]St. Johns River Water Management District, Palatka, FL

In the Indian River Lagoon, approximately 75% of coastal wetlands were impounded since the 1950s by building dikes to control interior water levels for mosquito management. Altering coastal wetland hydrology negatively impacted habitats and associated native flora and fauna. In Mosquito Lagoon, restoration of mosquito impoundments began in the late 1990s by mechanically leveling dikes to wetland elevations. Since 2007, abundance and diversity of plants, fishes, invertebrates, and birds were monitored at five impoundments and two reference marshes to evaluate the effectiveness of hydrological restoration at mosquito impoundments in the Indian River Lagoon. Post-restoration monitoring identified important factors in habitat recovery and provided management recommendations, including: 1) target elevations for promoting natural hydrological properties, 2) natural regeneration following dike leveling, 3) benefits of leaving shoreline vegetation intact to enhance the rate of plant recovery on leveled portion of dike, and 4) importance of abiotic conditions to prevent non-native plant recruitment.

Marine Turtles of the Indian River Lagoon System: History and Current Status

Llewellyn Ehrhart, William Redfoot, and Dean Bagley
University of Central Florida, Orlando, FL

Historically the Indian River Lagoon (IRL) supported an active green turtle (*Chelonia mydas*) fishery that collapsed in the mid 1890s. There is little information regarding other marine turtle species in the lagoon from that era. We began in-water studies of marine turtles in the northern region of the IRL in 1976, shifting operations to the central region in 1982. Our research and that of others has shown the IRL serves as developmental habitat primarily for immature green turtles and loggerheads. The catch-per-unit-effort data at our central region study site has demonstrated a substantial increase in the green turtle population over the past 30 years. This trend has been mirrored in the northern region by cold-stunning records. Recently we have documented an increase in the subadult loggerhead population in the central region as well. Aspects of green turtle feeding ecology and scientifically noteworthy elasmobranch capture records are also recounted.

FL.O.O.R. – Florida Oceanographic Oyster Restoration

Vincent Encomio
Florida Oceanographic Society, Stuart, FL

Oyster restoration has been a major focus of the Florida Oceanographic Society since 2005. Projects include oyster gardening, shell recycling and reef restoration programs. All of FOS' oyster restoration projects are encapsulated under **FL.O.O.R.** (**FL**orida **O**ceanographic **O**yster **R**estoration). Volunteer involvement has been paramount to the program's success and FL.O.O.R. projects will continue to be grass-roots based, involving the community in "restoration from the ground-up". Currently, we are partnering with Martin County in restoring the shoreline along downtown Stuart, creating new oyster reefs and restoring native plants to that area. At present, 366 volunteers have contributed nearly 900 hours to create 14 reefs (~2800 sq. ft) in this area of the St. Lucie River. This project is also part of the Martin County Oyster Restoration Project. We are also expanding FL.O.O.R. to include educational activities to use oyster reef ecology and restoration as a vehicle for science education.

A Two-Step Approach to Sediment Toxicity Testing

Beth Falls[1], Bjorn Tunberg[2], Edith Widder[1], Scott Jones[2], and Jerry Corsaut[1]
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ORCA developed a two-step approach to monitor marine pollution. First, a rapid, inexpensive, broad-spectrum bioassay identifies toxic "hot spots". This approach allows us to test a large number of sediment samples, thus minimizing the possibility of missing an area of high toxicity. Next, sites identified as toxic "hot spots" are analyzed further for specific pollutants by an EPA laboratory. ORCA tested the Microtox® bioassay as the broad-spectrum assay for step one of our monitoring program. We collected sediment samples from eighteen sites in the Indian River Lagoon and St. Lucie Estuary. The sites selected have been monitored for benthic biodiversity by the Benthic Ecology Group of the Smithsonian Marine Station. The Microtox® EC50 from the sediment samples tested were significantly inversely correlated with the benthic abundance, diversity and richness measured in sediment samples taken from the same sites. These findings indicate the Microtox® broad-spectrum toxicity bioassay is a promising method for step one of ORCA's two-step ecotoxicity monitoring program.

Nutrient Enrichment Intensifies Hurricane Damage and Prolongs Recovery in Indian River Lagoon Mangrove Ecosystems

Ilka C. Feller[1], Anne H. Chamberlain[1], Donna J. Devlin[2], Catherine E. Lovelock[3], C. Edward Proffitt[2], and Wilfrid Rodrigez[1]
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Our goal was to quantify the recovery of mangrove forests impacted by Hurricanes Frances and Jeanne that made landfall along the Atlantic coast of Florida in September 2004. We used a long-term fertilization experiment in the Indian River Lagoon (IRL) to investigate the influence of forest structure and nutrient availability on damage and recovery patterns. Our objectives were to determine: 1) levels of disturbance caused by these hurricanes; 2) if damage varied spatially or by species; 3) if nutrient enrichment affected damage or recovery; 4) and how long recovery takes. Leaf area index was used to measure canopy damage and monitor recovery. Most defoliation occurred in the first storm and was higher in the fringe and transition zones than in the dwarf zone. The N-fertilized trees sustained significantly higher damage than controls in all zones and were slower to recover.

Development of Non-Lethal Methods for Health Assessment of Free-Ranging Fish Populations

Carla M. Garreau[1] and Ruth Francis-Floyd[2]
[1]Innovative Health Applications, Kennedy Space Center, FL;[2]University of Florida, Gainesville, FL

Use of non-lethal methods to quantify indices of animal health are important tools used for management of terrestrial and aquatic wildlife. Historically these types of investigations have not been carried out on free-ranging populations of fish. We developed methods of restraint and handling protocols for adult fish that will minimize damage to the animal during sampling. Our protocols include collection of body weight, morphometric data, and collection of blood for stress and sex hormone profiles. Ancillary tests used to define "health" in a population include identification and description of resident microbial or parasite populations on fish, and collection of tissue for parasite analysis. These can be used to develop baseline data in sensitive environmental areas and will enhance our collective ability to make good management decisions and identify trends as these ecosystems are impacted by development, climate change and other natural or human-mediated events.

