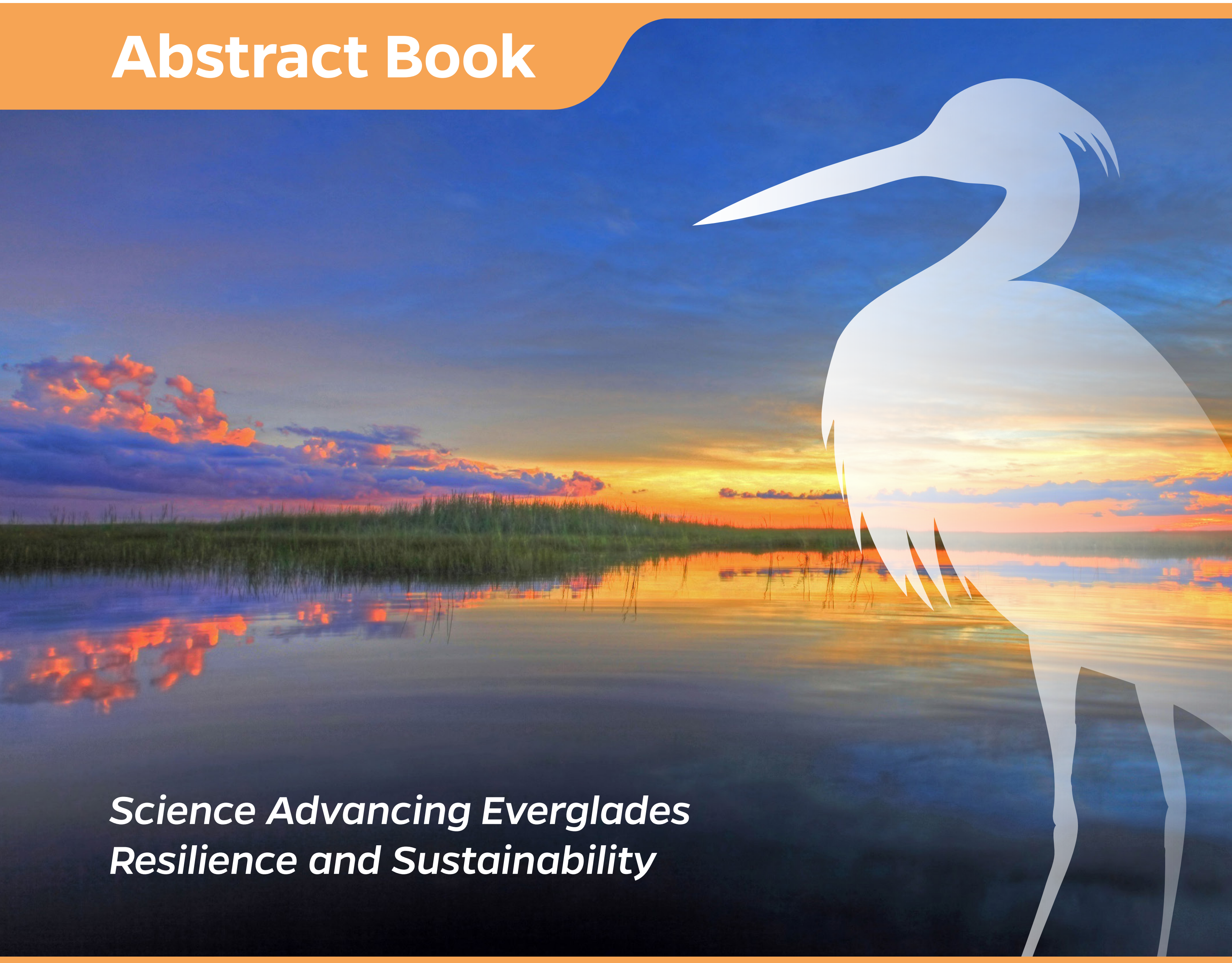
GEER 2019

Greater Everglades Ecosystem Restoration

Abstract Book



Science Advancing Everglades Resilience and Sustainability

April 22-25, 2019

Coral Springs, Florida

South Florida Water Management District

USGS science for a changing world

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GEER 2019

Greater Everglades Ecosystem Restoration

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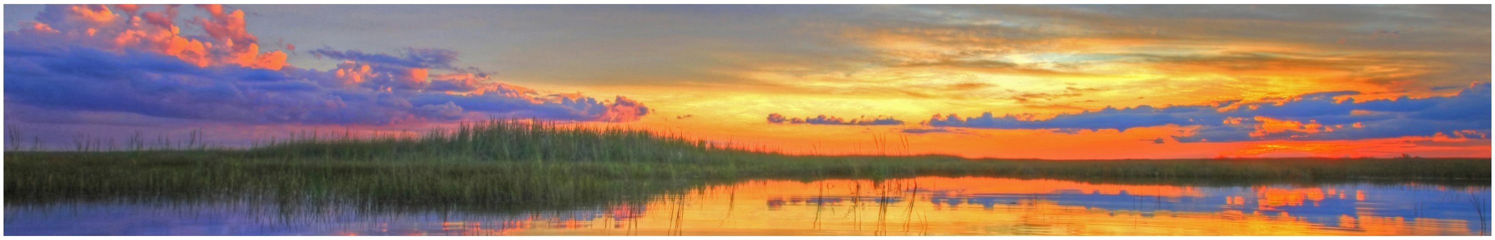


MEETING LOCATOR

Registration & A/V Download
Grand Floridian Foyer

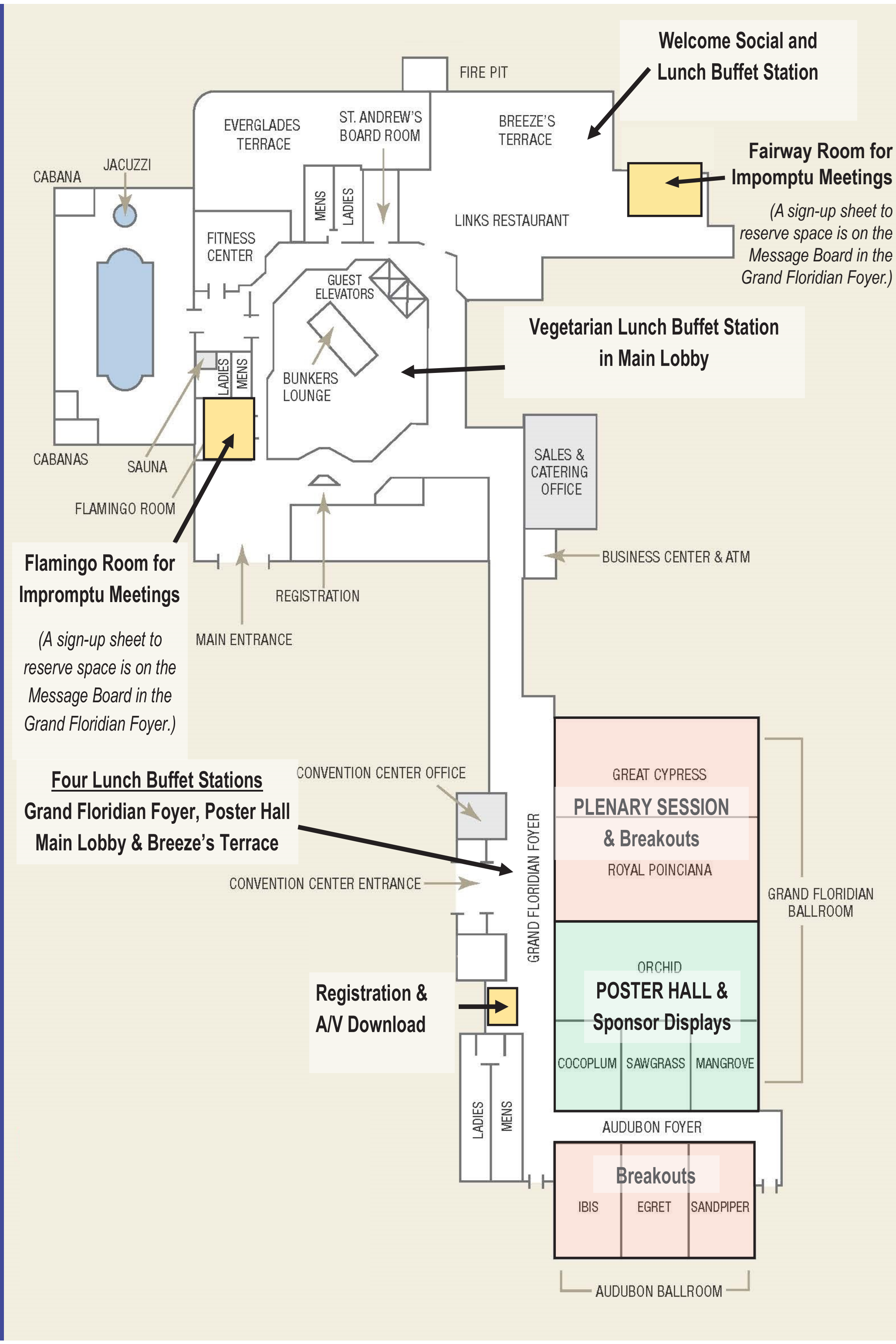
Plenary Session
Great Cypress &
Royal Poinciana

Breakout Sessions
Great Cypress
Royal Poinciana
Ibis
Egret
Sandpiper

Posters, Sponsor Displays & Refreshments
Orchid, Cocoplum,
Sawgrass & Mangrove

Lunch Buffet Locations
Poster Hall
Ballroom Foyer
Breeze's Terrace
Main Lobby *(vegetarian station)*

Impromptu Meetings
Flamingo Room
Fairway Room



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Greater Everglades Ecosystem Restoration

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In Honor of

Paul Anthony Conrads

(1957 – 2017)

A celebration of the contributions of an inspiring member of the restoration community...

Paul Conrads, 60, passed away suddenly on December 2, 2017. For the past 30 years, Paul Conrads worked with the U.S. Geological Survey in the South Atlantic Water Science Center in a variety of activities. He served as the Surface-Water Specialist in South Carolina. Principally, he was responsible for data collection, data analysis, and hydrodynamic and water-quality model applications, and Total Maximum Daily Load (TMDL) development. He assisted many water utilities, state agencies, universities and non-profits in making science-based decisions in water-resource management. He was on the cutting edge of science with regard to “big data” and data mining. He was one of the pioneers of Artificial Neural Networks, a science that utilized the real-time data of the USGS with a means to understand the effects of drought, which are challenging to quantify adjacent to the ocean. His work in this field was recognized internationally.

Paul also developed models for the majority of the river systems in South Carolina, provided technical assistance to U.S. Environmental Protection Agency (USEPA) Region IV TMDL Program and was a member of the Federal Technical Review Team of the development of the hydrodynamic and water-quality models developed for the Savannah Harbor Expansion Project. For the past 11 years, he worked on various projects in the Florida Everglades. He studied coastal drought and the influence of increased salinity stress on the structure and function of ecological habitats, and had recently developed a unique coastal drought index using salinity data.

Paul grew up in suburban Washington, D.C. and received a degree in History and American Studies from Connecticut College. He attended Landon School, Connecticut College. He was a huge Gamecock supporter in all sports and an avid follower of the Baltimore Orioles and the Washington Redskins. He was also a Peace Corps volunteer and spent two years in West Africa building potable water supply and sanitation systems in the neighborhoods of the capitol city of Liberia. After returning to the US, he earned an undergraduate and Master’s degrees in Civil Engineering at the University of South Carolina.

Paul loved his work but also his fishing, gardening, cooking and anything new he could conquer. As one colleague wrote, “Paul was truly special in a way that very few people are. It was easy to love him — his zest for life, his intelligence, his endless willingness to help, his love of good food and wine, his mischievous way and so much more. *I can honestly say that I know no one who compares to his integrity of spirit.*”

GEER conferences will not be the same without Paul being there. He will be sorely missed.

About GEER

Greater Everglades Science continues to be a foundation element for Everglades restoration and management. Building on the successful GEER conferences in 2017, 2015 and before, GEER 2019 will address the most pressing and complex science issues that we face now and into the future of restoration – a future that includes uncertain climate patterns, threats from invasive species, altered hydrology, development pressure, and degraded water quality.

High-quality science has supported new restoration projects underway, or soon to be underway, including:

- assessment of how a degraded Everglades will respond to restored sheet flow
- examining the ecological effects of Hurricane Irma on the Everglades and coastal environments
- how we should deal with invasive species, both those recently introduced and those long-established
- and the ongoing balance between restoration goals and endangered species protection

Sound science relevant to these challenges and the restoration efforts is required to provide resource managers and policy-makers with the best information possible. GEER 2019 will continue its legacy of providing a valuable forum for scientists and engineers to showcase and communicate the latest scientific developments, and to facilitate information exchange that builds shared understanding among federal, state, local, and tribal scientists and decision-makers, academia, non-governmental organizations, the private sector, and private citizens.

The conference organizers have worked hard to provide an excellent location and conference venue, cutting-edge plenary and contributed sessions, and opportunities for valuable interaction – all while minimizing travel, lodging, and meeting costs.

Thank you for joining us and participating in GEER 2019's dialogue to better understand and inform Everglades restoration!

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GEER 2019

Greater Everglades Ecosystem Restoration

Science Advancing Everglades Resilience and Sustainability

Welcome back to Coral Springs for GEER 2019 - the Greater Everglades Ecosystem Restoration (GEER) Science Conference. Initiated by the University of Florida-IFAS and the U.S. Geological Survey, GEER has become the preeminent Everglades science conference. The GEER 2019 theme is "*Science Advancing Everglades Resilience and Sustainability*," highlighting the importance of integrating resilience and sustainability into Everglades restoration.

Resilience and sustainability allows the Everglades to rebound from tropical storm impacts, such as those caused by Hurricane Irma, and from other natural and human-caused stressors and threats. GEER showcases the science behind recent advances in restoration that promote ecosystem resilience and sustainability, along with how we respond to significant restoration challenges: altered hydrology, degraded water quality, invasions by non-native plants and animals, human development placing pressure on our remaining natural systems, and climate change.

Even with hurdles that Mother Nature and humans provide, we have achieved major restoration and science advancements since GEER 2017. Significant progress has been made in the ongoing restoration of the Kissimmee River and Picayune strand. Planning is well underway for the Lake Okeechobee Watershed Restoration Project, the Western Everglades Restoration Project, and Loxahatchee River Watershed Restoration. The rehabilitation of the Herbert Hoover Dike around Lake Okeechobee is continuing and has been accelerated. Efforts to provide additional water storage are moving forward, including construction on the C-43 and C-44 Reservoirs to the west and east, and planning for the EAA Reservoir to the south. The SFWMD's Restoration Strategies program is creating more than 6,500 acres of new STAs and 116,000 acre-feet of additional water storage. Major projects by all involved in Everglades restoration are underway or completed to study the impacts of Hurricane Irma. Efforts to control, contain, and eradicate invasive plants and animals continue, as well as focused scientific studies to improve our ability to detect and remove these non-native species. As was the case in 2016, high rainfall in 2017 and 2018 allowed water managers to use new infrastructure to move record amounts of water into Everglades National Park.

Attended by scientists, engineers, managers, and regulators, GEER gives us an opportunity to showcase and communicate the latest scientific developments, and to facilitate information exchange that builds shared understanding among federal, state, local, and tribal scientists, as well as decision-makers, academia, nongovernmental organizations, the private sector, and private citizens. In addition to three preconference workshops on science communication, the program agenda features five concurrent sessions with 225 oral presentations, two evening poster sessions highlighting 85 posters on Tuesday and Wednesday and three plenary sessions plus a closing keynote address on Thursday.

For the Opening Plenary Tuesday morning, once again, we bring you DIG TALKS – presentations on "Design, Innovation, and Governance (DIG): Solutions for Everglades Restoration." The DIG session consists of Ted-style presentations by six speakers, each delivering thoughtful and provocative Everglades-focused and science-centric talks.

In keeping with our recent practice to engage young emerging scientists and youth, the Wednesday morning plenary focuses on young people working to become scientists and stewards of the environment. The session will consist of three segments: Part 1) the intersection of science and film through the eyes of

“ GEER gives us an opportunity to showcase and communicate the latest scientific developments, and to facilitate information exchange that builds shared understanding... ”

our youth; Part 2) young marine explorers featuring Bahamian youth; and Part 3) lightning talks on Everglades resilience and sustainability topics by three talented university undergraduates.

The Thursday morning plenary features two resilience and sustainability presentations. Dr. Temilola (Lola) Fatoyinbo-Agueh of NASA will talk about gradients in mangrove forest structure and their relationship to climate, geomorphology and human influence. Dr. Karl Havens of Florida Sea Grant will talk about blooms, nutrients and climate change, and what’s in the future for Florida lakes and estuaries.

We will wrap up at the end of the day on Thursday with a final Closing Plenary on the role of science. Dr. Jack Payne, Senior VP of Agriculture and Natural Resources at the University of Florida/IFAS, will talk about science at the intersection of agriculture and natural resources, followed by a presentation by Mr. Chauncey Goss, the newly elected Chair of the South Florida Water Management District, Governing Board.

We encourage you to stay until the very end. You won’t want to miss the closing plenary!

It takes the effort of many to make a conference of this scope and size come to fruition. We wish to thank the members of the Program Committee and Dedicated Session Organizers who spent considerable time developing the GEER scientific program, seeking individuals to speak, organizing individually submitted abstracts, and providing overall guidance to the conference. We also appreciate the time and effort of those who submitted abstracts for posters and talks, building presentations to share their work. We appreciate your commitment to GEER, and thank each and every one of you for making time in your schedule to be here, and for using GEER as a tool to network and engage with colleagues.

We also would like to express our deepest appreciation to our valued sponsors. Without their generosity and financial support, it would be impossible to have a conference of this caliber. Please join us in thanking our Gold Level Sponsors, the South Florida Water Management District, the U.S. Geological Survey, and the University of Florida/IFAS; our Silver Sponsors, Ecology and Environment, Inc., Florida Sea Grant, and the U.S. Department of Interior; our Bronze Sponsors including AECOM, Audubon, DHI, Eureka Water Probes, the Everglades Foundation, Everglades Wetland Research Park; Florida Atlantic University’s Center for Environmental Studies, Florida International University’s Institute of Water and Environment, In-Situ, and the US Army Corps of Engineers-Jacksonville District; and Friends of GEER, the Arthur R. Marshall Loxahatchee National Wildlife Refuge.

Last but not least, join us in thanking the UF/IFAS Office of Conferences and Institutes (OCI) for its diligence and superb management of conference logistics and details. Visit their web site at conference.ifas.ufl.edu to meet the team working tirelessly to make this and many other educational and scientific conferences possible. The exceptional quality of their work is why GEER is a much-anticipated feature in south Florida's science community.

We trust you will take advantage of every opportunity to view all of the posters, visit with exhibiting sponsors, attend program sessions, and step outside your comfort zone to make new connections. As Conference Co-Chairs and on behalf of the Program Committee and the Executive Committee, we welcome you to GEER 2019. ***We're glad you could join us!***

Nick Aumen
Regional Science Advisor - South Florida
Center for Collaborative Research
U.S. Geological Survey

K. Ramesh Reddy
Graduate Research Professor
Soil and Water Sciences Department
University of Florida/IFAS

Committee Recognition

Executive Committee

Nick Aumen, *Conference Chair*, U.S. Geological Survey, Davie, FL

K. Ramesh Reddy, *Conference Co-Chair*, University of Florida/IFAS, Gainesville, FL

Amy Castaneda, Miccosukee Tribe of Indians of Florida, Miami, FL

James Erskine, Florida Fish and Wildlife Conservation Commission, West Palm Beach, FL

Evelyn Gaiser, Florida International University, Miami, FL

Matt Harwell, Environmental Protection Agency, Gulf Breeze, FL

Bob Johnson, Everglades National Park, Homestead, FL

Rolf Olson, A.R.M. Loxahatchee National Wildlife Refuge, Boynton Beach, FL

Colin Polsky, Florida Atlantic University, Davie, FL

Bob Progulske, U.S. Fish and Wildlife Service, Vero Beach, FL

Pedro Ramos, Everglades National Park, Homestead, FL

Lt. Col. Jennifer Reynolds, U.S. Army Corps of Engineers, West Palm Beach, FL

Tom Van Lent, Everglades Foundation, Palmetto Bay, FL

Larry Williams, U.S. Fish and Wildlife Service, Vero Beach, FL

Program Committee

Nick Aumen, *Conference Chair*, U.S. Geological Survey, Davie, FL

Steve Davis, Everglades Foundation, Palmetto Bay, FL

Gretchen Ehlinger, U.S. Army Corps of Engineers, Jacksonville, FL

Dale Gawlik, Florida Atlantic University, Boca Raton, FL

Melissa Martin, USDA, Natural Resource Conservation Service, Washington DC, Boynton Beach, FL

Beth Miller-Tipton, *Conference Coordinator*, University of Florida/IFAS, Gainesville, FL

K. Ramesh Reddy, *Conference Co-Chair*, University of Florida/IFAS, Gainesville, FL

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In-Situ
United States Army Corps of Engineers

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Abstract Compilation

Abstracts are sorted alphabetical by presenting author's last name. Presenting author names appear in **bold**.

HURRICANE IRMA IMPACT ON SOUTH FLORIDA WATER MANAGEMENT SYSTEM AND STORM SURGE

Wossenu Abtew
Water and Environment Consulting, Boynton Beach, FL, USA

The 2017 hurricane season was an active year with landfalls from the Caribbean islands to the U.S. mainland with destruction and losses of life recorded. There were 17 named storms with 10 hurricanes, 6 reaching major hurricane category, and 7 tropical storms. It developed around 16^{o} N latitude and 28^{o} W longitude near the Cape Verde Islands on August 30, 2017, and later intensified to a Category 5 hurricane. It caused catastrophic damage to Barbuda and the Virgin Islands before impacting Cuba and making landfall in the Florida Keys on September 10, 2017, as a Category 4 storm. Hurricane Irma caused catastrophic damage before crossing the Florida peninsula for a second landfall in the U.S. near Marco Island as a Category 3 hurricane. It moved north along the west coast of Florida into southern Georgia causing impact on south Florida and further north.

Wind speed measurements do not seem to be consistent as several National Weather Service gauges were damaged and unstandardized reading of wind speed observations were reported. Wind speed measurement is dependent on height of measurement, frequency of sampling, time span of averaging and site characteristics. As high as 263 kph gust speed has been reported at Naples and generally South Florida Water Management District gauges inland reported gust speeds of 111 kph to 179 kph.

Storm surge was experienced along the coasts of south Florida on September 10, 2017 when Hurricane Irma was passing. USGS tide sensor at Matheson Park in Miami registered a mean high-water level of 1.71 m. Maximum above ground levels for portions of Miami-Dade County was 1.22 to 1.83 m. Out of thirty-three storm surge gauges of the Everglades National Park Marine Monitoring Network located in Florida Bay and southwest coast of the park, 19 recorded storm surges from Hurricane Irma at various levels of gauge performance. Storm surge was registered between 0.3 m and 2.1 m. Generally, the lower surges were inland in the park and higher surges were in Florida bay. The highest surges were in the southwest. Hurricane impact on south Florida water management system is always a concern for Lake Okeechobee earthen dam. Hurricane winds over a lake push water in the wind direction resulting in drawdown upwind and storm surge on the edge of the lake in the wind direction with the potential of levee damage. Hurricane Irma peak wind gust was from the southeast to the north and northwest over the lake. A stage difference of 3.3 m was created from the S-352 spillway at the southeast corner of the lake to the S-131 pump station to the northwest of the lake. Lake Okeechobee stage was raised by 0.9 m from runoff and rainfall from the hurricane.

Damages from Hurricane Irma to the south Florida water management system include tailwater monitoring platform erosion at S-65E on the Kissimmee River, inflow to Lake Okeechobee, where stage was raised by 2 m. The foundation of the tailwater stage monitoring platform was completely out of ground from wave run-up erosion. The importance of bank protection around structures was observed. Other damages include flooding, canal bank erosion and structural damage, and stormwater treatment area vegetation damage. Hurricane Irma increased phosphorus (TP) load into the lake and in-lake TP concentrations from increased runoff and resuspension of sediments resulting in high turbidity.

PRESENTER BIO: Dr. Abtew is a principal engineer with more than 28 years of experience in south Florida hydrology, water quality, water resources, and environmental restorations. He has extensive experience in the Nile River Basin and transboundary water issues.

MICROBIOMES ENHANCE GERMINATION AND GROWTH OF TREE ISLAND SPECIES

Michelle Afkhami *and Brianna Almeida*
University of Miami, Coral Gables, FL, USA

Tree islands are distinctive and important features of the Everglades ecosystem, and understanding and addressing the high rate of tree island loss is as an essential element in the success of Everglades restoration and management. Loss of tree islands not only affects wading birds, American alligators, and other animals that use these habitats, but can also cause large releases of nutrients into the surrounding ecosystem. While invisible to the naked eye, bacteria and fungi may be critical hidden players with strong effects that underlie the ecological significance as well as management, conservation, and restoration of tree islands. Recent papers have recognized microbiomes as crucial for plant health in many other ecosystems and have estimated that the growth and survival of c. 20,000 plant species are dependent on microbial interactions. In this talk, we will discuss our ongoing research program to determine the role of plant-microbiome interactions on the success of island trees in the Everglades at the Loxahatchee Impoundment Landscape Assessment (LILA). In collaboration with the South Florida Water Management District and the South Florida Terrestrial Ecosystems Lab at Florida International University, we are approaching this research in three ways: 1) manipulative growth room experiments, 2) field experiments on the constructed tree islands at LILA, and 3) microbiome sequencing of tree island soils and tree leaves. Recent work from our experiment factorially manipulating the presence of the soil microbiome and water stage indicate that microbial-plant interactions play a large role in the successful germination and growth of some tree island species. For example, 73% of the *Ficus aurea* germination we observed in the experiment occurred in the presence of the microbiome ($z=3.15$, $df=1,179$, $P=0.00163$) and the size of *F. aurea* seedlings was twice as large in the presence of the microbiome than in the sterilized treatment ($t=-7.55$, $df=1,26$, $p<0.00001$). Currently, we are assessing how different management strategies could interact with these microbiome effects on tree success and are working to sequence the soil microbiomes from plant understory community plots monitored by the South Florida Terrestrial Ecosystems Lab. Our preliminary data and analyses suggest that inoculating newly constructed or restored tree islands with soil microbiomes from healthy islands may promote tree establishment, but also emphasizes the need for additional research prior to implementing management decisions concerning tree island microbiomes.

PRESENTER BIO: Dr. Afkhami is an Assistant Professor of Biology at the University of Miami. She studies the ecology, evolution, and genomics of plant-microbiome interactions and is especially interested in the consequences of microbiomes for plant health and restoration/management practices. Since moving to South Florida in Fall of 2016, her lab has been developing research to address the importance of microbiome in local imperiled ecosystems, including pine rocklands, everglades tree islands, mangrove hammocks, and the Florida scrub.

TESTING WESTERN EVERGLADES RESTORATION PROJECT ECOLOGICAL RESILIENCE OUTSIDE THE PHYSICAL MODEL TIME DOMAIN

Alaa Ali[1], *Walter Wilcox*[1], *Kelly Keefe*[2], *Melissa Nasuti*[2]
[1]South Florida Water Management District, West Palm Beach, FL, USA
[2]U.S. Army Corps of Engineers, Jacksonville District, FL, USA

The Western Everglades is commonly referred to as the area west of WCA3A and EAA and it includes the Big Cypress Preserve as well as the Seminole and Miccosukee tribe reservations. This area was exposed to conditions leading to ecological disturbances and water quality deterioration. The Western Everglades Restoration Project (WREP) is intended to reestablish hydrologic and ecological pre-drainage conditions and promote ecosystem resilience. A measure for the WERP resilience is to rank four alternate plans on their ability to sustain certain ecological benefits under the broadest climate variability available. For each plan, current WREP ecological performance measures are derived based on stage output simulated by the Regional Simulation Model (RSM). To assess the resilience of these measures outside the RSM Period of Record (POR) 1965-2005, a Hydrologic Model Emulator (HME) is developed for each plan (Ali 2009). The HME is an autoregressive Artificial Neural Network with exogenous variable that predicts stage data based on rainfall. Rainfall, and corresponding RSM simulated data are used to train, test and validate each HME. Adequacy of fit for each HME is presented. For each alternate plan HME is applied to rainfall data for two PORS (1940-1964, and 2006-2016) to predict stage (hence ecological measures) at selected locations. Results show ecological resilience with variable extents across the alternate plans.

<u>PRESENTER BIO</u>: Alaa Ali, PhD, PE, PMP, DWRE is a Chief Engineer in the modeling section of the Hydrology & Hydraulics Bureau at the South Florida Water Management District. Dr. Ali provides innovative solutions for a wide array of problems using his advanced expertise in statistical modeling and system optimization. He is the developer of the iModel, a planning and real time system's operation tool, for the Everglades hydrologic and ecosystems. He brings three decades of engineering experience two of which has been in the Everglades.

INUNDATION OF THE KISSIMMEE RIVER FLOODPLAIN DURING A POST-CONSTRUCTION INTERIM PERIOD

David Anderson
South Florida Water Management District, West Palm Beach, FL, USA

To successfully restore ecological integrity to the Kissimmee River including its floodplain, the Kissimmee River Restoration Project (KRRP) will need to reestablish the pre-channelization pattern of floodplain inundation that was critical for creating the mosaic of floodplain wetlands and habitat for aquatic invertebrates, fish and birds. In 2001, the first phase of KRRP construction completed the backfilling of 8 miles of C-38 canal; this began an Interim Period during which flow was reestablished to 14 miles of reconnected river channel and periodic inundation of the floodplain. This period is considered “interim” because all project features had not been completed, especially the implementation of a new regulation schedule for the headwater lakes that is intended to increase storage in the lakes and provide the flow regime needed to restore the Kissimmee River. During the Interim Period, flow to the Kissimmee River has been managed using a provision for environmental flows in the existing regulation schedule for the headwater lakes but without the benefit of additional storage. This presentation contrasts floodplain inundation characteristics during the Interim Period with those of a pre-channelization Reference Period and describes efforts to modify operations during the Interim Period to improve floodplain inundation patterns.

During the pre-channelization Reference Period (1930-1961), periods of floodplain inundation, indicated by bankfull discharge of 1400 cfs, occurred every 1.5 years on average (22 events in 32 years) and had a mean duration of 146 days (SE=33) although some events lasted more than a year. Most events had peak discharges that were less than 3000 cfs. In contrast, floodplain inundation events during the Interim Period (2001-2018) occurred more frequently with an event every 0.4 years on average (43 events in 18 years) and were shorter with a mean duration of 47 days (SE=5). Most events had peak discharges that were greater than 3000 cfs. Consequently, floodplain inundation events were flashier (occurred with greater frequency and shorter duration) during the Interim Period than during the Reference Period and were not of the long duration needed to reestablish long hydroperiod wetland vegetation that predominated in the Reference Period.

Beginning with the 2015 wet season, operational plans were recommended to maximize the duration of floodplain inundation. The implementation of these plans in 2015, 2017, and 2018 resulted in a single wet season event (2017 had a second 3-day event) of 75, 79 and 105 days, respectively. In some years, the plans combined as a single event what would have been multiple and briefer events of inundation. These results indicate that interim operations can be improved but the reestablishment of Reference Period floodplain inundation patterns is likely dependent on the new regulation schedule with its additional storage.

<u>PRESENTER BIO</u>: David Anderson is an aquatic ecosystem ecologist with over 20 years of experience with the Kissimmee River Restoration Project and oversees hydrologic, geomorphic, and food web studies for the evaluation program.

DROUGHT, WINTER RAINS AND HURRICANES: HYDROLOGIC OBSERVATIONS FROM 2014-2017 OF THE EASTERN PANHANDLE COASTAL MARSH AND NORTHEAST FLORIDA BAY, EVERGLADES NATIONAL PARK, FL, USA

***Gordon Anderson*[1]**, *Amy Renshaw*[2] *and Alexander Blochel*[3]
[1]U.S. Geological Survey, Wetland and Aquatic Research Center, Gainesville, FL, USA
[2]Everglades National Park, South Florida Natural Resources Center, Homestead, FL USA
[3]Audubon of Florida, Audubon Everglades Science Center Tavernier, FL, USA

The Eastern Panhandle (EP) coastal marsh of Everglades National Park (ENP) is hydrologically disconnected from its historical upstream freshwater watershed by the C-111 canal. This marl sediment marsh transitions (north to south) from freshwater sedges into scrub mangrove, whose waters drain into NE Florida Bay via small ephemeral creeks. Seasonally, the marsh hydrology consists of flashy rain-driven pulsed events in the summer and fall, and prolonged dry conditions in the winter and spring. During the dry season, there is limited rainfall or upstream overland flow, causing marsh dry down and increased soil salinity. Marsh rainfall in the basin is the primary source of upland freshwater sheetflow into NE Florida Bay when upstream freshwater from canal water releases are limited.

The USGS and science partners at ENP and Florida Audubon have monitored surface water hydrology in the EP and NE Florida Bay since the early 1990's. In October 2015, two dormant U.S. Geological Survey paired shallow groundwater and surface water monitoring wells (LJB and LHC) located in the lower EP marsh were reactivated to improve monitoring of coastal groundwater salinity and to assist in the understanding of ground and sediment water salinity and water residence time. The combined hydrologic monitoring efforts continue to provide valuable data to water managers for Everglades restoration efforts for EP, Taylor Slough, and Florida Bay.

Our presentation highlights three dramatic hydrologic events from 2014-2017 that impacted the EP marsh habitat and NE Florida Bay. (1) Drought. During the spring 2014-summer 2015, the EP basin had its worst localized drought in over 25 years, creating hypersaline low-water marsh conditions that killed many red mangroves and freshwater marsh plants. (2) Wet Winter. The wettest winter rainfall (Nov 2015-Feb 2016) on record (1896-2016) prolonged marsh water levels into the late spring and reduced marsh soil salt levels. However, because of the preceding drought leading to high marsh plant mortality, subsequent plant recruitment and recovery has been slow. (3) Hurricane Irma. In September 2017, this hurricane generated historic localized daily rainfall of ~30 inches in the EP (Gauge HC, Sept 10, 2017), which overwhelmed the marsh and tidal creeks with freshwater into Florida Bay with flood discharge, damping NE Florida Bay water salinity for months. These extreme hydrologic events over three years have seriously tested the ecological resiliency of the marsh. However, observed annual Florida Bay water levels have continued to trend upward since the mid-2000's, and the EP marsh and Taylor Slough may lack sufficient fresh headwater storage to maintain freshwater levels needed to provide a stable habitat for existing marsh fauna and flora. The anticipated Spreader Canal Project (C111SCEP) Phase II includes plans to backfill the C-111 canal and construct an upstream spreader canal that would double the current EP watershed and greatly improve and stabilize the EP marsh. This project would improve the timing, distribution and quantity of water into the EP and Florida Bay.

PRESENTER BIO: Mr. Anderson has been involved in Everglades wetlands science since 1989. His research interests include coastal wetland hydrology and coastal mangrove-marsh sediment dynamics in the SW coastal Everglades.

CHALLENGES AND FUTURE POTENTIAL APPLICATIONS OF CFD IN RESTORATION HYDRAULICS

***Matahel Ansar**, Jie Zeng, Seyed Hajimirzaie, and Kang-Ren Jin*
South Florida Water Management District, FL, USA

In this paper, potential applications of Computational Fluid Dynamics to Everglades Restoration are discussed. The paper focuses on emerging hydrodynamics and sediment transport questions in restoration infrastructure that can potentially be addressed by CFD simulations. In particular, CFD can be used to accurately estimate the downward hydrodynamic force on a spillway gates, also known as hydraulic downpull. Hydraulic downpull is caused by localized flow acceleration at or near the gates lip and its accurate estimate is important for a proper design of the hoist mechanism of the gates. CFD can also be used to estimate fluctuating pressures on the face of a spillway. These pressure fluctuations estimates are important for a proper design of the spillway concrete slab thickness and armoring to prevent a future dam failure. The paper also discusses other challenges in restoration hydraulics that can potentially be tackled with CFD. These include estimate of the depth and extent of scour downstream of hydraulic structures, and improved simulations of transport of sediments in vegetated flows (for potential applications in Decompartmentalization Physical Model Project in WCA3).

PRESENTER BIO: Dr. Ansar is the Section Chief for the Applied Hydraulics Section at the South Florida Water Management District. Dr. Ansar has 22 years of experience with various water resources projects including small scale laboratory studies, numerical modeling and field-based flow measurements. He is the author of over sixty technical publications.

OPTIMIZING SCIENCE COMMUNICATION BETWEEN SCIENTISTS AND NATURAL RESOURCE MANAGERS – FROM PROJECT INCEPTION TO COMPLETION

Nicholas G. Aumen
US Geological Survey, Davie, FL, USA

Science communication between scientists and managers is a challenging and important process that is vital to the successful application of science to natural resource management and decision-making. The keys to effective communication include: 1) including decision-makers from the beginning, as science efforts are first conceptualized; 2) involving decision-makers in a meaningful way at regular intervals throughout the scientific process; 3) continual learning by both scientists and decision-makers how to improve communication skills and techniques, including professional training; 4) recognition by scientists and decision-makers that successful communication entails a significant investment of time and effort; and 5) dedicating sufficient time, financial, and human resources to science communication.

Scientists should not limit science communication to the end of a project by merely delivering their final results and expecting managers to understand, accept, and apply that information. The communication process and the science effort are optimized when communication begins at project conceptualization and continues until completion. As scientists, we should avoid the assumption that we know best what managers need from us. The co-production of that science effort between scientists and end-users is key to its success. And, we should recognize that most of us have not been formally trained in effective communication techniques, and that we all can benefit from some level of professional training. Finally, effective science communication requires a significant commitment of time and effort, both by scientists and by decision-makers. Too often, the communication process is not factored into project planning and scheduling, nor are sufficient resources allocated to accomplish it successfully.

PRESENTER BIO: Dr. Aumen is regional science advisor to the USGS Southeast Region with 27 years of experience conducting and managing science in support of Everglades restoration. He has extensive experience in microbial ecology, aquatic nutrient biogeochemistry, and wetland restoration, and coordinates the Greater Everglades Priority Ecosystem Sciences Program for the USGS.