Seagrass Mapping IS Management of the Indian River Lagoon, FL

Lauren M. Hall and Joel S. Steward
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Seagrass is regarded as critical habitat in the Indian River Lagoon (IRL) by several state and federal resource restoration programs. These programs recognize seagrass mapping as an essential monitoring-management stratagem. Mapping has been done every 2-3 years since 1986 (plus 1943), with 2011 mapping currently underway. Seagrass mapping technologies have evolved with advancements in image acquisition and processing, and improved photo-interpretation software. The uses for seagrass maps have also evolved. In the early years, the focus was on simple trend analysis. Although trend analysis continues, mapping is now being applied toward more specialized spatial analyses as in the use of union coverages of multiple mapping years to establish seagrass depth limits and TMDL targets. Consequently, assessment of management practices, TMDL compliance, as well as the IRL's response to episodic events (e.g., tropical storms, algal blooms) will be dependent on future seagrass mapping.

The Indian River Lagoon Observatory (IRLO): Biodiversity and Ecosystem Function of an Estuary in Transition

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The Indian River Lagoon Observatory is a long-term, multi-disciplinary, ecosystem-based program, designed to address emerging issues of environmental health in the Indian River Lagoon (IRL) system. IRLO seeks to achieve a better understanding of the biodiversity and ecological functions of the IRL and their relationships with human impacts, human health, and ultimately the economy of the IRL region. IRLO will acquire and disseminate new and existing data and knowledge on components of the IRL critical to its ecological function and its sustainable management. To be on the cutting edge of scientific innovation, IRLO will integrate scientific research with innovative technology development. IRLO's researchers will actively develop collaborations with other research institutions, federal and state agencies, not-for-profits, governmental bodies, and other interested parties to integrate IRLO research with existing and future programs and opportunities. The results of this work will be disseminated via scientific publications, conferences, and outreach in the form of websites, public lectures, and media.

Nutrient Pollution in the Indian River Lagoon: Getting at the Sources

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Although nitrogen is the primary nutrient responsible for macroalgal blooms in coastal waters, few studies have attempted to link specific nitrogen sources from the watershed to blooms in the Indian River Lagoon (IRL). In this preliminary, system-wide study: 1) dissolved nutrients are being used to characterize seasonal and spatial variations in near-bottom nutrient concentrations, 2) natural abundances of C:N:P and stable nitrogen isotopes from macroalgal tissue are being used to trace potential sources of biologically available nitrogen during wet and dry seasons, and 3) taxonomic composition and seasonal variability in benthic macroalgae are being quantified through site characterization. The current study addresses fundamental water quality issues and directly ties to overarching restoration goals outlined in IRL planning documents. The ability to fingerprint nutrient sources and reveal nutrient hotspots in the IRL are anticipated to be of value to resource managers and decision makers overseeing policy affecting the IRL.

Foraging Ecology Patterns of the Mosquito Lagoon Juvenile Green Turtle (*Chelonia mydas*) Population from 1978 to Present

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The life history of many marine turtle species includes residency for several years in estuarine habitats. Seagrass beds in the Indian River Lagoon Complex (IRLC) provide foraging resources for juvenile green turtles (*Chelonia mydas*). Mosquito Lagoon is part of the IRLC and is located within federally protected lands. The area has remained relatively pristine and historical data indicate the overall percent cover and composition of seagrasses since the1940's is relatively uniform. In other parts of the world, researchers document high seasonal and annual variation in submerged aquatic vegetation that influence the foraging habits of herbivorous juvenile green turtles. Seagrass percent cover and composition were compared with foraging samples collected from juvenile green turtles between 1978 and present day to determine if turtles in Mosquito Lagoon foraged selectively. Data indicate *H. wrightii* was the most abundant seagrass in; however, juvenile green turtles foraged more frequently on *Syringodium filiforme*.

A Crossroad of Needs – Indian River Lagoon Restoration and East Coast Water Supply

Lewis Hornung, L Hornung Consulting, Inc., Jupiter, FL and Anwar Khan, HDR Engineering, Inc., West Palm Beach, FL.

The discharge of excessive stormwater runoff into Indian River Lagoon (IRL) upsets natural salinity regimes and carries nutrients and sediment that degrade fish and shellfish habitats. At the same time, Martin and St Lucie Counties and areas served by the St Johns River experience frequent water supply shortages. An annual average of 135,000 acre-feet of stormwater is discharged to IRL at Ft. Pierce from the C-25 Canal Basin – harming the lagoon and wasting valuable water. Construction of a reservoir in the C-25 Basin could reduce discharges to the lagoon and St. Lucie Estuary and provide a much needed source of supplemental water supply. Moreover, the reservoir could be constructed and operated through a unique public private partnership that would allow costs to be shared among beneficiaries. Federal cost sharing could be pursued for construction as part of the IRL-South Project, a component of the Comprehensive Everglades Restoration Plan.

It's Your Lagoon

Chuck Jacoby
Indian River Lagoon National Estuary Program and St. Johns River Water Management District, Palatka, FL

The Indian River Lagoon yields significant ecological, economic and social value. Sustainable management of the estuary relies on a sound scientific understanding of this diverse system and its responses to people's actions. Scientists with interests in developing the necessary understanding and translating results from research into successful management need to change their approach in response to recent challenges, especially reduced funding. Such changes are critical to the Indian River Lagoon National Estuary Program as it implements place-based protection and restoration focused on ensuring the integrity of the lagoon's ecosystem. Thus, the program issues a call for stakeholders, including researchers, to join in refocusing and advancing scientific knowledge and related activities within current constraints.