BIOPHREE® — COST-EFFICIENT ULTRA-LOW EFFLUENT PHOSPHORUS CAPTURE AND REUSE TECHNOLOGY FOR INDUSTRIAL AND SURFACE WATER TREATMENTS

Frank Jochem and ***Koos Baas***
Green Water Solution, Inc., Wellington, FL, USA

"Capturing phosphorus is more efficient than fighting algae" reflects the core philosophy of the BioPhree® ultra-low effluent phosphorus capture and reuse technology for industrial use and natural surface waters to cost-efficiently prevent algae blooms. Removing phosphorus to concentrations below organisms' fundamental need prevents microbial and algal growth, irrespective of the presence of other nutrients. Hence, effective algae bloom prevention is possible by focusing on only one nutrient. This capability is especially valuable as no economically feasible way exists to remove algae from natural waters once the algae bloom has formed, and merely killing the algae will only recycle the phosphorus contained in the algae biomass for the next bloom.

BioPhree® prevents microbial/algal growth without toxic or oxidative chemicals by capture of dissolved phosphorus with a proprietary adsorbent resin. Captured phosphorus can subsequently be washed off the resin in a regeneration step, rendering the resin able to adsorb phosphorus for extended lifetimes and concomitantly providing the captured P in form of a concentrated aqueous fertilizer solution.

Microbial/algal growth is generally prevented at phosphorus concentrations <10 µg-P L^{-1}. BioPhree® effluent typically has well below 10 µg-P L^{-1} of dissolved phosphorus; mostly <5 µg-P L^{-1}, and <3 µg-P L^{-1} during an experiment with analyses administered by the Everglades Foundation through a certified laboratory. Effluent dissolved phosphorus concentrations are largely independent of influent concentrations. A 150 days monitored pilot study at a Dutch water plant showed effluent of consistently <5 µg-P L^{-1} at inflow concentrations varying between 100 µg-P L^{-1} and 1,800 µg-P L^{-1}.

For a three months pilot study in an Ontario marsh system with a flow varying between 2,500 and 8,500 gallons per day, a BioPhree® system was amended with pre-filtration for the high load of very small particulate phosphorus. Effluent Total Phosphorus (TP) ranged below 40 µg-P L^{-1} except at the beginning and end of the experiment characterized by exceptionally high runoff of suspended solids upon the melting of the marsh soil and washout by high rain events. Dissolved phosphate effluent was below 20 µg-P L^{-1} during the first half of the experiment at water temperatures around 5°C but dropped below 10 µg-P L^{-1} once water temperatures exceeded 15°C. Under higher water temperatures, the contribution of particulate P to TP effluent increased to >90%. The results point towards decreased adsorption kinetics for dissolved phosphorus at very low temperatures. The inability to retain TP to below 10 µg-P L^{-1} by pre-filtration was less of a concern; while particulate P is subject to biogeochemical nutrient cycling, these cycles run on time scales too long to make particulate P a relevant driver of acute algae bloom dynamics.

PRESENTER BIO: Educated as Chemical Engineer started a first job in water treatment in 1978 and never left since. Developed expertise on corrosion, scaling and biofouling, mostly on cooling tower- and boiler treatment. Started Aquacare Netherlands in 1988. Picked up the early stage of membrane technology in the Netherlands and co-authored many articles on the development and use of antiscalents. Since 2007 implementing innovative technologies to avoid bio-growth by Phosphorous- limitation. Current position is Owner/CEO of Aquacare.

SPATIAL AND TEMPORAL PATTERNS IN WATER QUALITY, MERCURY AND METHYLMERCURY FROM EVERGLADES NATIONAL PARK

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Elevated mercury (Hg) levels in the aquatic food web of the Everglades has been a public concern since the late 1980s and remains a persistent issue confronting the ecosystem restoration efforts. The formation of methylmercury (MeHg) -- the most toxic and bioaccumulative form of environmental Hg -- is driven by the bioavailability of inorganic Hg(II) and the metabolic activity of sulfate-reducing bacteria. These in turn are influenced, respectively, by the abundance and character of dissolved organic carbon (DOC) and sulfate concentrations. Here, we report on an 11-year collaboration between the U.S. Geological Survey and the National Park Service to examine the drivers of spatial and temporal variability of Hg and MeHg within the Everglades National Park. We collected annual samples of surface water and forage fish (*Gambusia holbrooki* and jewel cichlid) at 76 sites from 2008 to 2018. Water samples were analyzed for total mercury (HgT), MeHg, DOC, specific UV absorbance at 254 nm (SUVA), and major ions. Fish were analyzed for HgT, MeHg, and carbon and nitrogen stable isotopes. In addition, archived fish samples were analyzed for mercury stable isotopes to provide greater insight into mercury source attribution and the influence of habitat.

Methylmercury concentrations in water and fish exhibited distinct regional patterns with peak levels in the Shark River Slough (SRS) ¬– a receiving area for sulfate- and DOC-rich canal water. Throughout the SRS, HgT was a strong predictor of MeHg concentrations in filtered water (R^2=0.88), whereas in marsh sites unaffected by the canal this result does not hold true (R^2=0.34). Additional drivers of MeHg production include the number of dry days preceding sampling – particularly at marsh sites where precipitation is the dominant water source. Annual hydrologic conditions were often an important annual driver of mercury levels in water. Persistent high water levels during an El Niño event (2009-10) corresponded to a decrease in HgT and MeHg concentrations. Persistent low water levels during a strong La Niña event (2011-12) corresponded to a dramatic increase in concentrations due to drying and rewetting cycles. In 2017, the annual sampling occurred about 60 days after Hurricane Irma, one of the strongest Atlantic hurricanes on record to hit southern Florida. Average water concentrations of mercury across the park were among the lowest recorded in this study – indicating rapid processing of atmospherically derived mercury in the ecosystem.

Overall, trends of Hg in fish generally followed those of MeHg in filtered surface water. In addition, the prevalence of exotic Jewel Fish in the Everglades has greatly expanded over the course of this study. Data from the onset of their arrival (2010-2013) showed that Jewel Fish mercury concentrations (measured as HgT) were 15-20% higher than mercury concentrations in native Gambusia. We used stable isotope techniques (Hg, C, N) to better understand mercury uptake dynamics and diet differences between Jewel Fish and Gambusia. Both species have similar diets based on carbon and mercury isotopes but show distinct signatures reflecting the local habitat (Coastal, Marsh, Slough).

PRESENTER BIO: Christopher specializes in the biogeochemistry of mercury in freshwater ecosystems. After a 28-year career as a staff scientist with the Environmental Chemistry and Technology Program at the University of Wisconsin, Madison, he joined the USGS Mercury Research Laboratory in 2016.

TEN YEARS OF INVASIVE SPECIES DATA COLLECTION IN THE GREATER EVERGLADES

Chuck Bargeron *and Rebekah Wallace*
University of Georgia, Tifton, GA, USA

EDDMapS' primary goal is to discover the existing range and leading edge of invasive species while documenting vital information about the species and habitat using standardized data collection protocols. As an aggregate database, EDDMapS allows for data from many organizations and groups to be combined into one clearing house of invasive species data. The purpose of this is to show a better map of the range of an invasive species as well as to make tools to allow anyone to submit data, for data to be verified, and for the data to be available to anyone as maps, data analysis and more. Current goals include: integration of existing regional datasets, increase search options on EDDMapS websites, updating mapping standards to the 2018 NAISMA Standards, and coordinate with local, state, and regional organizations in untapped areas to develop early detection networks. After ten years of development of EDDMapS, it has become clear that these local organizations are key to developing a successful early detection and rapid response network.

IveGot1, Florida's portal to EDDMapS, was initiated as a partnership between the Florida Invasive Species Partnership and the Florida Exotic Pest Plant Council with support from National Park Service, U.S. Fish and Wildlife Service and Florida Fish and Wildlife Conservation Commission in cooperation with the Nature Conservancy and Florida Natural Areas Inventory.

The IveGot1 app was the first and most successful smartphone app developed for data entry into EDDMapS and has served as a model for other programs. It has been downloaded over forty-five thousand times as of December 2018. EDDMapS contains 326,166 Reports, from 3,960 Reporters, covering 1,702 Species for Florida. Over 60% of the reports in Florida have come from counties that are part of the Greater Everglades area. This success is largely due to the local Cooperative Invasive Species Management Areas involvement, statewide cooperation and marketing through billboards, bumper stickers, and extension publications.

This paper will highlight new and upcoming features of EDDMapS, the IveGot1 smartphone app and its integration into the Everglades Cooperative Invasive Species Management Area as well as how it is being used to fight invasive species in the Everglades.

PRESENTER BIO: Chuck has been with the University of Georgia for 19 years where his work focuses on invasive species and information technology. He focuses on mapping invasive species and tools for Early Detection and Rapid. Chuck has been an invited speaker at over 200 conferences and co-authored over 60 outreach publications.

ARE RACCOONS IN HUMAN-DOMINATED LANDSCAPES OF SOUTH FLORIDA DIFFERENT?

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Raccoons are one of the most adaptable and ubiquitous species. Raccoons are distributed throughout North America and thrive in both natural and heavily modified or urbanized environments, from Alaska to the Everglades. Raccoons can arguably be considered a keystone species: they play a key role in ecosystem functions, with a major predation impact on small mammal and bird populations, among others. In this context, raccoons are an ideal model species to investigate the impact of humans on wildlife populations. We started monitoring raccoons in Tree Tops Park, an urban park in the Greater Miami Area of South Florida. Captures of 48 individuals allowed us to collect morphometric measurements of raccoons for both sexes and all age classes, and to tag adults with GPS collars to understand their spatial behaviors. We then expanded the Raccoon Ecology Database (Rees et al. 2008), a comprehensive directory of raccoon studies covering a wide range of life-history traits, which we updated for the last ten years. This allowed to place our population in the context of the entire species range, and compare home range and morphology of South Florida raccoons to other populations in human-dominated landscapes. Forty-three raccoons have been captured in Tree Tops Park, Florida. Ten adults have been tagged with GPS collars, and monitored at fine temporal resolution (1 fix every hour). The update of the Raccoon Ecology Database included over 700 new studies for a grand total of over 1,500 documents (mostly research papers). Raccoons captured in South Florida were in average smaller than generally in their range (mean±sd: 5.2±2.2 kg vs. 6.4±1.6 kg; t-test: $t = -2.148$, $p = 0.040$), highlighting a gradient that seems to contrast heavier raccoons in the north and western ends of their range compared to the South-East. Home ranges computed using 95% Minimum convex polygons highlighted occasional excursions in neighborhoods outside the park, which sometimes required crossing primary roads for access. Raccoon home ranges in South Florida were actually smaller than generally in their range (median: 13.5 ha vs. 129.4 ha; Wilcoxon rank sum test: $W = 8$, $p = 0.006$), and contributed to a gradient of decreasing home range size from West to East ($r^2 = 0.27$), and with human influence ($r^2 = 0.20$). Our results indicate both behavioral and morphological adaptations of raccoons to urban areas, where resources are abundant (mostly due to human garbage), and territoriality is in turn reduced.

PRESENTER BIO: Mathieu Basille is an Assistant Professor of Landscape Ecology at the University of Florida's Fort Lauderdale Research and Education Center. He is primarily interested in spatial ecology of large vertebrates. He leads the MabLab, which focuses on movement and habitat selection of animals such as Raccoons, Wood Storks and Seabirds.

MICROSATELLITE ANALYSIS OF THE ENDANGERED CAPE SABLE SEASIDE SPARROW IN EVERGLADES NATIONAL PARK

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There are nine subspecies of seaside sparrows (*Ammospiza maritimus*) distributed along the east and Gulf coasts from Massachusetts to Texas. The federally endangered Cape Sable seaside sparrow subspecies (*A. m. mirabilis*) is found only in Everglades National Park in southern Florida. There are currently six subpopulations found in Everglades National Park inhabiting freshwater marl prairies. Habitat availability has diminished due to fires, introduction of exotic plants, and changes to natural water flow resulting in fragmented populations. While other sparrows more easily adapt to changing landscapes and plant species, the seaside sparrows have not shown this pliancy in habitat usage, and population numbers appear to be declining raising concerns about inbreeding and subpopulation loss. The purpose of this study was to utilize genetic tools to provide information on the connectivity and relatedness of individuals and subgroup management. To conduct genetic analysis, feather samples were collected from 68 birds and assessed at both mitochondrial and nuclear DNA markers. Mitochondrial DNA revealed that all samples contained the same sequences, indicating high relatedness. Therefore, to further evaluate the contemporary connectivity and genetic structure among subgroups, nuclear loci were employed. Nuclear microsatellite DNA can provide contemporary information across multiple loci and can provide more comprehensive levels of inbreeding within the subpopulations. Furthermore, microsatellites can inform real-time movements among subgroups and pedigree relationships. Five microsatellite multiplex panels comprising 17 individual loci have been developed for *A. m. mirabilis* to assess contemporary population structure in Everglades National Park. Assessment of these markers is ongoing as is the development of alternative isolation techniques for sample types such as cloacal swabs.

<u>PRESENTER BIO</u>: Caitlin Beaver is a research scientist in Dr. Margaret Hunter's lab at the USGS-WARC. She specializes in utilizing molecular biology and ecology to inform management for imperiled species conservation.

FORECASTING THE ECOLOGICAL OUTCOMES IN THE EVERGLADES

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Modeling and defining uncertainty for future states of ecosystems has become increasingly important with the rise of ecological degradation and global climate change. The use of ecological models by scientists, policy-makers, managers, and federal, state, and local officials is on the rise; and with improvements in spatial data resolution, models are an increasingly effective tool when responding to current or anticipated environmental change.

Operational forecasting is an emerging field in ecology that leverages ecological models in a new, cross-disciplinary way, i.e., using a real-time or nearly real-time climate forecast to project near-term ecosystem states. These applications give decision-makers lead time to anticipate and prevent harmful ecosystem state changes. Further, operational forecasts are continuously updated to reflect real-time conditions, providing an effective means to reduce uncertainty and manage adverse responses.

The Everglades Forecasting (EVER4CAST) application produces water depth forecasts informed by 1) quarterly precipitation forecasts and 2) historical variability from the Everglades Depth Estimation Network (EDEN). The simulated water depths serve as inputs to a suite of ecological models that are used for Everglades restoration planning. Outputs and integrated metrics from the application allow decision makers to identify regional management actions that can improve ecological conditions for multiple trophic levels and the probability of long-term restoration success.

PRESENTER BIO: James Beerens is an Ecologist at the USGS Wetland and Aquatic Research Center (WARC). He also serves as a lead developer of ecological applications for the Everglades Depth Estimation Network (EDEN). James has developed decision-support applications, ecological models, and visualization software for the Joint Ecosystem Modeling (JEM) community.

DISRUPTIVE EVENTS AND SALINITY RESPONSES IN WESTERN BISCAYNE BAY

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In Biscayne Bay ecologically disruptive events occur as extreme changes in salinity over a short duration. Perhaps the most dramatic example of these ecologically disruptive events was a 32 psu drop over a 4 hour period in May 2011. Although these extreme events are rare, occurring approximately 1% or less in the data set, the rapid change over time and extreme salinity range of these events are what make them so potentially ecologically disruptive. These salinity events appear to be driven by three primary sources; timing and delivery of freshwater, the movement of internal water masses within the bay, and by storms and climatic events. Salinity controls survival, growth, and physiological health of downstream benthic and water column organisms by affecting organisms' ability to maintain internal salinity homeostasis. Evaluating these events allows us the opportunity to identify ways to increase the resiliency of this ecosystem.

Salinity has been measured at 44 sites in Biscayne Bay in 15 minute increments since 2004. This project is a component of the Comprehensive Everglades Restoration Plan (CERP) Monitoring and Assessment Plan (MAP). Long-Term Salinity monitoring is a joint project between the National Park Service (NPS) and the University of Miami, funded by both NPS and the Army Corps of Engineers. It is a component of the Integrated Biscayne Bay Ecological Assessment Monitoring with the National Oceanographic and Atmospheric Administration National Marine Fisheries Service. The data from this project is used in the CERP-MAP process to evaluate baseline and post CERP changes of water flow into Biscayne Bay. The fine scale of Biscayne Bay MAP sampling has shown much larger and more rapid salinity changes over short timescales than was visible in the previous long term monthly sampling data such as that collected since 1979 by Miami-Dade County. These salinity extremes occur in a variety of different locations including a western embayment north of Black Point, in Manatee Bay, off of Deering Estate, and off of Convoy Point. Analysis of salinity events before and after 2010 show the potential for improved resiliency. In this presentation we will review the relative importance and occurrence of these events and the natural and anthropogenic drivers of salinity on multiple spatial and temporal scales. The results of the analysis of this long-term, high-resolution Biscayne Bay salinity data can be used to define water flow protocols and canal operations within the Biscayne Bay Coastal Wetlands Project. The implementation of the final stages of construction of Phase I of the CERP Biscayne Bay Coastal Wetlands Project offers an opportunity to increase resiliency of the natural system by providing the ability to better spatially and temporally buffer water management operations in a manner that reduces the frequency of rapid shifts in salinity near the shoreline.

PRESENTER BIO: Sarah Bellmund is an ecologist with National Park Service at the South Florida Natural Resources Center at Everglades National Park with 30 years of experience working on restoration in south Florida.

MODELING FUTURE URBANIZATION AND SEA-LEVEL RISE EFFECTS ON LANDSCAPE-SCALE CONSERVATION TARGETS

Allison M. Benscoter*, Saira M. Haider, Stephanie S. Romañach*
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Understanding how ecological and cultural resources may change in the future is an important component of conservation planning and for the implementation of long-term environmental monitoring. In the state of Florida, there is a high concentration of species and ecosystems of conservation concern, in addition to many threats including high human population growth, urbanization, habitat fragmentation, climate change, and sea-level rise (SLR). Comprehending these potential threats can help maintain valuable ecological and cultural resources into the future.

In this study, we modeled six future scenarios of urbanization and SLR to investigate their potential effects on important conservation targets. In collaboration with the Peninsular Florida Landscape Conservation Cooperative (PFLCC), we conducted susceptibility modeling for the PLFCC's state-wide identified conservation targets for the High Pine and Scrub, Coastal Uplands, and Freshwater Aquatics priority resources. The PFLCC is part of a national system of LCCs that consist of a partnership of federal, regional, and state agencies, tribes, non-governmental organizations, universities, and other private and public organizations to provide technical conservation science and support for ecological and cultural resources. Therefore, the conservation targets we modeled were chosen through a cooperative multi-partner effort to identify the most important measurable indicators of conditions for priority resources across the state.

The results of the susceptibility modeling indicated that both the loss and percent decrease in area from future urbanization and SLR were at higher levels in the 2070 scenarios than in the 2040 scenarios for all three priority resources, as expected. The Coastal Uplands conservation targets had the greatest decreases in area from SLR and urbanization, followed by High Pine and Scrub and Freshwater Aquatics. Because the Coastal Uplands are in closest proximity to the coast and most susceptible to SLR, the loss in area from SLR for Coastal Uplands was very high, showing up to a 46.8% loss for one of the Coastal Uplands conservation targets. We also developed a methodological approach, presented as a workflow diagram, that represents the susceptibility modeling process, which is applicable to conservation efforts in other states, regions, countries, continents, and globally. Not only are SLR and urbanization occurring at a global-scale, affecting land use and conservation planning, but they are expected to increase in the future. An understanding of how and where conservation targets are susceptible to future urbanization and SLR is valuable for the implementation of landscape-scale conservation action and the long-term monitoring of environmental trends.

PRESENTER BIO: Allison M. Benscoter is an Ecologist for the U.S. Geological Survey, who focuses on science and tools for ecological restoration and the conservation of wildlife. Allison's primary areas of interest include understanding spatial patterns of wildlife across space and time and investigating species-specific habitat and environmental relationships.

OPPORTUNITIES AND CHALLENGES FOR PRESCRIBED FIRE IN EVERGLADES RESTORATION

Brian W. Benscoter
Florida Atlantic University, Davie, FL, USA

Fire is a common and important aspect of the ecology of Florida ecosystems, with most having natural fire return intervals of <20 years. South Florida ecosystems are unique in that vegetation grows virtually year-round with hazardous fuel build-ups occurring in as little as 7 years. Within this fire-adapted landscape, prescribed burning is a frequent and extensive tool for land management, with the managed lands of south Florida having some of the most active fire management plans nationwide. While human-ignited fires have been used for centuries in the Everglades to promote desirable ecosystem conditions and services, the extensive alterations to the Everglades in modern times through the implementation of water management and the profound wildland-urban interface it serves have drastically changed the controls on the Everglades fire regime from site-to-landscape scales. Compounding these are additional direct changes to fire drivers due to climate change and indirect stresses from novel fuel types or distributions resulting from vegetation shifts. With novel fuels come novel fires, which may compromise the fire-vegetation feedbacks that maintain certain habitat types. However, fire has both positive and negative feedbacks on vegetation recovery and distribution; feedbacks that may be harnessed even under novel fire conditions to restore altered habitats to a more desirable state.

Here we will discuss the cause-and-effect terms of the fire-ecosystem feedback, emerging challenges to the conventional use of fire in natural resource management, and potential opportunities for engaging prescribed fire as an active tool in the restoration of Everglades wetlands. By using an adaptive management approach both in the application of prescribed fire and the definition of habitat targets, fire may be an effective and efficient tool for reducing or restricting undesirable conditions and restoring both desirable habitats and a healthy integrated wetland landscape.

<u>PRESENTER BIO</u>: Dr. Benscoter is Associate Professor of Wetland Plant Ecology at Florida Atlantic University and Vice-Chair of the South Atlantic Chapter of the Society of Wetland Scientists. He has over 15 years of experience researching wetland fire ecology and carbon cycling from sub-arctic to sub-boreal biomes.

INFLUENCE OF HYDROLOGIC FLOW ON BENTHIC MICROBIAL ENZYME ACTIVITY IN EVERGLADES STORMWATER TREATMENT AREAS (STAS)

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Nutrient removal in the Everglades Stormwater Treatment Areas (STAs), a constructed wetland, is influenced by microbial biomass and functions. Hydrologic flow is an important management factor affecting both the nutrient loading and vegetation type, and thus, also influencing microbial activities related to nutrient uptake in STAs. Despite this importance, there is little understanding of the role of flow and vegetation type on microbial biomass and functions like extracellular hydrolytic enzyme activities related to C, N, and P. In the present study, enzymes for C (β-glucosidase, BG), N (Leucine aminopeptidase, LAP and β-N-acetyl-glucosaminidase, NAG), and P (alkaline phosphomonoesterase, APA and phosphodiesterase, BisP) were analyzed in benthic floc materials at inflow and outflow stations of STA 3/4 Cell 3B characterized by emergent and submerged aquatic vegetation (EAV and SAV, respectively) during stagnant and flowing conditions. Present study results suggested that flowing conditions stimulated the C ($p=0.02$) and N ($p=0.002$) enzymes but did not impact the P enzymes ($p=0.2$). Similarly, the floc materials at the inflow site had greater enzyme activities for C ($p=0.001$), N ($p=.004$), and P ($p=0.03$) than the outflow site. Vegetation did not appear to influence any of the enzyme activities. Thus, it is evident that sampling station characterized by nutrient gradient developed over the years is major driver of enzyme activities than the hydrological flow which brings interim changes in nutrient loading in STAs.

<u>PRESENTER BIO</u>: Dr. Bera is a postdoctoral research associate working on soil and sediment. He has recently started working on microbial aspects of Everglades Stormwater Treatment Areas (STAs) functioning. He has published research finding on soil microbial aspects in several high impact factor journals.

GEOSPATIAL ANALYSIS TO DETECT CHANGES OF FLORIDA BAY ISLANDS DUE TO HURRICANE IRMA

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Hurricane Irma hit south Florida as a category 4 storm on September 10, 2017, significantly impacting Florida Bay, part of Everglades National Park. Cores had previously been collected (in 2014) from four islands in Florida Bay to gain insight into sea-level rise and island change, development, and resilience. Each of the four islands studied, Russell Key, Bob Allen Key, Buttonwood Key #7, and Jim Foot Key are characterized by a central open mudflat or flats that are below sea level and a vegetated berm perimeter that commonly rises 1-2 meters above sea level. To assess the geospatial impact of Hurricane Irma to the vegetated area of the islands, satellite imagery was obtained for August 13, 2017, about a month before the storm, and July 13, 2018, approximately 10 months after the hurricane. These images were manually interpreted within GIS to create digitized polygons of the vegetated areas of the islands. The polygons from the August 2017 imagery were compared with the ones from the July 2018 imagery to determine visible changes to the islands during that time. The 10-month interval between Hurricane Irma and the July 2018 imagery minimized the chance that floating debris from the storm would be mistaken for island landmass, thus allowing for more permanent changes to be detected. Further, since the interpretation was done manually, it was important that both images were within the rainy seasons of each year. The results indicated that all four of the islands decreased in vegetated area following Irma. Jim Foot decreased by approximately 9.3%, Buttonwood #7 by 7.1%, Bob Allen by 4.9%, and Russell by 1.9%. Most of these changes occurred to the interiors of the islands, however Jim Foot and Russell experienced a loss of vegetated perimeter on their eastern sides. The two islands closest to the eye of the hurricane, Jim Foot and Buttonwood #7, had the greatest percentage loss in vegetated landmass. This satellite image analysis serves as one method of studying changes to the islands, allowing for the depiction of visible changes in vegetated landmass due to Irma. The insight gathered was used in conjunction with post-Irma fieldwork done in January 2018 to gain a greater understanding of changes to the islands caused by the hurricane. The close correlation of imagery dates and field observation improves confidence that the detected changes are attributed to Irma, especially a loss of vegetated landmass. Conversely, field observations assisted the satellite image interpretation since the possibility of misclassifying land for water, and vice versa, is high due to the flat nature and shallow water depths of the islands. Satellite imagery informed fieldwork in terms of the timing and severity of the change, and fieldwork observations, photographs, and measurements allowed for better interpretation of the satellite imagery.

PRESENTER BIO: Ms. Bergstresser is a geographer and GIS specialist with experience using remote sensing and geospatial analysis methods to map activity related to land cover and topographic changes in various national and international regions.

INTEGRATED BISCAYNE BAY ECOLOGICAL ASSESSMENT AND MONITORING (IBBEAM): 6 YR OF EVERGLADES RESTORATION IMPACTS ON THE NEARSHORE ECOSYSTEM

Diego Lirman[1], Erik Stabenau[2], Joan A. Browder[3], Joseph E. Serafy[1,3], Ian C. Zink[4,3], Herve Jobert[1,5] ***Nicole Besemer[1]***

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The Integrated Biscayne Bay Ecological Assessment and Monitoring (IBBEAM) program was initiated in 2012 to monitor the impacts of the Comprehensive Everglades Restoration Plan (CERP) implementation on Biscayne Bay nearshore ecosystems. The IBBEAM program consolidated four previously independent monitoring efforts: 1) continuous recording of nearshore salinity conditions, 2) survey of coastal mangrove habitat utilization by fishes, 3) assessment of submerged aquatic vegetation (SAV), and 4) survey of nearshore epifaunal communities. The IBBEAM program involves field sampling, laboratory analyses, database management, and statistical modelling to monitor a suite of ecological performance measures for ecological indicator assessment and use in adaptive management. A key ecological goal of CERP is to reestablish oligo- and mesohaline salinity habitats along the southwestern Biscayne Bay shoreline which in turn is anticipated to restore historical SAV, fish, and invertebrate community diversity and abundance. IBBEAM evaluates progress towards this goal by: 1) collection of time-series data needed to characterize, and determine change over time in, salinity regimes, SAV communities, SAV-associated fish and invertebrate communities, and mangrove-associated fishes; 2) exploring key relationships between salinity and diversity, distribution, and abundance of SAV, epifaunal fishes and invertebrates, and shoreline fishes; and 3) formulating performance measures and targets to demonstrate the effectiveness of CERP implementation effectiveness. This presentation will describe lessons learned from the IBBEAM program to date, including field methods, scientific findings, habitat suitability models, and adaptive management recommendations, that can be applied to a long term monitoring program in conjunction with full CERP implementation.

<u>PRESENTER BIO</u>: Ms. Besemer is a Senior Research Associate at the University of Miami with 5 years of experience in south Florida and Caribbean marine ecosystems. She has worked with the university for 2 years focusing on the Epifauna community analysis part of IBBEAM acting as Lab manager and field technician.

CULTIVATING FLOODED RICE AS A TREATMENT TECHNOLOGY TO MITIGATE PHOSPHORUS LOADS FROM AGRICULTURAL WATERSHEDS

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During summer more than 50,000 acres of fallow sugarcane land is available for rice production in South Florida. The net value of growing flooded rice in the region as a rotational crop with sugarcane far exceeds its monetary return. Soil conservation, pest control, and phosphorus (P) load reduction are only some of the benefits. With no P fertilizer applied, rice cultivation in Florida can potentially function as a sink for P as a result of particulate settling and plant P uptake, while harvested whole grain rice can effectively remove P from a rice field per growing season. As part of the George Barley Water Prize, we proposed utilizing flooded rice cultivation as a treatment technology to mitigate P loads from farmlands. A controlled experimental plot (32 × 8 feet) was designed to quantify reduction in P concentration and loads between inflow and outflow over a 110 day rice cultivation cycle. Daily water samples were collected from inflow and outflow over a six-week period once a steady flood was established. Inflow water P concentration was manipulated weekly, from 0, 0.075, 0.22, 0.50, 0.22, and 0.075 mg/L P concentration. Approximately 160 L of water was treated daily. On average 28% reduction in TP concentration and 51% reduction in SRP was observed between inflow and outflow, corresponding to significant P load reductions using this treatment technology. Future research work includes (i) evaluating P use efficiency in crop management by identifying and selecting rice varieties tolerant to low P inputs; and (ii) effect of varying flood depth on P loads from rice fields.

PRESENTER BIO: Dr. Bhadha is an Assistant Professor at the University of Florida, Soil and Water sciences Department located at the Everglades Research and Education Center. His research and extension program deals with promoting sustainable agriculture in South Florida and beyond. Focusing on issues related to soil sustainability, water quality and nutrient management. He is PI of the Soil, Water and Nutrient Management Lab, and published over 30 peer-reviewed journal articles during his academic career.

LINKING RECREATIONAL ECOSYSTEM SERVICE BENEFITS WITH FRESHWATER MANAGEMENT IN THE EVERGLADES

Mahadev Bhat *and Christina Brown*
Florida International University, Miami, FL, USA

Declining freshwater delivery has negatively impacted the productivity of the Florida Everglades (FE) ecosystem over the years. The sealevel rise will likely conflate these impacts due to increasing salinity in the costal ecosystem. Restoring freshwater flow in FE is the major goal of the ongoing multi-year, multi-billion dollar restoration project. FE restoration effort has often become politically contentious and does not enjoy sustained funding commitment. Missing in this contentious debate is the adequate information and awareness about the true economic values of non-market benefits of restoration. This research develops an integrated methodology to determine the economic value of one of the key ecosystem services, recreation in the Everglades National Park. The study first used bio-hydrological models and published literature to link managed freshwater inflows to indicators of fishery productivity and overall ecosystem. We then linked those models to anglers' willingness-to-pay for various attributes of the recreational fishing experience. This approach allowed us to estimate the foregone economic benefits of failing to meet monthly freshwater delivery targets.

The study found that the managed freshwater delivery to the parts of the Everglades had declined substantially over the years and had fallen short of management targets. On one hand, this shortage in the flow resulted in the decline of biological productivity of recreational fisheries and the overall water depth, which in turn affected the overall health of the ecosystem. The study estimated the annual value of lost recreational services alone ranged from $6.9 million to $16.2 million depending on whether we considered the anglers' perception of future climate risk. The losses were greater in the months of dry season when the water shortage was higher and the number of anglers fishing also was higher than the levels in wet season. We further simulated the lost recreational value under different freshwater management scenarios. Doing so, we illustrated that linking the economic values of the above ecosystem services directly to a decision variable such as water delivery is a powerful and effective way to make management decisions. We also demonstrated that ecosystem service values can be influenced by future population, economic conditions and overall recreational demand. Therefore, future management policies cannot stay static, but consider both ecological and economic factors that affect the recreation industry.

PRESENTER BIO: Dr. Bhat is a professor of natural resource economics in the Department of Earth and Environment and Economics at Florida International University. He has over 30 years of research and teaching in the area of environmental economics, policy, water management, and sustainable agriculture.

MANGROVE CROWN DETECTION FROM HIGH RESOLUTION AERIAL PHOTOGRAPHY USING VEGETATION INDICES AND IMAGE SEGMENTATION TECHNIQUE

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Mangroves form an important coastal wetland ecosystem and dominate the coastal ecosystem in tropical and sub-tropical coastlines globally. In south Florida, Ross et al. (2000) established that the landward margin of red mangroves (Rhizophora mangle) in the Southeast Saline Everglades (SESE) (Egler 1952) have moved further inland by more than a kilometer as a consequence of sea-level rise, and reduction in freshwater supply. Consequently, understanding the way mangroves are distributed may provide crucial clues in comprehending the pattern of transgression. The fact that the location of mangrove habitats typically lie in briefly inundated and inaccessible regions, it becomes challenging to survey them using traditional survey methods besides being time-consuming and cost intensive (Kuenzer et al. 2011). To overcome this challenge, remote sensing can play a pivotal role in assessing mangrove tree cover and its distribution with minimal field work reducing the time, effort, and money involved in such studies. Therefore, we propose an innovative approach to separate mangrove individuals from background and delineate mangrove crowns automatically using a combination of different vegetation indices and image segmentation technique. We used 5 vegetation indices with watershed segmentation technique. Results from visual comparison and accuracy assessment have been presented.

PRESENTER BIO: Mr. Biswas is a 3rd year Ph.D. student at Department of Earth and Environment at Florida International University, Miami, FL. His research interests involve the use of GIS and remote sensing tools to understand mangrove dynamics especially mangrove distribution and expansion in the southern Everglades.

HIGH SPATIAL RESOLUTION MEASUREMENTS USING HYDROGEOPHYSICAL METHODS REVEAL THE PRESENCE OF HOTSPOTS FOR BIOGENIC GAS ACCUMULATION AND RELEASE IN THE FLORIDA EVERGLADES

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It is well known that biogenic gas emissions (mainly methane and carbon dioxide) vary both spatially and temporally in peatlands. While most studies have focused on northern systems, several recent studies in tropical and subtropical peatlands have revealed the presence of areas of increased gas accumulation and emissions, or hotspots that may be related to physical and/or biogeochemical changes within the peat's matrix. However, these studies are often limited in terms of sampling volume and resolution, or are based in laboratory studies that may not be totally representative of field conditions. In this study we investigate the spatial variability (both lateral and vertical) in gas accumulation and release at the field scale, over 10 m long transects at two locations in Water Conservation Area 1 of the Florida Everglades, using an array of hydrogeophysical methods. Resulting data infers the presence of hotspots with dimensions ranging from 1-2 m in width and approximately 0.5 m thick. These areas showed high variations in biogenic gas accumulation and release an order of magnitude higher than surrounding areas and occur seasonally as the highest gas releases were observed during Florida's wet season. This study therefore has implications for better understanding the spatial and temporal variability of biogenic gas hotspots in peat soils, and how matrix structure affects gas accumulation and release. This study shows the importance of considering the heterogenous nature of the peat's matrix when quantifying gas fluxes in the Everglades, and particularly when using methods with small sampling volumes like gas chambers.

PRESENTER BIO: Troy is a MS Geosciences student that will be graduating in May, 2019 from Florida Atlantic University. His research uses geophysical methods to estimate biogenic gas emissions and characteristics from peatlands.

FRUIT FARM CREEK RESTORATION PROJECT PAST, PRESENT & FUTURE

Roy R. Lewis[1], *Kathy B. Worley*[2], *Laura L. Flynn*[1], ***Vanessa Booher***[2] *and Jeff A. Carter*[3]
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Goodland Fruit Farm Creek Mangrove System (FFC) is located near the southwest boundary of Rookery Bay National Estuarine Research Reserve. Historically, this area was a viable black mangrove (*Avicennia germinans*) forest. Urban encroachment adjacent to FFC interrupted the natural hydrology causing reduced tidal flushing and freshwater impoundment, ultimately resulting in mangrove forest mortality. Prior to restoration, these die-offs had no signs of sustainable mangrove re-establishment. The ecology of the areas deteriorated as fish and invertebrate movements into and out of the areas became restricted, and export of detrital material to the estuary was reduced. The die-off areas became compromised to the extent that intervention was required.
A team of scientists formed a partnership to develop and implement a restoration program. The die-offs will be addressed in stages beginning with the die-off north of C.R. 92, designated as Phase 1a. A 275 linear-foot tidal channel was constructed to connect the die-off area to an existing tidal tributary in effort to restore hydrologic connections to facilitate natural mangrove recovery. Monitoring data illustrated that mangrove saplings and young trees are on the increase and the canopy is beginning to form. Species of aquatic and terrestrial organisms commonly found in mangrove forests have colonized into the die-off area. All of these indicators are signs that the Phase 1a restoration is advancing. Hurricane Irma likely brought about only a temporary setback to the Phase 1a restoration area. It is unrealistic to expect restoration initiatives to return this die-off to the historic old-growth black mangrove forest. More realistic restoration expectations in mangrove areas that have been impacted by development should be geared at preventing further decline and restoring areas that have suffered major habitat loss to a state that the hydrology and topography can support.

PRESENTER BIO: Booher is a biologist at the Conservancy of Southwest Florida with 6 years of experience in Mangrove and Wetland Ecology.