Assessing the Outcome of Small- and Large-Scale Oyster Reef Restoration in the Loxahatchee River Using Baselines Derived from Long-Term Monitoring of Benthic Community Structure at Natural Oyster Reefs

Zachary R. Jud and Craig A. Layman
Florida International University, North Miami, FL

A major concern of oyster reef restoration is understanding how human-made reefs compare to natural reefs over time. We used our long-term monitoring dataset, containing >28,000 benthic organisms, to establish baseline values for natural oyster reef-associated communities in the Loxahatchee River. These baselines allowed us to compare community structure at a series of small- and large-scale restoration reefs (deployed by LRD, TNC, NOAA, and Martin County) to nearby natural reefs. After one year, biomass and abundance of benthic organisms at the restoration reefs were similar to values found at natural reefs. However, community composition still differed between the restored reefs and nearby natural reefs. Multivariate analyses showed that restored reef communities progressively became more similar to natural reef communities over time. Experimentally constructed areas of high vertical relief had significantly greater biomass than flat sections of the reef, suggesting that vertical relief should be an important component of future restorations.

Recent Invasion of the Loxahatchee River Estuary by Lionfish, *Pterois volitans/P. miles*

Zachary R. Jud[1], Craig A. Layman[1], Jessica A. Lee[1], and D. Albrey Arrington[2]
[1]Florida International University, North Miami, FL; [2]Loxahatchee River District, Jupiter, FL

The invasion of lionfish (*Pterois volitans/P. miles*) in the western Atlantic and Caribbean is emerging as a potentially serious ecological problem. Here we identify the first estuarine intrusion of lionfish in their invasive range. Between August 2010 and present, we have killed >300 lionfish in the Loxahatchee River estuary, up to 5.5 km from the ocean. All individuals were found in close association with anthropogenically created habitats (e.g., docks, sea walls, debris), suggesting that human-driven changes in habitat availability may facilitate estuarine invasion. Multiple size classes were documented (23-185 mm SL) and small post-settlement juveniles (< ~40 mm) were collected year round, implying that recruitment was an ongoing process rather than a one-time chance event. Mark/recapture of 55 individuals revealed extremely high site fidelity and rapid growth rates, while stomach content analyses identified a generalist diet. Our findings suggest that portions of the IRL near inlets may be susceptible to lionfish colonization.

Caffeine and Estrone Had No Effect on Fertilization and Development of *Lytechinus variegatus* (Variegated Sea Urchin)

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Pharmaceuticals and hormones from treated and untreated sewage are common in the marine environment, yet little is known about the effect these substances have on the reproduction of marine invertebrates. Here, the effect of caffeine and estrone, two of the most abundant compounds in the South Florida near shore environment, was tested on sea urchin fertilization and development. Gametes from four male-female pairs were introduced in seawater containing one of three naturally occurring concentrations of caffeine (15-60 ng/L) and estrone (1-5 ng/L). The resulting embryos were also reared in seawater with these three concentrations, and after 48 hours the number of normally developed larvae was quantified. Despite concerns of the effect prevalent pharmaceutical and hormones have on marine invertebrates living in the nearshore environment, we did not find a significant effect of caffeine and estrone on the earliest life history stages.

Use of Hyperspectral Data for Improved Mapping of Water Column Chlorophyll and Seagrass Beds

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Remote sensing of submerged plants or phytoplakton is often limited due to the water absorption of Near InfraRed (NIR) and the light scattering from suspended particles. Field and controlled spectral measurements were made over seagrass beds and algal water in order to understand the unique spectral signatures of the algae and seagrass. The spectral features of algal waters include: a maximum green reflectivity between 575-590 nm; a minor inflection at 650 nm probably caused by accessory pigment backscattering; a red absorption near 676 nm; prominent NIR reflectivity at approximately 697 nm; and a minor NIR reflectance peak at 805 nm probably caused by organic substance backscattering. The controlled spectral reflectance positively correlated with turbidity. This information will be used to develop a spectral algorithm for an improved mapping of water column chlorophyll distribution and benthic vegetation of Indian River Lagoon using airborne hyperspectral data.

Prevalence of the Haplosporidian Parasite *Bonamia* in bivalves in Florida's Indian River Lagoon

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In 2007 oysters exposed to Indian River Lagoon (IRL) waters were PCR positive for *Bonamia*. In summer 2010 bivalves were collected from ten locations in the southern IRL and tested for *Bonamia*, by PCR using general (BoF/BoaR) and species specific primers for *B. exitiosa* (CaBon146F/471R) and *B. perspora* (OEBon154F/472R). Positive bivalves were found at 8/10 sites (3-45% prevalence). Two sites (WCC, RB) were revisited in summer 2011 along with new sites in the southern (TC, BP, SLE) and middle IRL (SR, WA, OCA). Preserved *C. virginica* tissues collected fall 2010 from the middle (SR, WA) and southern (WCC, TC, SLE, FPI) IRL were also assayed. All sites surveyed in summer 2011 were positive for *Bonamia* (5-62% prevalence) and 5/6 sites surveyed in fall 2010 were positive (5-48% prevalence). Results indicate a wider geographic range for *Bonamia* exists than has been previously reported and underscores the need for continued monitoring.

Water Quality in the Indian River Lagoon (1996-2011)

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Protecting and maintaining good water quality is a prerequisite for a healthy seagrass ecosystem and is a primary goal of the St. Johns River Water Management District's (SJRWMD) Indian River Lagoon (IRL) program. We present and describe the status and trends of water quality in the IRL system (within the SJRWMD) since 1996, with a focus on nitrogen, phosphorus, salinity, water clarity (K_d, Secchi depth), and the principal light attenuating or optical variables: turbidity, color and chlorophyll *a*. Spatial and temporal gradients in water quality are explained as a function of water residence time and climatic patterns. In northern IRL and Banana River Lagoon, the recent onset of a "superbloom", characterized by unprecedented levels of chlorophyll *a*, nutrients, and light attenuation is described (its investigation is described in a poster by Chamberlain et al.). The state of the estuary relative to preliminary, optical water quality targets is also assessed.

The Creation of Volusia County's Adopt-An-Estuary Program

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The Adopt-An-Estuary (AAE) program was created in 2010 through a partnership between Volusia County Environmental Management and the Volusia County School District. The goals of the program were to collect baseline estuary health data, educate and train schoolchildren and adults to monitor estuaries, increase public awareness about estuarine issues, and provide a website portal for easy access to estuary information and data. Our aim was to help develop environmentally sensitive citizens through AAE training who would be more aware and informed about issues concerning their local environment. Over the course of the 2010-2011 school year, 1,135 students and 61 teachers from 14 Volusia County schools were trained in visual, physical/chemical, and biological monitoring of local estuaries. Through four training workshops, 20 community volunteers were also trained in visual and physical/chemical monitoring. As a result of the workshops, seven sites around Volusia County have been adopted for regular monitoring by volunteers.

Saving History: Stabilizing Turtle Mound with Living Shorelines

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Twelve hundred years of history are being eroded away in Mosquito Lagoon from wind and boat wakes. The Timucuan Native Americans left their mark in Canaveral National Seashore through shell middens, mounds composed of oyster shells, pottery shards and animal remains. Recently CANA wanted to protect Turtle Mound with stabilization techniques that would be natural, while minimizing erosion on the shoreline. Our goal was to create a living shoreline, a type of soft-armoring technique using native flora and fauna to stabilize the shoreline. After 2 years of testing various species and deployment options, 4 species were chosen to armor Turtle Mound's shore: the native eastern oyster *Crassostrea virginica*, cordgrass *Spartina alterniflora*, red mangrove *Rhizophora mangle* and black mangrove *Avicennia germinans*. All restoration took place during May 2011, and included 2,000 oyster mats, 600 *Spartina* plants, 500 mangrove seedlings and over 250 volunteers. The site will be monitored monthly to check for recruitment, survival and shoreline erosion.

Life History Inference from Carcass Recovery in Bottlenose Dolphins (*Tursiops truncatus*) in the Indian River Lagoon, Florida, U.S.

Marilyn Mazzoil[1], Megan K. Stolen[2], Wendy Noke Durden[2], Teresa Mazza[2], Elisabeth Howells[1], M. Elizabeth Murdoch[1], Sarah Rodgers[1] and Greg O'Corry-Crowe[1]
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In studies of cetacean populations, mortality of individuals is assumed but rarely confirmed. The goals of this study were to combine IRL dolphin photo-identification and stranding data and use a novel method to predict mortality and calculate a carcass recovery correction factor. Presumed loss of an individual to the population was estimated using the 99% frequency interval (the number of days within which 99% of re-sights occurred) added to the last sighting date. We predicted 33 marked dolphins (adult/juvenile) to have died: 14 were recovered and 12 decomposed carcasses were also recovered. We applied the marked dorsal fin ratio (62%) to the decomposed carcasses and predicted 7 dolphins were potentially marked, thus 13 dolphins (or 39%) were presumed unrecovered. The recovery correction factor (1.9) significantly increases the minimum estimate of mortality for IRL dolphins (228 vs. 154), and is critical to calculate potential biological removal rates for effective stock management.

Dolphins as Sentinels of Ocean and Human Health – An Overview of the Indian River Lagoon Dolphin Health and Environmental Risk Assessment Project

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Health and environmental risk assessments of dolphins are especially critical in areas where stocks are depleted or show signs of epidemic disease and/or high mortality, and in areas where habitat is altered or impacted by human influences. In 2003, a multi-disciplinary, multi-institutional HERA was initiated in the Indian River Lagoon, Florida (IRL) by Harbor Branch. Since 2003, more than 200 IRL dolphins have been captured, examined, sampled, marked and safely released. Primary research goals include evaluating dolphin health from individual, population and comparative perspectives from different geographic locations; application of classical and novel methods and diagnostic tools to assess anthropogenic and environmental factors that affect dolphin health; and utilization of HERA data to develop predictive models and evaluate conservation and management strategies. This presentation highlights the methods and results of an ongoing effort resulting in more than 60 peer-reviewed publications focused on the health of the IRL resident dolphin population.

17 Years of Seagrass Monitoring in the Indian River Lagoon, FL

Lori J. Morris, Lauren M. Hall and Robert H. Chamberlain
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The seagrass beds in Florida's Indian River Lagoon system have been monitored using two methods – photo-interpretation of aerial photographs every 2-3 years and 100 fixed seagrass transects. Both methods are intended to detect spatial and temporal changes in seagrass depth distribution, abundance, and diversity. Over the past 17 years, the results from the two methods have been mostly complementary, showing positive trends in the seagrass coverage footprint. The mapped seagrass coverage has increased by over 24,000 acres (31%) and the total bed width (transect length) has increased by 80 m (36%), which is concurrent with an increase in seagrass depth limits by 0.3 m (23%). However, other response parameters show inconsistencies with these positive trends. For example, seagrass density (% cover) has declined 33%. This decline has become most evident during the last decade, adding to the challenges of setting area-sensitive seagrass coverage, depth, and density targets.