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EVALUATION OF CITIZEN SCIENCE DATA FOR BIODIVERSITY RESEARCH IN THE GREATER EVERGLADES

Matthew Boone*; Henry Hochmair, and Mathieu Basille*

The use of citizen science collected data in scientific research is rapidly expanding. The two most popular citizen science data portals, iNaturalist and eBird, have seen exponential growth in usership and daily observations in the past 10 years, and now contribute massively to online databases. These data enter into the Global Biodiversity Information Facility database (GBIF) where they contribute to the understanding of species occurrence and seasonal movement patterns. Of the current 1 billion presence records of species in the GBIF database, the majority come from citizen science data collection, with more than 14 and 500 million records from iNaturalist and eBird alone, respectively. Citizen science data offers scientists the opportunity to increase spatial and temporal coverage of current biodiversity research compared to expert only collections. However, citizen science data can suffer from issues of imbalanced effort and data quality concerns, necessitating a need to assess usefulness of citizen science data in biodiversity research. We compared iNaturalist and eBird data to expert only data extracted from the GBIF database with metrics of coverage, saturation, completeness, and overall scientific value. To test their contribution for future global biodiversity research we created species distribution models using citizen science data and expert-only data for 16 wading bird species in Florida. Wading birds are common breeders throughout Florida wetland systems and act as important ecosystem indicators in the everglades. We found that throughout Florida, coverage of citizen science data was more complete than expert only data, and allowed for more detailed temporal studies and more accurate biodiversity metrics. Known issues with temporal modeling were evident in data sets like iNaturalist whose data collection is more opportunistic in nature than eBird. Coverage and accuracy generally declined with decreasing urban cover. Areas in high urban cover or highly trafficked areas (like State Parks) were generally robust in biodiversity calculations, however a lack of data persisted in the remote areas of the Everglades. Expert-only data sets showed strong statistical power when taken from controlled studies in small areas, but were weak in the coverage across time and space. Citizen science data sets contained larger spread of data points over time and space, but suffered from uneven effort. Both cases required careful statistical care to model and interpret effectively. We particularly recommend using citizen science data for biodiversity research in areas where coverage and effort is appropriate like Florida. Our results stress the importance of understanding the strengths and weaknesses of citizen science data set for biodiversity research, but highlight the power of harnessing these large global data set versus traditional data collection.

MONITORING OF NUTRIENTS AND CHLOROPHYLL IN THE CALOOSAHATCHEE RIVER, 2017-2018

Amanda C. Booth
U.S. Geological Survey, Fort Myers, FL, USA

The U.S. Geological Survey, Greater Everglades Priority Ecosystem Sciences program is investigating the use of in situ fluorescence sensors to develop an early warning system for harmful algal blooms and to document the extent of blooms and the water-quality associated with them. Harmful algal blooms (HABs) have been documented in Lake Okeechobee and in the Caloosahatchee River and the adjacent estuary since the early 1980s and are often linked to eutrophication. The Caloosahatchee River is connected to Lake Okeechobee via the C-43 Canal, and three lock structures regulate the amount of freshwater that is received into the lower river and estuary. The U.S. Geological Survey monitors water-quality upstream of S-79, the final lock structure between the C-43 Canal and the Caloosahatchee River Estuary. Parameters monitored at 15-minute intervals include temperature, specific conductance, turbidity, dissolved oxygen, pH, nitrate+nitrite, chlorophyll fluorescence, phycocyanin fluorescence, and fluorescence of colored dissolved organic material (fDOM). Discrete samples are collected monthly for the analysis of nutrients, chlorophyll and algal identification. Surrogate models to calculate total nitrogen concentrations and loads and chlorophyll concentrations using relationships between discrete samples and sensor data are being developed.

Additionally, the spatiotemporal distribution of physical water-quality parameters from the Caloosahatchee River and Estuary to Lake Okeechobee were documented during geo-referenced, near-surface, synoptic water-quality surveys conducted during July and August of 2018. Data were collected using an onboard pump system and multi-parameter sondes. Discrete samples for analysis of nutrients, chlorophyll, algal identification and stable isotopes of nitrate were collected at fixed locations and in response to specific water-quality sensor readings. Surrogate models to calculate total nitrogen and chlorophyll concentrations for the synoptic surveys are also being developed. The fixed monitoring station upstream of S-79 and the water-quality surveys within Lake Okeechobee and the Caloosahatchee River and Estuary will provide information on the relations between nutrients and HABs, as well as insights as to the annual and seasonal variations.

SPOIL ISLAND RESTORATION AND RESILIENCY

Amanda Bourque
National Park Service, Biscayne National Park, Homestead, FL, USA

Restoration of spoil islands and peninsulas is a means to enhance degraded lands, reduce shoreline erosion, improve nearshore water quality, and create valuable habitat for coastal wildlife. In Miami-Dade County, two spoil islands at the C-102 canal within the boundary of Biscayne National Park have been the focus of recent restoration efforts by the National Park Service. In 2015-2017, the islands were cleared of exotic vegetation and densely planted with 25+ species of native trees, shrubs, and grasses. Hurricane Irma became the 9th named storm of the 2017 hurricane season, and made landfall in Miami-Dade County, Florida on September 10, 2017. After the passing of Hurricane Irma, severe effects of wind damage, storm surge, and wave erosion were observed on both islands. The fringing vegetation on both islands (mature mangroves and buttonwoods that preceded the restoration efforts) was heavily wind damaged. On the eastern island, planted in 2015, some vegetation was lost or salt damaged, while the majority remained in place. On the western island, planted in June-July 2017, all planted vegetation was lost, except on the highest portion of the island which presumably escaped inundation and wave erosion. An analysis of the timing of planting, the susceptibility of planted species to severe perturbations, and patterns of post-storm recruitment on the islands provide valuable insight on designing resilience into revegetation projects in the coastal zone.

PRESENTER BIO: Dr. Bourque is an ecologist with the National Park Service, and has spent the past 15 years restoring marine and coastal habitat in Biscayne National Park.

LANDSCAPE CHANGE IN THE BISCAYNE BAY AREA FROM THE MID-1800S TO THE PRESENT

Mason Bradbury
Florida International University, Miami, FL, USA

Biscayne Bay has experienced human occupation for millennia, with intensive land use and landscape change taking place over the last 150 years. A number of restoration projects have been implemented along the shores of Biscayne Bay in order to address damage caused by anthropogenic disturbances, including destruction of wetlands, deforestation, and introduction of invasive species. One of the primary challenges in ecosystem restoration is the identification of accurate historical references. Historical references are crucial for establishing restoration targets that reflect the ecological trajectories of natural systems. Identification of historical references is particularly challenging for landscapes in South Florida that experienced intense anthropogenic disturbance before scientific documentation of vegetation boundaries occurred. To address this challenge and provide better historical references, I will analyze landscape change in the Biscayne Bay area from the mid-1800s through the present.

In order to analyze landscape change, I will first determine historical vegetation boundaries in the Biscayne Bay area in two different years, 1847 and 1928. Vegetation in 1847 will be mapped based on the US Government's General Land Office Public Land Survey maps as well as surveyors' notes. These maps and notes describe vegetation boundaries and other land marks along one square mile grids. Vegetation in 1928 will be classified and mapped using a set of aerial photographs. Finally, to determine landscape change, I will compare the 1847 and 1928 vegetation maps to each other and to contemporary vegetation maps using ArcGIS software. This project will create the earliest estimates of spatio-temporal landscape change in the Biscayne Bay area. I expect results to include a steep reduction in the extent of pine rockland and tropical hardwood hammock vegetation types between 1847 and 1928, with smaller decreases in wetlands. Upland areas occupied by pine and hardwood forests were targeted by early settlers, making it likely that these vegetation types experienced the highest rates of conversion in the period of early settlement and urbanization. I expect higher conversion of wetland vegetation types in the period from 1928 to the present, reflecting the progression of urbanization from upland areas into lower elevation wetlands. The results of this project will provide valuable information on historical baselines for restoration projects and advance understanding of the environmental history of the Biscayne Bay area.

PRESENTER BIO: Mason Bradbury is a PhD student in Florida International University's Department of Earth and Environment. His research interests include environmental history and sociocultural issues around ecosystem restoration in South Florida.

COMMUNICATING SCIENCE INFORMATION ON EVERGLADES RESTORATION

Laura A. Brandt
U.S. Fish and Wildlife Service, Davie, FL, USA

Communicating progress toward ecosystem restoration is challenging because of complexity of natural systems and diversity of audiences. Progress may mean different things to different audiences because of their responsibilities or values about different components of the ecosystem. In addition, there may be multiple reporting mechanisms required or used that may appear to give different messages. A way to tackle these challenges is to be explicit about communication goals and audiences, develop clear consistent messages, deliver them using multiple vehicles, evaluate if the intended audiences are reached and if the intended message was conveyed, and revise as needed. In this presentation, I will discuss how the South Florida Ecosystem Restoration Task Force System-wide Ecological Indicators for Greater Everglades Restoration has evolved over time to address (or not) these challenges.

The South Florida Ecosystem Restoration Task Force reports on progress towards Everglades restoration in a biennial report to Congress. The general status of the ecosystem and how the key ecological components respond to implementation of restoration projects is reported on using a suite of eleven system-wide ecological indicators. The Initial reporting format of a red, yellow, green "stoplight" report card was developed in 2006 to serve as a synthesizing tool for assessing Everglades restoration, and to facilitate interpretation of the results into a common language to effectively communicate the status of restoration. There are two versions of the report, the short version for the biennial report to Congress and a longer version that has more technical details. Over the years the reports have evolved with an eye toward better addressing needs of the audiences and better integration among indicators and across other reporting mechanisms including the Comprehensive Everglades Restoration Plan (CERP) Restoration Coordination and Verification (RECOVER) System Status Report (SSR) and Interim Goals report. Some of the steps necessary for better integration and communication have been fairly straight forward and easy (having a standard format for displaying the status of indicators and coordination on reporting years) while others have been more challenging (integrating with other reports prepared for different audiences, integrating indicators in a true system-wide manner, and dealing with funding shortfalls that have changed what data are available for reporting). Recognizing progress on effective reporting and opportunities for improvements is important for communicating the status of Everglades restoration.

PRESENTER BIO: Dr. Brandt has been a Wildlife Biologist with U.S. Fish and Wildlife Service in South Florida since 1999. Her current position is a multi-agency (USFWS and USGS) position within the Science Applications program of USFWS. She works with scientists and managers to facilitate getting ecological information into decision-making.

COMPARING RATES OF VERTICAL CHANGE IN MANGROVE AND MARSH SOILS OF THE COASTAL EVERGLADES USING MEASUREMENTS FROM SURFACE ELEVATION TABLES, MARKER HORIZONS, CS-137, PB-210, AND C-14

Joshua L. Breithaupt[1], *Gordon H. Anderson*[2], *Kevin R.T. Whelan*[3], *Joseph M. Smoak*[4], *Laura C. Feher*[5], *Michael J. Osland*[5], *and William C. Vervaeke*[5]

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Rates of vertical change in coastal wetland soils vary in response to many processes including sediment deposition, erosion, hydrologic fluctuations, and the preservation and decomposition of aboveground and belowground vegetation. Establishing a long-term, broad areal understanding of rates of vertical change in soils is challenging because the tools used to make these measurements operate over different spatial and temporal scales. Here we compare rates of vertical change at two mangrove and two marsh locations in the coastal Everglades using Cs-137, Pb-210, C-14 and surface elevation table-marker horizon (SET-MH) data. Our objectives were to investigate both the spatial and temporal variability of rates derived from these different methods, and to compare rates between mangrove and marsh locations.

Rates of vertical change were similar for these sites in previous millennia, but in recent centuries, differences began occurring between the mangrove and marsh sites. Accretion rates derived from C-14 were 0.7–0.8 mm yr^{-1} for marshes and mangroves over the last 2,000–4,000 years. Accretion rates determined with Pb-210 were approximately twice as high in the mangroves as they were in the marshes at each of the two locations over 50 and 100-yr timescales. Peak activities of Cs-137 were in good agreement with 50-yr average accretion rates derived from Pb-210 in the marsh sites, but no Cs-137 peaks were discernible in the more saline mangrove soils. At two of the sites, there was general agreement for accretion rates derived from marker horizons and the most recent 10-yr period identified by Pb-210. However, at the downstream mangrove site, the 10-year Pb-210 accretion rate was greater than the rate derived from marker horizons. One advantage of the SET-MH data is the ability to measure sub-surface expansion and contraction and attribute elevation change to different portions of the soil profile. For example, the SET-MH data indicate that root zone contraction and sub-root zone expansion have occurred at the upstream site. In contrast, the more downstream marsh site has experienced expansion within the root-zone and contraction below the root zone. Collectively, our analyses highlight some of the strengths and weaknesses of different approaches for measuring rates of vertical change in coastal wetland soils.

PRESENTER BIO: Dr. Breithaupt is a postdoctoral scholar in the Aquatic Biogeochemistry Lab of Dr. Lisa Chambers at the University of Central Florida.

FRACTIONATION OF PHOSPHOROUS IN CANALS DRAINING TO NE SHARK RIVER SLOUGH

***Henry Briceño*[1]**, *Eduardo Mollinedo*[1], *Sandro Stumpf*[1], *Dilip Shinde*[2], *Piero Gardinali*[1], *and Reinaldo García*[1]
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Water levels in Everglades' marshes and canals are closely tied to management and climate variability, and in turn, water quality is related to water levels, especially to Total Phosphorous (TP). As stages in the Water Conservation Area 3A (WCA-3A) decline, TP in the L67A canal increases, especially at S333 (inflow structure to Everglades National Park). Preliminary work suggests that bottom sediments at low stage, especially from the bottom of L29 canal (Tamiami Canal), have the potential of re-suspending and remobilizing nutrient-rich sediments that accumulate at the bottom that canal. These phosphorus- and organic-rich sediments are transported downstream while contributing part of their P load to canal waters which finally reach the Park. We explored the nature and composition of sediments and floc at the bottom of the study sites, trying to understand the mechanisms of short- and long-term storage and exchange of phosphorous in the canals. Given that the amount of phosphorous partitioned to the water column depends upon the chemical species bounding the phosphorous to the solid phase, we extracted phosphorous from floc and bottom sediments. Briefly, the fractionation scheme adopted in this research entailed: 1) Deionized water extraction (bioavailable P), corresponding to plant available and water extractable P; 2) Sodium bicarbonate extraction, equivalent to weakly-sorbed and bioavailable organic and inorganic P; 3) Sodium hydroxide extraction, rendering strongly bound chemisorbed P-potentially bioavailable; and 4) Hydrochloric acid extraction, equivalent to apatite or Carbonate-bound, non-bioavailable P. In general, for all sites, media and sampling event, the order of TP extracted by different reagents is as follows: Bioavailable ($H2O$) < weakly-sorbed ($NaHCO3$) = chemisorbed ($NaOH$)<< non-bioavailable (HCL). Finally, extraction by $H2O$, $NaHCO3$ and $NaOH$ from floc are slightly higher than those extractions from sediment, and substantially higher when extracted with HCL from floc than from sediments. These partitioning of P-species is relevant to the assessment of effective P-loads to ENP.

PRESENTER BIO: Dr. Briceño is a Full Research Professor with vast experience implementing water quality monitoring and nutrient cycling studies, assessing climate and human-induced impacts at the land-ocean interface, especially in the Florida Keys National Marine Sanctuary, Coastal Everglades, Biscayne Bay, Florida Bay, Florida Shelf, and in the Everglades.

ALLIGATORS AND CROCODILES AS INDICATORS OF ECOLOGICAL RESPONSES TO EVERGLADES RESTORATION

***Venetia S. Briggs-Gonzalez*[1]**, *Michiko A. Squires*[1], *Seth C. Farris*[1], *Caitlin Hackett*[1], *Michael S. Cherkiss*[2], *Brian J. Smith*[2], *Kristin M. Hart*[2], [3]*Hardin J. Waddle*, *Laura A. Brandt*[4] *and Frank J. Mazzotti*[1]

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[4]U.S. Fish and Wildlife Service, Davie, FL USA

At all life stages, alligators and crocodiles integrate biological impacts of hydrologic conditions. Florida's two native species of crocodilians—the American alligator (*Alligator mississippiensis*) and the American crocodile (*Crocodylus acutus*)—are important indicators of ecosystem health in the Everglades. Research has linked three key aspects of Everglades' ecology to these crocodilians: (1) as top predators they are directly dependent on prey density, especially aquatic and semi-aquatic organisms and thus provide a surrogate for status of many other species, (2) drier (nests) and wetter (trails and holes) conditions created by these ecosystem engineers provide habitat for plants and animals that otherwise would not be able to survive, (3) distribution and abundance of crocodilians in estuaries is directly dependent on timing, amount, and location of freshwater flow and crocodiles and alligators exhibit an immediate response to changes in freshwater inputs into the estuaries. Restoration success or failure can be evaluated by comparing recent and future trends and status of alligators and crocodile populations with historical population data and model predictions. Restoration hypotheses for alligators and crocodiles are as follows:

Alligators

- Restoration of hydropatterns (depth, duration, distribution, and flow) will improve relative density and body condition of alligators in southern marl prairie/rocky glades and ridge and slough landscapes.
- Restoration of estuarine salinity regimes will expand distribution and abundance of reproducing alligators into oligohaline portions of estuaries.

Crocodiles

- Restoration of freshwater flows and salinity regimes to estuaries will increase relative density, body condition, growth, and survival of crocodiles.

The main objectives of this monitoring effort have been to: 1) monitor changes in alligator populations resulting from restoration over short-term (body condition), medium-term (distribution, relative density, hole occupancy) and long-term (demography) temporal scales, and 2) monitor changes in growth, survival, body condition, relative density, and nesting of crocodiles in response to restoration projects. Interim results of the monitoring program provide quantitative support for the restoration hypotheses. Positive ecological responses of alligators and crocodiles are expected as ecosystem restoration proceeds.

PRESENTER BIO: Dr. Venetia Briggs-Gonzalez is research biologist with the CrocDocs at University of Florida using long-term data sets of crocodilians to assess response to Everglades restoration projects.

USING HALOHABITAT-DEFINED EPIFAUNA COMMUNITIES FROM THE NEARSHORE EPIFAUNA TO DETERMINE ESTUARINE RESPONSES TO HURRICANE IRMA AND OTHER EXTREME EVENTS

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Shrimp, crabs, and small fishes are being monitored in western nearshore Biscayne Bay to assess implementation effects of the Comprehensive Everglades Restoration Plan (CERP). To gain perspective on potential responses to CERP, we used data from 12 years of pre-CERP and early-CERP monitoring to assess the effect of natural disturbances, including Hurricane Irma, on the epifaunal community. Other extreme events observed during the years of monitoring included the severe cold snap of Dry 2010, the microalgal bloom of Wet 2013, the atypical hypersaline wet seasons of 2011 and 2015, and the sargassum intrusions of the 2015 and 2018 wet seasons. The epifauna were sampled twice each year, dry season and wet season, with 3 deployments of a 1-m^2 throw-trap at each of 47 fixed, alongshore sites located between Shoal Point and Turkey Point. Sampling from Dry 2007 to Wet 2018 captured 71,840 individuals, representing 123 unique taxa, of which 67 were fishes, 22 were crabs, 5 were penaeid shrimps, and 29 were caridean shrimps. We expected the epifaunal community to respond to disruptive events with a change in number, biomass, or biodiversity. Realizing all species were unlikely to have the same response, we separated them into groups we thought likely to respond similarly in order to see responses more clearly. Because departure from the usual range of salinity variation was a major hurricane effect and also integral to hypersaline wet seasons, we separated the species into groups by salinity affinity. Each taxon was assigned to one of four “halohabitat” groups based on its median salinity of occurrence, weighted by abundance, over the multi-year sampling period. We defined four halohabitat groups and salinity ranges for inclusion into each group as follows: mesohaline (5-18), low polyhaline (18.1-24), high polyhaline (24.1-30) and low euhaline (30.1-35), in a refinement of the Venice system. The samples included 7 mesohaline taxa, 47 low polyhaline taxa, 54 high polyhaline taxa, and 15 low euhaline taxa, represented by 83; 43,967; 27,525; and 264 organisms, respectively. A species-time matrix of number of individuals of each species, coded by halohabitat, was subjected to a hierarchal clustering procedure that grouped species by similarity of their year-season patterns of variation. Significant differences among the temporal patterns of halohabitat species groups were determined with PERMANOVA. Then time series of year-season patterns of halohabitat groups were investigated in relation to the timing of disruptive events to determine responses and resiliency of the nearshore epifauna.

<u>PRESENTER BIO</u>: Dr. Browder is Research Biologist and Unit Leader at NOAA NMFS. Her main research interest concerns the effect of water management on estuarine ecosystems. She conducts monitoring and assessment in south Florida estuaries for CERP. Principal research subjects are shrimp and small forage fishes.

MONITORING FLOWS TO THE COASTAL EVERGLADES IN RESPONSE TO RESTORATION EFFORTS

Eric Carlson

U.S. Geological Survey Caribbean-Florida Water Science Center

The Florida Everglades is a diverse ecosystem that has been adversely affected by urbanization and water management practices. As south Florida and parts of the Everglades were developed for agricultural use and expanding urban centers, water management structures were installed to regulate the natural hydrology of the Everglades altering the freshwater quantity, quality, timing, and distribution to northeastern Florida Bay and the southwest coast of Florida. During the last decade, Florida Bay has experienced a substantial seagrass die-off and algal blooms, possible signs of ecological deterioration attributed to decreased flows and increased salinity in the streams flowing to the bay. As projects are implemented to aid in restoring the hydrology of the Everglades, the effects of these water management operations on the coastal hydrology must be understood.

Efforts to restore Everglades wetlands to more natural conditions aim to increase the amount of freshwater delivered to northeastern Florida Bay and the southwest coast of Florida. A study was conducted to quantify flows delivered to Florida Bay and the southwest coast via Taylor Slough and Shark River Slough, the primary flow paths to the coastal Everglades. Inflows to Everglades National Park from water management structures and rainfall were compared to outflows from coastal creeks and rivers spanning three different water management operational periods, pre-Interim Operational Period (1997-1999), Interim Operational Period (2000-2012), and Everglades Restoration Transition Plan (2013-2017). Annual flow and salinity data are presented to illustrate hydrologic conditions across water management operational periods and will be the baseline to evaluate future Everglades restoration efforts.

PRESENTER BIO: Eric Carlson earned his Master's degree in Hydrogeology from FAU in 2008. He is a Physical Scientist with the USGS and has been working in the Everglades for over 10 years and has been a Project Investigator since 2016.

EFFECTS OF KISSIMMEE RIVER RESTORATION ON UPSTREAM LAKES: A LOOK AT LITTORAL VEGETATION

Zach Welch and ***Camille Carroll***
South Florida Water Management District, West Palm Beach, FL, USA

The Kissimmee Chain of Lakes (the KCOL) is the starting point for the Kissimmee-Okeechobee-Everglades system. Three of the southernmost lakes are managed at the same water level and form the Headwater Lakes of the Kissimmee River, playing a critical role in delivering water to the downstream restoration project. The Kissimmee River Headwaters Revitalization Project (HRP) is designed to increase storage in the Headwater Lakes to provide appropriate flow patterns to the Kissimmee River and its floodplain upon completion of restoration construction. These changes are expected to also benefit the Headwater Lakes by shifting the seasonality and variability of water levels closer to pre-management levels resulting in increased quantity and quality of littoral zone vegetation around the lakes. This project will evaluate vegetation changes over time to determine effects of HRP on the Headwater Lakes.

The HRP will allow stages to rise up to 1.5 ft. higher than the current maximum stage and raise the seasonal low pool by up to 3.5 ft., which constitute major changes in littoral zone hydrology from conditions of the last half-century. Long-term, permanent monitoring stations were established on three of the major water bodies in the KCOL in early 2015: East Lake Tohopekaliga, Lake Tohopekaliga, and Lake Kissimmee. Lake Kissimmee is the only lake that will have a different regulation schedule under the HRP, while Lake Tohopekaliga and East Lake Tohopekaliga will serve as control lakes for comparison. The permanent monitoring stations include circular plots that are stratified by water depth and community type throughout the littoral zone, as well as belt transects set perpendicular to shore in the upper reaches of the littoral zone.

Here we compare historical and simulated hydrological data to assess how water levels may differ under the HRP and we present vegetation monitoring data that describe littoral vegetation communities under observed, pre-HRP conditions. Monitoring to date has documented distinct vegetation communities that occur along littoral zone elevation gradients and are likely sensitive to changes in water levels. Communities differ by indicator species, species richness, and wetland indicator status. Our baseline characterizations of littoral zone vegetation communities prior to restoration actions will enable examinations of shifts in community type that may result from hydrological changes. Likewise, our vegetation community analysis will aid in the overall understanding of the relationship between littoral zone plant communities and hydrology within lake ecosystems.

PRESENTER BIO: Camille has worked in South Florida plant communities since 1999, and recently started working in the lakes of Central Florida.

EXAMINING THE THREAT OF CONTAMINANTS TO SOUTH FLORIDA BONEFISH: A SPATIAL APPROACH

***Nicholas A. Castillo*[1]*,** *Jennifer S. Rehage*[1]*, Rolando O. Santos*[1]*, Aaron Adams*[2]*, Ross Boucek*[2]*, Tomas Brodin*[3]*, Jerker Fick*[3]

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In South Florida, the recreational fishing industry accounts for a significant economic impact, with the flats fishery being particularly important. A decline in the Bonefish stock has been observed over the last decades. This study examines the potential role of contaminants in the decline of Bonefish in South Florida. We apply a spatial approach to ask: 1) how does exposure to key contaminants (copper and pharmaceuticals) vary across large scales in the Caribbean and 2) across small scales across regions in South Florida. Recent studies have shown elevated levels of copper contaminants in the Biscayne Bay region, and preliminary studies have shown the presence of pharmaceuticals in Keys bonefish. Previous work has shown that pharmaceuticals pose a threat to marine fish and can result in significant and unintended behavioral alterations. With the documented presence and impact of contaminants and pharmaceuticals to marine biota, there exists the need to explore the impacts and effects of these contaminants, particularly on valuable recreational fisheries.

PRESENTER BIO: Nicholas Castillo is a Doctoral student in the Coastal Fisheries lab at Florida International University. His interests include the relationship between environmental conditions and behavioral responses in fish, which he is applying to the aforementioned project looking at the effects of contaminants to South Florida Bonefish.

VALLISNERIA AMERICANA RESTORATION IN THE CALOOSAHATCHEE RIVER & ESTUARY: BUILDING COASTAL RESILIENCY THROUGH PARTNERSHIPS, APPLIED RESEARCH & ADAPTIVE MANAGEMENT

*Brett Fitzgerald[1], **David W. Ceilley[2]**, Carter Henne[3], Jim Anderson[3], Edwin M. Everham III[4] and James Douglass[4]*
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Historically, the tidal Caloosahatchee River and upper (oligohaline) estuary was covered with vast submerged beds of tape grass, (*Vallisneria americana*) also known as eel grass and wild celery. Research has shown that these *Vallisneria* beds provided habitat for shrimp, crabs, bivalves and over 44 species of fish. They also provided forage for threatened manatees, freshwater turtles, migratory waterfowl, and many other aquatic herbivores. Since 2001, the Caloosahatchee estuary has lost over 1,200 acres of dense *Vallisneria* beds due to a combination of factors including anthropogenic discharges of freshwater from Lake Okeechobee, reductions in base flow, and droughts in 2001 and 2007-08 resulting in abnormally high salinity levels (>20 ppt) for several weeks or months. There has been no documented *Vallisneria* pistillate (female) flowering since 1999 and the sediment seed bank appears completely exhausted, with little prospect for natural recovery. Several small pilot restoration projects were conducted between 2002-2009 with two slightly larger projects completed in 2013 and each found that excessive grazing pressure was controlling growth and recovery of *Vallisneria*, both in the estuary and freshwater sections of the Caloosahatchee. The most recent, and larger pilot restoration project (2015-2018) was conducted at four freshwater sites upstream of the S-79 control structure using ten (10) Grow SAV^{tm} exclosures at each site. Flowering and seed production was observed in four months, but only inside exclosures. *Vallisneria* shoot densities inside exclosures peaked at 1,700 shoots/square meter within 16 months of planting. After three years, there was no growth outside of exclosures due to grazing pressure. Primary grazers include freshwater turtles, manatees, crabs, fishes and the invasive non-native apple snail, *Pomacea maculata*. It became clear that a much larger scale up of the restoration was needed to ensure establishment of plants and allow for flowering and seed production. Such scaled-up *Vallisneria* restoration have been successful in King's Bay, Citrus County, Florida. A scaled-up 20-acre *Vallisneria* restoration project is currently underway at three sites in the Caloosahatchee River estuary funded by the State of Florida. The project represents a unique public/private/academic partnership with the not-for profit Angler Action Foundation administering the project for the State of Florida. Sea and Shoreline LLC constructed Grow SAV^{tm} exclosure cages and installed >12,500 *Vallisneria americana* plants in 500 exclosures (≥25/exclosure), as well as planting 75,000 individual plugs along with 25,000 *Ruppia maritima* plugs. Johnson Engineering ecologists are integrating research and restoration by quantifying ecosystem services provided by *Vallisneria* beds through monitoring fish and macroinvertebrate communities, C, TN and TP uptake, water clarity, and plant growth and reproduction. Florida Gulf Coast University faculty and graduate students have teamed with Johnson Engineering to quantify ecosystem services provided by the *Vallisneria* restoration. The restoration project was initiated in October 2018 with initial planting completed in January 2019. The study includes three years of maintenance and monitoring.

PRESENTER BIO: David W. Ceilley, M.S. CSE is an aquatic ecologist, project manager and researcher with 30-years of experience in SW Florida with an emphasis on restoration ecology including Everglades Restoration projects. He has extensive experience in fish and macroinvertebrate community assessments, wetlands and aquatic ecosystem monitoring, and biological indicators.

CULTIVATION OF THE MOST ABUNDANT BACTERIA FROM THE FRESHWATER MARSHES OF THE EVERGLADES AND THEIR METABOLIC RESPONSE TO SALTWATER INTRUSION

Seemanti Chakrabarti[1], *Peeter Laas*[1], *Demi Carballosa*[2], *Elizabeth Gomez*[2] *and Ulrich Stingl*[1]
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Bacteria in wetlands are pivotal for the degradation and conversion of complex dissolved organic matter, uptake and recycling of inorganic nutrients, and transport of nutrients to higher trophic levels. In a recent cultivation-independent approach, our lab identified heterotrophic betaproteobacteria of the genus *Polynucleobacter* as the dominating species in the waters of the freshwater marshes in the Everglades (Laas et al., submitted). *Polynucleobacter* accounted for approximately 29% of the bacterial community in the water column of low-salinity stations along the Shark River and Taylor Slough transects, both of which are part of the NSF-funded FCE-LTER project run by FIU.

By using a combination of dilution-to-extinction culturing and traditional plate culturing, we were able to obtain isolates from the two most abundant species of *Polynucleobacter*: *Polynucleobacter asymbioticus* and *Polynucleobacter cosmopolitanus*. Based on data from literature searches, these organisms are essential for the initial degradation of humic substances in oligotrophic limnic environments.

Saltwater intrusion (SWI) is increasing salinity concentrations in inland freshwater habitats in the Everglades and will most likely have a significant impact on microbial community structure and microbial processes there, both in the sediments as well as in the water column. Here, we show that Everglades *Polynucleobacter* strains can only tolerate low concentrations of salt, and therefore, with increasing SWI, will most likely be outcompeted by other bacteria. This hypothesized change in microbial community structure that we are currently testing in our lab, will be accompanied by unknown consequences on changes in rates of DOM degradation and unknown impacts on higher trophic levels.

PRESENTER BIO: Dr. Chakrabarti got her Ph.D in veterinary entomology from Kansas State University. She has worked on determining the dispersal patterns of insect vectors and their potential role in disease transmission in an event of an outbreak. She is currently working on culturing the most abundant bacteria found in the Everglades and use them as representatives to do SWI studies.

SOIL ACCRETION AND ORGANIC CARBON BURIAL OVER CENTENNIAL AND MILLENNIAL TIME SCALES ON MANGROVE ISLANDS IN THE LOWER FLORIDA KEYS

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Vertical soil accretion on mangrove islands in the Florida Keys has been able to keep pace with the rate of relative sea-level rise (SLR) for several millennia. However, projected rates of future SLR show continued acceleration, far surpassing observed rates of accretion. The objective of this study was to compare rates of soil accretion and organic carbon (OC) burial from three sites in the Lower Florida Keys using two different time scales via ^{210}Pb and ^{14}C (i.e., centennial and millennial). This permitted examination of various temporal responses and drivers. All rates were greater when assessed over shorter timescales. The centennial OC burial rates measured via ^{210}Pb during this study ranged from 106 ± 6 to 151 ± 7 g m^{-2} yr^{-1}. A radiocarbon-based age-depth model was constructed at Snipe Key, giving a mean OC burial rate of 39.98 ± 13.53 g m^{-2} y^{-1}, with basal peat estimated to have formed around 6 ka BP (mid-Holocene). The ^{14}C mean accretion rate was 0.69 ± 0.17 mm y^{-1}, whereas the ^{210}Pb mean accretion rates ranged from 2.0 ± 0.76 to 4.2 ± 1.5 mm yr^{-1} (100-, 50-, and 10-yr most-recent mean rates, respectively). The 100- and 50-yr mean accretion rates are within error of the associated rates of SLR. However, rates of SLR have increased over the past ten years and are now greater than the rates of accretion required for these mangrove forests to avoid submergence. Lower rates of accretion and OC burial for longer timescales suggests rates vary over time, likely driven by sea level's influence on sediment delivery and/or soil preservation.

<u>PRESENTER BIO</u>: Amanda has a Master's in Environmental Science from the University of South Florida. She has been a technician with the Coastal Wetlands Program at Florida Fish and Wildlife Research Institute for five years, with research emphasis on blue carbon quantification and the impacts of sea-level rise on mangrove ecosystems.

RESTORATION BENEFITS OBSERVED FROM THE BISCAYNE BAY COASTAL WETLANDS PROJECT

Bahram Charkhian
South Florida Water Management District, West Palm Beach, FL, USA

The purpose of the Biscayne Bay Coastal Wetlands (BBCW) project is to contribute to the restoration of Biscayne Bay and adjacent coastal wetlands as part of a comprehensive plan for restoring the south Florida ecosystem. The project redistributes freshwater from existing point source canal discharges to coastal wetlands adjacent to Biscayne Bay providing for a more natural and historic overland flow to remnant tidal creeks. The project will improve the ecological function of saltwater wetlands and the nearshore bay environment by improving salinity conditions for fish and shellfish nursery habitat.

The Water Resources Reform and Development Act of 2014 authorized the Biscayne Bay Coastal Wetlands Project. Elements of these projects have been constructed and operated over the last 5 years.
BBCW Phase 1 is composed of three components: Deering Estate, Cutler Wetlands and L-31E Component. In advance of congressional authorization, the South Florida Water Management District (SFWMD) constructed the Deering Estate Component and installed culverts for the L-31E Component. By expediting the completion of these project features, hydrologic improvements and environmental benefits are already being realized.

Comparison of ecological monitoring data collected during the last seven years with previous baseline data, indicates that the project is trending towards success. There is improved water quality to the bay as fresh water is redirected from canals to wetlands via the L-31E Culverts and the Deering Estate Component. Additionally, point source fresh water discharges have been reduced. Monitoring results clearly demonstrate improved hydrologic conditions in response to operation of the Deering Estate pump station (S-700). The BBCW L-31E Flow way Interim electric pump (S-709) was installed in March 2016 and became operational in August 2017. Salinity in L-31E tilde wetlands reduce below 5 psi and some improvement in salinity concentration within zone of influence of freshwater interim pump observed. There were no exceedances of Class III marine water criteria for Deering Estate Component and L-31E Culverts.

Vegetation within the vicinity of Deering Estate Flow-way is responding to improved hydrology demonstrated by die-off of upland vegetation, emergence of wetland species and expansion of sawgrass and Thelypteris patens recruitment observed. Surface water salinity decreased to <1 in response to the pumping of fresh water from the Deering Estate Component Pump Station into the historic remnant wetlands in the vicinity of Cutler Creek. Groundwater salinity near the Deering Estate Flow-way also responded to the input of fresh water from S-700 into the historic remnant wetlands, salinity decreased to less than 10. Sawgrass mapping of 470 acres in the Miami Dade-County Preserve wetlands was performed in 2013 and 2017. During this period there was a 9-acre increase. The District recently, recommended changes in operation of Deering Estate Pump station using a 25cfs pumping and regime that will improve the condition for developing natural wetland hydroperiods and other recommendations that would improve sheet flow across wetlands.
This presentation will focus on recent restoration benefits in the Biscayne Bay Coastal Wetland Project.

FROM PASTURE TO WETLANDS: WETLAND CREATION & RESTORATION AT WINDING WATERS NATURAL AREA

Jennifer E. Chastant
Palm Beach County Department of Environmental Resources Management, West Palm Beach, FL, USA

Since the early 1990s, Palm Beach County (County) has acquired, restored, and preserved over 31,000 acres of land as natural areas. A highlight of the County's restoration success is Winding Waters Natural Area. Winding Waters Natural Area is located in the northeastern portion of Palm Beach County. The County purchased this 562-acre natural area in 2001 with two primary goals of 1) preserving remnant natural communities supporting listed plant and animal species, and2) enhancing local groundwater resources. Restoration efforts focused on improving hydrology, removing invasive nonnative vegetation, wetland creation, and planting and relocating existing native vegetation. Excavation of the 185-acre wetland began in 2009, a mile of canal was removed to re-route flows into the created wetland, and water control elevations were raised from 9 to 13.5 feet on the site. Likewise, within the footprint of the wetland creation area, contractors removed 150-acres of melaleuca (*Melaleuca quinquenervia*) and Brazilian peppertree (*Schinus terebinthifolius*). Between May 2015 and May 2017, over 1,300 native Florida apple snail (*Pomacea paludosa*) hatchlings were released in 6 locations around the created wetland. Monitoring stations suggest the snails have established and spread throughout nearly the entire wetland. Moreover, Limpkin (*Aramus guarauna*) and Everglades Snail Kite (*Rostrhamus sociabilis*) are now regularly seen utilizing the site. The success documented at Winding Waters Natural Area is just one example of the County's many restoration achievements.

PRESENTER BIO: Dr. Chastant is an Environmental Analyst with over 9 years of experience in south Florida wetland ecosystems and more than 15 years of experience studying and restoring freshwater ecosystems throughout North America.

DETERMINING COARSE WOODY DEBRIS IN MANGROVE FOREST OF THE FLORIDA EVERGLADES AFTER HURRICANE IRMA USING AIRBORNE LIDAR IMAGERY

Selena Chavez[1], *David Lagomasino*[2], *Lola Fatoyinbo*[2], *Bruce Cook*[2], *Edward Castaneda*[1], *Ryan Moy r*[3], *Kara Radabaugh*[3,4], *Joseph M. Smoak*[4], *Shimon Wdowinski*[1]

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Mangroves have been shown to have potential benefits in protecting coastal areas from natural disasters, such as hurricanes. Hurricane Irma hit the coast of southwest Florida in September of 2017, impacting large swaths of mangrove forests. A combination of strong winds and high storm surge were extensive across the area resulting defoliation, broken branches, and downed trees. As a result, large volumes of Coarse Woody Debris (CWD), in the form of downed branches and trees fell to the forest floor. This material is important to the ecosystem as it helps in nutrient recycling and provides food and new habitat for other organisms. Unique airborne imagery collected by NASA Goddard's Lidar, Hyperspectral and Thermal imager (G-LiHT) before and after Hurricane Irma provides new opportunities to estimate the volume of CWD deposited during the storm. We developed novel metrics derived from the high-resolution lidar points clouds to determine the amount of live woody volume in the canopy before the storm and CWD on the ground after the storm. Derived metrics from G-LiHT were also used to model dead biomass for the mangrove forest where G-LiHT data was collected to identify regional patterns of disturbance. The modeled dead biomass for the Shark River and Harney River is estimated to be 6.0 Mg/ha and 8.3 Mg/ha, respectively, representing roughly 5-10% of the pre-hurricane above ground biomass in the study areas. Preliminary results reveal that the Harney river was more impacted than the Shark river based on field data and modeled dead biomass. The extent and distribution of CWD can not only identify regions of major disturbance across south Florida, but also help to model the future effects on these systems as nutrients are released as CWD decomposes over the next few years.

<ins>PRESENTER BIO</ins>: Selena Chavez is a currently a first year Ph.d student at Florida International University and works in the Geodesy Lab under the advisory of Dr. Shimon Wdowinski. She holds a Bachelor's of Science in environment science and policy with a concentration in marine and coastal management from the University Maryland.

RESPONSES OF RIVER METABOLISM TO PHASE I OF THE KISSIMMEE RIVER RESTORATION PROJECT

Hongjun Chen
South Florida Water Management District, West Palm Beach, FL, USA

Metabolism estimates provide an integrated response to a broad range of changes and disturbances within an aquatic ecosystem and are useful in evaluating restoration and recovery of degraded riverine ecosystems. The single station diel oxygen curve method was used to determine the response of river metabolism to restoration of flow in the river channel of the Phase I area of the Kissimmee River Restoration Project. Daily gross primary productivity (GPP), community respiration (CR), GPP/CR ratio, and net daily metabolism (NDM) were estimated before and after reestablishment of near-continuous flow through the river channel. Daily metabolic rates varied greatly. Annual GPP and CR rates had a similar seasonal pattern and were high in the spring and summer and low in the fall and winter for most of the years after reestablishment of continuous flow. Mean annual GPP and CR rates were 3.07 g O_2 m^{-2} d^{-1} and 2.54 g O_2 m^{-2} d^{-1}, respectively, before reestablishment of flow in December 1997 - May 1999 (Baseline period). After reestablishment of river channel flow, mean annual GPP and CR rates increased to 8.02 g O_2 m^{-2} d^{-1} and 6.69 g O_2 m^{-2} d^{-1}, respectively, for the period December 2005 – December 2010 (Impact period). Mean annual NDM increased from 0.53 g O_2 m^{-2} d^{-1} during the baseline period to 1.34 g O_2 m^{-2} d^{-1} after river channel flow was reestablished. The ratio of GPP/CR changed little after river channel flow was reestablished. Mean annual dissolved oxygen concentration significantly increased from 2.7 mg l^{-1} in the baseline period to 5.0 mg l^{-1} after river channel flow was reestablished. The significant increases in GPP, CR, NDM, and DO suggest ecological condition improvement in the river channel with reestablished river channel flow.

PRESENTER BIO: Dr. Chen is a senior scientist with more than 15 years of experience designing and implementing ecological research projects. He has extensive experience with the Everglades restoration, stormwater treatment wetlands, and Kissimmee River Restoration Project.

CHARACTERISTICS OF DISSOLVED OXYGEN AND HYPOXIA IN THE ST. LUCIE ESTUARY, FLORIDA: EFFECTS OF FRESHWATER INFLOW AND CHLOROPHYLL A

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The spatial and temporal distributions of bottom dissolved oxygen and hypoxia (i.e., dissolved oxygen concentration < 2 mg l^{-1}) and the physical and biological factors affecting formation and dissipation of hypoxia were evaluated by examining water quality monitoring data collected on three different time scales from monthly (1995 to 2017), weekly (2000) and every 30 minutes (2005). Hypoxia was observed mostly in the upper estuary (i.e., up to 30% of total measurements at the heads of its three tributaries) during the wet season (May-October) and was less frequently observed in the lower estuary (i.e., did not occur at inlet station) and in the dry season (November-April). Overall hypoxia incidence in the SLE was not often observed (only ~3 % of total observations excluding those three tributary stations). Both correlation analyses and time series data revealed that dissolved oxygen/hypoxia were closely related to stratification, which was in turn impacted by freshwater inflow. The low occurrence of hypoxia was likely attributable to relatively weak stratification (average surface and bottom density difference of ~3.3 kg m^3) in the SLE. Despite DO was primarily controlled by stratification, dissolved oxygen also appeared to be closely associated with chlorophyll *a* concentration, suggesting that reductions in chlorophyll *a* may help improve oxygen conditions in the SLE. The observed hypoxia patterns and associated factors suggest that both physical (e.g., freshwater inflow) and biological (chlorophyll *a* concentration) factors be considered in effective management and assessment of hypoxia in the SLE.

SHIFTS IN HATCHING DATE OF AMERICAN CROCODILE (*CROCODYLUS ACUTUS*) IN SOUTHERN FLORIDA

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Around the world, temperature of marine environments is rising and temperature plays an important role in the life-history of reptiles. In this study, we examined the relationship between sea surface temperature (SST) and date of hatching for American crocodiles (*Crocodylus acutus*) over a 37-year period at two nesting sites, Everglades National Park (Everglades) and Florida Power and Light Turkey Point Power Plant (Turkey Point) in southern Florida. Our results indicate that hatch dates are shifting 1.5 days earlier every two years at Everglades and at half that rate for Turkey Point. W with every 1° C degree increase in SST, hatch date occurs about 10 days earlier in Everglades and 6 days at Turkey Point. Our results provide further details about the impacts of temperature on crocodile life history and suggest that increased temperature may affect their nesting phenology.

PRESENTER BIO: Michael Cherkiss is a Wildlife Biologist with over 20 years of experience conducting research in the coastal areas of South Florida, Everglades ecosystems and internationally throughout the Caribbean, and Central America. He has extensive experience with crocodilians, sea turtles, pythons and other species of reptiles and amphibians throughout South Florida.

TOWARDS A SELF-SUSTAINING EVERGLADES: ECOLOGICALLY-BASED FLOW MODELING TO ACCOUNT FOR EFFECTS OF CHANGING VEGETATION AND PEAT MICROTOPOGRAPHY ON EVERGLADES HYDROLOGY

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Everglades restoration managers need reliable hydrological and ecological models to simulate outcomes of alternative management actions. Once levees are removed, Everglades water depths and flows become increasingly under the control of the ecosystem. These controls must be better understood and modeled to manage the system adaptively. Central to this need is a hydrological model that includes direction, volume and rate of sheet flow based on parameters that are fundamentally ecological, that is, the flow resistance of various types of vegetation and of peat microtopography. These resistances can completely block sheet flow, even when considerable surface water remains. We propose that hydrologic simulations that explicitly consider vegetation drag and microtopography can improve the regional hydrologic models used for simulation and management. For our analysis we used upscaled flow resistance modeling parameters terms derived from the statistics of detailed simulations through a full range of landscape configurations (Larsen et al., 2017) to produce a weighted expression that considers the proportion of dense sawgrass ridges, the directional connectivity of the sloughs, and the associated water depths for ridges and sloughs. To keep it simple for stakeholders who might apply our results, we summarized our physically-based rate law in terms of the traditionally used empirical rates laws, Manning's law and Kadlec's law, which are commonly used in system-wide modeling of flow through wetlands. Our physically-based rate law uses as input the characteristics of vegetation and microtopography. We used data from 23 of the approximately 62 PSUs (approximately 2 x 5 km) that characterized six sub-basins of the central Everglades. These 23 quadrats featured aerial vegetation images that overlapped locations of microtopographic measurements. Data were pooled by sub-basin, and for each the percent sawgrass ridge, directional connectivity of sloughs, anisotropy of ridges, and characteristic elevation difference between ridges and sloughs were quantified, from which the physically-based rate laws were parameterized. The resulting upscaled rate law was tested at three sites, in south-central WCA-2A, in west-central WCA-3A, and in the pocket between WCA-3A and WCA-3B where experimental high flows are now being investigated in the "DPM" high flow study. Those sites were chosen based on availability of detailed measurements of flow depth and velocity over a wet season or longer. Preliminary findings of our improved physically-based model of Everglades flow will have prospects for applications in system-wide models such as Regional Simulation Model (RSM).

PRESENTER BIO: Dr. Jay Choi is a hydrologist with the USGS and is the technical lead of the USGS program with the interagency Decomp Physical Model (DPM) Science Team. He has eleven years of research experience in Everglades science.

MONITORING SUCCESS OF THE PICAYUNE STRAND RESTORATION PROJECT (PSRP)

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The Picayune Strand Restoration Project (PSRP) is located to the west of Fakahatchee Strand State Park Preserve in Collier County, Florida. This 55,000-acre restoration project is part of the Comprehensive Everglades Restoration Plan and was one of the Acceler-8 projects initiated in 2004. The PSRP is intended to restore the hydrology of a system that was impacted by roads and canals constructed for a Gulf American Corporation development project. In order to assess the success of the restoration, ecological monitoring efforts occur

periodically in conjunction with continuous water level monitoring wells. As potential indicators of hydrologic restoration, anuran, fish, macroinvertebrate, and plant communities have been monitored. Anurans are sampled using PVC pipe refugia, fish are sampled using Breder traps and throw traps, macroinvertebrates are sampled by dip netting, and plants are monitored along transects. Reference sites at Florida Panther National Wildlife Refuge and Fakahatchee Strand Preserve State Park are also sampled in the same manner. Univariate analysis of biodiversity indices and multivariate analyses, within and across taxa, are used to compare biotic communities across the restoration and reference sites. These results will be utilized to compare the effectiveness of each measure of restoration success, and the overall progress of the project.

PRESENTER BIO: Phoebe Clark is an Environmental Science Masters Student at Florida Gulf Coast University with an Environmental Science BA from the University of Virginia. She has experience in lobster aquaculture, shorebird monitoring, natural community surveys, and environmental education. She is interested in working with non-profits and governmental organizations doing research and conservation.

A CASE FOR PHYSIOLOGICAL METRICS IN THE MANAGEMENT AND PREVENTION OF REPTILE INVASIONS

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Despite the prevalence of reptiles as successful invaders, little is known about the physiological traits that facilitate reptile invasion success after establishment. Currently, physiological screening of invaders focuses on thermal limits and reproductive output. These metrics are useful for determining coarse estimates of suitable habitat and rate of population growth, but determining these values requires time-intensive experiments with captive animals. In addition, these metrics focus on later stages of invasion. Investigation of additional physiological responses, especially those indicated in establishment and early spatial spread, can provide management guidance while eradication is still feasible.

More than 50 species of introduced reptiles from different phylogenetic and geographic origins are established in Florida. It is likely that these species converged on similar physiological mechanisms to facilitate successful establishment. Invasive species are removed from many of their natural enemies that regulate populations in their native range, including pathogens and parasites. With the reduced threat, invasive vertebrates may suppress immune responses, which may allow them to divert energy for reproduction and spread. Glucocorticoid (or stress) hormones regulate immune responses and have been implicated in the success of other invasive species. This research explores the utility of immune and stress response metrics as indicators of invasion success. These metrics can be assessed from blood samples of wild individuals, and results can be obtained within a few days at relatively low cost. Blood-derived physiological metrics may prove useful as a screening tool for establishment risk. If stress and immune metrics indicate current range expansion by an established species, these metrics may be used to prioritize targeted eradication of a population while it is still cost-effective and feasible. If metrics predict invader establishment, blood samples can be used to screen species common in trade for establishment risk and prioritize rapid response efforts for newly introduced species. This research directly investigates physiological mechanisms that may flag a species as a potential invader and thus furthers knowledge of invasive species prevention, the most cost-effective management action.

PRESENTER BIO: Natalie Claunch is a PhD candidate at the University of Florida. She is an animal physiologist and herpetologist interested in applying physiological tools in conservation and wildlife management.

FRESHWATER PREY ENHANCES WHITE IBIS (*EUDOCIMUS ALBUS*) NESTING AT COASTAL COLONIES IN EVERGLADES NATIONAL PARK

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Prior to extensive draining and compartmentalization of wetlands in south Florida, coastal nesting colonies within the freshwater-marine ecotone of the southern Everglades (Everglades National Park, ENP) hosted most wading bird breeding activity. The White Ibis (*Eudocimus albus*) is, currently and historically, the most abundant wading bird species nesting in the Everglades, and its nesting dynamics in this formerly productive region are a metric of ecosystem restoration success. Previous studies of White Ibis diet in the central Everglades highlight the importance of crayfish (*Procambarus fallax*) to colony energetics. However, prey use in the remnant coastal colonies of the southern Everglades has been unstudied since the 1970s, and we have little understanding of how hydrologic conditions influence prey production and availability in this part of the ecosystem. To address this, we assessed prey composition of chicks at three coastal colonies within ENP in 2017 and 2018 through examination of regurgitated food boluses.

Prey composition of boluses varied between years (p=0.001), driven by changes in the abundances of crabs, crayfish, and fish. In 2017, bolus biomass was dominated by estuarine crabs (75.4%) and comprised lower crayfish and fish contributions (14.6% and 7.9%, respectively). In 2018, boluses contained more crayfish and fish (45% and 27.7%, respectively) and less crab (26%). During the 2018 breeding season, prey composition varied between collection dates (p=0.001). Between the first (14 April) and last (11 May) sampling dates, crayfish biomass declined (84.4% to 16.5%), fish biomass increased (9.7% to 58.7%), and crab biomass varied from low to modest levels.

The 2017 and 2018 nesting years contrasted in both regional nesting effort (2017: 1,206 peak nests; 2018: 31,320 peak nests) and hydrologic conditions: post-hurricane flooding in late 2017 led to higher water levels preceding the 2018 breeding season. Water gauges near these coastal colonies indicate that the southern Everglades remained inundated for longer into 2018. Crayfish abundances at trapping sites within foraging distance of these colonies were higher prior to the 2018 breeding season than the 2017 breeding season (p=0.046). Presumably, higher densities of crayfish and prolonged inundation led to increased crayfish availability for foraging White Ibis nesting at coastal colonies in ENP prior to, and during, the breeding season in 2018 compared to 2017.

Our results suggest that freshwater prey production, and crayfish production in particular, is important to White Ibis nesting in the southern Everglades, especially in years with high nesting effort. Alternative prey (i.e., fish and crabs) may also contribute to prey composition when water levels recede (both) or in poorer nesting years (crabs). These results increase our understanding of factors that influence prey production and availability in the southern Everglades and provide insight into the trophic relationships between White Ibis and their prey in a region relevant to Everglades restoration.

<u>PRESENTER BIO</u>: Tasso Cocoves is a master's student in the Department of Biological Sciences Environmental Science Program at Florida Atlantic University. Prior to attending FAU, he has been involved with several projects monitoring and conserving endangered avian species.

REMOVAL OF ARGENTINE BLACK AND WHITE TEGUS AND RESPONSE TO TRAPPING EFFORTS

***Jenna M. Cole**, Sarah K. Cooke, Jennifer H. Nestler, and Frank J. Mazzotti*
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The Argentine black and white tegu (*Salvator merianae*) is a terrestrial lizard native to South America. Argentine black and white tegus are established in southern Miami-Dade County, and the core of their distribution is in southern residential areas of Florida City, along with agricultural and natural areas to the south. Tegus are habitat generalists and are frequently found associated with water. They have a broad diet that includes land snails, small mammals, and eggs, and therefore have potential for severe impact on biological resources. Tegus are especially known for eating eggs of reptiles and ground nesting birds, and have been documented eating alligator and turtle eggs in Florida. Hence, tegus may pose a significant threat to nests of crocodiles, alligators, marine and freshwater turtles, and migratory and endangered birds such as shorebirds and the Cape Sable seaside sparrow.

Tegus have been captured or sighted within the Everglades National Park (ENP), the Southern Glades Wildlife and Environmental Area, at the Florida Power and Light (FPL) Turkey Point Power Plant (TP) and adjacent to the FPL mitigation area, and in scattered locations throughout the South Dade Redland Agricultural Area. Tegus have been seen to disperse from the core of their range into surrounding areas, which include the boundaries of ENP, TP, Bird Drive Basin, and Crocodile Lake National Wildlife refuge (CLNWR). Prevention of spread of Argentine black and white tegus throughout the Comprehensive Everglades Restoration Plan (CERP) footprint and especially prevention or early detection of invasion of CLNWR, ENP, and TP is crucial to the management of this invasive lizard.

Argentine black and white tegus have been removed through systematic trapping from 2014 through 2018 in the Southern Glades Wildlife Management Environmental Area. Trapping occurs from early February through October of each year, which coincides with periods of increased activity in the species. Various combinations of live traps baited with chicken eggs are deployed along the main road and intersecting levees adjacent to the canal system within the management area. We open traps in the morning at the beginning of each week, check them daily, and close them at the end of the week.

Relative density, based on encounter rates, was used as a surrogate for abundance and the performance measure used was tegus captured per live trap night. Changes in abundance were evaluated using spatially referenced capture rates and total capture numbers for each year. Overall, the capture per unit effort (CPUE) and total number of tegus removed per year have displayed a downward trend since 2015. Based on these trends we hypothesize that the tegu population in the Southern Glades Wildlife Management Area is declining.

PRESENTER BIO: Jenna Cole is a M.S. graduate student at the University of Florida studying the diet and removal of Argentine black and white tegus from the Everglades ecosystem. She is involved in the Everglades Invasive Reptile and Amphibian Management Program where she conducts herpetofaunal surveys throughout southern Florida.

USING HYDROGEOPHYSICAL METHODS TO UNDERSTAND DISTURBANCE IN PEAT SOILS OF THE EVERGLADES DUE TO SALTWATER INTRUSION: FROM SOIL COLLAPSE TO CHANGES IN BIOGENIC GAS DYNAMICS

***Xavier Comas**, Matt Sirianni, Carlos Coronado, and David Rudnick*

While sea level rise is a critical issue for low-lying coastal areas such as South Florida, its effects on freshwater habitats in the Everglades are unclear. As saltwater penetrates into freshwater marshes, it accelerates soil decomposition, altering carbon storage and nutrient cycling in the soil, and inducing peat collapse. While research during the last few decades has been devoted to better understanding these issues, there are still many uncertainties regarding how salinization alters the carbon cycle in peat soils, and how peat soils respond (at the matrix level) to increases in salinity. In this work we investigate the effect of salinization in peat soils of the Everglades by using an array of hydrogeophysical measurements (both at the laboratory and field scales). Specifically, we explore how salinization affects peat soils in relation to: 1) changes in the production, accumulation and release of biogenic gases within peat soil; and 2) changes in their physical properties (i.e. porosity, hydraulic conductivity) leading to pore dilation, and its relevance for peat matrix deformation in peat soils and potential collapse. This study is unique as it combines: 1) a truly multi-disciplinary approach that includes an array of geophysical, hydrological and ecological techniques such as ground penetrating radar (GPR), terrain conductivity (GEM-2), time-lapse photography, gas chromatography, and constant head permeameter tests; 2) a multi-scale approach, since it combines both laboratory and field components in order to investigate a wider array of conditions and induced salinities; and 3) a non-invasive approach, since most methods do not require invasive sampling that may disturb soil conditions. This study will help improve our understanding of dynamic coastal ecosystem responses to sea-level rise, particularly in terms of biogeochemical and ecological effects of salinization on soil communities. For that reason, it has direct implications for restoration efforts by better understanding changes in the carbon storage function of peat soils and their key role for combating the effects of sea level rise, or for devising strategies to prevent peat matrix deformation, accelerated decomposition, and potential soil collapse.

ASSESSING THE EFFECTS OF NUTRIENT INPUTS ON THE PRIMARY MECHANISMS OF VERTICAL LAND MOVEMENT IN TIDAL MANGROVE FORESTS OF THE FLORIDA EVERGLADES

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Coastal zones globally are at risk of being submerged due to sea level rise (SLR), requiring coastal ecosystems to migrate inland or build soil elevation at rates faster than SLR if they are to persist. Coastal wetlands have biotic and physical feedback mechanisms that allow them to accrete soils and maintain or even gain relative surface elevation, a process known as vertical land movement. In tidal mangrove wetlands, vertical land movement is influenced by belowground root production, plant litter deposition, decomposition, sedimentation, erosion, and algal mat development, the combination of which results in a net change in soil surface elevation. Historically, mangrove vertical land movement rates have offset rising sea levels allowing these coastal ecosystems to keep pace with SLR. However, anthropogenic disturbances, such as altered hydrology and eutrophication, can degrade mangrove forest health and compromise their land building capabilities, placing them at risk of succumbing to rising seas.

Most of Florida's mangroves are within a much larger, highly modified and managed Everglades watershed. Management of this modified watershed delivers eutrophic freshwater inputs to historically nutrient limited, brackish coastal mangrove forests, adding environmental stresses to the ecosystem and potentially reducing its capacity for resilience in the face of climate change. The overall aim of this project is to identify the primary mechanisms of elevation change in two distinct mangrove zones and to experimentally assess how nutrient inputs influence those mechanisms and the resulting net vertical land movement. This study will provide land managers with an assessment of how the management of inland watersheds impact the health of coastal mangroves and their capacity for resilience to sea level rise.

<u>PRESENTER BIO</u>: Jeremy Conrad is a senior wildlife biologist with the U.S. Fish and Wildlife Service and a doctoral candidate at Florida Atlantic University. Jeremy is also a co-PI on a USGS/USFWS blue carbon assessment project and lead PI for coastal wetland assessment on Florida National Wildlife Refuges.

USING CAMERA TRAP SURVEILLANCE NETWORKS TO MODEL FACTORS AFFECTING ARGENTINE BLACK AND WHITE TEGU OCCUPANCY IN SOUTHERN FLORIDA

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The Argentine black and white tegu (*Salvator merianae*) is a heavy-bodied lizard native to South America that can reach 1.5 m in length and weigh up to 8 kg. Tegus are omnivorous, exhibiting a broad-spectrum diet consisting of fruits, seeds and other plant matter, small vertebrates, invertebrates, and eggs of various species including those of alligators, turtles, and ground nesting birds. Two established populations of *S. merianae* exist in Florida: one in Hillsborough County, and the other in southern Miami-Dade County, where our research is focused. This population is located near important biological resource sites such as Everglades National Park, Crocodile Lake National Wildlife Refuge, and American crocodile nests at the Florida Power and Light Co. Turkey Point Power Plant. Camera trap surveillance networks have been placed throughout South Florida by several agencies, including the University of Florida (UF), the US Geological Survey (USGS), and the National Park Service (NPS), to monitor potential occurrence and expansion of tegus.

We analyzed the combined agency surveillance network data from 2016 using a single-season occupancy analysis, which allowed us to assess a greater number of sites throughout South Florida and decrease our level of uncertainty. Modeled site covariates included primary habitat type, distance to water source, and distances from two core areas for tegus in Miami-Dade County. These are the Redland Rock Pit in Florida City, considered to be the original point of discovery of the tegu source population, and the intersection of 424th St. and US-1, which is the area of focus for management efforts and a major path of tegu dispersal. Detection covariates included average monthly temperature, total monthly precipitation, and the presence of a baited camera trap at each site.

In 2016, UF deployed 40 cameras throughout southern Miami-Dade County and USGS/NPS deployed 29 camera traps, for a total of 69 cameras. Thirty-two of these (46%) observed a tegu at least once. The null model detection probability of tegus is 0.28, and the occupancy probability is 0.49. The most predictive model for the combined surveillance data included detection as a function of temperature and occupancy as a function of distance to the 424th St/US-1 core area. The ΔAIC between the top model and the next best model was 29.41, suggesting that the top model had a very high probability of being selected over the other candidate models. The detection probability remained at 0.28, while the occupancy probability decreased to 0.38.

Our results suggest that sites closer to the 424th St/ US-1 core area display a higher probability of tegu occurrence in Miami-Dade County. We plan to use these results to predict areas of tegu occurrence and to improve removal and detection methods for Argentine black and white tegus in South Florida.

PRESENTER BIO: Sarah is a master's student at the University of Florida, in the Department of Wildlife Ecology and Conservation. She works as a member of the Croc Docs, where she is heavily involved in invasive reptile management projects, specifically tegus, as well as long-term population monitoring projects of American alligators and crocodiles.

ELEVATION-DEPENDENT SOIL ACCRETION AND CARBON ACCUMULATION: IMPLICATIONS FOR TREE ISLANDS PERSISTENCE IN THE WATER CONSERVATION AREA 3

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Restoration of degraded tree islands and protection of intact tree islands are among the goals for restoring the Everglades ridge-and-slough ecosystem. Information about soil elevation change and topographic differences across the tree island-ridge-slough ecosystem are important to estimate the effects of proposed hydrologic changes on the ecological function of tree islands. Furthermore, extreme events such as droughts can lead to oxidation of peat material and allow muck fires, both of which reduce surface elevation in wetlands. In contrast, long hydroperiods can lead to reduced belowground production, a process that leads to low both soil accretion and elevation change. Thus, predicting the effects of changes in water depth and hydroperiod on soil elevation change on tree islands cannot be accomplished until the spatial and temporal patterns of soil accretion on tree islands are better known.

This presentation highlights the effects of changes in hydroperiod on soil accretion and elevation on tree islands experiencing contrasting hydropatterns. The main objective of this presentation is to address the question whether tree islands are in equilibrium with increasing water levels, accrete material and gain elevation at rates that allow tree islands to experience less frequent inundation. Particularly, we are addressing a management question whether surface water fluctuation is important in controlling soil elevation and carbon accumulation in forested wetlands.

Elevation change rates have been very small and there has been measured a lost in soil elevation, particularly at tree islands where the high-water depth and long period of inundation characterized the near tail and transition marsh sites. This result suggests that subsurface process within the root zone, including root production and decomposition, may control elevation changes in these tree islands. In contrast tree islands located within a drier region in WCA3A showed lower soil elevation loss. Based on this initial analysis it seems that variations in microtopography on the islands and surrounding marsh play an important role in creating the hydrological conditions to promote soil formation and therefore increase in soil elevation relative to the surrounding marsh.

PRESENTER BIO: Dr. Coronado is Lead Environmental Scientist. He has been conducting research on tree island ecology since 2000. His interests include tree island ecology, including nutrient cycling, soil elevation and accretion, forest structure and function, and tree island restoration.

JOINT SPECIES DISTRIBUTION MODELS OF EVERGLADES WADING BIRDS: A COMMUNITY PERSPECTIVE

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The presence of nesting wading bird colonies such as the great egret (*Ardea alba*), wood stork (*Mycteria americana*), and white ibis (*Eudocimus albus*) are indicators of a restored Everglades ecosystem. As such, considerable effort has been dedicated to identifying the habitat conditions needed by each species. Species distribution models have been developed to explicitly address environmental conditions as drivers of wading bird presence but have not directly considered the impacts of species interactions as drivers of presence across the landscape.

Species distributions are driven not only by environmental conditions, but also through biotic interactions such as competition or predator-prey dynamics. In studies of community ecology, patterns of species co-occurrence can provide insight into the strength of species interactions within a community. Studies of species' habitat largely overlook the impact of species interactions in driving patterns of occurrence across the landscape. Joint species distribution models (JSDMs) provide a framework for modeling species co-occurrence, allowing scientists to tease apart the relative effects of species interactions and environmental conditions on a species' distribution. Using a Bayesian statistical framework, a JSDM can 'borrow' information from common species to provide insight on relatively rare species that previously could not be statistically assessed.

In this study, we develop a joint species distribution model of the Everglades wading bird community using distribution data obtained from 10 years of Systematic Reconnaissance Flight (SRFs) surveys flown over the Greater Everglades during the wading bird breeding season. In addition to the great egret, white ibis, and wood stork, we also included glossy ibis (*Plegadis falcinellus*), great blue heron (*Ardea herodias*), and roseate spoonbill (*Platalea ajaja*) detection data in our models. Analysis of the shared environmental and residual correlations estimated from the JSDM provides insight on the relative influences of environmental factors and biotic interactions (e.g., competition) on species distributions. These results provide an important community ecology perspective to Everglades wading birds by integrating multiple, colonial-nesting species into a single modeling framework.

Future work will seek to include additional Everglades wildlife into this modeling framework. For example, addition of prey fish detection would provide understanding of predator-prey dynamics between wading birds and their fish prey, while addition of alligator detection could provide additional quantitative evidence of alligators as nest protectors to wading birds.

<u>PRESENTER BIO</u>: Laura D'Acunto is a quantitative ecologist at the USGS Wetland and Aquatic Research Center (WARC). Laura's research interests include behavioral landscape ecology of wildlife, simulation and spatial ecological models, and integrated species distribution modeling.

EVALUATING EFFECTIVENESS OF TARGETED OUTREACH FOR INVASIVE REPTILES IN SOUTH FLORIDA

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Natural ecosystems in Florida are under increasing threat of invasion by nonnative wildlife. The four largest lizards currently breeding in Florida are from other countries. Nile monitors (*Varanus niloticus*) and Argentine black and white tegus (*Salvator merianae*) have broad diets and may be a significant risk for threatened and endangered wildlife such as nesting American crocodiles, sea turtles, burrowing owls, and Cape Sable seaside sparrows. Their burrowing capability not only increases their threat to native wildlife, it also decreases their detectability on the landscape.

As part of an interagency effort to detect and remove invasive reptiles from South Florida, the University of Florida (UF) has developed a targeted outreach strategy to form a widespread observational network and fill in existing gaps in knowledge about tegu and monitor lizards. There is much to learn about the distribution, abundance, occupancy, nesting, and habitat use of Nile monitors in the C-51 Basin and Argentine black and white tegus in the Redlands agricultural area. Since established populations of Nile monitors are localized to urban environments and a portion of the tegu population is centered in a largely rural/agricultural environment, we hypothesize that building an observational network within surrounding neighborhoods will improve detection and help managers concentrate removal efforts.

Evaluating effectiveness of various types of media, such as door hangers and flyers, multiple times in multiple neighborhoods (defined by zip codes or homeowner associations) provides a basis for spatial and temporal replication. Results from these targeted outreach efforts can be applied to enhance removals and to determine the most effective method for increasing public awareness of invasive species threats.

With the right tools and knowledge, it may be possible to contain monitor populations and prevent the spread of tegu populations into ecologically sensitive areas including Everglades National Park. While preliminary results from targeted outreach are far from conclusive, we have successfully shown that if Nile monitors or tegus occur in residential areas, someone is seeing them. Furthermore, the sooner more individuals are aware of the presence of invasive wildlife and how to respond, the more equipped we are to deal with the ongoing threat of invasion moving forward.

<u>PRESENTER BIO</u>: Justin Dalaba is a science writer and outreach coordinator for the University of Florida Croc Docs. He is currently involved with outreach and communication efforts to enhance public and scientific understanding invasive wildlife threats to Everglades restoration. He also serves as outreach chair for the Everglades Cooperative Invasive Species Management Area (ECISMA).

CHANGING TIDES: PHOSPHATE DESORPTION FROM CALCITE IN FRESHWATER-SEAWATER MIXING ZONES

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Seawater intrusion has a number of effects on estuarine environments, including an increase in phosphate (P) concentration in ambient water due to water-rock interactions. Bedrock may contain P that is attached, or "adsorbed," to mineral grains. The intrusion of seawater causes the release, or "desorption," of P from the mineral surface. When P is desorbed from the bedrock, it is released into the ambient water, becoming bioavailable. As P is a limiting nutrient in estuarine environments, such P concentration changes may have ecological impacts.

Groundwater undergoes a mixing continuum at estuaries and other coastal ecosystems, with freshwater at the landward end, and seawater concentrations increasing seaward. Since seawater is denser and thus has a higher water pressure, it can push inland underneath the freshwater. It is important to understand how much seawater intrusion is required for an initial release of P from calcite, as this will determine the pattern of P availability along the salinity gradient.

Many coastal regions have limestone bedrock (composed of the mineral calcite), and such bedrock has exhibited the ability to adsorb/desorb P. To determine how much seawater is required to initiate P desorption, we placed 0.5 g of reagent-grade calcite, pre-loaded with P, into test tubes. We simulated seawater intrusion by introducing 40 mL of solution that represented a range of freshwater and seawater mixtures. The 43 incremental solutions ranged from 0% seawater (100% freshwater) to 100% seawater (0% freshwater). After a 2-day equilibration on a platform shaker to allow the water and calcite to interact, the solutions were filtered and analyzed for P.

We found that as seawater percentage rose, P desorption from the P-loaded calcite increased. When the P-loaded calcite was immersed in pure seawater, P desorbed by a factor of 1.7 higher concentration than when calcite was immersed in pure freshwater. An increase in P desorption from calcite was observed in mixtures with as little as 2.8% proportion seawater (97.2% proportion freshwater). Solutions with increasing proportions of seawater increased desorption of P along a logarithmic growth curve ($R^2 = 0.99$). We conclude that a relatively small intrusion of seawater would induce a relatively significant increase in P desorption, raising the P concentration in the ambient water. Our findings may inform water management and estuarine restoration efforts as seawater intrusion affects phosphate levels in areas with calcareous sediments or bedrock, such as the Florida Everglades, Apulia, Italy, and Majorca, Spain.

PRESENTER BIO: Robert "Trey" Dalton is a senior Environmental Sciences and Biology double major at Southern Methodist University in Dallas, TX. His role as a research assistant during the summer of 2018 at the University of South Florida with Dr. Hilary Flower led to this research project.

TOOLS FOR PREDICTING AND COMMUNICATING RISK OF AQUATIC SPECIES INVASIONS

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The U.S. Geological Survey's Nonindigenous Aquatic Species (NAS) database is the national repository for spatially referenced biogeographic accounts of introduced aquatic species (IAS). The program tracks the distribution of >1,270 nonindigenous species across the United States (contiguous U.S., Alaska, Hawaii, and U.S. territories). The program primarily tracks fish, crustaceans, mollusks, reptiles and amphibians, and obligate aquatic plants. The NAS Database houses greater than a half a million expertly verified records of IAS occurrences. The program's interactive website allows users to perform a variety of queries, download data, obtain information from species profiles, and see animations of species' spread. The NAS Database is an unmatched source of spatially referenced data, providing information on status and trends of IAS. The NAS group has developed two new tools for predicting and communicating the risk of new introductions and possible movement of IAS from flooding events.

Introduction and spread of IAS into novel waterbodies presents challenges for natural resource management: identifying areas at-risk for further colonization can help prioritize management decisions on prevention and control efforts. The NAS team has developed a new tool, the Alert Risk Mapper (ARM), to characterize the potential water bodies at-risk from a new IAS sighting for the contiguous U.S. and Hawaii. This tool indicates lakes and river reaches that are at-risk of invasion from a new IAS sighting built on credible scenarios of its potential movement within a drainage based on its mobility and drainage barriers. Since June 2018, 170 ARM maps have been created and accompanied the NAS Alert emails sent out to subscribers and managers. The goal of the ARM tool is to provide management agencies with a much needed first continuous national mapper for early detection and rapid response (EDRR) efforts that will enable them to quickly focus their limited resources on sites that have the greatest risk of being invaded.

Hurricanes and their associated storm surge and inland flooding can assist the expansion and distribution of IAS. During these flooding conditions, IAS can spread to new areas, including new drainages where they could otherwise not gain access. The NAS program has developed the Flood and Storm Tracker (FaST) mapper to allow managers to view which drainages may have IAS spread due to flooding from adjacent drainages. The FaST mapper can help natural resource managers determine potential new locations for individual species, or to develop a watchlist of possible new IAS within a watershed. Current FaST maps include all flooded areas from the 2017 storms (Hurricanes Harvey, Irma, Maria, and Nate) and 2018 storms (Hurricanes Lane, Florence, and Michael).

PRESENTER BIO: Dr. Wesley Daniel is a fisheries scientist with the U.S. Geological Survey, Nonindigenous Aquatic Species Program in Gainesville, FL. Wesley is an aquatic landscape ecologist by training and specializes in the development of management tools for assisting in strategic planning, public engagement, and assessment.

FAUNAL AND VEGETATION MONITORING IN RESPONSE TO HARBOR DREDGING IN THE PORT OF MIAMI

Andre Daniels[1], *Rachael Stevenson*[2], *Erin Smith*[2], *and Michael Robblee*[3]
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Seagrasses are highly productive ecosystems. A before-after-control-impact (BACI) design was used to examine effects of dredging on seagrasses and the animals that inhabit them. The control site North Biscayne Bay and the affected site Port of Miami had seagrass densities decrease during both the before, Fish and Invertebrate Assessment Network 2006-2011, and after, Faunal Monitoring in Response to Harbor Dredging 2014-2016, studies. Turbidity levels increased at North Biscayne Bay and Port of Miami basins during the Faunal Monitoring in Response to Harbor Dredging study, especially in 2016. Animal populations decreased significantly in North Biscayne Bay and Port of Miami in the Faunal Monitoring in Response to Harbor Dredging study compared to the Fish and Invertebrate Assessment Network study. Predictive modeling shows that numbers of animal populations will likely continue to decrease if the negative trends in seagrass densities continue unabated. There could be effects on several fisheries vital to the south Florida economy. Additional research could determine if animal populations and seagrass densities have rebounded or continued to decrease.