A Preliminary Study of Group Size and Social Affiliations of Atlantic Bottlenose Dolphins in the St. Lucie River Estuary

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Harbor Branch Oceanographic Institute at Florida Atlantic University, Fort Pierce, FL

The St. Lucie River estuary is a significant dolphin habitat in the IRL, characterized by high levels of anthropogenic and environmental stressors. Photo-identification data were analyzed to determine group characteristics and social affiliations. Group size ranged from 1-27, with an average group size of 5.89. Groups with calves were larger than groups without calves, suggesting that mothers may rely on the assistance of conspecifics in calf-rearing. Coefficients of association for frequently sighted dolphins ranged from 0.27-0.78 and associations were higher within sex classes. Males tended to form exclusive pair bonds; females formed associations with multiple females. Mothers and calves had the strongest associations. Understanding dolphin group and home range structure will help determine population level responses to stressors over time.

Environmental Correlates of Habitat Use by Manatees in the HBOI Channel Using Advanced Technologies

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To assess the impacts of environmental change on marine systems, a more complete understanding of the habitat requirements of key species is required. Assessing habitat and its use typically involves active sampling (e.g., CTD, behavioral observations) for short periods convenient to the sampler and constrained by the technique, its cost and the time required to process the data. Continuous monitoring systems that are cost effective and low impact combined with efficient data processing are needed. We propose to employ the importance of the HBOI channel to manatees and the convenience of the location as a test-bed to develop such a system to: (a) assess manatee habitat and (b) monitor habitat use. The ultimate goal is to develop a system that can be efficiently deployed at other locations and is conducive to engaging the student body and public in data analysis.

Implications of Fine-Scale Regional Differentiation of Stable Isotope and Fatty Acid Signatures of Putative Prey on Interpreting Feeding Habits of Bottlenose Dolphins in the Indian River Lagoon, Florida

Jennifer Fletcher Odom[1], Graham A.J.Worthy[1], and Richard Paperno[2]
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The Indian River Lagoon is a unique closed "bar built" estuary system that has little interchange with the ocean waters. It is split into sub-basins with each having unique biotic and abiotic properties. Three fish species were investigated to determine if they have isotopic and fatty acid signatures distinctive to collection sub-basin. Spotted seatrout (n=40), pinfish (n=60) and white mullet (n=60) were collected at sites 30 km apart in two sub-basins of the IRL. Fish were analyzed for $d^{13}C$ and $d^{15}N$ isotopes and fatty acid composition. There were significant differences in $d^{13}C$ based on sub-basin for both mullet and seatrout. Analysis of each species fatty acid profiles revealed that geographic sub-basin is a significant biochemical variable for all species. The ability to discern fine-scale differences in prey allows for the possibility of better resolution of predator feeding habits and hence a better understanding of both habitat utilization and health impacts.

A Look at Sixteen Years of Mangrove Restoration along the Indian River Lagoon

Jacqueline Owen
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The Indian River Lagoon (IRL) Shoreline Restoration Project (SRP) is a grant funded project focused on the "re-establishment of fringing mangrove habitat along the IRL." During the first ten years of the project 11,719 red mangroves were planted using the Riley Encasement Method, and 800 were planted between 2008-2010 using a three method (mature, multistem, and PVC-encased propagules), three elevation (1.5m increments from mean high water) experimental grid design. Results from these methods showed an overall low survival in plantings. In the spring of 2010 the project further transitioned from strictly planting mangroves along high-energy shorelines to planting saltmarsh vegetation. Research conducted on saltmarsh planting sites suggests the vegetation can quickly stabilize an area and naturally recruit mangroves for long-term shoreline restoration. The IRL SRP's goal remains the same but the method with which restoration is carried out is evolving to examine the whole ecological system.

Assessment of Sebastian River Dredging on Fish

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Fish communities were monitored in the St. Sebastian River to address initial concerns that muck dredging would result in long-term impacts on fish, particularly to tropical peripheral species and rare snook species. Dredging activity in the St. Sebastian River did not appear to have an effect on the overall long-term community structure; however, several species exhibited either declines in abundance (*Evorthodus lyricus* and *Citharichthys spilopterus*), shifts in population structure (*E. lyricus*), or changes in habitat use patterns (*Microphis brachyurus* and *Trinectes maculatus*) between pre-dredge and post-dredge periods. We also detected short-term changes in the faunal community that were unrelated to disturbances from dredging activities. Continued monitoring efforts are required to determine whether the changes seen in individual taxa such as *E. lyricus* and the flatfishes are a result of temporary disturbances that will rebound over time or instead represent permanent changes to the community.

Oyster Colonization and Growth on Created Reefs in the St. Lucie River

Edward Proffitt and Elizabeth Salewski
Florida Atlantic University at Harbor Branch Oceanographic Institute, Fort Pierce, FL

Oysters colonized and grew on created reefs at different rates depending on location in the SLR. Sediment elevation table analysis indicated that reef development can keep up with subsidence and sedimentation at some sites. Alternative models linking oysters to water quality were data from DBHYDRO and geographic features were tested using structural equation modeling (SEM). SEM is a data analysis methodology that allows testing of multivariate models for "fit" to the data. From September 2009 - July 2011 low rainfall and canal discharge were the norm. Hence salinity was not as important a factor as it likely will be in wet years when salinities can be <5 psu in much of the estuary for extended points in time. Results of alternative models will be presented and discussed.

Biodiversity within the *Oculina* Coral Habitat in the Region of the Indian River Lagoon

John Reed
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Oculina varicosa is a dominant hard coral within and offshore the Indian River Lagoon. The offshore *Oculina* reefs provide essential fish habitat for important fisheries species such as scamp and gag grouper; juveniles use grassbeds and mangroves within the lagoon and then move offshore to the deep reefs when they are sexually mature. The biodiversity of the faunal community associated within colonies of *Oculina* was analyzed over one year at four reef sites offshore the IRL. A total of 42 corals samples yielded 2,300 decapods in 50 species; molluscs- 5,132 individuals and 230 species, including 153 gastropods and 68 bivalves. In 1984, the *Oculina* Habitat Area of Particular Concern (OHAPC) was designated by NOAA to protect the coral from mechanically destructive fishing activities. This was the first marine protected area in the U.S. for the conservation of deep water coral. In 2000, the OHAPC was further expanded to 300 nm^2.