BIOLOGICAL CONTROL AS PART OF INTEGRATED WEED MANAGEMENT OF OLD WORLD CLIMBING FERN (*LYGODIUM MICROPHYLLUM*)

***Aaron S. David**, LeRoy Rodgers, Andrew Eastwick IV, and Ellen C. Lake*

Lygodium microphyllum (Lygodiaceae), Old World climbing fern, is an invasive non-native vine found throughout much of south and central Florida and is expanding northward. The plant forms dense mats that smother native vegetation and alters fire behavior. The fern can be difficult to control using conventional management techniques. Two approved biological control agents, the defoliating moth *Neomusotima conspurcatalis* (Crambidae) and a leaf-galling mite *Floracarus perrepae* (Eriophyidae), were introduced from the native range and have established in Florida. Our recent studies demonstrate that these agents can reduce *L. microphyllum* biomass and, in the case of *F. perrepae*, substantially reduce the growth rate of individual climbing rachises. Over the past five years, we have mass-reared and released both agents to establish viable populations across the invaded landscape in Florida. These efforts include release of >1 million agents in two regions of the Loxahatchee National Wildlife Refuge—tree islands within Water Conservation Area 1 and cypress swamps of the adjacent Strazzulla Tract. Surveys indicate that the agents have successfully established in many of these sites. The *N. conspurcatalis* population generally is highest in the cooler winter months and lowest in the summer. Monitoring of *F. perrepae* in an outdoor, shade house colony indicates similar seasonal dynamics, with populations highest in months with low rainfall. Importantly, establishment of the agents must work in conjunction with other control efforts. Collaboration and coordination between US Fish and Wildlife Service, South Florida Water Management District, and the USDA Agricultural Research Service has led to a strategy of releasing agents in areas not slated for immediate herbicide treatment and the demarcation of no-spray zones within active treatment areas. This strategy will allow agents to locally establish and persist during herbicide treatments and colonize *L. microphyllum* regrowth post-treatment. Further research is underway to better integrate biological control with mechanical controls, herbicide applications, and prescribed fire. An integrated management approach in the Loxahatchee National Wildlife Refuge is expected to achieve the most effective long-term control of *L. microphyllum*.

AN INVESTIGATION INTO LED TECHNOLOGY FOR INSECT SURVEYS

***Branden Davis**, and Jennifer Bishop*
Miccosukee Tribe of Indians of Florida, Miami, FL USA

The habitats found within the Florida Everglades present certain challenges for scientists who attempt to survey their inhabitants and especially if one hopes to do so on a regular basis. Trapping methods unique to entomologists tend to be lightweight, easy to transport, and best of all, can be made from cheap materials. Many methods can be accomplished using household or easily obtained store-bought items while others can be manufactured; provided one has the tools and determination to do so. Light trapping for insects has a long history and much research has been done to reveal the best light wavelengths, reflective materials, temperatures, trap shapes, and sizes to obtain the optimum yield of a target species. Some require the right combination while others are content with the mere presence of a lighted surface. Two of the most preferred setups for this method of surveying revolve around using an intensely bright and incredibly hot, mercury vapor bulb and the familiar “black light” or UV fluorescent bulb.

While these have been the mainstay for many years, there are drawbacks to each of these methods, chiefly the wattage it requires to run these power-hungry devices. Given the remoteness and unforgiving nature of the Everglades, the longer a trap can stay put and function, the better. Seeking to increase battery life, lower wattage, photovoltaic cells, photocells, timer switches, or larger batteries may be used. Traps quickly become cumbersome, heavy, and expensive to operate for such a short time frame. In the course of finding a more viable solution, research into lighting has provided a simple solution which has been proven to be rather effective, LEDs.

This design process piggybacks off of the already proven method of utilizing buckets with reflective fins and a battery powered lit middle section which may all be set inside the bucket for transport. These lighted traps have been initially tested in grass prairies and tree hammocks and were found to be successful in drawing many orders of insects and at high yields. Testing is continuing throughout tree islands, marl prairies, and swamps across the Everglades.

PRESENTER BIO: Branden Davis is an entomologist with the Miccosukee Tribe of Indians of Florida working throughout the Florida Everglades across tribal lands. He is currently producing an inventory of the insects among the unique habitats of the Florida Everglades focusing on the effects of water levels and plant diversity inside of tribal lands.

COMMUNICATING SCIENCE TO POLICY-MAKERS

Steve Davis
The Everglades Foundation, Palmetto Bay, FL, USA

Communicating science effectively is not easy, and it requires much more time than most people think. In any situation, effective communication begins with knowing your audience. For an audience of non-scientists, making a connection between what you do and how they may relate to the environment—either through business/economics, recreation (e.g., fishing), or merely as a concerned citizen—is perhaps the most important thing. Drawing these connections with policy-makers is also essential; however, there are a variety of things to consider in your preparations. First, they are busy people and hear from a diverse array of stakeholders. Keep that in mind. Be non-political and respectful of their time. Find out who their staff persons are and whether they are in attendance during your briefing. Staff members are incredibly bright, hard-working young professionals that represent the eyes, ears and sources of informed advice for elected officials. Given an opportunity to brief policy-maker staff is oftentimes as important—if not more important—as briefing their boss.

At a fundamental level, policy-makers (and staff) are concerned about the welfare of their jurisdictions and constituents. Start here with your preparations. If your science overlaps with their jurisdiction or focuses on an aspect that will affect a plurality of their constituents, there will be some interest. At a higher level, policy-makers often have other connections to what you do through previous support of policies or funding for everything from science and monitoring to authorizations for project construction. If you are aware of this and it has benefitted your work in some way, thank them. They not only deserve it, but it may help to garner more interest in what you have to say. There are also obvious differences in what is relevant to elected officials at local, state or federal levels. Understanding what is within their purview will make for a more efficient use of their time and will also help to avoid embarrassment.

In my communications with policy-makers, I employ visuals (usually maps and infographics) to help explain more technical aspects of the subject matter. Being able to see what or where you are talking about is important. I also recommend being genuine and honest. You are not trying to impress them with what you know or convince them of something they may not believe. Rather, you are explaining how something works or why it may be of importance to them. Do not dominate the conversation. Give them an opportunity to ask you questions, and do not hesitate to say so if you do not know something. After all of this, speak clearly with a good pace and be mindful of word efficiency. If you can explain something with fewer words or with a simple analogy, do so. Like a python, you can easily lose them if you dive into the sawgrass.

PRESENTER BIO: Steve has 20+ years of Everglades science experience, including the past 10 years as The Everglades Foundation's Ecologist where his time is spent on science communication, Everglades restoration planning, and research on the role of episodic disturbance, sea level rise & saltwater intrusion and freshwater flow in affecting coastal biogeochemistry.

COMBINING STABLE ISOTOPE MEASUREMENTS WITH SIMULATION MODELING BY MANTRA-O18 TO PREDICT EFFECTS OF SALINITY INTRUSION ON VEGETATION DYNAMICS

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Sea level rise and the increasing landward intrusion of storm surges pose the threat of replacement of salinity-intolerant vegetation of important coastal habitats by salinity-tolerant vegetation. Therefore, a means is needed to gain better understanding of the processes that influence this vegetation shift and to aid in the management of coastal resources. For this purpose, a hydrology–salinity–vegetation model known as MANTRA was developed by coupling a spatially explicit model (MANHAM) for simulation of vegetation community dynamics along coastal salinity gradients with the USGS's groundwater flow and transport model (SUTRA). MANTRA has been used to project possible future changes in Coot Bay Hammock in southern Florida under conditions of gradually rising sea level and storm surges. The simulation study concluded the feasibility of a regime shift from hardwood hammocks to mangroves subject to a few conditions, namely severe damage to an existing hammock after a storm surge, a sufficiently persistent high salinity condition and high input of mangrove seedlings. Early detection of salinity stress in vegetation may facilitate sustainable conservation measures being applied. It has been shown that the $\delta^{18}O$ value of water in the xylem of trees can be used as a surrogate for salinity in the rooting zone of plants, which is difficult to measure directly. Hence, the model MANTRA is revised into MANTRA-O18 by including the $\delta^{18}O$ of the tree xylem dynamics. A simulation study by MANTRA-O18 shows that effects of increasing salinization can be detected many years before the salinity-intolerant trees are threatened with replacement.

<u>PRESENTER BIO</u>: Dr. DeAngelis is a Senior Scientist with more than 40 years of experience as an ecological modeler, focusing on population, ecosystem, and landscape modeling in support of Everglades restoration.

SHRUB ENCROACHMENT IMPACTS ON CARBON, WATER, AND ENERGY IN HERBACEOUS PEATLANDS

Jessica A. Dell *and Brian W. Benscoter*
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Shifts in dominant vegetation can alter wetland function and the mechanisms responsible for the maintenance of wetlands. Shrub encroachment by the native Carolina willow (*Salix caroliniana*) into historically herbaceous, sawgrass (*Cladium jamaicense*) marshes can alter processes associated with ecosystem carbon, water, and energy cycling due to morphological and physiological differences between the two species. Willow has greater rates of photosynthetic CO_2 exchange and stomatal conductance compared to sawgrass and can increase carbon assimilation. However, greater leaf area index and lower water use efficiency in willow can increase water loss through transpiration. The project examines the effects of willow encroachment on peat accumulation processes in a subtropical, sawgrass-dominant peatland.

We compared production, soil carbon input through litterfall, and decomposition in sawgrass and willow following reduced water levels and a prescribed burn at the Blue Cypress Marsh Conservation Area. Production and leaf litter were measured with nondestructive, allometric equations, fine root ingrowth bags, and litter traps. The effect of water level on photosynthetic capacity and chlorophyll fluorescence as a measure of water stress were examined on sawgrass and willow cultivars with a portable infrared gas analyzer (LI-6400XT, LI-COR, Lincoln, NE, U.S.A.). Sawgrass and willow litter decomposition was examined with decomposition bags using a reciprocal site-source design and jar incubations. Sawgrass and willow microclimates were monitored with sensors installed within the canopies, soil, and water.

Our preliminary results suggest increased aboveground carbon storage by willow encroachment is likely offset by increased soil decomposition. Furthermore, once established, willow shrubs may be able to withstand future disturbances and control techniques, driving these wetlands into an alternate structure-function regime. Degradation or loss of these peatlands would have major impacts on regional ecosystem services and global biogeochemical cycles.

PRESENTER BIO: Jessica Dell is a Ph.D. candidate at Florida Atlantic University.

STABLE ISOTOPE ECOLOGY OF AMERICAN ALLIGATORS ACROSS THE GREATER EVERGLADES: CONSISTENCY AND VARIATION

Mathew J. Denton[1], *Brian J. Smith*[2], *Michiko Squires*[3], *Frank J. Mazzotti*[3], *Laura A. Brandt*[4], *Michael S. Cherkiss*[5], *Michael R. Heithaus*[6], *and Kristen M. Hart*[5]

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The American alligator (*Alligator mississippiensis*), perhaps the most recognized symbol of the Everglades, affects nearly all aquatic life in the ecosystem in some way. While abundant throughout Florida in a variety of fresh to saline water habitats, Everglades alligator populations in contrast tend to occur at lower densities and with poorer body condition than those in other parts of their range. Many important questions concerning effects of Greater Everglades restoration on alligator populations remain unanswered, such as the impacts of de-compartmentalization and effects of hydrology on population growth, survival, and body condition. Long-term monitoring of alligators contributes to understanding how the ecosystem is responding to Everglades Restoration.

We have monitored effects of hydropattern on alligator production, movement, and body condition, and have documented an overall decline in alligator body condition throughout the Everglades over an 18-year period (2000-2018). To determine if there is a relationship between body condition and isotopic composition, we began collecting blood samples for stable isotope analysis (SIA) of carbon and nitrogen (^{13}C and ^{15}N). Carbon isotopes are used to identify carbon sources in food web studies and nitrogen isotopes are indicative of trophic position, thus they serve as a tool to measure ecosystem patterns and processes and to monitor changes in these patterns over time.

Between 2012-2017 we collected over 500 blood samples from alligators throughout Everglades' wetlands and applied SIA to elucidate temporal and spatial variation in their isotopic niche. There was little correlation between body condition and isotopic composition: $\delta^{13}C$ (μ= -27.3‰ ± 1.2 SD), $\delta^{15}N$ (μ = 8.2‰ ± 1.0 SD). However, their isotopic niche varied between sampling sites and water years, and the niches from several sites overlapped in δ-space. Alligators within the estuarine sites showed more variability in resource use than those from the freshwater areas. Thus, the alligator isotopic niche reflects the variability in the resources within each site and tracks temporal fluctuations across years. Continued collection and analysis of alligator isotope samples will allow us to identify shifts in resource use over time in response to restoration efforts.

PRESENTER BIO: Mathew Denton is a biologist with over 10 years of experience in Everglades restoration projects. He has extensive experience with stable isotope analysis of various fauna from multiple wetlands. He has led several different projects and is dedicated to preserving and restoring wetlands.

COUPLING SEA-LEVEL RISE AND FRESHWATER MANAGEMENT ON THE COASTAL EVERGLADES THROUGH DETERMINATION OF THE FRESH-TO-MARINE HEAD DIFFERENCE

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Current Everglades restoration efforts have been addressing the negative environmental impacts of extensive engineering solutions aimed at expanding and protecting both the agricultural and built environments of south Florida. However, the low lying coastal Everglades ecosystem is also threatened by the effects of sea-level rise, such as increasing salinity, peat collapse and loss of fauna and flora. Our objective is to understand how freshwater delivery and sea-level rise affect water quality of the coastal Everglades. We used sixteen years of daily hydrologic data (water level and sea level) and water quality data (salinity and total phosphorous concentrations) from the Shark River Slough (SRS), Taylor Slough (TS) and Florida Bay in Everglades National Park. Water quality data were obtained from the Florida Coastal Everglades Long Term Ecological Research Program. We calculated a fresh-to-marine head difference (FMHD) as the water level at the most downstream freshwater site minus sea level at Key West, for both SRS and TS. The long-term signatures and pattern of the data were mapped using a Percentile Range Indexed Mapping and Evaluation (PRIME) tool. Results have demonstrated that the three systems have displayed a common underlying hydrologic and salinity pattern underscored by their unique signature. The results were that the FMHD explained the long-term pattern of salinity and TP in SRS, TS and Florida Bay better than either sea level or water levels. With rising sea level, FMHD may help to couple the effects of sea level changes with freshwater management in coastal Everglades.

<u>PRESENTER BIO</u>: Dr. Dessu is a post-doctoral associate with more than 15 years of experience in hydrological modeling, water management, and has been participating on multiple Everglades restoration projects.

HURRICANE IMPACTS TO MANGROVE FORESTS ON THE SOUTHWEST COAST OF FLORIDA

Gianna Diaz *and Edwin M. Everham III*
Florida Gulf Coast University, Fort Myers, FL, USA

Mangroves may be uniquely impacted by climate change, as rising temperatures alter decomposition rates, sea level rise changes conditions for seedling establishment, and frequency or intensity of hurricanes directly affects forest structure. Hurricane Irma subjected much of the coastal line in Sarasota, Charlotte, Lee, Collier and Monroe counties to hurricane winds in 2017. We established plots to quantify the impact to forest structure, and to incorporate the complex legacies of previous hurricane disturbance in the last three decades (Andrew, Katrina, Charlie, Wilma, and Irene). In addition, we compared plots that are tidally restricted to those with more natural tidal flushing. In each plot we identified, mapped, and measured the woody vegetation to determine if this hurricane history and human alteration to hydrology, has altered the composition of forest communities, influenced impacts of Hurricane Irma, or shifted trajectories of recovery. It is important to understand the potential complex synergy of multiple disturbances to these critical coastal ecosystems.

PRESENTER BIO: Gianna Diaz is a second year graduate student at Florida Gulf Coast University pursuing her Master's degree in Environmental Science. She earned her Bachelor's degree in Environmental Science at Florida State University. Her thesis focuses on how an increase in hurricane frequency effects mangrove community composition and resilience.

EVALUATION OF INUNDATION DEPTH AND DURATION FOR CATTAIL SUSTAINABILITY: IN SITU STUDY

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Typha (cattail) species are currently the dominant macrophytes in the emergent aquatic vegetation (EAV) cells of the Everglades Stormwater Treatment Areas (STAs). Cattail losses have been observed in the STAs over the past two decades of operation. Exposure to deep water conditions for prolonged periods and sudden changes in water depths are among the key causes for cattail stress and eventual loss. High flows during the wet season can result in excessive inundation and deep-water conditions that can stress the cattail communities of these cells. For this study, we monitored cattail density, leaf elongation, photosynthesis, and plant biomass in the deeper areas in the inflow region and shallower area in the outflow region from WY2016 to WY2018. During this period, daily average water depths in the inflow region were consistently higher than those in the outflow region, with 52% of the daily water depths >76 cm compared to 16% in the outflow region of the cell. The inflow region of this cell experienced water depths >91 cm for 40 consecutive days in WY2016; three periods in WY2017 for 50, 29, and 35 consecutive days; and three periods in WY2018 for 19, 19, and 76 consecutive days. The outflow region also experienced occasional deep conditions, but at a lesser extent and frequency than the inflow region.

During the 2015 wet season, no significant differences were observed in total cattail shoot density between the inflow and outflow regions. Total cattail densities during the 2016 and 2017 wet seasons were significantly lower in the inflow than in the outflow plots, indicating a decline in cattail population in the deeper areas of the cell over time. Similarly, juvenile shoot density from the inflow were lower than in outflow plots during all monitoring seasons, with significantly lower density during the 2016 and 2017 wet seasons. Cattail decline is attributed primarily to the period of prolonged water depths during the 2016 and 2017 seasons particularly in the inflow region that experienced a total of 219 days of water depth exceeding 91 cm WY2017 and WY2018. The higher number of juveniles shoots, dead cattail plants, and higher amount of necromass in the outflow region suggest a higher turnover rate in the outflow region of this cell.

Leaf elongation rates were consistently higher in the inflow region, with higher rates measured early in the wet season. Data indicates that deep and prolonged inundation periods, such as those experienced in 2016 and 2017, affected leaf elongation rates, especially in the deeper areas within the inflow region. Photosynthetic rates and total live biomass were not significantly different ($p > 0.05$) between inflow and outflow regions. However, for the entire cell there was a significant decline in all biomass components over time. There was also a noticeable decrease in the belowground biomass:leaf ratio in the inflow region over the three-year period, suggesting that the belowground biomass were stressed more than shoots in the deeper region of this cell. Results from this study quantified the stress in cattail communities in deep water conditions. Further study is underway to determine the inundation threshold (depth and duration) to sustain cattail communities in the STAS.

<u>PRESENTER BIO</u>: Dr. Orlando Diaz is a senior environmental scientist with the District with more than 10 years of experience in the implementation of Everglades restoration projects in the Stormwater Treatment Areas. He has also been involved in several restoration projects in the Lake Okeechobee Watershed.

OVERVIEW OF UNITED STATES GEOLOCIAL SURVEY HYDROLOGIC MONITORING IN SOUTH FLORIDA AND TOOLS TO VIEW AND ACCESS DATA

Mark Dickman
United States Geological Survey, Davie, FL, USA

The U.S. Geological Survey (USGS) Water Mission Area states that water information is fundamental to national and local economic well-being, protection of life and property, and effective management of the Nation's water resources. The USGS collaborates with Federal, state, and local partners to monitor, assess, conduct targeted research, and deliver information on a wide range of water resources and conditions including streamflow, groundwater, water quality, and water use and availability. The USGS delivers hydrologic monitoring data to users through several national and local websites and mappers.

In south Florida, the USGS Caribbean-Florida Water Science Center (CFWSC) hydrologic monitoring program provides information that is used to understand Everglades restoration, adaptive management, inland and coastal flooding, droughts, water availability, saltwater intrusion into the surficial aquifer, and minimum flows to estuaries. Though monitoring may have been established to answer one specific information need, data are frequently used for multiple purposes.

Standard time series and discrete groundwater, surface water, water quality, and precipitation datasets collected by the USGS at active and inactive stations from across the nation are stored in the National Water Information System (NWIS), and the NWIS Mapper (http://waterdata.usgs.gov/nwis) provides a map view of the station locations and access to the data. In addition to access to the data, the NWIS Mapper can be used to create ESRI ShapeFiles and Google Earth Keyhole Markup Language maps of monitoring stations. The USGS operates supplementary websites that use the hydrologic data stored in NWIS to display current and past conditions across the United States for streamflow (Water Watch, Flood Inundation Mapper, Gulf of Mexico Dashboard), groundwater (Groundwater Watch), and water quality (Water Quality Watch). Additionally, users can request data by web, email, or text message from USGS web services (Water Services, Water Now, Water Alert).

The USGS provides websites to display current and past conditions for local topics. For example, the Water Level and Salinity Mapper primarily addresses saltwater intrusion in the surficial aquifer in south Florida by displaying statistical and graphical analyses of water-level and salinity data from USGS monitoring stations. In another example, the Everglades Depth Estimation Network (EDEN) uses data from multiple agencies to generate daily water level surfaces in the freshwater part of the Everglades.
For nonstandard datasets that do not fit into the NWIS database, the USGS publishes the data in alternate databases. For example, time-series electromagnetic induction logs, which are used to assess saltwater intrusion, and evapotranspiration data are published in Science Base (https://www.sciencebase.gov/catalog/). In another example, coastal flood event data is released through the Flood Event Viewer (https://stn.wim.usgs.gov/FEV/).

PRESENTER BIO: Mark Dickman has been the Davie Office Hydrologic Data Section Chief since 2008. In that time, he has developed many monitoring projects and answered many questions about USGS monitoring stations and data in south Florida.

LONGEVITY OF PHOSPHORUS REMOVAL IN A SUBMERGED AQUATIC VEGETATION-DOMINATED STORMWATER TREATMENT AREA WETLAND: STA-2 FLOW-WAY 3

Janelle Potts[1], Michelle Kharbanda[1], ***Forrest E. Dierberg[1]****, Kevin Grace[1], Thomas DeBusk[1], Dawn Sierer-Finn[1], and Delia Ivanoff[2]*

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Flow-way (FW) 3 of STA-2, a 930-ha submerged aquatic vegetation (SAV) wetland, has had a 17-yr history of exemplary phosphorus (P) removal performance. Despite the extensive documentation of its effective P removal performance, little emphasis has been placed on understanding the longevity of P removal under the prevailing P loadings in this FW. One approach to evaluate the longevity of P removal is to periodically sample internal soil P gradients along the flow path as the FW "ages". Three spatially-intensive soil sampling events, at ~ 5 year intervals, were performed to characterize the longevity of wetland P removal. Mass balances comparing the cumulative mass of P recovered in the accrued soils to the P removed in the surface water for these efforts ranged from 104 to 119%.

Steady states for soil accrual, total P (TP) concentration, and P storage along the FW were achieved early during the wetland's operational history, and were maintained throughout the 17-yr period of record (POR). The SAV soils accrued at a relatively consistent average rate of 0.9-1.5 cm/yr within each of the sampling intervals under a mean P loading rate of 1.4 g P/m^2-yr, and by 2016 contained 155 metric tons of P (18 g P/m^2). The soil TP concentrations and storages were highest within the upper 45% of the FW footprint, then precipitously declined at that point and remained relatively constant for the remaining part of the FW. Bulk soil P properties were temporally and spatially resilient with congruent profiles along the FW throughout the POR, indicating that the soil P-enrichment front has not advanced downstream. The results indicate that SAV-dominated wetlands sequester P through new soil accrual, rather than by enriching existing soil. This implies that soil P saturation will not limit the capacity of SAV-dominated Everglades STA FWs to remove P under moderate-to-low loading rates, i.e. at 1.4 g P/m^2-yr or lower.

<u>PRESENTER BIO</u>: Dr. Dierberg has studied P removal and control technologies in wetlands for more than 40 years. His involvement with the STAs began in the 1990s with the prototype STA (ENRP), and he has subsequently published 17 peer-reviewed articles on P and sulfur hydrobiogeochemistry in the STAs.

EVALUATING THE PHYSICAL CHEMISTRY OF EVERGLADES STORMWATER TREATMENT AREAS AT HIGH TEMPORAL RESOLUTION

Jacob Dombrowski
South Florida Water Management District, West Palm Beach, FL, USA

The Everglades Stormwater Treatment Areas (STAs) have been highly effective in removing phosphorus (P) from surface water through multiple biogeochemical pathways. Treatment cells in these STAs are designed to incorporate various configurations of Emergent Aquatic Vegetation (EAV) and Submerged Aquatic Vegetation (SAV) that facilitate P removal through assimilation and sedimentation. Subtropical temperatures and low water turbidity allow for the formation and persistence of periphyton communities that provide additional quick but short-term P assimilation. The photosynthetic activity of both SAV and periphyton communities results in increased water column pH through removal of carbon dioxide, creating ideal conditions for the co-precipitation of P with calcium carbonate.

A large-scale study evaluating the forms, sources, and transformations of P is currently underway as part of Science Plan implementation under the Restoration Strategies for Clean Water for the Everglades. This study operates across entire treatment cells during managed flow events, comprised of high flow, low flow, and stagnant phases. Well-performing flow-ways of STA-2 were selected as study areas: one cell dominated by EAV (Cell 1) and another by SAV (Cell 3). To date, sampling for four events in Cell 1 and three events in Cell 3 have been conducted. While the broader study incorporates multiple components targeting the complex chemical and ecological interactions of STAs, the present analysis is focused on trends and relationships in water column chemistry along a transect from inflow to outflow at high temporal resolution. Surface water samples were collected at 4-hour intervals using autosamplers deployed along the flow-way. Samples were analyzed for Total P (TP). Additionally, co-located EXO2 data sondes were deployed to continually monitor the water column's physical chemistry at 30-minute intervals. Parameters monitored include temperature, pH, dissolved oxygen, specific conductance, turbidity, and total algae. Initial results show distinct diurnal trends in water temperature, dissolved oxygen, and pH, though TP concentrations typically cycle through longer time intervals. Additionally, elevated turbidity and chlorophyll concentrations were directly related to TP concentrations within the inflow areas of SAV dominated communities. Comparisons with in-situ water depth and light intensity measurements will also be presented. Although general trends in surface water physical chemistry are evident at the flow-way scale, investigation of higher resolution relationships with surface water P may yield additional insights to the biogeochemical pathways of subtropical treatment wetlands.

<u>PRESENTER BIO</u>: Jacob Dombrowski is a wetland ecologist with the South Florida Water Management District. He has previously worked as a research technician in various ecology labs at Florida Atlantic University and Wayne State University.

FEEDING ON THE EDGE: FORAGING WHITE IBIS (*EUDOCIMUS ALBUS*) TARGET INTER-HABITAT PREY MOVEMENTS

Erin E. Binkley[1], ***Nathan J. Dorn***[1] *and Mark I. Cook*[2]
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The mechanisms of prey production, concentration, and prey exploitation by wading birds are crucial biological processes affected by hydropattern and landscape features in wetlands. Fish and crayfish prey move downgradient within and across wetland habitats as water recedes over the dry season, concentrating prey in optimal foraging patches. Where and how predators exploit concentrating prey depends on movement of prey, predator foraging mode and water depths. The most abundant nesting wading bird in the Florida Everglades (U.S.A.), the White Ibis (Eudocimus albus), is a tactile forager that feeds extensively on crayfish. Literature suggests White Ibis mainly forage between 5-24 cm of water, but observations indicate crayfish can concentrate at deeper depths. We conducted an observational study of White Ibis foraging and crayfish density in drying sloughs to examine this predator-prey interaction. The study took place February – April 2017, in three wetlands at the Loxahatchee Impoundment Landscape Assessment facility in Boynton Beach, Florida. We used time-lapse imagery to quantify mean White Ibis densities over ~0.16 ha of slough (with adjacent higher elevation ridges) over 61 days. Crayfish densities in the sloughs rose as they moved off drying ridges (4-10 cm). Approximately 60-80% of White Ibis foraging occurred in deep sloughs (≥30 cm) during the drydown. White Ibis spatial distributions on peak foraging days favored the slough edge (10-12% of a given slough area) with 73 – 100% of daily foraging birds. Our observations suggest White Ibis exploit crayfish on the slough edge when the majority of the slough is too deep for foraging.

<u>PRESENTER BIO</u>: Nathan Dorn is an aquatic ecologist and Professor of Biological Sciences at Florida Atlantic University in Davie, Florida. He and his lab members investigate hydrological variation, animal communities, and trophic interactions in the Everglades.

INVESTIGATION OF THE REMOVAL OF PHOSPHORUS SPECIES AND OTHER NUTRIENTS IN THE STORM-WATER TREATMENT AREA (1E)

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[2]South Florida Water Management, Palm Beach, FL, USA

The Everglades stormwater treatment areas (STAs) were established to decrease nutrients in waters entering the Everglades. STA-1E is a wetland that filters water from the C51 canal before entering the Water Conservation Area 1A (WCA1; Arthur R Marshall Wildlife Refuge); the northern-most extent of the remnant Everglades. These STAs remove excess P and other nutrients from agricultural runoff by plant and microbial uptake. The dynamics and species of P in water and soil have implications for P availability.

This study investigated the efficacy of the removal of P from agricultural runoff and examined the transformations of P compounds available for plant uptake. STA-1E soil and water samples were examined for various P species during the wet and dry season by solution ^{31}P Nuclear Magnetic Resonance (NMR) spectroscopy. The NaOH-EDTA (EN) extraction method was used for the extraction of P compounds. The percent of P extracted from solid samples was found to be 40-100%. ICP-OES was used to determine the total P and of many other nutrients. Concentration of P in the water at the intersection of L8 and C51 canal was found to be as high as 786 ppb before entering STA 1E. Results from the STA 1E showed as much as 84.3% reduction in total P from the treatment water flow through cells 3, 4N, and 4S. Through integration of the peaks in the ^{31}P NMR spectra, many different P species were identified and quantified. Vegetation was also examined for nutrient uptake by ICP-OES as well as by ^{31}P NMR spectra for P speciation and transformations. X-ray diffraction was used to help characterize the soil as it pertains to P species and the dynamics with the metal cations.

Acknowledgement: This research is being funded by an award to the senior author (BD) from the Everglades Foundation and that support is gratefully appreciated

PRESENTER BIO: Bobby Duersch is a PhD Candidate at the Department of Chemistry and Biochemistry at Florida Atlantic University. Recently, he was just awarded a scholarship of $10,000 from the Everglades Foundation to be used in implementing plans in restoring the Everglades.

SPECIATION AND DYNAMICS OF PHOSPHORUS: THE ROLE OF RICE PLANTS IN SEQUESTERING PHOSPHORUS COMPOUNDS

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In the Everglades Agricultural Area (EAA) of South Florida, farming practices have long been mindful of phosphorus (P) management as it relates to sufficiency and efficiency of P utilization. Over two decades of P best management practices have resulted in more than 3000 metric-tons of P load reduction from the EAA to downstream ecosystems. Research is being conducted on organic and sandy soils to improve efficiency of P uptake and minimize discharge loads. During the summer, more than 50,000 acres of fallow sugarcane land is available for rice (*Oryza sativa L.*) production in the EAA. The net value of growing flooded rice in the EAA as a rotational crop with sugarcane far exceeds its monetary return. Soil conservation, pest control, and P load reduction are only some of the benefits. With no P fertilizer applied, rice cultivation can potentially function as a sink for P as a result of particulate settling and plant P uptake, while harvested whole grain rice can effectively remove P from a rice field per growing season on organic soils.

P-31 Nuclear Magnetic Resonance spectroscopy (NMR) is a powerful tool in determining and quantifying P compounds in soils and plants. ^{31}P NMR spectra collected at different segments of the rice plant showed many forms of P compounds being transported and/or formed throughout the entirety of the rice plant. These various forms of P were quantified by the integration of peaks in ^{31}P NMR spectra coupled with ICP-OES analysis for total P concentrations. ^{31}P NMR spectra showed a difference of P speciation between sugarcane and rice plants as well. ^{31}P NMR spectra were taken of the rice plant during the vegetative period and ripening periods. The rice grain produced the largest amount of P compared to the rest of the plant which is removed during harvesting. X-ray diffraction suggested chemical transformation of flooded rice soil versus the harvest stage, as the soil was dried. P concentrations in the soil decreased from the inflows and outflows region of the rice fields.

Acknowledgement: This research is being funded by an award to the senior author (BD) from the Everglades Foundation and that support is gratefully appreciated

PRESENTER BIO: Bobby Duersch is a PhD Candidate at the Department of Chemistry and Biochemistry at Florida Atlantic University. Recently, he was just awarded a scholarship of $10,000 from the Everglades Foundation to be used in implementing plans in restoring the Everglades.

LIKELY CAUSES OF DRAMATICALLY LOWER DRY SEASON WATER TABLES AT CORKSCREW SWAMP SANCTUARY IN SOUTHWEST FLORIDA

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Daily water level monitoring began at Corkscrew Swamp Sanctuary (CSS) in 1959 when there had been relatively few hydrologic alterations in its watershed. Agricultural and residential development have since come to dominate the watershed, and a 55-year-long water level monitoring record has detected substantial changes in the swamp's hydrology. Rainfall records indicate no significant changes from 1960 to 2015. Water level data indicate no decadal change in the timing or magnitude of peak wet season hydrologic conditions or in the hydroperiods of the upland hammock and pine forests or wet prairies. A notable change occurred around 2000, after which hydroperiods decreased 41% in marshes, 27% in bald cypress, and 23% in pond habitats. The frequency of dry down in open water ponds increased from 22% of years WY1960-1999 to 81% of years WY2000-2015, with the duration of dry down increasing 41%.
There are a number of likely interacting causes of the hydrologic changes we observed in the Corkscrew Swamp watershed over the period from 1960 through 2015: (1) pumping surface and shallow groundwater levels lowers local wet season water levels to facilitate upstream agriculture by sending water downstream (to CSS), thereby reducing upstream wet season water storage that helped maintain downstream dry season water levels; (2) year-around increased downstream drainage for residential development has increased hydrologic gradients, and thus outflows from Corkscrew Swamp; (3) population growth and agricultural expansion has required increasingly larger extractions from southwest Florida's freshwater aquifers underlying CSS; and (4) decades of fire suppression has allowed herbaceous marsh and wet prairie plant communities and open pine forests that were originally dominated by a dense herbaceous groundcover with relatively little woody vegetation to succeed to dense, more-deeply rooted, multi-strata shrub and/or hardwood forests, which could be significantly increasing dry season evapotranspiration rates.

These types of landscape changes can have major effects on plant and animal communities throughout southwest Florida. As wetland water levels are lowered and hydroperiods shortened, it is expected that plant communities distributed along south Florida's very low topographic gradients will gradually move downslope resulting in the partial or complete loss of wetlands, depending on their position along the topographic gradient and the severity of drainage. This change can happen slowly over long periods of time or very rapidly due to a more severe fire regime on these drained sites. There have been numerous severe fires in recent years in some of the more drained portions of southwest Florida. These types of fires would be virtually impossible to control in Corkscrew Swamp with its deep organic soils, which are crucial to the survival of its old growth cypress forest.

PRESENTER BIO: Mike Duever has been conducting research on wetland ecology for over 40 years. Much of his work has been focused on South Florida, but projects in many other parts of the United States has broadened his perspective on how these ecosystems work and what can significantly impact them.

HABITAT PREFERENCE AND RESOURCE USE OF COMMON SNOOK (*CENTROPOMUS UNDECIMALIS*) AND SUB-ADULT ATLANTIC TARPON (*MEGALOPS ATLANTICUS*) IN ALTERED COASTAL EVERGLADES LAKES

Cody Eggenberger[1], *Rolando Santos*[1], *Thomas Frankovich*[1], *Chris Madden*[2], *Jimmy Nelson*[3], *Jennifer Rehage*[1]

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[3]University of Louisiana at Lafayette, Lafayette, Louisiana, USA

Habitat selection by organisms can be driven by a number of factors, including the availability of resources. Nutrient enrichment can alter the quality of landscapes, and thus the availability of resources, with implications for consumer movement and habitat use. In coastal ecosystems, eutrophication can affect the production and distribution of resources, and thus the behaviors and space use of consumers. Understanding how these impacts may be altering animal habitat selection mechanisms and resource use is critical to both management and restoration efforts. Coastal lakes in the Everglades have experienced major changes including higher salinities and nutrient concentrations relative to pre-drainage conditions. These changes in water quality have caused state shifts from SAV-dominated to phytoplankton-dominated primary production in some coastal lakes. In this project, we couple acoustic telemetry methods and stable isotope analyses (SIA) to examine the habitat preference and resource use of Common Snook (*Centropomus undecimalis*) and sub-adult Atlantic Tarpon (*Megalops atlanticus*) across two neighboring estuarine lake systems of varying trophic state (eutrophic vs. mesotrophic), located in Florida Bay (Florida, USA).

<u>PRESENTER BIO</u>: Cody Eggenberger is a Master's student at Florida International University in the Earth and Environment Department in Dr. Jennifer Rehage's lab.

AQUALUTIONS®™ – CLOSING THE LOOP ON SURFACE WATER RESTORATION

William A. Eggers
AquaFiber Technologies Corporation, Winter Park, FL, USA

AquaFiber Technologies Corporation's water remediation technology called AquaLutions®™ restores surface waters using a modified dissolved air flotation system to harvest algae, cyanobacteria and other suspended solids from them. By flowing millions of gallons of water per day, this process removes tons of phosphorus and nitrogen permanently from the watershed each year. It also yields millions of pounds of organic biomass made primarily from algae and cyanobacteria collected from the water column. The resultant product water's clarity is close to drinking water, free of excess nutrients, and almost fully saturated with oxygen.

While algae and cyanobacteria absorb and adsorb phosphorus, nitrogen and other nutrients, they also ingest and have metals, pesticides, pharmaceuticals, etc. attached to them. By removing this biomass from the water column, the return water is free of excess nutrients and many other pollutants. The harvested biomass is not disposed but used for a beneficial purpose. AquaFiber®™ has tested the biomass as a feedstock for various forms of energy or fuel production. It has been used to make JP-8 jet fuel, high altitude dry fuel, and pure hydrogen gas. It has also been shown to have advantages over other feedstocks when converted to electricity using gasification, anaerobic digestion or a fluidized gas bed. Proven non-energy uses include fertilizer in raw or pelletized form, building products, and plastic alternatives. The act of harvesting the biomass also makes for an effective carbon capture or wetland mitigation strategy. And since an AquaLutions project would have no "baseline" treatment requirement, all the recovered nutrients could be monetized and traded as water quality credits.

After testing all of the above algae conversion techniques, the most beneficial use of the biomass was found to be as a fertilizer feedstock. AquaFiber®™ has partnered with a fertilizer company that uses a revolutionary technique to obliterate the biomass and reduce it to its atomic constituents, destroying any trace of the former pollutants. The raw components are then re-assembled to manufacture a zero-P, slow release, and organic pellet that is sold worldwide as a specialized fertilizer for agriculture and turf grasses. If plants are grown from it, then the carbon "captured" by the algae can be considered "utilized." The second, best use is as a feedstock for another partner's one-of-a-kind waste to energy machine that reduces wet biomass to ash and produces purified water and liquid ammonia. The machine can be co-located alongside AquaLutions®™ and tooled to produce a modest amount of electricity.

Depending on a combination of factors including scale, location, water quality and the end goals, AquaLutions®™ and beneficial biomass conversion can be linked to create an effective and sustainable way to provide regional surface water remediation and renewable product development. It provides nutrient and pollutant-free water that meets both TMDL and NNC requirements and produces a beneficial product to create a sustainable process that provides for a full waterbody restoration.

PRESENTER BIO: Eggers is a Board-Certified Environmental Professional, Certified Wildlife Biologist, Florida Master Naturalist and Professional Wetland Scientist. Eggers graduated from UF with a BS in Wildlife Ecology/Zoology and has worked as an Environmental Scientist in Florida for over 25 years. Eggers currently serves as AquaFiber's Vice President of Science and Technology.

2012-2017 RECOVER EVERGLADES REPORT CARD

Alexandra Fries[1], Laura Brandt[2], Caroline Donovan[1], ***Gretchen Ehlinger***[3]*, Jack Gentile[4], Donna George[3] Patricia Gorman[5], Phyllis Klarmann[5], Heath Kelsey[1], Jenna May[6], Amanda McDonald[5], Agnes Mclean[7], Miles Meyer[7], Emily Nastase[1], William Nuttle[1], Patrick Pitts[2], Andrew Rodusky[5], David Rudnick[7], Michael Simmons[3], Steve Schubert[8], Fred Sklar[5], Christa Zweig[5]*

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The REstoration COordination and VERification (RECOVER) program gives the health of the Everglades an overall score of 43 percent, which is at the low end of the “Fair” range. Ecological health is evaluated for the period May 2012 through April 2017, and the overall score is an average of four regional scores. Following are scorings and descriptions of general ecological conditions for the four regional systems.

Conditions in Lake Okeechobee were “Fair,” represented by a score of 44 percent. Overall, lake stage remained close to desired targets, but with several notable instances of high water during the growing season. These may explain why scores for flora and fauna indictors scored “Fair” and “Poor,” respectively, while lake stage scored “Good.”

Northern Estuaries scored at the high end of the “Fair” range, with a score of 58 percent. Conditions were affected by environmental events, such as a strong El Nino and hurricanes, which disrupted salinity patterns due to regulatory water releases from Lake Okeechobee. This had negative impacts on submerged aquatic vegetation (SAV), oysters, and benthic infauna. Reduced salinity impacted oysters in the St. Lucie estuary, but recovery is expected. Chlorophyll *a* scores ranged from “Good” to “Poor,” reflecting variable conditions from year-to-year and differences between the three estuaries.

The Greater Everglades scored “Fair,” with an overall score of 46 percent. Conditions varied throughout the five-year reporting period, with indicator scores ranging from good to very poor. Conditions for periphyton were “Good” despite legacy nutrients and the effects of high-water levels, which negatively impacted prey availability and wading birds. Marl prairie and ridge and slough habitat in many areas remain degraded, but tree islands in the Water Conservation Areas showed resilience, scoring “Good.”

The “Poor” score for the Southern Coastal Systems, 38 percent, reflects the impact of decreased freshwater inflow combined with sea level rise. Salinity was high relative to targets throughout the region, exacerbated by drought in 2014 and 2015. High salinity impacts SAV, crocodilians, fish, and roseate spoonbills. Improvement in the health of the estuarine ecosystems of the Southern Coastal System requires a sustained improvement in freshwater inflow.

PRESENTER BIO: Dr. Ehlinger is a senior biologist with more than 14 years of experience in Everglades restoration and system-wide science. She is a long-time manager for the RECOVER program which is responsible for establishing a framework to measure and interpret system-wide responses to the Comprehensive Everglades Restoration Plan.

EVALUATING ECOLOGICAL VULNERABILITIES OF THE GREATER EVERGLADES ECOSYSTEM USING BAYESIAN NETWORK MODELS

Gretchen Ehlinger[1], *Jenna May*[2], *David Rudnick*[3], *Laura D'acunto*[4] *and Leonard Pearlstine*[3]
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Understanding of the Everglades' ecological vulnerabilities and restoration needs has greatly advanced over the past decade, but has yet been applied in a system-wide, integrated manner. To address this, the system-wide science arm of Everglades restoration, REstoration COoridnation and VERification (RECOVER), has set out to develop a tool that will enable an integrative, multi-scale analysis of ecological responses to multiple ecological stressors and restoration actions. As outlined in the RECOVER Five-Year Plan, the purpose of this vulnerability analysis is to develop and establish an ecological network model to evaluate ecosystem vulnerability and provide decision support for Everglades Restoration management actions within the Comprehensive Everglades Restoration Plan (CERP).

The vulnerability analysis will use Bayesian Belief Network (BBN) models, which combine graphical depictions of ecological systems and conditional probability theory to predict system outcomes. Draft models will be developed and tested using case studies that explore a range of stress exposures such as climate change impacts including sea level rise, temperature, and precipitation, yielding a range of ecological responses that reflect the Everglades ecological vulnerability or resilience. Case studies selected represent system components at varying stages of development and with varying levels of uncertainty, and include the existing RECOVER Trophic hypothesis cluster and a peat collapse case study. The Trophic hypothesis cluster is a well-understood system with established predictive models. The vulnerability analysis would allow for integration of disparate species models, assessment of species interactions, and the potential to elucidate emergent patterns or processes not previously known. In contrast, the peat collapse case study is less developed and encompasses a high level of uncertainty. Modeling processes associated with peat collapse is of great interest to managers and scientists in the system.

Our integrated understanding is essential for accurate evaluation of benefits and trade-offs at local and system-wide scales. Through execution of the vulnerability analysis, RECOVER will more effectively guide CERP planning and implementation and help to actuate management measures that mitigate and minimize ecological vulnerabilities.

PRESENTER BIO: Dr. Ehlinger is a senior biologist with more than 14 years of experience in Everglades restoration and system-wide science. She is a long-time manager for the RECOVER program which is primarily responsible for establishing a framework for measuring and interpreting system-wide responses to the Comprehensive Everglades Restoration Plan.

RESPONSES OF LARGE AND SMALL WADING BIRD SPECIES TO HABITAT AND PREY AVAILABILITY

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Reduced prey availability is hypothesized as a primary constraint on wading bird populations in South Florida, yet not all species exhibit the same response to changes in prey densities. One hypothesis suggests larger species are more sensitive to changes in habitat availability because they can travel longer distances at lower relative costs, which allows them access a greater variety of foraging areas farther from the nest. In contrast, smaller species that forage closer to their colony are more sensitive to changes in prey availability, because they have less area of foraging habitat within reach and have shorter nesting periods, which requires them to synchronize their nest initiations with peak prey availability. We tested these hypotheses by estimating the relative effect of habitat availability and prey availability on nest abundance of the Great Egret (*Ardea alba*), and the smaller Snowy Egret (*Egretta thula*). We also tested the effect of these variableson daily nest survival rates for the Great Egret and two small heron species, the Snowy Egret and Tricolored Herons (*Egretta tricolor*). From 2011-2018, we conducted systematic aerial surveys to estimate nest abundance of white wading birds, and weekly ground surveys to monitor nest survival. Concurrently, we estimated prey density and biomass m^{-1} by throw trapping at randomly selected sites within the foraging ranges of monitored colonies. For the species monitored on aerial surveys, Great Egrets and Snowy Egrets, we tested the effect of habitat and prey availability on nest abundance using linear regressions. We estimated daily survival rates of nests using logistic exposure models. For Great Egrets, nest abundance was not related to the availability of prey ($R^2 = 0.13$, $p = 0.23$) nor habitat ($R^2 = 0.17$, $p = 0.20$). Similarly, prey density and habitat availability were uninformative in Great Egret nest survival models. For Snowy Egrets, there was a significant positive correlation between nest abundance and prey density ($R^2 = 0.51$, $p = 0.04$), but not habitat availability ($R^2 = 0.35$, p 0.09). Nest survival of small herons increased with fish density, but the strength of this relationship diminished when habitat availability was low. Our results do not support the hypothesis that habitat availability has a stronger relative effect on large wading birds. However, we did find support for the hypothesis that prey availability has a stronger relative effect on small wading birds.

<u>PRESENTER BIO</u>: David Essian is a PhD candidate at Florida Atlantic University, in the Gawlik Avian Ecology Lab. His research focuses on the impact of hydrological variation on wading bird populations at Lake Okeechobee.

RESPONSES OF SMALL HERONS AND WOOD STORKS TO A CHANGING PREY BASE

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Urban expansion in South Florida has resulted in the creation of anthropogenic water bodies and the introduction of non-native fishes into the landscape. Wading birds in the Everglades are adapting to different degrees to these rapid, human-induced changes. We examined the influence of non-native fishes and creation of alternative foraging habitats, such as anthropogenic water bodies, on diet of Wood Storks (*Mycteria americana*) and three small heron species; Tricolored Herons (*Egretta tricolor*), Snowy Egrets (*Egretta thula*), and Little Blue Herons (*Egretta caerulea*). We hypothesized that the use of non-native species would be highest during suboptimal hydrologic conditions for all bird species. We expected that non-native species would be higher in diets during suboptimal conditions due to birds accessing alternative foraging habitats where non-native species are more prevalent. For Wood Storks, we also tested whether the prevalence of non-native species and other alternative food sources provided in urban areas influenced the reproductive performance of urban and natural wetland birds.

Diets of Tricolored Herons and Snowy Egrets were statistically similar, primarily consisting of native marsh fish, commonly found within the natural wetland system. In contrast, Little Blue Heron and Wood Stork diets consisted of higher proportions of non-native prey, which are not as commonly found in the natural freshwater wetlands. Diet also varied across hydrologic conditions. During suboptimal conditions, which is linked to low prey density in the natural system, non-native fish increased in all bird diets whereas non-native fish availability in the natural marsh remained constant. The increase of non-native fish use during suboptimal conditions aligns with foraging theory, which predicts individuals should be more opportunistic as preferred prey types become scarce.

For Wood Storks, we assessed reproductive performance across both natural wetland and urban colonies. During optimal hydrologic conditions, both urban and natural wetland storks increased productivity. However, during suboptimal conditions, urban storks produced significantly more chicks than natural wetland storks. Both urban and natural wetland storks increased diet breadth during suboptimal conditions to include non-native fish into their diets. Urban storks, however, also included alternative food sources, such as human refuse, suggesting that urban storks may be more resilient to hydrologic fluctuations than storks nesting in natural wetlands.

The increase of non-native fishes in the diets of small herons and Wood Storks during suboptimal conditions suggests that these species have behavioral flexibility to deal with the fluctuations of the natural marsh system. We found that non-native fishes are more common in anthropogenic water bodies than natural wetlands, suggesting that birds may be accessing these areas when conditions in the marsh are suboptimal. These patterns suggest that the responses of small herons and storks to natural hydrologic conditions may be mediated by foraging habitat and prey species in urban environments.

PRESENTER BIO: Betsy Evans is a graduate student at Florida Atlantic University working towards a Ph.D. in Integrative Biology. Her research focuses on Wood Stork use of roadway corridors and their responses to human-induced rapid environmental change in South Florida.

NUTRIENT CYCLING BY FISHES AND MACROINVERTEBRATES IN THE EVERGLADES STORMWATER TREATMENT AREAS

Nathan T. Evans[1], *Joel C. Trexler*[1], *Susan Newman*[2], *and Mark I. Cook*[2]
[1]Florida International University, North Miami, FL USA
[2]South Florida Water Management District, West Palm Beach, FL USA

The Everglades Stormwater Treatment Areas (STAs) consist of 23,067 ha of constructed wetlands designed to reduce phosphorus concentrations in surface water runoff prior to flowing into the Everglades. However, the effects of fishes and macroinvertebrates, increasingly recognized as important contributors to nutrient cycling in aquatic ecosystems, are not currently included in STA phosphorus budgets. The objective of this study is to determine the role of fishes and macroinvertebrates in STA nutrient cycling. In 2017, we surveyed fish and macroinvertebrate community structure in the STAs with throw trapping and electrofishing. These surveys indicated that fish and macroinvertebrate abundances and biomasses were greater in STAs than in other areas of the Everglades. However, average STA fish species richness and condition factors were similar for all Everglades regions. Additionally, community similarity analyses indicated that species composition differed among the Everglades regions. To estimate the contribution of fishes to STA nutrient recycling and translocation, we are currently quantifying P and N excretion, resuspension (bioturbation), and sequestration (tissue stoichiometry) for abundant STA species. Moving forward, the resulting excretion and resuspension estimates will be combined with habitat-specific biomass estimates to calculate areal excretion and resuspension rates that will be incorporated into future STA nutrient budgets.

PRESENTER BIO: Nathan Evans is a fish biologist at the US Fish and Wildlife Service Carterville FWCO Wilmington Substation and a former postdoctoral research associate at FIU. His research focused on understanding the role of aquatic fauna on nutrient recycling and translocation in the Everglades.

MORPHOMETRIC AND REPRODUCTIVE PHENOLOGY OF BURMESE PYTHONS IN THE EVERGLADES

Bryan Falk[1] *and Robert Reed*[2]
[1]National Park Service, Homestead, FL, USA
[2]US Geological Survey, Fort Collins, CO, USA

Invasive Burmese pythons (*Python bivittatus*) have severely impacted the Everglades ecosystem, and research on control-tool development is underway. Basic biological information is critical to tool development, but many aspects of Burmese python biology, including demography and phenology, remain undocumented. We use necropsy information collected over multiple years to characterize: 1) phenology of reproduction; and 2) size and shape of young-of-year pythons. We show that mature pythons undergo substantial gonadal changes associated with their breeding season and that pythons undergo significant growth in the first year of their life. This information has implications for development of pheromone attractants, potential impacts of young pythons, and potential rates of predation on young pythons.

PRESENTER BIO: Dr. Falk is the supervisory invasive species biologist at the South Florida Natural Resources Center, serving Everglades and Dry Tortugas National Parks.

LONG-TERM REGIONAL NUTRIENT CONTRIBUTIONS AND IN-LAKE WATER QUALITY TRENDS FOR LAKE OKEECHOBEE RESTORATION ASSESSMENT

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Data analysis and evaluation of long-term trends are a critical aspect of a successful adaptive planning and management of any ecosystem. Lake Okeechobee is in south-central Florida and is the liquid heart of the greater Everglades ecosystem as it is connected to different watersheds. The lake has suffered from substantial environmental deterioration since early 1970s while restoration efforts began over 3 decades ago. The overall aim of this study was to evaluate the contribution of flows and nutrient loadings from the different Lake Okeechobee tributary regions during the last 5 decades and to provide a comprehensive trend analysis assessment of nutrient loadings and concentrations of inflows and outflows as well as in-lake water and sediments.

A long-term data set was used to investigate the historical changes in flow rate, Total Phosphorus (TP) and Total Nitrogen (TN) loadings and concentrations in and out of Lake Okeechobee for the period of 1973 to 2018. The average annual TP loading accumulation in the Lake sediments was assessed as well as the average annual TP Unit Area Load contributed to Lake Okeechobee from the different regions. The TP load inflows from the northern tributary regions to the lake remained statistically stable during the investigated period while TP load outflows from the Lake increased substantially over the study period. Lake Okeechobee TP sedimentation rate showed a statistically significant decreasing trend indicating the reduction in the Lake sediments' capacity to assimilate phosphorus, further indicating that the lake sediments may become a continuous source of phosphorus in the near future. During the investigated period, TN flow weighted mean concentration from water flowing into the Lake from the southern region was higher than from the other tributary regions. TP flow weighted mean concentration in water flowing into the Lake from the southern and northern regions had higher levels when compared to in-lake TP levels. The in-lake TP concentrations showed a statistically significant increase with important implications on Lake Okeechobee restoration efforts.

<u>PRESENTER BIO</u>: Dr. Faridmarandi received her PhD in Geoscience in 2017 from Texas A&M University working on assessing the environmental and management factors impacting the phosphorus loadings in the Everglades Agricultural Area. She is currently consulting with the Everglades Foundation on a project investigating the long-term trend of water quality reaching Lake Okeechobee.

GRADIENTS IN MANGROVE FOREST STRUCTURE AND THEIR RELATIONSHIP TO CLIMATE, GEOMORPHOLOGY AND HUMAN INFLUENCE

Lola Fatoyinbo
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Mangrove wetlands are among the most productive and carbon-dense ecosystems in the world. Their structural attributes vary considerably across spatial scales, yielding large uncertainties in regional and global estimates of carbon stocks. Rapid losses of mangroves over the past 50 years have had negative consequences on the environment, climate, and humanity, through diminished benefits such as carbon storage, coastal protection and fish production.

In this presentation, I will present several new mangrove datasets developed at NASA, focused on generating a better understanding of the drivers of mangrove structure worldwide. In a first part, I will present new global maps of mangrove canopy height gradients and aboveground carbon stocks based on remotely sensed measurements and field data. The maps show that maximum attainable mangrove canopy height is driven by regional precipitation rate and temperature and can be limited by hurricane frequency. These conclusions are supported by large scale patterns of mangrove structure observed along the coast of the various continents and the complex spatial patterns at regional and local scales underscore the role of environmental and geophysical factors driving mangrove productivity. In a second part, I will focus on more regional effects of cyclones on mangrove structure and resilience, by showing recent the effect of the intensive 2017 hurricane season on mangrove structure and recovery in the Florida Everglades as measured by the 2017 NASA G-LiHT airborne Lidar campaign.

PRESENTER BIO: Dr. Temilola (Lola) Fatoyinbo Agueh is a Research Physical Scientist in the Biospheric Sciences Lab at NASA GSFC where she studies forest ecology and ecosystem structure using active remote sensing instruments. Lola received her Doctorate in Environmental sciences in 2008 with a focus on forest ecology of tropical wetlands. After her Ph.D, she received a NASA postdoctoral program fellowship at the Radar Science and Engineering Section at JPL, where her primary research focus was on using interferometric radar data to quantify tropical forest extent, height and biomass through the development of radar-lidar fusion algorithms. In 2010, Dr. Fatoyinbo joined Goddard's Biospheric Sciences Laboratory. Her current research focus is the fusion of optical, SAR and lidar data to quantify forest structure, biomass, extent and degradation. She is the Principal Investigator on the P-band EcoSAR SAR instrument and PI/CO-I on several other NASA-funded projects.

REMOVAL AND RECOVERY OF PHOSPHORUS FROM WASTEWATERS USING MINE DRAINAGE OCHRES

Phillip L. Sibrell and ***Stephen P. Faulkner***
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Excessive phosphorus (P) inputs to the environment have resulted in the formation of harmful algal blooms and anoxic dead zones, leading to the degradation of sensitive water bodies worldwide. Existing technology for the removal of P from wastewaters typically consists of treatment with aluminum or iron salts or constructed wetlands. While these approaches can be effective, they are often expensive with large land requirements and/or high operating costs. There is a need for cost-effective approaches to remove phosphorus from waste waters. A promising approach has been developed with fixed-bed sorption of P using low-cost iron oxides, or ochres, obtained from the treatment of mine drainage. When acid mine drainage is remediated, it is neutralized with a base and an iron-rich ochre is formed that must be disposed of, often at considerable cost. This new approach of using the ochre to adsorb P from wastewaters has the potential to both reduce P loads to aquatic systems and reduce costs associated with disposal of the ochre material. In addition, the ochre can be regenerated and the P recovered through treatment at elevated pH with sodium hydroxide, after which the P can be precipitated into a potentially marketable fertilizer product. The process has been applied to aquaculture facilities and to dairy manure effluent with up to 90% P removal rates. More recent field applications treating a range of flow rates (~9,500 to ~375,000 liters per day) for several months have resulted in P removal rates between 73% and 86%. Reduced capital and operating costs are achieved by using the by-product ochre media and reducing solid-liquid separation and sludge disposal required by conventional processes. Application of this patented technology has the potential to simultaneously help to decrease acid mine drainage treatment costs, prevent degradation of aquatic ecosystems, and recycle a valuable nutrient as a fertilizer product.

PRESENTER BIO: Dr. Faulkner has been a wetland scientist for over 25 years studying various aspects of forest and wetland ecosystem sustainability and restoration including soil redox chemistry and carbon and nitrogen biogeochemistry. He is currently the Chief of the Aquatic Ecology Laboratory at the Leetown Science Center where he leads a diverse team of scientists with expertise in landscape and aquatic ecology, decision analysis, ecosystem restoration, and conservation genetics and genomics. He is also a Past President of the Society of Wetland Scientists (2013-2014).

THE LONG-TERM EFFECTS OF HURRICANES WILMA AND IRMA ON SOIL ELEVATION CHANGE IN EVERGLADES MANGROVE FORESTS

Laura C. Feher[1]*, Michael J. Osland*[1]*, Gordon H. Anderson*[2]*, William C. Vervaeke*[1]*, Ken W. Krauss*[1]*, Kevin R.T. Whelan*[3]*, Karen M. Balentine*[4]*, Ginger Tiling-Range*[5]*, Thomas J. Smith III*[6]*, Donald R. Cahoon*[7]

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Mangrove forests in the Florida Everglades are frequently affected by hurricanes that bring damaging winds, storm surge, and extreme rainfall. Hurricanes can also provide phosphorus-rich sediment inputs, which stimulate plant growth in these nutrient-limited ecosystems. The long-term influence of hurricane sediment inputs on soil elevation dynamics in mangrove forests are not well understood. Here, we assessed the effects of sediment deposition during Hurricanes Wilma (2005) and Irma (2017) on soil elevation change at two mangrove forest sites in Everglades National Park. The sites were located along the Shark and Lostmans Rivers. Surface elevation change was measured across a sixteen-year period (2002-2018) using the surface elevation table-marker horizon (SET-MH) approach. At the Shark River site, we used marker horizons and deep, shallow, and original SETs to quantify the contribution of four soil zones to net soil elevation change. Rates of elevation change were greatly influenced by large deposits of storm sediments from Hurricanes Wilma and Irma. At both sites, changes in soil elevation followed similar, cyclical patterns of elevation change. Sediment additions during Hurricane Wilma were followed by a multi-year, post-hurricane period of elevation loss due to erosion of hurricane sediments as well as subsurface contraction, and then a multi-year period of increasing elevation due to accretion and subsurface expansion prior to the deposition of new sediment during Hurricane Irma. Our findings suggest that elevation change in hurricane-impacted mangrove forests can be non-linear and cyclical, which is critical information for advancing the understanding of wetland responses to sea-level rise given the expectation of increased storm intensity due to climate change.

PRESENTER BIO: Laura Feher is an Ecologist at the U.S. Geological Survey's Wetland and Aquatic Research Center. Her research has focused on understanding and predicting the impacts of climate change in coastal wetlands.

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HOW FIRE AND WATER AVAILABILITY DRIVE CHANGES IN PHOSPHORUS CYCLING AND VEGETATION COMPOSITION IN INTERMITTENT WETLANDS

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Fire is a critical driver of phosphorus (P) cycling and ecosystem development, especially in seasonally inundated, intermittent wetlands. Intermittent wetlands with longer hydroperiods generally have higher plant and soil organic carbon (C) than those with shorter hydroperiods. However, it is uncertain how fire affects C and P cycling among intermittent wetlands with different hydroperiods. We tested the interactive effects of fire and hydroperiod on soil and plant C and P cycling in intermittent wetlands at Archbold Biological Station, located in the southcentral Florida scrub, an area with detailed prescribed fire history and active fire management. We used historic information relating fire history, hydroperiod, and soil C and P to predict how wetlands with different hydroperiods differentially use and allocate fire-released P above- and below-ground. To test this, we collected data on plant species composition and % cover, as well as plant and soil C and P concentrations from shorter- (n = 6) and longer-hydroperiod wetlands (n = 6). We then burned both shorter- (n = 4) and longer-hydroperiod wetlands (n = 4), maintaining replicates of both as no-burn controls (n = 4). We measured changes in water, soil, and plant C and P concentrations following fire. We also took aerial drone images pre- and post-burn and used the plant species composition and % cover data to characterize each pixel of these images using ArcMap to quantitatively analyze changes in aboveground composition for each experimental wetland (n = 8). Historic measurements found higher soil C and P concentrations in longer-hydroperiod wetlands that had been recently burned (< 2 years) compared to unburned and burned wetlands with shorter-hydroperiods ($P < 0.05$). Before our experimental burn treatment, we detected higher soil C concentrations in longer- than shorter-hydroperiod wetlands, and soil P was similar among wetlands despite differences in soil C concentrations. Plant C was an order of magnitude higher than soil C, and plant P was nearly 2x greater than soil P, but both plant C and P were similar among all wetlands. Post burning, we predicted higher soil organic matter and plant cover would have released more organically bound P during the fire in longer- than shorter-hydroperiod wetlands as well as have higher nutrient retention in soils and regrowing plants. Shorter-hydroperiod wetlands burned more completely, which resulted in more release of P post-burn. Soil P concentrations decreased by up to 50% in these wetlands and regrowing plants had nearly 2x greater P concentrations than pre-fire conditions. Post-fire, there was also a decrease in total P and total organic C in the water column of shorter-hydroperiod wetlands by up to 80% and 50%, respectively. Understanding how variation in hydroperiod and fire frequency affect ecosystem biogeochemistry and how wetland plants and soils differentially utilize available P can improve conservation of intermittent wetlands.

<u>PRESENTER BIO</u>: Mr. Fernandez obtained his BSc Biology from Florida International University with three years of undergraduate research. His research tests interactive effects of (i) crossed gradients of salinity and phosphorus concentrations on peat soil microbial processes and (ii) water availability and fire on phosphorus cycling and plant regrowth in intermittent wetlands.

USING EDNA AS AN EARLY DETECTOR FOR BURMESE PYTHON PRESENCE IN THE ARM LOXAHATCHEE NATIONAL WILDLIFE REFUGE IN THE GREATER EVERGLADES ECOSYSTEM

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Environmental DNA (eDNA) detection of invasive species can be used to inform management decisions by delimiting occupied ranges and estimating detection probabilities. Environmental DNA is shed into the environment through skin cells and bodily fluids and can be detected in water samples collected from lakes, rivers, and swamps. In south Florida, invasive Burmese pythons occupy much of the Greater Everglades in mostly inaccessible habitat and are credited with causing the severe declines of native species' populations. Detection of Burmese pythons by traditional methods, such as trapping and visual searching, have been largely ineffective, making eDNA a superior method for differentiating invaded habitat. We adapted a quantitative PCR eDNA assay for droplet digital PCR, a state-of-the-art method that improves precision and accuracy. From August 2014 to October 2016, locations in and around Arthur R. Marshall Loxahatchee National Wildlife Refuge in southeast Florida were surveyed for Burmese python eDNA. The Refuge is maintained to provide water storage and is considered one of the last remnants of the northern Everglades wetlands. Positive eDNA detections were made at each of the five sampling events, assessing a total of 399 samples, with moderate-to-high occurrence (ψ=58-91%) and moderate detection (p=40-70%) probabilities, potentially reduced by high presence of PCR inhibiting compounds in the water. The high occurrence rates and geographic distribution of the positive samples within the Refuge suggests a steady release of python eDNA from a resident Burmese python population and reduces support for the alternative hypothesis that primary transport of eDNA is through boats or flowing water from the north. The first confirmed sighting of a Burmese python in the Refuge occurred in September 2016, notably after eDNA testing had indicated the presence of pythons. While an established population was not expected this far north, the detections likely indicate a northern range limit of a consistent population at Loxahatchee on the eastern side of the Florida peninsula. Our study demonstrates the utility of eDNA for determining more accurate range limits and expansion information for Burmese pythons, as well as laying the foundation for the assessment of control efforts.

<u>PRESENTER BIO</u>: Dr. Ferrante is a research scientist contracted to Dr. Hunter's Conservation Genetics Lab at the U.S. Geological Survey. He specializes in the development and implementation of molecular biology approaches to investigate cryptic invasive and imperiled species using environmental DNA and to investigate immune function in imperiled wildlife.

TRIBAL AQUACULTURE USED TO BOLSTER FLORIDA APPLE SNAIL (*POMACEAE PADULOSA*) FOOD SOURCE POPULATIONS FOR THE EVERGLADES SNAIL KITE (*ROSTRHAMUS SOCIABILIS PLUMBEUS*)

Kenton A Finkbeiner*, Craig van der Heiden*

Miccosukee Tribe of Indians of Florida – Fish and Wildlife Department, Miami, FL

The Everglades Snail Kite (*Rostrhamus sociabilis plumbeus*) is a federal and state listed species that exists throughout the Miccosukee Indian Reservation and tribal trust lands in South Florida. The canalization, clearing, draining, and subsequent hydrologic alteration of water levels in the Everglades since the mid 1900’s has been the leading cause of their decline. This change in habitat has caused the Snail Kite’s only food source, the Florida Apple Snail (*Pomaceae padulosa*), to decline in population and become more inaccessible. In an effort to increase numbers of apple snail on tribal lands, the Miccosukee Tribe has established an aquaculture program that releases up to 100,000 snails into tribal lands per year. Snails will be released after 3 months of growth at 2.5cm in size. Research in habitat and tank population density, habitat preference of released individuals, and best release size recruitment is ongoing.

PRESENTER BIO: Kenton Finkbeiner is an aquaculturist for the Miccosukee Tribe of Indians of Florida under the direction of Director, Craig van der Heiden. He received his bachelor’s degree from the School of Fishery and Aquatic Science at the University of Washington, and Master’s from New Mexico State University in Fishery and Wildlife Science; Kenton’s experience spans 18 years spent in private consulting, the USGS, and Hubb’s SeaWorld Research Institute (San Diego).

TORTOISE OR HARE? LANDSCAPE HYDRO-ECOLOGICAL INTERACTIONS FROM PRESSES (SEA LEVEL RISE) AND PULSES (FRESHWATER FLOWS) IN THE COASTAL EVERGLADES

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Ecosystems within regional landscapes may have a broad range of interactions. The freshwater Everglades ecosystems are constantly interacting with adjacent marine/estuarine ecosystems associated with Florida Bay and the Gulf of Mexico, with habitats that are dynamic at decadal (or faster) time scales. This paper explores intriguing hydro-ecological system dynamics in the coastal Everglades, under a range of "slow" and "fast" driving hydrologic scenarios. Rising sea level is a slow press. Upstream rainfall events and managed flows are fast pulses. From an ecosystem perspective within broad landscapes and along linear transects, what happens when we model press-pulse hydrologic scenario games?

Freshwater flows and depths define much of the habitat variability within the Everglades, and that can be characterized as a major focus of CERP (Everglades restoration). Water quality (linked to flows), particularly phosphorus eutrophication, is recognized as a formal constraint on CERP projects. But things appear more complicated approaching the coast. Tides, and the tortoise of rising sea level, press estuarine water inland, while the hare of rain events (and associated water management) pulse freshwater downstream. Who wins - tortoise or hare?

In 4-decade model experiments, we subjected the Everglades to CERP0 "nominal restoration" conditions, and to several additional scenarios involving incremental sea level rise (SLR) that peaked at +50 cm. Coincident with the SLR press, we varied the managed freshwater pulses into Everglades National Park at levels of CERP0-nominal, double, and half flow volumes while adhering to the nominal, rainfall-based temporal patterns. For a fourth scenario, inflow water control structures were operated to meet hypothetical stage targets in Shark River Slough.

In general, SLR dominated the progression of increased water stage in the coastal region, with associated inland movement of mangrove and open-water habitats. Variation in upstream freshwater flows modified patterns of salinity and habitats in complex ways, with pulses moving the saline isolines particularly during dry seasons. Who wins? Probably the tortoise, but it depends on the definition of winning (i.e., what habitat etc. is preferred?).

<u>PRESENTER BIO</u>: Dr. Fitz was first intrigued by tropical seagrass-coral reef carbon flux interactions, but did graduate research on blue crabs as a vector of carbon flux interactions among temperate salt marshes and estuaries. That evolved to modeling Everglades landscape dynamics, and now to extending our understanding of Everglades & Florida Bay system interactions.

COMMUNITY COMPOSITION OF THE UPPER TAYLOR SLOUGH REGION: MONITORING RESPONSES TO AN ALTERED FLOW REGIME

Peter J. Flood *and Joel C. Trexler*
Florida International University, Miami

The Upper Taylor Slough (UTS) project increases water delivery to Taylor Slough in Everglades National Park (ENP) to restore hydroperiod and mitigate hyper-salinity events downstream in Florida Bay. We hypothesize that hydrological restoration in the UTS will stimulate secondary productivity by lengthening the growing season for aquatic organisms. Unfortunately, lengthening hydroperiod may mimic early successional changes from nutrient enrichment at short-hydroperiod sites, creating a challenge to interpreting monitoring data from these areas. We will use a space-for-time substitution and a structural equation model (SEM) to create a successional model that links environmental TP (from periphyton) and algal-community development along a hydroperiod gradient to biomass of primary and secondary consumers in reference areas not experiencing nutrient enrichment. The goal of this model is to serve as a reference for a before-after-control-impact (BACI) analysis of UTS re-hydration.

To evaluate how well our hydrological successional model matches periphyton, macroinvertebrate, and fish communities in the UTS, monitoring data are being gathered there at 10 impact sites and 2 reference sites. Sampling began in November 2017 and has been conducted bi-monthly since that time. Fish and macroinvertebrates are being collected by 1-m^2 throw traps with 5 samples per site each visit. We are supplementing the UTS data with data characterizing a short to long hydroperiod gradient from long-term monitoring sites in the Panhandle of ENP, downstream in Taylor Slough, and Shark River Slough. Early results indicate that pre-project fish species richness in the UTS is slightly lower or similar to the other study areas, with species accumulation curves suggesting less species evenness in the UTS than the other areas. Fish density is positively correlated with hydroperiod along the hydrological gradient and the most abundant species in the UTS is different than in the other study areas (Eastern Mosquitofish in the UTS and Bluefin Killifish elsewhere). Mayan Cichlids were the most common non-native fish in the UTS throw-trap collections made to date. Predatory creeping waterbugs, which eat small fish, tadpoles, and other macroinvertebrates, were the most common invertebrate in the UTS, Panhandle, and Taylor Slough. Grass shrimp were the most common macroinvertebrate at the longer hydroperiod Shark River Slough. Grass shrimp are omnivores eating detritus, periphyton, and small invertebrates. Parameterization of the food-web SEM and its use in a BACI framework for evaluating monitoring data will be discussed.

PRESENTER BIO: Peter is a second year PhD student at Florida International University under Joel Trexler. He studies non-native species through the lens of trophic dynamics and ecosystem function.

SALTWATER INTRUSION RELEASES PHOSPHORUS: INSIGHTS FROM EXPERIMENTS USING EVERGLADES BEDROCK

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An important but often overlooked consequence of saltwater intrusion is the potential increase of groundwater phosphorus concentrations due to saltwater-induced desorption of phosphorus. In this project we investigated carbonate bedrock with low phosphorus content and sought to answer two key questions: (1) in freshwater-seawater mixing zones, how much saltwater content is necessary to trigger seawater-induced phosphorus desorption? And (2) what is the rate, peak intensity, and duration of seawater-induced desorption of phosphorus?

To determine the proportion of saltwater that is sufficient to induce phosphorus desorption, the phosphorus sorption dynamics of two limestone rocks of different composition were investigated by simulating seawater intrusion over a wide range of mixing ratios between freshwater and saltwater. Both rocks exhibited a logarithmic loss of sorption efficiency in mixtures containing more than approximately 3 mM Cl- concentration (100 mg Cl- /L; about 0.5% saltwater). We infer that aquifer solids immersed in freshwater would undergo phosphorus desorption in response to the introduction of this minor amount of seawater. This Cl- concentration is within the range designated as fresh water. Thus we conclude that increased phosphorus availability from saltwater-induced desorption may occur at the ion exchange front, which is actually landward of the saltwater intrusion front as it is commonly defined. Sorption efficiency in our experiments continued to decline as salinity increased, until Cl- concentration reached a second threshold of 50 or 200 mM (1,700 or 7,700 mg Cl- /L), depending on the rock composition, particularly iron content. Further increase in salinity would produce little increase in groundwater phosphorus concentration.

To investigate the rate and intensity of seawater-induced phosphorus desorption, we conducted column leaching experiments using two carbonate rock samples. We measured total sedimentary phosphorus and found both rocks to be very low in phosphorus. For each rock sample, we packed a glass column with coarse grains and alternated flow between freshwater and saltwater. Phosphorus concentration was low in freshwater leachate, with a mean of 0.2 μM. With the first influx of saltwater, phosphorus concentration increased rapidly to peaks of between 0.8 and 1.6 μM. The phosphorus concentration began to diminish as saltwater continued to flow, but sustained desorption continued for over two hours. Our results indicate that an influx of saltwater triggers an immediate and intense pulse of phosphorus desorption from carbonate rock with low phosphorus content.

We conclude that small changes in seawater contribution can result in large changes in phosphorus sorption dynamics. Our results have implications for phosphorus availability in estuaries that receive mixing zone groundwater discharge.

<u>PRESENTER BIO</u>: Dr. Flower is an Assistant Professor of Environmental Studies at Eckerd College. Her research focuses on the geochemical consequences of sea level rise and climate change in coastal wetlands.

SHIFTING GROUND: LANDSCAPE-SCALE MODELING OF SOIL BIOGEOCHEMISTRY UNDER CLIMATE CHANGE IN THE FLORIDA EVERGLADES

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Climate change is a key uncertainty in global wetland restoration and management. Many large wetlands are likely to be affected by changes in precipitation and evapotranspiration, sea level rise, and related water-use management. In this project, we help Everglades restoration planning to take climate change into account by simulating plausible soil biogeochemical responses to future climate change scenarios. We used three climate change scenarios: a Baseline scenario of 2010 climate, and two scenarios that both included 1.5 ºC warming and 7% increase in evapotranspiration, and differed only by rainfall: either increase or decrease by 10%. In conjunction with output from a water-use management model, we used these scenarios to drive the Everglades Landscape Model to simulate changes to water depth, flow velocity, P, sulfate, carbon accretion, risk to fire and methylmercury in the freshwater Everglades. Previous work focused on sea level rise; this project focuses on changes to the freshwater remnant.

The decreased rainfall scenario produced marked changes across the system in comparison to the Baseline scenario. In regions that are currently too dry, surface water depths diminished substantially; in regions that are currently too wet, both soil accretion and soil phosphorus accumulation rates increased. Areas near water control structure inflows underwent declines in surface water sulfate concentration as well as phosphorus content of surface water, pore water, and soil, due to diminished flow-loading. Elevated methylmercury production risk decreased in areal extent and migrated closer to structural inflow points in response to reductions in sulfate loading. Surface water flow velocity slowed drastically across most of the system. The increased rainfall scenario was hydrologically similar to the Baseline scenario because water management criteria generally removed excess water during high rainfall events, and compensated for the losses via evapotranspiration. As such, this scenario exhibited little deviation in biogeochemical response, although one of the three areas we analyzed for muck fire risk had a 4% risk reduction under increased rainfall, and soil phosphorus accumulation accelerated adjacent to key water control structures.