Macroinvertebrate Community Development on Restored Oyster Reefs in the St. Lucie Estuary, Florida

Elizabeth Salewski and C. Edward Proffitt
Florida Atlantic University at Harbor Branch Oceanographic Institute, Fort Pierce, FL

Understanding changes in community structure is critical to evaluate restoration success. Colonization of sessile and motile invertebrate species was recorded on the created oyster reefs 3 weeks after installation; and species richness increased from 5 to 18 species within 5 months. The reduced salinity resulting from the 2010 Lake Okeechobee releases did not have a significant effect on oyster survival, but may have resulted in a shift in dominant invertebrate species. We used a 2 x 2 factorial experimental design to elucidate the separate and combined effects of topographic relief and architectural complexity of the restored reefs on the development of the invertebrate community. Topographic relief had the largest effect on the colonizing sessile community overall with *Balanus* and ascidean species dominating the community. Relief and complexity, although separately significant, were not independent of one another for most sessile species observed; however, complexity remained independent from relief for non-oyster bivalves.

An Integrated Approach to the Study of Mercury in the Indian River Lagoon: Dolphins, Fish, and Humans

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Previous research has described elevated levels of mercury in skin and blood from bottlenose dolphins inhabiting the Indian River Lagoon. Mercury biomagnifies in the food chain; therefore, dolphins serve as sentinels for environmental and public health. We assessed mercury exposure through fish consumption by sampling common dolphin prey species. Of the 904 fish sampled, *Lagodon rhomboides* (0.07 ppm $\pm$ 0.03) and *Bairdiella chrysoura* (0.20 ppm $\pm$ 0.09) had the highest mean total mercury concentrations observed. There were positive relationships between trophic position and mercury concentration. Human exposure to mercury among individuals living near and utilizing the lagoon was assessed using hair sampling and fish consumption surveys. Forty two percent of human participants had mercury levels >1 ppm, with a mean concentration of 1.5 ppm (n=59; range= 0.04-16.18 ppm). Associations between mercury levels and fish consumption were also observed. The findings demonstrate a need for regionally specific human exposure estimates.

Quantitative Assessment of Seagrass Scarring in Southern Mosquito Lagoon and Northern Indian River, East Central Florida.

Ron Schaub, Douglas M. Scheidt, Carla M. Garreau, and Carlton R. Hall. Innovative Health Applications, Kennedy Space Center, FL

Previous assessments of seagrass prop scarring follow the Sargent et al (1995) technique of drawing polygons around scarred regions to define three broad categories of scar density. The technique applied during this assessment includes the digitizing of individual scars and fusing the scars with one acre virtual sampling plots where scar density is calculated as the percentage of scarred seagrass within each virtual plot. Approximately a third of all virtual plots contained scarring and a total of 476,945 m of scar were identified. Most scars (84%) were categorized as low severity with little substrate exposure. This investigation found less scarring than reported by Sargent et al. (1995), with a maximum scar density of 7.9%. This technique provides a high fidelity scar map and eliminates the subjectivity of determining the polygonal bounds of different scar severity classes, thereby providing a more reproducible means of quantifying scars.

Environmental and Recreational Enhancement of SL-3, a Spoil Island in St. Lucie County

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Spoil Island SL3 is owned by the state, classified for recreation, and managed by the FDEP Indian River Lagoon Aquatic Preserves program. It was identified by St. Lucie County as a significant mosquito breeding site because of its isolated interior wetland. Exotic Brazilian peppers (*Schinus terebinthifolius*) and Australian pines (*Casuarina equisetifolia*) had overgrown almost the whole island, including trails, campsites, and shoreline. Grant funding for large-scale enhancement was obtained through federal and state partnerships. During March-October 2010, exotic species were completely removed, native species were planted, and a stabilized swale (with crossover bridge) was constructed to reconnect the wetland to the Indian River Lagoon. During the following year, some plant replacement and swale depth adjustment were needed, but now essentially all of the added plants are thriving, and the swale is effectively exchanging water to the high marsh during higher tides. Continued volunteer efforts ensure exotic plant suppression, campsite and boardwalk maintenance, and swale functionality.

Interacting Effects of Sea Level Rise, Nitrogen Enrichment and Competition in the Mangrove-Salt Marsh Community

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Understanding how coastal ecotonal communities will respond to sea level rise and other interacting global change factors is critical in forecasting species distributions and associated ecosystem services. Individual species responses to sea level rise and nutrient eutrophication may be further modified by interspecific competition thus translating into changes in plant community structure and function. We investigated the response of *Rhizophora* mangle seedlings in competition with *Spartina alterniflora* using a marsh-mangrove organ. The organ allowed us to simultaneously manipulate sea level rise and nitrogen enrichment on species assemblages during the summer of 2010 in the Indian River Lagoon. Increased nitrogen and inundation decreased *Rhizophora mangle* seedling growth and productivity as compared to controls. However, plants growing under competitive conditions were 64% shorter than control plants. Preliminary data from 2011 organs suggest that increased nitrogen, inundation and competition with *Spartina* decrease growth of *Avicennia germinans*. Our findings suggest that nitrogen pollution may exacerbate coastal ecosystem resilience to sea level rise.

The Effects of Temperature on the Feeding Kinematics and Behavior in Two Trophically Distinct Species of Invasive Fishes: The Specialist *Belonesox belizanus* and the Generalist *Cichlasoma urophthalmus*

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Invasive fishes have the ability to adapt to environmental conditions in the invaded ecosystem and utilize resources that may have been absent in their native ecosystem. *Belonesox belizanus* and *Cichlasoma urophthalmus* are both invasive fishes in Florida. Ecomorphological studies conclude that *C. urophthalmus* is a trophic generalist while *B. belizanus* is a trophic specialist. The current Florida distribution of these species suggests that *C. urophthalmus* spreads northerly into the colder regions of Florida at a faster rate. This study was designed to test the hypothesis that the prey-capture kinematics and behavior differ between both invasive fish species at a given temperature and also vary for each species across temperatures. Analysis of variance revealed that (1) excursion and timing variables differed between species and (2) the kinematics of prey-capture did not vary across temperatures in both species.

This interspecific comparison suggests that both species have the same temperature tolerance and that any difference in their rate of spread across Florida may be driven by factors other than species-specific physiological tolerance to temperature.

Ecology of Harmful Cyanobacterial Blooms (*Lyngbya* spp.) in the Indian River Lagoon

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Benthic cyanobacteria (blue-green algae) are becoming increasingly abundant in many coastal habitats including the Indian River Lagoon (IRL). They produce natural products that can deter feeding by generalist herbivores and may play a role in competitive interactions. Many species of *Lyngbya*, *Oscillatoria*, *Phormidium* and *Symploca* occur regularly throughout Florida, especially during the summer months, and these have yielded a diversity of natural products. We have sampled *Lyngbya* spp. in the IRL for the past six years, and in the summers of 2008 and 2011 we quantified the abundance of these cyanobacteria in the IRL near Fort Pierce, FL, over the course of the summer. The abundance of *Lyngbya* spp. was highly variable at different sites throughout the summer, ranging from 0-100% cover. Several different species were common and occasionally formed blooms on seagrass and sediments, and they produced a variety of natural products. The majority of the species collected produced compounds that had herbivore deterrent and/or antifungal activity.

Community Development of an Intertidal Wetland Created from a Restored Spoil Island

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Interactions among species and with the physical environment are key to community formation. The Indian River Lagoon uniquely overlaps temperate and sub-tropical climates, where interactions depend on the interplay of dominant temperate salt marsh and sub-tropical/tropical mangrove species interactions and relative colonization and growth rates. At a restoration site in the Indian River Lagoon, we have monitored colonization and growth of the salt marsh grass *Spartina alterniflora* and three mangrove species (*Avicennia germinans, Laguncularia racemosa,* and *Rhizophora mangle)* as it relates to the construction of the island. Early *S. alterniflora* seedling colonization was dependent on the formation of tidal channels. Early mangrove colonization was dependent on *S. alterniflora* presence and varied between competitive/facilitative over an elevation gradient.

Salinity Tolerance of Juvenile Sunray Venus Clams, *Macrocallista nimbosa*

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Florida's bivalve aquaculture industry is based on a single species; the hard clam *Mercenaria mercenaria*. The industry's economic growth may increase through utilization of other species. The sunray venus clam (SRV), *Macrocallista nimbosa*, is a potential candidate and native to Florida. As climate change may bring on greater salinity variation through storms and droughts, the natural salinity tolerance of this species was examined. Ten juvenile SRV (avg shell length 35.8 mm and total weight 6.6 g) acclimated at 24 ppt were each placed in triplicate 15L containers of 16, 24, 32, and 40 ppt saltwater and observed for mortality over 28 days. Average mortality was greatest in the 40 ppt treatment (30%) and least in the 16 and 24 ppt treatments (0%). SRV tolerated upwards of 16 ppt change, which is a good characteristic for culturing in areas that may experience sudden or drastic salinity changes from storms or droughts.

The High Variability of Seagrass Biomass Makes Prediction Difficult

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Monospecific (initially) beds of *Halodule wrightii*, *Syringodium filiforme*, and *Thalassia testudinum* have been monitored since 1983. Above-ground biomass was sampled summer and winter by harvesting haphazardly tossed 0.1-m^2 quadrats (n = 6, 8, and 4 in the three species, respectively). Despite the continued persistence of the 3 species in their 3 plots, mean biomass of all 3 species has varied by at least an order of magnitude. Each species has had periods when biomass was high, and each species has had crashes, not always simultaneous. This high variability makes prediction difficult, such as recovery from the recent "superbloom."

Estuarine Impacts on St. Lucie Reef: Determining the Effects of Changing Resource Management on Florida's Northernmost Coral Reef

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Development of sound management strategies is critical for conserving coral reef communities, particular in nearshore systems subject to elevated human impacts. St. Lucie Reef is strongly influenced by freshwater discharges from the Indian River Lagoon and its expanded watershed. During the wet season, freshwater discharge persists for days, weeks, or months over the reef. For the dominant hard corals, *Montastraea cavernosa* and *Diploria clivosa*, relative health was quantified using coral stress gene expression microarrays, and 16S rRNA-based bacterial community profiling of coral mucus. *M. cavernosa* exhibited variable expression of genes related to xenobiotics, pesticides, decreased salinity, and symbiosis regulations. Mucus associated bacterial communities on *D. clivosa* were dominated by alpha- and gamma-proteobacteria, differed significantly over time, and differed from the communities found in other Caribbean regions. Ongoing work will assess coral health and benthic community responses to changing watershed management and water quality resulting from the Comprehensive Everglades Restoration Plan.

Water Quality Monitoring with the ORCA Kilroy Network

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Ecosystem-based management requires marine monitoring in real time with high temporal frequency and high spatial density. It also requires sensors that can provide direct measurements of biological processes and the means to track water movement and evaluate water quality. ORCA has designed the ORCA Kilroy Network, an observatory designed as a whole system down to the sensors at the component level. The ORCA Network consists of a wireless network of remote semiautonomous marine sensor systems, and a central supervisory system that directs operations of the remote systems, collects data, and relays that via the Internet through a standard SOAP web service interface to a geospatial database. Remote subsystems of the ORCA Kilroy network have been deployed in the Indian River Lagoon, Florida Keys and Chesapeake Bay. Each is designed to take advantage of a shared power and communications infrastructure, and is integrated at the component level to lower cost, reduce size, and improve efficiency.