Our numerical simulations of hydro-ecological processes under future climate change scenarios provide quantitative and visual support for the conclusion that future changes in macroclimate have the potential to produce significantly different ecological responses in the freshwater remnant Everglades depending on whether rainfall increases or decreases.

PRESENTER BIO: Dr. Flower is an Assistant Professor of Environmental Studies at Eckerd College. Her research focuses on the geochemical consequences of sea level rise and climate change in coastal wetlands.

POTENTIAL INFLUENCE OF LAND-BASED RUNOFF ON THE MICROBIOME OF NORTHERN AND CENTRAL BISCAYNE BAY

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Biscayne Bay (BB) is a shallow oligotrophic estuary in Southeast Florida proximal to the Miami metropolitan region. Channelization of rivers, and dredging of canals has greatly altered the historical, natural flow of fresh water into the bay. Coupled with the rise of a sprawling urban & suburban development, these factors have greatly increased the nutrient load in the bay. While previous time series data on water quality have been collected, BB bacterioplankton community has not been well described. This study examines the bacterial community at 14 stations throughout Biscayne Bay, focusing on the mouths of canals. One liter, surface water grab samples were taken monthly for one year (beginning in September 2017) and can be linked to nutrient and water chemistry data. The filtered samples were then sequenced for 16s rRNA, to identify bacterial community composition. Based on previous research, hypotheses tested in this project include the following: 1) microbial communities will correlate closely with water quality. Highly oligotrophic areas will have lower microbial diversity and eutrophic areas will display higher diversity. 2) Stations located at canal mouths will have higher diversity. 3) Stratification in the bacterial community based on the land use of the area surrounding the station. Erroneous sequences will be filtered out using DADA2 in QIIME 2. Statistical analysis will be done using Phyloseq, VEGAN, Picante & Unifrac in R-Studio.

PRESENTER BIO: Eric Fortman is a Biology MS student at Nova Southeastern University. Most of his research has centered around fish & avian biology and ecology. In addition to his studies, he instructs undergraduate organismal biology lab; and creates art to communicate science to both general & professional audiences.

HYDROLOGY DRIVES FISH CALLING BEHAVIOR IN FLORIDA BAY: THE POTENTIAL FOR AN ECOSYSTEM INDICATOR

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Long-term hydrological monitoring of the Florida Bay Estuary has significantly improved scientific understanding of physical environmental processes within the southern portion of Everglades National Park. To link environmental processes to ecosystem dynamics, however, requires a relevant metric of biological activity that is 1) representative of ecosystem interactions 2) can be measured at the same temporal and spatial scales of hydrological data collection, and 3) is at sufficient resolution to provide an understanding of organismal, population, and community-level changes. Passive acoustic detection of sonic fishes may provide an opportunity to link physical and ecosystem processes in estuary systems. Gulf toadfish (*Opsanus beta*) are a mid-tropic level estuary obligate with a widespread distribution throughout Florida Bay. Advertising males call frequently and predictably in both reproductive and agonistic contexts and exhibit high degrees of nest fidelity. As a result, their calls can be reliably used as an indication of animal presence or absence, as well as behavioral and physiological states. By investigating toadfish call occurrence across three hydrological monitoring stations in Florida Bay, we determined that toadfish have highest probability of occupancy at sites with lower salinity and higher temperatures (Dunn's test, $p<0.01$), and that toadfish responded significantly to variation in water quality regimes at their nesting locations. Increases in salinity and decreases in temperature both depress toadfish calling (logistic regression, $p<0.0001$), indicating that changes in these environmental parameters results in either nest abandonment by males, or decreased advertisement behavior. These data show significant behavioral and acoustic heterogeneity over relatively short distances within Florida Bay, and demonstrate that local environmental conditions drive calling behavior in addition to, or perhaps more so than the effects of seasonality or broader climatic conditions. When couched in what is known about this species' behavior, physiology and life history, that toadfish responses to salinity and temperature were consistent between and within sites lends strong support for the use of toadfish calling behavior as an indicator of estuary conditions and environmental change in Florida Bay.

PRESENTER BIO: Dr. Fournet is a postdoctoral research fellow with over a decade of experience planning, designing, and implementing bioacoustics field studies throughout North America. She received her PhD in Wildlife Science from Oregon State University in 2018, and her MS in Marine Resource Management from Oregon State University in 2014.

A DECADE OF SUBMERGED AQUATIC VEGETATION DYNAMICS IN MANGROVE LAKES AFFECTED BY ALTERED FRESHWATER DELIVERIES

***Thomas Frankovich*[1]**, *James Fourqurean*[1] *and David Rudnick*[2]
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The Mangrove Lakes region of the southern Everglades lies at the interface between freshwater marsh and marine Florida Bay and is therefore greatly affected by seasonal and longer-term changes in rainfall. Engineered diversions of freshwater during the last century have also reduced the delivery of freshwater into and through these lakes, increasing water residence times and salinities with negative consequences of increased phytoplankton abundance and reduced cover of the macroalgae *Chara hornemannii*. Water quality and submerged aquatic vegetation (SAV) are highly dynamic in the Mangrove Lakes and responsive to both natural and anthropogenic changes in freshwater deliveries. As part of Everglades restoration, the C-111 Spreader Canal Western project aims to reverse some of the freshwater loss from these systems and provide greater flushing and reduced salinities that promote the growth of *Chara*. From 2006 through 2011, *Chara* cover was very low in the western mangrove lakes and phytoplankton abundance was high. *Chara* cover increased greatly in 2012 and was associated with greater underwater light availability, lower phytoplankton abundance, and lower salinities. The change from a phytoplankton dominant system to that dominated by benthic SAV production followed the start of operations of C-111 water restoration operations in the spring of 2012, suggesting that increased freshwater deliveries either through increased rainfall or water diversions will have positive effects on the lakes ecosystem. In the following winter of 2012-2013, wintering waterfowl that feed on and in the *Chara* meadows also returned to the lakes in approximately 10X greater abundances than in previous decades.

<u>PRESENTER BIO</u>: Tom Frankovich is a research biologist studying the ecology and taxonomy of submerged aquatic vegetation, micro- and macroalgae.

CYCLIC AND PERSISTENT FLORIDA BAY ALGAL BLOOMS

Zachary Fratto *and Christopher Kavanagh*
Everglades National Park, Homestead, FL, USA

Florida Bay has been exposed to a series of events in recent years that has drastically changed the seascape. Beginning with the seagrass die-off of 2015, water quality began to deteriorate and a subsequent phytoplankton bloom began in the late wet season of 2016. While the phytoplankton bloom abated in early 2017, after Hurricane Irma arrived in September of that same year the phytoplankton bloom was once again observed and continued through March of 2018. A sequence of bloom events, with intermittent short interruptions, occurred in the end of the wet season in 2018.

Throughout these events, Chlorophyll-a pigment concentrations, a proxy for phytoplankton biomass, were measured from water samples collected from locations across the bay documenting the concentration and distribution of the bloom. Consistent monitoring of phytoplankton along with other parameters such as dissolved oxygen, turbidity, and nutrients continues by both discrete and continuous sampling through stations in our marine monitoring network. Through our study, we suggest that the phytoplankton bloom within the bay exhibits a pattern with highest concentration and possible point of origin centered around the northern bights of the bay with expansion outward west or east driven by combinations of wind and tide. This presentation will highlight what we have learned about phytoplankton blooms in Florida Bay and disseminate information that will be useful for the understanding of seagrass recovery, faunal communities, and overall benthic ecology.

PRESENTER BIO: Zachary Fratto is a biological science technician with over 10 years of experience investigating Everglades ecological processes. He is versed in both freshwater and marine environments exploring aspects of flora, fauna, and water quality and has worked on more than 15 projects dedicated to preserving the Everglades.

COMPARING OVERWINTERING POPULATION DYNAMICS OF SNOOK IN ST. LUCIE AND LOXAHATCHEE RIVERS

Delaney Frazier[1], *Lauren Kircher*[1], *Joy Young*[2] *John Baldwin*[1]
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Common snook (*Centropomus undecimalis*), a catadromous gamefish, inhabit South Florida's rivers and estuaries and contribute significantly to Florida's economy through angler expenses. They occur only in the southern portion of the peninsula because they are extremely sensitive to cold temperatures. Snook are protandric hermaphrodites, so they are born as males and most transition into females as they grow. The Big Old Fat Fecund Female Fish (BOFFFF) hypothesis suggests that large females contribute proportionately larger than other fish to spawning aggregations and larval recruitment by producing more and larger offspring.

Habitats that harbor these individuals are especially important to the population stock. It has been hypothesized that St. Lucie serves as an important common snook overwintering habitat, especially to large spawning females. Although snook are known to travel to river mouths and inlets between May and September to take part in large spawning aggregations, some overwinter in a different system from where they spawn. For example, in our data we saw that many snook were taking part in spawning aggregations in the Loxahatchee River in Jupiter, FL but overwintered in the St. Lucie River in Port St. Lucie, FL. This indicates that habitats serve different purposes in the life history of common snook thus making them more important to a specific size or sex of snook.

We examined the use of St. Lucie Estuary by large mature common snook. This study utilized acoustic telemetry data of 172 snook in the St. Lucie Estuary provided by FWC between February 2008 and January 2015. We classified snook as transient (leave the SLE) or resident based on movement data (i.e. if they use a different or the same system for spawning and overwintering). We compared the sex and lengths of transients and residents in St. Lucie using t-tests. This information helps us identify if some overwintering habitats are sheltering a higher proportion of larger, female snook. This will help with the management and conservation of both the species and their habitats.

<u>PRESENTER BIO</u>: Delaney Frazier is a senior undergraduate at Florida Atlantic University. She is working under Lauren Kircher and Dr. John Baldwin studying population dynamics of snook in the St. Lucie River in partnership with Dr. Joy Young FWC-Tequesta. She is also working on an additional project with Katherine Galloway and Dr. Marianne Porter in the Biomechanics lab studying facial spines of the red lionfish.

THE LARGEST NESTING YEAR FOR WADING BIRDS SINCE 1934, AND ITS IMPLICATIONS FOR RESTORATION

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Numbers of nests of long legged wading birds (herons, egrets, ibises, storks, spoonbills) in the Everglades are used as indicators of annual ecological conditions, and of progress towards restoration. The Everglades has the longest running and largest wading bird nesting monitoring program in the world, including all nondeveloped lands from Lake Okeechobee to Florida Bay, and includes the only estimates of population dynamics of wetland-dependent vertebrates in the Everglades from the pre-drainage period of the Everglades (1900 – 1945).

During the 2018 nesting season (January through July) we documented a total of 122,280 nesting pairs of all species combined. This was the largest documented nesting event in the ecosystem since 1934, and was 72% larger than the highest numbers recorded since systematic full-coverage surveys began in the 1980s. Colonies of over 2,000 pairs occurred throughout the ecosystem, and for the first time since the 1940s, very large colonies occurred in the coastal zone of Everglades National Park (44,397 nests). Nest numbers were dominated by White Ibises (95,728 nests), including the massive Alley North colony (56,402 nests). Nesting by Wood Storks and Roseate Spoonbills was the highest in 18 years, and timing of nesting for Wood Storks was close to the CERP target, in late December. Generally, nest success was average to high in comparison to previous years for all species monitored (Wood Storks, White Ibises, Great Egrets, Roseate Spoonbills).

This nesting event is therefore unprecedented by any standard in the last half century of the Everglades. During 2018, the Everglades wetland mosaic was apparently able to provide both strong cues for nesting, and a concentrated and continuous supply of food that supported successful nesting of hundreds of thousands of birds. These responses were likely the result of a rare mix of hydrological conditions occurring in both the current and previous years. First, the spring of 2017 was abnormally dry, which probably reduced populations of piscine predators, and is often a precursor to supernormal nesting events, in part because it allows proliferation of crayfish populations. Second, the wet season of 2017 was characterized by record breaking rainfall, driven by hurricane Irma, which flooded short hydroperiod marshes within and outside the Everglades. We hypothesize that this boosted small fish and crayfish production over a very large area that is not usually available for prey production. Third, the dry season of 2018 was dryer than normal, and surface water receded largely uninterrupted, allowing wading birds almost continuous access to dense prey throughout the nesting season and across nearly the entire Everglades.

Several aspects of this combination of events were fortuitous alignments (drying followed by unusually wet wet season, followed by consistent drying) and we would have predicted a strong nesting season based on those characteristics alone. However, extended flooding of the high elevation appears to be one condition that was stood out during the 2017 – 2018 sequence, and we feel was critical to early nesting, unusual carrying capacity for large coastal colonies, and a long period of prey availability. Regular hydration of high elevation marshes is a critical difference between the pre- and post-drainage Everglades, and is a likely outcome of hydrological restoration under CERP. The results of the 2018 nesting season suggest strongly that 1) the current smaller footprint of the Everglades ecosystem is still capable of supporting wading bird nesting populations that are in the same size range as historical populations, and 2) that higher frequency of flooding in high elevation marshes throughout the system may be a key factor supporting early, successful nesting throughout the system.

<ins>PRESENTER BIO</ins>: Peter Frederick is a research professor who has studied nesting ecology and restoration of long legged wading birds in the Everglades and other wetland systems for over 30 years.

EFFECTS OF SCALED VEGETATION CLASSIFICATION SCHEMES ON CLASS DETECTABILITY FROM LANDSAT DATA

Daniel Gann
Geographical Information Systems and Remote Sensing Center, Florida International University, Miami, FL, USA

Spatially explicit models of ecological processes depend on accurate detection of spatially exhaustive change patterns in land-cover at adequate spatial and temporal resolutions. Land-cover change models frequently integrate maps that were generated from remotely sensed data at different spatial scales and hence require reconciliation of scales by either upscaling the higher-resolution data or downscaling the lower-resolution data. A reliable scaling algorithm is needed to combine categorical land-cover maps that are derived from remotely sensed data at different spatial resolutions. The most commonly used aggregation methods for categorical data are the mode or majority rule, the nearest-neighbor rule, and the random rule. However, for heterogeneous landscapes and large scaling factors, use of these functions raises two critical issues: (1) ignoring large portions of information present in the high-resolution grid cells leads to high and uncontrolled loss of information in the scaled dataset; and (2) assuming validity of the high-resolution classification scheme for the low-resolution scale fails to recognize recurring mixes of heterogeneous classes at the aggregated scale. A new scaling algorithm, the multi-dimensional grid point (MDGP) algorithm, was developed to resolve these issues. The MDGP algorithm aggregates categorical data while both controlling for information loss and generating a non-hierarchical, representative, classification system valid at the aggregated scale.

In a neutral-landscape simulation testing the effects of the class-precision parameter, the algorithm consistently preserved information at a significantly higher level than majority and random-rule algorithms, while achieving class-label consistency when generating the low-resolution classification scheme. Applying the MDGP-scaling algorithm to real landscapes within the greater Everglades, information retention rates for scaling solutions were significantly higher than the *majority-rule* solutions. The analysis also demonstrated that MDGP-scaled classes were detectable from low-resolution remotely sensed data with higher accuracy when compared to landscapes scaled with the standard *majority-rule* method.

Optimizing the MDGP-scaling algorithm parameters of class-label precision and class-representativeness thresholds across the landscape was possible when implemented in a full factorial evaluation framework. The trade-offs among information retention, class-label fidelity, and spectral detectability of scaled classes from multi-spectral data indicate that no single-best solution exists. Weighting all three criteria when selecting the optimal solution is user- and application-dependent. For the evaluated landscapes, negotiating the trade-offs led to suitable solutions for an intermediate class-label precision of 33%, achieving mean information retention rates of 78.7% (SD = 4.9%) with a mean classification accuracy of 72% (SD = 1.5%). The majority rule attained a slightly lower detection accuracy of 69% (SD = 1.2%), but with a much lower information retention of only 66.1% (SD = 4.4%).

<ins>PRESENTER BIO</ins>: Dr. Gann is a research associate at the Geographical Information Systems and Remote Sensing Center at Florida International University with a strong background in remote sensing and has 15 years of experience in applications of remote sensing in landscape, vegetation and ecosystems ecology.

UNDERSTANDING NATIVE SPECIES' RESILIENCE TO INVASIVES IN THE GREATER EVERGLADES ECOSYSTEM: THE ROLE OF FOOD WEB NETWORKS IN ECOSYSTEM-LEVEL RESTORATION EFFORTS

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Ecosystems are experiencing the loss of biodiversity and ecosystem function through habitat alteration, nonnative species introductions, pollution, and climate change. The effects of these losses depend on the number and function of species lost, as well as complexity of the ecosystem. The construction of food web networks can provide a wealth of information regarding the structure and dynamics of ecological communities. In addition to yielding classic biodiversity measures such as species richness and composition, food web networks depict feeding interactions, and serve as roadmaps of energy and biomass flows. More recently, food web networks have been conceptualized as a framework for implementing both species- and ecosystem-level management. Network graphs yield whole-ecosystem metrics that are indicators of food web resiliency and ecosystem functioning as well as species-specific metrics that provide detailed information on where threatened and invasive species lie within a food web network, who their competitors, predators, and prey are, and how these interactions change through time.

There is strong evidence for the importance of food-web structure in ecosystem-level restoration efforts, and yet an up-to-date, high-resolution food web network for the Everglades that also includes invasive species is not available. We will take a data-driven approach to compile an open access, comprehensive, high-quality food web network for the Everglades ecosystem. The product of this research project will provide a backbone for interdisciplinary research questions in network science, biology, ecology, and hydrology as well as detailed food web analyses of endangered and invasive species in the Everglades ecosystem.

PRESENTER BIO: Elizabeth is a senior undergraduate student majoring in Wildlife Ecology and Conservation at the University of Florida. Her interests include avian and mammalian ecology and conservation, effects of urbanization on carnivores, and human impacts on coastal environments. She spent summer of 2018 in Everglades National Park as an Everglades BioCorps Intern working on various projects and continues research on food webs in the Everglades. She also currently works with avian and mammal ecology labs where she has assisted with graduate student research on hierarchy in mixed avian flocks, and analyzing camera trap data to assess patterns of mammalian carnivore distributions in the Pakke Tiger Preserve in India. Elizabeth is an educational outreach coordinator for the Student Chapter of The Wildlife Society, vice president of GREBE (Gators Ready for Exceptional Birding Experiences), and an artist for The Rattlesnake Conservancy.

IMPROVING MESOCOMS AND FIELD SCALE CONSTRUCTED WETLANDS PHOSPHOUS REMOVAL BY OPTIMIZING DESIGN WITH ADVANCED MULTIPHYSICS SIMULATION

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Eutrophication is a widespread global scale pollution problem. Agricultural areas are generally the main contributors to eutrophication, whereas sewage and industrial discharges, which usually receive some treatment prior to discharge, are a secondary source. This is mostly the case of the Everglades, because their natural water sources are enriched with nutrients from agricultural runoff. These agricultural polluted waters could even have significant amounts of pesticides. Agricultural runoff is a type of non-point pollution characterized by high and fluctuating flows in space and time, and relatively low concentrations of pollutants (in comparison to other wastes and wastewaters). Especially for these intrinsic properties, remediation of these agricultural waters cannot be conducted with the usual environmental engineering solutions, and in this context ecological engineering approaches such as constructed wetlands are much more suitable. Constructed wetlands provide large hydraulic retention times, and a number of differentiated compartments giving place to multiple microenvironments, where multitude of processes can interact among them for the benefit of water quality improvement. However, their hydraulic design and functioning is not trivial and, in many cases reported in literature, the systems perform in suboptimal conditions reducing their predicted capacities.

In recent years a number of rigorously scientific studies carried out in the Everglades area have demonstrated the capacity of mesocosm wetlands to remediate agricultural runoff, and in particular to reduce significantly phosphorus concentrations. Also extensive monitoring studies on field-scale constructed wetlands (named storm treatment areas STA), which are already in operation in the area, have demonstrated the potential of the technology. However, these mesocosms and field scale studies have also shown the difficulties to achieve the 10 P ppb limit in the long term which have been stablished by authorities to protect the Everglades. The objective of this on-going research is therefore to analyze how constructed wetland hydraulic design can be improved to increase their removal efficiencies to reach the 10 P ppb limit by means advanced dynamic modeling. For this purpose we are using extensive data from 2.5 years in 6 x 1 x 0.4 m mesocosms studies to calibrate and validate a mechanistic model written into the COMSOL Multiphysics software. Preliminary results show that mesocosms performed under strongly laminar conditions and much of water volume (>50%) is never in contact with the bottom of the wetlands, where many of the key phosphorus retention processes occur. This has led to suboptimal removal efficiency of the mesocosms. In the next steps of the research we are going to study different hydraulic configurations of the mesocosms to improve their hydraulic performance and evaluate subsequent improvements in P removal. Finally, the model will be extrapolated to the currently functioning storm treatment areas to evaluate how changes in their design can improve their removal efficiencies.

<u>PRESENTER BIO</u>: Dr. Joan Garcia is Professor of environmental engineering at Technical University of Catalonia in Barcelona and visiting Fulbright scholar at FGCU's Everglades Wetland Research Park in Naples. He has > 20 years of experience on the use of natural treatments such as microalgae systems and constructed wetlands for wastewater engineering.

HYPER-RESOLUTION HYDRODYNAMIC AND SEDIMENT TRANSPORT MODELING AROUND STRUCTURES IN THE NORTHEAST SHARK RIVER SLOUGH (NESRS) CANALS

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Flood and water pollution assessments using numerical models were until recently forced to use relatively coarse resolution due to limitations in bathymetric, and exceedingly low performance of sequential computer codes. However, often there is a need to use high resolution models in areas where many small canals, and terrain features drive the water hydrodynamics generating a significant impact on the spatial and temporal distribution of pollutants. The increased availability of high resolution bathymetric surveys, and novel water velocity and pollutant concentration instrumentation, has brought the opportunity to use flexible-mesh models with cells small enough to ensure capturing the complex environment. Still, many numerical modeling tools sometimes require days if not weeks to run typical simulations. Hydrologic and hydraulic models using Graphic Processing Units (GPUs) have proven able to accelerate simulations more than 600 times with respect to conventional models, opening new opportunities for sub-meter evaluations. This presentation will discuss hyper-resolution hydrodynamic and sediment transport simulations in Everglades National Park canals with high performance computing models using GPU parallelization. The models use unstructured meshes that can handle millions of computational cells ranging from a few centimeters to several meters. These meshes can resolve flow and determine solute and sediment distribution at canals, culverts, bridges, and over highly irregular bathymetry. We present preliminary results of applications to the canals surrounding S333 hydraulic structure. Current studies have identified a strong correlation between Total Phosphorous (TP) at S333 (inflow structure to ENP) and canal stage and WCA-3A stage. Low stages are associated with high TP levels at S333. The 12-month flow-weighted mean TP concentration exceeded the Consent Decree limits in water year 2012 and in 2014. The conditions and mechanisms that caused elevated TP in FY2014 (and in previous years) are unknown. The purpose of this study is to identify the sources of the elevated TP at S333 and, if possible, characterize them as to be from either local effects and conditions at S333 or upstream of S333 within the L67A Canal, L29 Canal or the marsh. Our conceptual model considers that waters from upstream and along the L67A Canal are mostly the results of managed deliveries by the SFWMD and the exchange with freshwater marshes and groundwater. Also, canal flows, especially at low stage, have the potential of re-suspending and remobilizing nutrient-rich sediments that accumulate at the bottom of canals. These phosphorus-rich sediments can be rapidly transported downstream while contributing part of their P load to canal waters to finally reach the park. Besides stage, preliminary results suggest that turbidity is closely related to water TP concentrations. Furthermore, precisely defined stage level and time of the day thresholds seem to control these physical-chemical and compositional parameters. The high resolution model that has been implement can simulate extremely detailed water velocity fields, and suspended sediment concentration patterns, and highlight the importance of mesh resolution to accurately assess pollutant mitigation solutions.

PRESENTER BIO: Dr. Garcia has over 37 years of experience in modeling flow, sediment and pollutant transport. He has participated in hundreds of river, coastal, groundwater, and pollutant dispersion modeling studies worldwide, and has developed models to simulate 2D and 3D flows, riverine flooding, pollutants transport and sediment dynamics.

NILE MONITORS IN THE C-51 BASIN: IS CONTAINMENT OR ERADICATION FEASIBLE?

***Emily V. Gati*[1]**, *Justin R. Dalaba*[1], *Peter C. Iacono*[2], *Laura A. Brandt*[3], *Frank J. Mazzotti*[1]
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Nile Monitors are a large carnivorous lizard species native to sub-Saharan Africa. They are aquatic habitat generalists and can be found in both freshwater and estuaries. They are also diet generalists, consuming invertebrates, fish, reptiles, amphibians, mammals, eggs, and carrion. They have established populations in several counties in Florida, including the C-51 Basin within Palm Beach County. Nile Monitors have been confirmed as far east as I-95 along the C-51 Canal, north and south of the C-51 Canal, and west to within 2 kilometers of Stormwater Treatment Area (STA) 1E and the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Lox NWR). In Florida, they have been most often found along networks of vegetated canal banks.

The population of Nile Monitors in the C-51 basin is currently being targeted for active removals by Florida Fish and Wildlife Conservation Commission (FWC) through shotgun removal, however the effect of the population pressure generated by these removals is currently unknown. To explore this question, we conducted a combination of active surveys and targeted outreach. We also received data collected by FWC from their monitoring and removal efforts on the following canals: C-51 East, C-51 West, and E-2 System.

We conducted exploratory surveys in the C-51 basin and surrounding areas, which were then used to develop 15 standardized survey routes. For each survey route, we mapped habitat suitability for Nile monitors. Four temporal replicates were conducted of each survey route, with the following exceptions: the E-2 System (heavily surveyed by FWC and thus we only surveyed it once), and the C-51 East and C-51 West where we conducted monthly temporal replicates. We conducted targeted outreach in proximity to the survey routes within the C-51 basin, in the form of door hangers, flyers, and presentations.

We analyzed Nile monitor observations and removals from October 2017 to August 2018 in relation to effort, using survey duration (time) and survey distance. During exploratory surveys, two Nile Monitors were sighted. During standardized surveys, four Nile Monitors were sighted, all on the C-51 East canal. FWC observed a total of 48 Nile monitors, with 27 removals. In the E-2 system, the number of observations and removals are both trending downward, though this trend is less severe when we corrected for effort. As result of our outreach efforts, a total of 1082 door hangers were distributed, and two confirmed Nile Monitor sightings were reported to the FWC hotline.

We hypothesize that current removal efforts by FWC in the C-51 Basin are negatively impacting Nile monitors at locations where removal efforts are taking place. However, lower levels of detection and removal may be a result of seasonal changes in activity patterns, rather than effects of removal. To separate seasonal effects from annual trends, we recommend continued monitoring of the Nile monitor population over subsequent years.

PRESENTER BIO: Emily is a wildlife biologist working in the Croc Docs lab, and is currently studying invasive species research and management, with interest in conservation and ecology of herpetofauna.

EVALUATING OTOLITH MICROCHEMISTRY FOR TRACKING PHOSPHORUS EXPERIENCED BY EVERGLADES FISH

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Otolith microchemistry has become an important tool for identifying habitat usage of anadromous fish and for establishing natal habitats. A recent study suggested that fish otolith phosphorus (P) concentrations may be used as an indicator for water P pollution in areas they inhabit. We collected 20 wild free-ranging fish from three distinct Everglades regions: Stormwater Treatment Area (STA) Cell 4, Shark River Slough (SRS) Site 07, and Water Conservation Area (WCA) Site 03. We also conducted an outdoor mesocosm dosing study to determine if Eastern Mosquitofish (*Gambusia holbrooki*) uptake water column P in their otoliths. Six mescosms filled with 72-liters of water were stocked with 30 Eastern Mosquitofish and exposed to one of two treatments for seven weeks: 1) No Phosphorus Added, 2) Phosphorus Added. Fish otoliths were extracted, polished to expose growth rings, and burned using laser ablation plasma mass spectrometry (LA-ICP-MS). A laser spot size of 60 µm moved across each otolith at a speed of 5 µm/s to analyze elemental concentrations of P, magnesium (Mg), barium (Ba), strontium (Sr), and calcium (Ca).

We observed regional differences in otolith microchemistry using element to Ca ratios and element concentrations. Our analyses revealed that P alone was a poor chemical marker to differentiate fish based on the site where they were collected. However, we were able to identify the natal habitat origin with 100% accuracy when using all chemical markers. This was driven primarily by large differences in otolith Sr:Ca ratios between regions. Our results support past work indicating that otolith microchemistry can be used as a marker for natal habitat origin and tracking fish life histories using Ca, Sr, P, and possibly Ba. Although our mesocosm study revealed that fish can uptake increased P in their otoliths, more work is needed to understand individual variability in otolith P concentrations and its implications in understanding P pollution in the Florida Everglades.

<u>PRESENTER BIO</u>: John Gatto is a doctoral candidate in Dr. Joel Trexler's Aquatic Ecology lab at FIU. His dissertation research focuses on the impact of hydrological disturbance on recruitment success of small-bodied marsh fish inhabiting the Everglades.

LINKING WATER COLUMN, VEGETATION AND SOIL DATA IN TREATMENT WETLANDS USING A MECHANISTIC MODEL

Stefan Gerber *and Kalindhi Larios*
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Everglades Stormwater treatment areas (STAs), managed by the South Florida Water Management District, reduce phosphorus (P) in runoff waters to protect and restore the ecological health and value of the Everglades Protection Area. To understand key mechanisms and factors affecting this P reduction, the Restoration Strategies Regional Water Quality Science Plan for the Everglades STAs (SFWMD 2012) led to collection of critical biogeochemistry data in the water column, the underlying floc and soil layers and in vegetation. Conceptual models were developed to synthesize the linkages among these disparate water column, floc, soil and vegetation data. While these conceptual models show linkages among these various components, complex interactions and feedback are difficult to evaluate based on the qualitative mapping of relationships. Therefore, mechanistic biogeochemical models were developed to explicitly characterize the relationships among the conceptual model elements by building explicit mathematical linkages using predictive associations.

Here we present analyses of a mechanistic model that considers these linkages along the flowpath of a STA. First a global sensitivity analysis of the model tested the degree to which various parameters contribute to reduction in water column phosphorus. Second, Bayesian Inversion analyzed the degree that existing data constrained critical processes identified with the sensitivity analysis. Bayesian analyses can lead to three outcomes for a given parameter: 1) a narrow range of the parameter leads to a good model fit; 2) the best model-data fit reveal parameters at low or high end of the potential range; or 3) a wide range of parameter values results in no improvement of model fit.

The sensitivity results show, that the fast processes related to the direct removal of P out of the water column are important to predict nutrient concentration (mostly direct settling, but also biological uptake into the floc surface, vegetation and periphyton). However, processes that operate on a longer time scale (slow processes), such as the mineralization and long-term sorption of phosphorus in soils also affect water quality. On the other hand, processes at medium time scales (at which vegetation, floc and periphyton turnover occur) were less sensitive in determining nutrient reduction.

The important processes based on sensitivity analyses (slow soil processes and immediate removal of P from the water column by vegetation and settling), were constrained in the Bayesian inversion (moderately narrow parameter range, category 1 above), suggesting that these processes are important contributors to overall uptake and retention of P in STAs. Some of the resulting parameter values associated with fast and medium processes were extreme compared to published literature values (category 2). Such deviations suggest that the STAs operating differently from the systems where the published parameters were obtained, or more likely, that there are structural errors in the mechanistic model. Finally, a set of parameters, mostly associated with medium time scales, such as vegetation, floc turnover and reactive soils turnover were not constrained during the inversion (category 3). Overall the combination of sensitivity test and inversion suggests that the current set of data is useful to determine the essential mechanisms of nutrient retention in STAs.

<ins>PRESENTER BIO</ins>: Dr. Stefan Gerber is an Assistant Professor in the Soil and Water Sciences Department at University of Florida. His work encompasses development and analysis of biogeochemical data using models, including models that predict nutrient losses from terrestrial systems and help to understand how nutrient dynamics in water bodies help to understand the biogeochemistry of larger systems from watershed to global scale.

FISH COMMUNITIES IN THE CROCODILE SANCTUARY: EFFECTS OF THE CLOSURE & OPENING OF JOE BAY

Carissa L. Gervasi[1], *Jennifer S. Rehage*[1], *Rolando Santos*[1], *Kerry Flaherty-Walia*[2], *Natasha Viadero*[1], *and Shakira Trabelsi*[1]
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Two large coastal embayments in northeastern Florida Bay have been closed to public access since the creation of the Crocodile Sanctuary in 1980. In 2016, the Everglades National Park General Management Plan called for the opening of about 48% of the Sanctuary, Joe Bay and Snag Bay, to non-motorized access and catch-and-release fishing, while maintaining the closed status for Little Madeira. This has provided an opportunity to examine the effects of the closure on fish communities and the recreational fisheries they support, for which little data are available. Further, the opening of Joe Bay (and Snag Bay) allows for evaluation of the effectiveness of non-motorized access and catch-and-release fishing as a management tool. Thus, the objectives of our study are 2-fold: (I) examine the effects of the 35-year closure on fish and recreational fishery metrics , and (II) quantify effects of opening Joe Bay to catch-and-release fishing on fish and recreational fishery metrics, on the quality of recreational fishing, and on overall visitor experience.

In order to achieve these objectives, we compared fish communities and recreational fish species across 3 embayments of interest: a) Little Madeira (closed to fishing since 1980), b) Joe Bay (re-opened to catch-and-release fishing since Nov 2016), and c) Long Sound (open to fishing). Our project entails 2 research components: (1) Conduct fisheries-independent visual surveys to compare fish communities across the 3 embayments and assess the effect of the closure using baited remote underwater video systems or BRUVS, and (2) Develop a fisheries-dependent angler reporting system for tracking the effect of opening Joe Bay over time.

BRUVS have been deployed in all three embayments each wet and dry season since December 2016 to assess fish abundance and diversity. Species richness and composition was similar among the three embayments, but contrary to expectation, results show a higher relative abundance of fish in Long Sound than in either protected embayment. Crevalle Jack and Gray Snapper were the most abundant sportfish observed in all three embayments, but were most abundant in the fished embayment (Long Sound). Angler surveys in Joe Bay generally agree with the BRUV data, with anglers reporting highest catches of Crevalle Jack, Common Snook, and Gray Snapper. Visitation rate remains relatively low, with most visitors report visiting the region primarily for fishing and are highly satisfied with their experience.

PRESENTER BIO: Carissa Gervasi is a PhD student at Florida International University. She received B.S. degrees in marine biology and chemistry from Roger Williams University and an M.S. degree in Marine Science from the Virginia Institute of Marine Science. She is a fish ecologist by training with a passion for science policy.

MULTIPLE DATA SOURCES TO ASSESS THE STATUS OF AN UNDERVALUED RECREATIONAL FISHERY: CREVALLE JACK IN SOUTH FLORIDA

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The Crevalle Jack (*Caranx hippos*) is a large marine fish found throughout the tropical and temperate waters of the North Atlantic. A voracious carnivore, the Crevalle Jack is an important apex predator, targeted by both commercial and recreational anglers. In Everglades National Park, Crevalle Jack is the second most captured species by recreational anglers, with 84,000 landings reported in creel dockside surveys conducted at Flamingo and Everglades City since 1980.

Despite Crevalle Jacks being highly targeted, they are currently an unregulated species and little research has been done to assess life history, track abundance patterns, or determine mortality rates. In recent years, reports from recreational anglers in the Florida Keys indicate a decline in Crevalle Jack catch. In congruence with these reports, fisheries dependent monitoring by Everglades National Park shows a downward trend in Jack catches. If these data are indicative of a decline in Jack abundance, management efforts will need to be enacted to conserve and restore the population.

The purpose of this study is to use a combination of research and angler knowledge to determine spatiotemporal patterns of Crevalle Jack abundance throughout Florida and assess movement and migration patterns. The goal is to determine where and when Crevalle Jack populations began to decline, assess possible factors that may be contributing to the decline, and determine the spatial scale of management that will be necessary to conserve and restore the population.

Since a stock assessment has never been conducted for Crevalle Jack, patterns of abundance will be inferred using multiple existing fisheries-dependent and -independent data sets and key informant surveys of anglers throughout the Florida Keys. With data-poor or data-limited recreational fisheries, highly-experienced fishing guides and anglers can provide vast amounts of spatiotemporal data that complement other biological data and provide unique perspectives. To assess movement and migration patterns of Crevalle Jack, two complimentary methods will be used; stable isotope analysis of otoliths and acoustic telemetry. These two methods combined will provide a complete picture of Crevalle Jack movement on daily, seasonal, and lifetime scales, which can be used to inform management.

By collaborating with recreational anglers and state management, we hope to develop a sound management plan for the data-poor Crevalle Jack fishery that will successfully restore and conserve this important fish species.

PRESENTER BIO: Carissa Gervasi is a PhD student at Florida International University. She received B.S. degrees in marine biology and chemistry from Roger Williams University and an M.S. degree in Marine Science from the Virginia Institute of Marine Science. She is a fish ecologist by training with a passion for science policy.

USING STAKEHOLDER ENGAGEMENT, TRANSLATIONAL SCIENCE AND DECISION SUPPORT TOOLS FOR ECOSYSTEM BASED MANAGEMENT IN THE FLORIDA EVERGLADES

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Managing water for competing human and environmental demands in the Greater Everglades is a multi-dimensional challenge that includes managing for 72 threatened and endangered species (including plants) and numerous other species and habitats of concern, while providing water supply and flood control for widespread high-density urban communities and nationally important agricultural lands. Ecosystem based management (EBM) is a management approach that integrates the full spectrum of ecosystem interactions, including humans and the full array of associated issues, species, and ecosystem services. Applying EBM in the Florida Everglades involves multiple spatial and temporal scales of governance. Daily-scale water management directly involve a relatively small group of primary stakeholders, whereas quarterly and seasonal-scales involve more stakeholders due to the increased complexity of managing for diverse, longer-term goals and objectives. Across the Everglades landscape, EBM of water resources to support multiple uses and ecosystem restoration involves the greatest number of stakeholders and engaged parties. Therefore, translational science, decision support tools, effective stakeholder engagement, and communication becomes paramount to successful management that achieves goals and objectives of these multiple stakeholders. This talk describes a framework for applying EBM in the Everglades system that builds on an initial set of guidelines or ‘best practices’ that were initially developed by the U. S. Fish and Wildlife Service South Florida Ecological Services office to guide water management for the protection of threatened and endangered species. This management approach guides the navigation of multi-agency governance models and competing stakeholder visions using socio-ecological science to address practical and theoretical challenges for managing freshwater wetlands. In the development of best practices for stakeholder engagement and linking translational science with multiple, science-driven decision support tools, important lessons learned can be carried forward in an effort to continually improve governance and collaboration for ecosystem management and restoration in and beyond the Everglades.