Nitrate Removal from Contaminated Surface Water Using a Microbial-based Bioremediation System

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This study evaluated the potential use of flow-through bioreactors for their nitrate-remediation ability. Duplicate bioreactors were constructed at a local foliage plant nursery. Each bioreactor consisted of four 242 L tanks with connections alternating between bottom and top. Each tank was filled with 113 L of Kaldness media to provide surface area for attachment of native microflora. Molasses was supplied as a carbon source for denitrification and water flow rates through the systems were 5.4 or 18 L/min during tests. Composite water samples were collected every 15 minutes from both the inflow and the exit water. Results indicate consistent removal of greater than 95% of the nitrate flowing into the systems. Accumulation of ammoniacal and nitrite nitrogen did not occur; indicating that the nitrate-nitrogen was removed from the water, and not simply transformed into another water-soluble species. These systems may be useful for helping meet stringent nitrogen water quality regulations.

Contamination of Surface Water within Residential-use Areas with Fipronil, Fipronil Sulfide, and Fipronil Sulfone

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The phenylpyrazole pesticide fipronil has been increasingly used for pest control in residential landscapes. The presence of fipronil and its metabolites in surface water has attracted public attention due to their potential risks to ecosystem and human health. Surface water samples were collected from five canals and three stormwater retention ponds and analyzed by GC-ECD weekly from September 2008 to July 2010. Fipronil and fipronil sulfone were detected in 3.1% and 1.0-5.2% of the samples collected from three of the canals, and in 33-45% and 78-81% of samples collected in two of the ponds, with concentrations ranging from 0.5-210.6 and 0.5-77.1 ng L^{-1}, respectively. Fipronil sulfide was detected in 16-46% of the samples from the two ponds and in 1-2% from the other sites, at concentrations ranging from 0.4-26.9 ng/L. Contamination appears to be significantly influenced by irrigation management, as well as by rainfall/stormwater runoff events.

An Introduction to the Florida Atlantic Coast Telemetry (FACT) Array

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The development of low cost and scalable autonomous acoustic telemetry systems now allows the movements of aquatic animals to be resolved over large geographic areas and extended time periods. The Florida Atlantic Coast Telemetry (FACT) Array, a collaboration of several marine research programs operating in Florida, has grown into one of the largest acoustic arrays in the world. Spanning 300 km of the Florida east coast, the FACT Array consists of over 200 autonomous receivers deployed along a continuum of habitats from freshwater rivers to offshore reefs. The FACT Array has proven itself well-suited for evaluating site fidelity, seasonal migration patterns, and reproductive strategies of nearly two

dozen of Florida's most valuable coastal sportfish, sharks, and marine turtles, providing insights which have already helped guide management decisions. FACT has enhanced communication among partner groups, spurring additional collaborative fish life history studies which otherwise would have been logistically and financially prohibitive.

The Effect of Invasive *Perna viridis* and *Megabalanus coccopoma* on Settlement of Larvae of *Crassostrea virginica*

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Within the past twelve years, *Perna viridis* and *Megabalanus coccopoma* were introduced into Florida waters. Little is known how *Perna viridis* and *Megabalanus coccopoma* interact with the native eastern oyster *C. virginica* in the novel range. *Crassostrea virginica* is a keystone species that provides great ecological services and economic benefits. A manipulative experiment was designed to test the effects of *Perna viridis* and *Megabalanus coccopoma* on the settlement on larvae of *C. virginica*. Our results indicate that *C. virginica* larvae settlement were significantly reduced in tanks with *P. viridis* and *M. coccopoma* when compared to tanks with just *C. virginica* shells (Random block ANOVA, $P = 0.0007$). This data shows that *Perna viridis* and *Megabalanus coccopoma* are species of concern.

Seasonal Changes in Water Quality and Fouling Communities at a Static Immersion Site on the Indian River Lagoon, Florida

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Water quality and fouling settlement have been monitored at a static immersion test site since January 2006, as part of a study that examines the biofouling performance of different materials. Water quality data were recorded using a YSI Sonde. Measurements included temperature, conductivity, salinity, pH, turbidity, dissolved oxygen, chlorophyll a, and blue green algae. Microfouling samples were collected every two weeks from PVC panels and were largely composed of fouling diatoms, especially the following taxa: *Achnanthes*, *Amphora*, *Bacillaria*, *Cocconeis*, *Cylindrotheca*, *Melosira*, *Navicula*, and *Nitzschia*. An additional set of PVC panels were visually inspected every 30, 60, and 90 days for macrofouling settlement and succession. Barnacles, tubeworms, arborescent bryozoans, encrusting bryozoans, tunicates, sponges, and hydroids were common throughout the sampling period. A better understanding of the fouling dynamics and the influence of the surrounding water quality is important for both biofouling research and the ecological assessment of the Indian River Lagoon.

Passive Acoustics as a Monitoring Tool for Evaluating Oyster Reef Restoration

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Passive acoustics uses naturally occurring sounds produced by marine organisms to study their behavior, biology, and location. Ambient marine sounds are known to vary from place to place, and these sounds can be used to detect differences in habitats. Oyster toadfish, naked goby, mud crabs, and snapping shrimps inhabit oyster reefs, and they are known to produce sounds. Restored and natural reefs were recorded for 5-minutes using a hydrophone. Acoustic signatures were compared using spectra (frequency (Hz) vs. intensity (dB)) overlays. Results showed that shortly after restoration, acoustic signatures from the natural and restored reefs differed. Passive acoustics has the potential to provide a new methodology to rapidly monitor oyster reefs and other ecosystems, such as coral reefs and rocky reefs.