PRESENTER BIO: Dr. Gibble is the Senior Biologist at the Arthur R. Marshall Loxahatchee National Wildlife Refuge with more than 12 years’ experience planning, designing, and implementing habitat conservation projects. As part of overall efforts to conserve Refuge habitats, her work has focused on identifying ways to best manage water and trust resources found on the Refuge and northern Everglades.

HERBICIDE EFFICACY TRIALS FOR THE MANAGEMENT OF OLD WORLD CLIMBING FERN ON THE TREE ISLANDS OF A.R.M. LOXAHATCHEE NATIONAL WILDLIFE REFUGE

Jonathan Glueckert*, and Stephen Enloe*
University of Florida Center for Aquatic & Invasive Plants, Gainesville, FL, USA

Old World Climbing Fern (*Lygodium microphyllum)* is an aggressive invasive fern that is native to Africa, Asia, and Australia. It was first detected in Florida in Martin County in 1960 and has since spread throughout South and Central Florida, with isolated populations observed as far North as Jacksonville. OWCF is one of the most difficult invasive plants to manage in Florida due to its wind dispersed spores, tolerance to flooding, and its tendency to grow in areas with challenging access and stipulations that limit treatment methods. Over the last decade, glyphosate and metsulfuron have been the only viable herbicides that provide control, yet the fern continues to advance. The tree islands of the Arthur R. Marshall Loxahatchee National Wildlife Refuge have proven to be important habitat for wading birds, native mammals, and the endangered everglades snail kite. Thousands of tree islands are infested with OWCF, interfering with the success of native plants. In 2016 a partnership was formed between the UF Center for Aquatic and Invasive Plants, FWC, SFWMD, and the Arthur R. Marshall Loxahatchee NWR to reinvigorate research of better management practices for OWCF. This talk will focus on results from studies initiated during the last two years that are helping to develop new tools and strategies such as recently registered herbicides and glyphosate alternatives to aid the refuge and other natural areas in Florida in the management of the fern.

PRESENTER BIO: Jonathan is a biologist at the University of Florida Center for Aquatic and Invasive Plants in Gainesville, FL. His primary objective is a multi-agency project with SFWMD, USFWS, and the FWC to research Old World Climbing Fern management practices and biology.

HAVE YOU SEEN A SKINNY ALLIGATOR IN SOUTH FLORIDA?

***Avishka Godahewa*[1]**, *Nicole D. Jennings*[1], *Justin R. Dalaba*[1], *Michiko A. Squires*[1], *Caitlin E. Hackett Farris*[1], *Seth C. Farris*[1], *Laura A. Brandt*[2], *Frank J. Mazzotti*[1]

[1]University of Florida, Davie, FL USA

[2]U.S. Fish and Wildlife Service, Davie, FL USA

The American alligator (*Alligator mississippiensis*) is a keystone species inhabiting aquatic environments across the southeastern United States. Alligators play a significant role as ecosystem engineers by creating habitats and altering hydrology, which in turn provides safe haven not only for themselves but many other species of fish and wading birds. Since alligators are sensitive to changes in depth and timing of water flow, as well as availability of prey, they make an effective indicator for ecological responses. The Florida Everglades is a highly modified system undergoing restoration; monitoring the alligator population will apprise progress of restoration efforts.

In response to a recent increase in reports of skinny alligators, we developed a body condition score (BCS) using body condition factor Fulton's K and alligator appearance. This BCS system is specific to alligators of the Greater Everglades and provides a visual reference to our quantitative measurements of alligator body condition. We base numeric scores on key identifying visual characteristics for the jowls, spinal column, limbs, and tail girth to categorize alligators into skinny/emaciated (1), thin/slender (2), or normal (3). These categories also correlate with restoration targets for Fulton's K as identified by RECOVER's Monitoring and Assessment Plan (MAP). Alligators that fall into BCS categories 1 and 2 are below restoration targets, and alligators with a BCS of 3 meet or exceed restoration targets. This simplified scoring system, combined with an established reporting system (skinny.gators@gmail.com) allow the general public and citizen scientists to help document the condition of wild alligators to improve understanding of their health throughout the Greater Everglades.

PRESENTER BIO: Avishka, a crocodilian researcher and conservationist from Sri Lanka, has worked with crocodilians since 2012. He is a recipient of the Rafael Crespo Conservation Scholarship Fund, and currently works with the Croc Docs at the University of Florida monitoring American alligators and American crocodiles as indicators of Everglades restoration.

SPECTACLED CAIMAN (*CAIMAN CROCODILUS*) REMOVAL IN SOUTHERN FLORIDA

Sidney T. Godfrey*, Edward F. Metzger III, Jennifer H. Nestler, Michael R. Rochford, Emily V. Gati, and Frank J. Mazzotti*

University of Florida IFAS Fort Lauderdale Research & Education Center, Davie, FL, USA

Spectacled caiman (*Caiman crocodilus*) have occurred in southern Florida since the 1960s and established a population in the 1970s. Their core use area is near Homestead Air Reserve Base in southeastern Miami-Dade County, and they occasionally appear in other areas of southern Florida. Historic caiman sightings and captures have occurred within and adjacent to Everglades National Park, Southern Glades Wildlife and Environmental Area, Florida Power & Light Turkey Point Power Plant and an adjacent mitigation area, Everglades & Francis S. Taylor Wildlife Management Area, Big Cypress National Preserve, Biscayne National Park, and Biscayne Bay Coastal Wetlands.

Spectacled caiman are semi-aquatic crocodylians reaching over two meters in total length. Caiman have a broad diet including invertebrates, fish, amphibians, reptiles, birds, and mammals and therefore impact biological resources. Caiman may prey upon federally protected species such as eastern indigo snakes (*Drymarchon couperi*) and young American crocodiles (*Crocodylus acutus*). Caiman may compete for food and space with native crocodylians, the American alligator (*Alligator mississippiensis*) and American crocodile. Caiman are defensive and may pose a threat to human health and safety if harassed.

Our purpose is to remove spectacled caiman from the Greater Everglades Ecosystem, as well as perform necropsies to augment what is known of their diet and reproductive activity in Florida. Our objectives are: (1) improve removal of caiman; (2) determine seasonal reproductive activity; (3) augment knowledge of caiman diet in Florida; and (4) test the management hypothesis that as caiman are removed encounter rates and occupancy will decrease and native crocodylian encounter rates and occupancy will increase.

From 2012 to 2018 we removed of 154 caiman, 40 of which were removed from October 2017-November 2018. Necropsies revealed that the caiman reproductive schedule in southern Florida may be roughly a month earlier than the schedule in their native range and overlaps the schedule of American alligators. Diet analysis yielded prey items composed of 24 insects, 18 plants, 15 reptiles, 10 gastropods, eight crustaceans, five fish, three mammals, three gastroliths, two amphibians, and one occurrence of garbage (plastic). The most frequent prey items were insects for juvenile males, reptiles for juvenile females, reptiles and plants for adult males, and equal occurrences of plants, reptiles, worms, and fish for adult females. We documented ten previously unreported prey species, seven of which are native to Florida. Catch-per-unit effort and occupancy analysis results suggested that caiman encounter rates and occupancy did not decrease with removals, nor did native crocodylian encounter rates and occupancy increase.

PRESENTER BIO: Sidney Godfrey is a wildlife biologist with several years of experience implementing wildlife research and monitoring projects. He is currently the project leader for the University of Florida "CrocDocs" team's spectacled caiman removal efforts.

EFFECTS OF DEPTH AND P LOADING ON PERIPHYTON-BASED NUTRIENT REMOVAL

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Presence of a periphyton community adapted to low water column P concentrations is considered a central design element that has contributed to effective low-level P removal by a 40-ha periphyton-based stormwater treatment area (PSTA) cell over the last decade. The low-P environment in this cell was created, in part, by removing muck soil to expose the underlying limestone substrate. PSTA systems also were originally thought to require relatively shallow water conditions for optimum performance. Shallow conditions facilitate light penetration to the sediment (benthic) surface, and in the highly-colored surface waters of the STAs, slight increases in water depth can dramatically reduce light penetration. Shallow depths may be difficult to maintain consistently in full-scale STA flow paths, however, so it is important to characterize the effects of water depth on PSTA performance. To provide insights into the effects of water depth on surface water TP concentrations in PSTA systems, replicated outdoor mesocosms were established at four water depths, using periphyton and macrophytes collected from the STA-3/4 PSTA Cell.

During our study, the mesocosm platform provided comparable performance to the STA-3/4 PSTA cell. Over an 11-year period of record, at mean annual depths ranging from 32 to 72 cm, annual inflow TP concentrations to the PSTA Cell (10-27 µg/L) were reduced to 8-13 µg/L. The mesocosms, operated in triplicate flow-ways at depths of 23, 46, 69 and 92 cm for 2.7 years, reduced inflow TP concentrations (mean of 20 µg/L) to 10-12 µg/L at mesocosm midpoints and 7-8 µg/L at the outflows. The benthic periphyton community that developed in the outflow region of the mesocosms was taxonomically similar to that in the PSTA Cell and to several low-P regions of the Everglades (WCA-2A U3 and WCA-3A DB-15), and showed fewer green algae taxa than at the mesocosm midpoint. Phosphorus-sensitive diatom taxa such as *Mastogloia smithii* and *Cymbella minuta* were found in all depth treatments at both midpoint and outflow locations.

Chemical composition of mesocosm benthic periphyton was relatively uniform across the range of operating water depths, but P content showed changes over time and with respect to position along each mesocosm flow way. Both periphyton biomass and alkaline phosphatase activity (APA), a sensitive indicator of P limitation, increased over time under prevailing low P loading conditions. Phosphatase enzyme activity in the water column was not directly related to water P concentration, but increased from inflow to outflow, increased with water depth, and decreased in response to increased hydraulic and P loading.

Under the replicated experimental conditions of the mesocosm study, periphyton development and TP removal was not hindered by water depths up to 92 cm, suggesting that these biological communities, typically found in low-P Everglades marshes, can become established in, and provide treatment of, STA-treated waters over a broad range of water depths.

PRESENTER BIO: Mr. Grace is an Associate Scientist with DB Environmental and studies phosphorus cycling in aquatic ecosystems, treatment wetland optimization, water quality assessments and biomonitoring. He earned a MS degree in Soil and Water Science from the University of Florida.

A CERP MID-COURSE ASSESSMENT

Wendy D. Graham
University of Florida, Gainesville, FL, USA

The National Academies' 2018 biennial review of Everglades restoration progress recommended that Comprehensive Everglades Restoration Plan (CERP) agencies conduct a mid-course assessment that rigorously considers the future of the South Florida ecosystem. New information about climate variability, climate change and sea level rise in South Florida continues to emerge, and many of these changes will impact the capacity for the CERP to meet its goals. The restoration is likely to have important benefits that increase the resilience of the ecosystem in the face of climate change but these benefits have not been adequately studied or quantified. A system-wide, program- level analysis should assess the resilience and robustness of the CERP program to the changing conditions that will drive the Everglades of the future. A mid-course assessment should include system-wide modeling of interactions among both authorized and planned projects under scenarios of future possible climate and sea level rise conditions. This assessment is essential to communicate the benefits of the CERP to stakeholders, guide project sequencing and investment decisions, and manage the restoration under changing conditions.

PRESENTER BIO: Dr. Graham is the Swisher Chair in Water Resources and Director of the University of Florida Water Institute. Her current research focuses on integrated hydrologic modeling; evaluation of impacts of agricultural production on surface and groundwater quality; and evaluation of impacts of climate variability and climate change on hydrologic systems.

CHANGES IN REGIONAL HYDROLOGY COULD MODIFY THE SWIMMING BEHAVIOR OF LARVAL STONE CRABS

Philip M. Gravinese
Mote Marine Laboratory, Sarasota, FL, USA

Brachyuran crustacean larvae exhibit a suite of swimming behaviors in response to exogenous stimuli which orient an individual's swimming toward or away from the surface. These movements position larvae in regions of the water column that can influence horizontal dispersal by exposing larvae to depth stratified currents. For example, brachyuran crustaceans typically elicit a negative feedback response to exogenous stimuli (i.e., gravity, pressure, and light) that controls depth maintenance and positions earlier larval stages in shallower parts of the water column to facilitate transport offshore where they will complete larval development. Later larval stages often reverse their response to these cues resulting in positioning individuals at depth where currents facilitate transport back toward settlement habitats.

Some coastal habitats are experiencing an increase in organic runoff, which when coupled with a loss of vegetated coastline can accelerate reductions in pH. Marine larvae that hatch in coastal habitats may not have the ability to detect, and respond to changes in seawater pH, especially when combined with elevated temperature. Additionally, Everglades Restoration is aimed at restoring freshwater back to historical flow regimes. Parts of the Everglades, Biscayne Bay, and Florida Bay may therefore see changes in salinity and freshwater flow over the next several decades. Changes in pH and salinity could therefore have an impact on the vertical position and subsequently the horizontal trajectories of larvae seeking settlement habitats.

Florida Bay plays a key role in the life cycle of one of the Florida Key's most lucrative fisheries, the stone crab, *Menippe mercenaria*. Changes in coastal seawater pH and the reintroduction of freshwater flow could alter the orientation of larval stone crabs to exogenous stimuli. We first tested the response of stone crab larvae to elevated temperature and reductions in pH to determine whether simultaneous stressors affect larval vertical swimming orientation (i.e., geotaxis or orientation to gravity) through ontogeny. Geotactic responses varied throughout ontogeny, and directional movement was dependent on pH rather than on temperature. Most notably, we found that stage-III larvae swam upwards under ambient pH conditions, but swam downwards under reduced-pH treatment. In a separate experiment, stage-1 stone crab larvae and post-larvae were exposed to different rates of salinity change and their vertical swimming activity was observed. During high rates of salinity change stage-1 stone crab larvae exhibited a reversal in their vertical swimming response while post-larvae became less active. The reversal in orientation may limit larval transport in habitats that experience decreases in pH and rapidly changing salinity regimes over the next several decades.

PRESENTER BIO: Dr. Gravinese is a postdoctoral fellow at Mote Marine Laboratory in the Fisheries Ecology and Enhancement Program. His research focuses on determining how various environmental stressors like elevated temperature, salinity, pH, hypoxia, and red tide, impact the tolerance of commercially important crustaceans throughout their life history.

NUTRIENT RETENTION FROM URBAN RUNOFF VIA VEGETATIVE UPTAKE AND SEDIMENTATION IN CREATED WETLANDS IN SUBTROPICAL FLORIDA

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Nutrient removal by a 4.6 ha urban stormwater treatment wetland system in a 20-ha water/nature park in southwest Florida has been studied for over two years, suggesting that the wetlands are significant sinks of both phosphorus and nitrogen. The first two years of water quality studies have indicated a slightly decreasing ability for total phosphorus concentration reduction with average total phosphorus reductions of 55%, whereas nitrogen retention has remained consistent at about 26% reduction. This study investigated the importance of vegetative and sedimentation intrasystem processes on nutrient concentrations and fluxes through these wetlands. Macrophyte vegetation samples were collected every six months in the dry and wet seasons to estimate productivity, biomass, and nutrient storage/retention in the vegetative tissues. Additionally, gross sedimentation measurements along with sediment nutrient analyses every six months estimate the role of sedimentation on nutrient retention. Nitrogen and phosphorus loading rates are 28.1 g-N m^{-2} yr^{-1} and 5.7 g-P m^{-2} yr^{-1}, respectively. Preliminary results suggest that sedimentation is a larger factor in nutrient retention than vegetative uptake. After one year, data suggests gross sedimentation rates of 0.26 ± 0.03 mm day^{-1} and nutrient retention of approximately 81.7 g-N m^{-2} yr^{-1} and 7.8 g-P m^{-2} yr^{-1}. With gross sedimentation of nutrients higher than nutrient loading, we theorize that sediment resuspension is a major influence on the system. Data suggests that sedimentation and vegetative uptake play a larger role in nitrogen retention than they do in phosphorus retention. Ongoing research focuses on the extent to which resuspension plays a role in the nutrient storage and reintroduction to the system to attempt to determine the expected lifespan of the wetlands' nutrient retention capabilities and allow land managers to better understand how the wetland system is working to optimize nutrient retention in the greater Everglades region.

PRESENTER BIO: Lauren Griffiths is in the Geology Ph.D. program at the University of South Florida. She is a graduate assistant at FGCU's Everglades Wetland Research Park in Naples, Florida with research focusing on water quality and nutrient cycling in created freshwater wetlands as well as carbon sequestration in mangrove systems.

INVASIVE TEGUS INTRODUCED AN EXOTIC HOOKWORM TO FLORIDA

Andrew J. Gritzmaker*, and Michael B. Harvey*
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Co-introduction of parasites with their invasive hosts is an understudied facet of the ecology of invasive species. We surveyed internal and external macroparasites of all age classes of the invasive Argentine Black and White Tegu Salvator merianae. The hookworm Diaphanocephalus galeatus infected 83% of specimens, even occurring in juveniles (14.5 cm snout-vent length). This hookworm occurred primarily in the small intestine of hosts, although specimens sometimes (10%) also had low numbers of hookworms in their anterior large intestine. Hookworm numbers increase with snout-vent length of its host, and hosts usually contain more female than male hookworms. Comparing female to male tegus, we failed to find a difference in parasite numbers. Diaphanocephalus galeatus has a highly aggregated population structure as indicated by a high coefficient of dispersion and close fit to a negative binomial distribution; infected hosts contained 1–557 (35 ± 78, n = 58) hookworms. We suspected that heavily infected hosts might have lower than normal mass, however our data did not support this hypothesis. High infection rates in our samples are comparable to those in the native range of S. merianae, suggesting that this parasite-host relationship has been little effected by transplantation to South Florida.

PRESENTER BIO: Andrew Gritzmaker is a NSF- STRIDES Scholar program senior at Broward College in the Bachelors of Environmental Science program. His research as an undergraduate student focuses on the effects of invasive species on South Florida ecology.

INCREASING ACCESSIBILITY OF THE EVERGLADES DEPTH ESTIMATION NETWORK (EDEN)

***Saira M. Haider*[1]**, *James M. Beerens*[2], *Eric D. Swain*[1], *Bryan J. McCloskey*[3], *Leonard G. Pearlstine*[4], *Stephanie S. Romañach*[1]

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Water managers and scientists working in the Everglades use hydrologic data to analyze ecological responses to current and past conditions, assess restoration, and model ecosystem states. The Everglades Depth Estimation Network (EDEN) is a real-time integrated network of 220 water-level gages, interpolated water-levels, and applications that provides daily water level data in 400m X 400m grid cells across the Greater Everglades landscape. Combined with a digital elevation model, EDEN's spatiotemporally continuous water level surfaces are used to calculate water depth, recession rates, hydroperiod, and number of days since dry, among other derived hydrologic data.

The current publicly available EDEN (version 2) uses proprietary GIS software tied to a specific computer architecture to run the interpolation of the gage network and create the daily surfaces. We developed a new version of EDEN (version 3) using R, a free and open-source cross-platform language used for statistical and geospatial analyses. Changing software platforms increases the transparency of the interpolation method and significantly shortens computation time.

Although both versions of EDEN use the same interpolation method, they result in slightly different simulated water surfaces; the exact reasons for these differences cannot be explored because version 2 uses GIS interpolation methods which are proprietary and not accessible. For a historical validation, we compared four years of surfaces and found that the root mean squared difference between the versions was 3.71 cm (standard deviation = 0.50 cm). The largest differences between the two versions occur in the Pennsuco Wetlands, along the southwestern border of Everglades National Park, and the northwest corner of Water Conservation Area 3A. We believe most of these differences are due to differences in the interpolation code. We also compared the version 3 surfaces to 284 field measurements taken at 72 benchmark locations in the Everglades and found a root mean squared error of 4.79 cm (standard deviation = 4.77cm), compared to 4.78 cm (standard deviation = 4.77cm) for version 2.

Converting the EDEN surface interpolation scheme from proprietary software to R has several benefits for the user community. The version 3 R scripts can be more easily modified and updated to accommodate changes to gage information and network, whereas in version 2 artifacts were hard-coded and could not be modified. Further, version 3 can also run on any machine, is not tied to a specific server, and runs up to ten times faster than the prior interpolation.

PRESENTER BIO: Saira Haider is an Ecologist at the USGS Wetland and Aquatic Research Center (WARC). Saira's research interests include using ecological modeling and spatial statistics to improve conservation management outcomes.

VISUALIZING TRADEOFFS FOR MULTI-SPECIES OPTIMIZATION IN THE EVERGLADES

Saira M. Haider[1], *James M. Beerens*[2], *Leonard G. Pearlstine*[3], *Stephanie S. Romañach*[1]
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The Everglades is a highly-managed ecosystem and managing hydrology to achieve optimal water conditions for several species of concern is a challenging task. Restoration planners face the challenge of balancing competing conservation goals for multiple species. Federal and state agencies put enormous effort toward conserving species of concern, but often focus on habitat requirements for one species at a time. While conservation planning that is focused on a single species can have benefits for additional species with shared habitat requirements, in many cases a single-species focus ignores the needs of other species in the ecosystem. Decisions based off the needs of one species lead to trade-offs for other species.

Water managers allocate water in the natural system based on how they foresee upcoming needs for species of concern. To assist with these decisions, we have developed Everglades Forecasting (EVER4CAST), a spatially-explicit near-term hydrologic forecasting application. Using National Oceanic and Atmospheric Administration monthly precipitation predictions and historical depth change distributions from the Everglades Depth Estimation Network, EVER4CAST generates simulations of future water surfaces over the Everglades. We run these forecasted water surfaces through a set of ecological models of species of concern and determine optimal, near-term water conditions given a set of management priorities.

Two of our main objectives with EVER4CAST are (1) finding optimal, near-term hydrologic conditions for water managers to consider while making water operations decisions and (2) visualizing and communicating output from multiple species models in a clear and effective way. First, while the ecological model output is explicitly spatial, means are often used to inform restoration actions, thereby reducing a landscape of data to a single value and potentially missing solutions that provide optimal results for multiple species with fewer trade-offs. We explore ways to find optimal hydrologic conditions, with the goal of maximizing suitable habitat conditions for multiple species. Second, we are developing methods to visualize multiple species output and illustrate species trade-offs across the landscape. With better visualization and communication tools, managers can make more informed decisions regarding restoration actions and water allocation.

PRESENTER BIO: Saira Haider is an Ecologist at the U.S. Geological Survey's Wetland and Aquatic Research Center (WARC). Saira's research interests include using ecological modeling and spatial statistics to improve conservation management outcomes.

STATUS OF FLORIDA BAY SEAGRASS COMMUNITIES FOLLOWING THE RECURRENCE OF TURTLEGRASS DIE-OFF AND THE IMPACTS OF HURRICANE IRMA: ADDING INSULT TO INJURY?

Margaret O. Hall[1]*, Bradley T. Furman*[1] *and Michael J. Durako*[2]
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Widespread mortality of *Thalassia testudinum* (turtlegrass) was first documented in north-central Florida Bay during the summer of 1987. The unprecedented event spanned three years, affected 40 km^2 of seagrass and catalyzed nearly a decade of ecological distress including persistent phytoplankton blooms and further seagrass loss. Putative causes for die-off initially ranged from changes in watershed management to lack of hurricanes, eutrophication and wasting disease. Subsequent experimental research revealed that high turtlegrass biomass, elevated summer temperatures and prolonged hypersalinity led to oxygen imbalance in the plants, sulfide intrusion into the roots and rhizomes, and death. Since 1995, FWRI's Fisheries Habitat Assessment Program (FHAP) has tracked the system's slow recovery, finding that by 2012 even the hardest-hit locations had returned to *T. testudinum* dominance, with above- and belowground biomass sufficient to fuel another bout of sulfide-driven die-off.

In mid-July 2015, researchers working in Everglades National Park reported warm water temperatures, elevated salinities (50-70 PSU), widespread bottom-water anoxia, fish kills and renewed reports of turtlegrass die-off in north-central Florida Bay. Cover-abundance data collected during FHAP, and additional die-off-response monitoring allowed us to quickly estimate the scope and scale of seagrass loss – both comparable to the 1987 event. Surveys conducted in Fall 2015 and Spring 2016 documented the near-complete loss of *T. testudinum* in Rankin Lake, and a substantial reduction in other basins, particularly Johnson Key. By Spring 2017, however, the fast-growing seagrass *Halodule wrightii* and the green macroalgae *Batophora* sp. had colonized much of the affected region. Remnant turtlegrass patches, aerial *Thalassia* shoots with multiple apical meristems, and the occurrence of *Thalassia* seedlings all indicated that recovery was underway.

Then, in September 2017, Hurricane Irma swept through Florida Bay. Post-storm monitoring showed that despite fears of widespread seagrass loss, direct physical damage was minor, and most declines were related to freshwater discharge and confined to coastal basins. However, in the months following Hurricane Irma, recurrent and persistent algal blooms have plagued Florida Bay, raising concerns that the pace of die-off recovery will slow and that secondary seagrass losses will occur due to shading, as was observed during the 1990s. Recent reductions in Johnson Key turtlegrass densities hint that light-related losses may have already begun. Thus, the trajectory of Florida Bay seagrass recovery remains uncertain, and will depend on multiple environmental factors, particularly the stalling effects of phytoplankton blooms and sediment re-suspension events. We anticipate that the Spring 2019 FHAP monitoring campaign will shed light on these issues.

PRESENTER BIO: Margaret O. Hall (Penny) is a research scientist at the Florida Fish and Wildlife Research Institute and has participated in wide range of seagrass research activities during the past 30 years. She has worked in Florida Bay since 1994 and has led the South Florida Fisheries Habitat Assessment Program since 2005.

LYGODIUM MICROPHYLLUM DISTRIBUTION IN EVERGLADES TREE ISLANDS: PATTERNS AND PROCESSES

Helen Hammond[1], *Nicole Cortez*[1], *Michael Manna*[2], *Carlos Coronado*[2] *and Sharon Ewe*[1]
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The fern Lygodium microphyllum (Old Word Climbing Fern) is a widely distributed invasive exotic species across the ecosystems of Florida. Found from upland pinelands to coastal marshes, this non-native species has been shown to impact the structure and function of native communities by shading out the native vegetation once it gets into the canopy.

Tree islands are key habitats within the Everglades marsh landscape as they are topographically elevated and provide upland and seasonally dry habitat for a diverse range of plants and faunal species. Within Water Conservation Areas 3A and 3B, this fern has been observed reproducing and potentially displacing the native tree island community. This effort focuses on identifying the location and size of this fern in tree islands of both WCA-3A and -3B, and notes the conditions around these plants that may provide insight into the factors influencing the distribution and further establishment of this invasive exotic fern.

To date, the team has surveyed over 150 islands in WCA-3A and 3B, and over 300 islands have been surveyed when considering the E&E, FWD, and SFWMD databases. Presence nor island elevation appears to provide a clear pattern to explain this fern on the tree islands. Findings indicate that hydrology, soil microtopography, vegetation community type and canopy cover may explain the presence of Lygodium on the tree islands; however, further investigation is ongoing.

<u>PRESENTER BIO</u>: Helen Hammond has a broad background in vegetation ecology in South Florida. She has conducted vegetation surveys on tree islands since 2010 and managed the Lygodium tree island surveys for the past 3 years.

INFLUENCE OF FLOW FROM THE C-44 CANAL ON THE WATER QUALITY OF THE SOUTH FORK OF THE ST. LUCIE ESTUARY, FLORIDA

***M. Dennis Hanisak**, Kristen S. Davis, and Bryan Botson*
Harbor Branch Oceanographic Institute at Florida Atlantic University, FL, USA

The St. Lucie Estuary (SLE) is a part of the larger Indian River Lagoon (IRL) system, one of the most diverse estuarine environments in North America. Over the last 100 years, the SLE and its watershed have been modified to allow navigation, flood control, and water supply. Intermittent freshwater discharges from Lake Okeechobee via the C-44 Canal have negatively impacted the SLE and the connected Indian River Lagoon, including severe reductions in salinity; elevated turbidity, nutrients, and contaminants; and increasingly harmful algal blooms of the cyanobacterium *Microcystis*.

The Indian River Lagoon Observatory (IRLO) at Florida Atlantic University's Harbor Branch Oceanographic Institute in Fort Pierce, Florida, is investigating the Indian River Lagoon's plants, animals and environment, and the impact of natural and human-induced stressors. The goal of IRLO is to acquire and disseminate data and knowledge on the IRL critical to ecological function and its sustainable management. IRLO research and education activities are being enhanced by deployment of an estuarine observation network, the Indian River Lagoon Observatory Network of Environmental Sensors (IRLON; https://fau.edu/hboi/irlo/irlon.php), comprised of land/ocean biogeochemical observatory (LOBO) units and weather sensors to provide real-time, high-accuracy and high-resolution water quality/weather data through a dedicated interactive website (http://fau.loboviz.com/).

Continuous real-time monitoring of water quality by IRLON for two years (May 2016-April 2018) revealed that water quality in the South Fork of the SLE near the S-80 lock on the C-44 canal changes rapidly with discharges from Lake Okeechobee. The location of IRLON's SLE-SF2 site is unique compared to other IRLON sites because conditions can change rapidly based on the flow, or lack of flow, of freshwater from the C-44 canal. The parameters most impacted in the SLE are salinity, pH, phosphate, and dissolved oxygen. During periods of heavy discharge, salinity plummets and the site is in essence a flowing river of fresh water. However, when there are prolonged periods without flow, the site is essentially a stagnant brackish lake, with increasingly anoxic conditions as time since discharge increases. When precipitation occurs, and the S-80 is not discharging, this site is positioned to capture the effects of local runoff, such as the spike of phosphate levels during the first flush in June 2017.

These high-frequency, continuous observatory data are enabling better quantification and modeling of relationships between environmental factors and biological processes in an estuary with tremendous climate-related interannual variability These real-time data enable researchers to follow environmental changes in the SLE and IRL, 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.

PRESENTER BIO: Dr. Hanisak is a Research Professor at Harbor Branch Oceanographic Institute at Florida Atlantic University and Director of its Indian River Lagoon Observatory. His research, focused on the biology and ecology of marine plants, particularly macroalgae (seaweeds) and seagrasses, has been conducted primarily in Florida, the Bahamas, and the Caribbean.

EFFECTS OF RETURNING FLOW TO THE FLORIDA EVERGLADES ON THE MACROINVERTEBRATE COMMUNITY

***Chris Hansen*[1]**, *Nathan J. Dorn*[1], *Colin Saunders*[2], *and Sue Newman*[2]
[1]Florida Atlantic University, Davie, FL, USA
[2]South Florida Water Management District, West Palm Beach, FL, USA

The South Florida Water Management District has been investigating the ecological impacts of returning flow to the GEE through the Decompartmentalization Physical Model (DPM). As part of DPM, we are studying the effects of returning flow on the macroinvertebrate community. Flow may impact macroinvertebrates in the Everglades as flow is a physical stress and alters both the distribution of organic matter and food quality. In this presentation we present preliminary results comparing the densities of macroinvertebrates in flowing and non-flowing sloughs in the DPM.

Our study sites consisted of three experimentally flowing sloughs (velocities >2 cm/s) and six non-flowing control sloughs (velocities <<1 cm/s) surrounding the cluster of flowing sloughs with three control sloughs to the NE (1.75 km removed) and three to the SW (2.92 km removed). Macroinvertebrates were sampled at three randomly positioned 9 m^2 plots, each with 10 stations, in all nine sloughs. Using dip nets, 0.5 m sweeps were conducted at each station totaling 1.5 m^2 of habitat searched in each plot. The sweeps captured smaller (0.5-3 mm) macroinvertebrates (mostly chironomids and oligochaetes) living in the organic flocculent material and periphyton mats as well as larger rare macroinvertebrates (LR: total length > 3 mm) consisting of larger chironomid instars, odonates larvae, and adult insects. We took a standard volume of sediment from the back to the lab and searched the remaining floc and periphyton for LR macroinvertebrates in the field. In the lab we subsampled the organic material and picked out macroinvertebrates larger than 500µm using a dissecting microscope. Once the samples had been searched in the lab for macroinvertebrates the remaining organic substrate was dried. Counts were extrapolated to densities (#/m^2). Mean densities of all macroinvertebrates and chironomidae alone (they were the dominant taxon by numbers with 84% of the total) were analyzed to look for significant effects of flow on densities. We combined the control sloughs for comparison with the flowing sloughs when controls on either side of the flow did not differ.

While the flowing sloughs appeared to have fewer small macroinvertebrates, the densities were variable between sloughs and the differences were not significant (total small macroinvertebrates: $p = 0.12$; chironomids: $p = 0.18$; $n = 3$ flowing sloughs vs. $n = 6$ non-flowing controls). There was also no significant difference between flowing and non-flowing sloughs when comparing macroinvertebrate density per g of organic matter (total small macroinvertebrates: $p = 0.86$; small chironomids: $p = 0.96$). For the LR macroinvertebrates the controls showed near-significant differences ($p = 0.076$) so we compared all three sites directly and found differences ($p = 0.033$) in the average density of LR macroinvertebrates between sites. The flowing sites had more LR macroinvertebrates than the control sloughs to the southwest ($p = 0.036$), but similar densities as the control sloughs to the northeast ($p = 0.82$).

In summary, our preliminary analyses have not indicated any clear net impact of flow on dry season densities of small macroinvertebrates in the floc and periphyton nor the larger macroinvertebrates in the slough.

<u>PRESENTER BIO</u>: Chris Hansen works for Florida Atlantic University as an Environmental Scientist II and is currently enrolled in FAU's Environmental Sciences master's program. Chris has been assisting the SFWMD studying multiple aspects of DPM for the past six years.

TRACKING FAUNAL SPECIES OF CONCERN IN EVERGLADES SOUTHERN ESTUARIES

Kristen M. Hart[1]*, Michael S. Cherkiss*[1]*, Andrew G. Crowder*[3]*, Ikuko Fujisaki*[2]*, Frank J. Mazzotti*[3]*, Jeffrey S. Beauchamp*[2,4]*, Mathew J. Denton*[1]*, Brian J. Smith*[3]

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Animal movements are often determined by resource need and evolutionary history, and such movements can, in turn, affect the environment as well as other organisms. Data on animal movement patterns is thus critical for understanding ecological processes and informing conservation strategies, particularly for focal species that play crucial roles in shaping ecosystem function.

Satellite telemetry allows for remote tracking of animal movement in large areas such as the Greater Everglades. Over the past decade, we satellite-tracked several reptile species of conservation concern, including three species of sea turtles (endangered hawksbills [*Eretmochelys imbricata*], endangered green turtles [*Chelonia mydas*], and threatened loggerheads [*Caretta caretta*]), American alligators (*Alligator mississippiensis*), and threatened American crocodiles (*Crocodylus acutus*). Capture and tagging sites were within both Everglades (alligators, crocodiles, sea turtles) and Dry Tortugas National Parks (sea turtles). For each species we quantified home range sizes and identified important high-use areas.

Tracking results for 15 adult female American crocodiles showed high-use areas in Florida Bay and off Cape Sable, as well as in the Fox Lakes, which may represent an important mating ground. Tracking results for 5 adult American alligators showed high-use areas within the Shark River Estuary. Tracking results for 28 sea turtles showed high-use of Florida Bay, areas off Cape Sable, and areas near Shark River Estuary as either inter-nesting habitat during the breeding season or as resident foraging areas post-breeding.

Important multi-species ”hotspots” exist for these reptiles in Everglades southern estuaries. Future tracking studies could reveal how changes to water flows as well as both water and habitat quality associated with restoration activities alter reptile use of these areas.

PRESENTER BIO: Dr. Hart is a Research Ecologist with more than 18 years of experience in planning, designing, and implementing Everglades restoration projects focused on large reptiles. She has extensive experience with threatened and endangered species population restoration including delineation of animal habitat use patterns throughout coastal and marine seascapes.

SALTWATER INTRUSION IN THE EVERGLADES: MICROBIAL COMMUNITY COMPOSITION AND CARBON DYNAMICS UNDER NEW SALINITY REGIMES

***Sarah Harttung**, and Lisa G. Chambers*
University of Central Florida, Orlando, FL, USA

Coastal wetlands are well-known for their ability to sequester and store carbon, but this ecosystem function is vulnerable to biogeochemistry-altering saltwater intrusion. When freshwater wetlands experience saltwater intrusion, short-term soil respiration usually increases and vegetation productivity decreases. Previous studies on the biogeochemical effects of saltwater intrusion suggest the rates and pathways of soil microbial metabolism can be significantly altered by salinity, but it is unclear over what time span, and what is the fate of the affected microbes (i.e., do individuals die or become dormant when stressed by high salinity, subsequently being replaced by a more salt-tolerant community, or do individuals simply down-regulate metabolism until they are able to osmoregulate?). Determining the function and diversity of the biologically active microbial community in wetlands is challenging because DNA can persist in the soil long after a microorganism's death. Viability quantitative polymerase chain reaction (qPCR) allows only the extraction of DNA within membrane-bound cells, i.e. cells with the capacity to do biological work. This type of qPCR is not commonly used for wetland soils, but it has the capacity to help determine the potentially living portion of the microbial community. The objectives of this study were to investigate the effect of prolonged (70-day) saltwater exposure on viable microbial community composition and soil carbon dynamics on vegetation-free intact soil cores collected from the Fakahatchee River (SW Everglades, Naples, FL) using viability qPCR.

Triplicate soil cores were collected along a salinity-induced vegetation ecotone spanning freshwater herbaceous vegetation, mixed (brackish) herbaceous/mangrove, and saline mangrove communities. Herbaceous cores were treated with 0 ppt, transition cores were treated with 15 ppt, and mangrove cores were treated with 30 ppt as controls. Saltwater intrusion was simulated by exposing soil cores from the herbaceous and transition site to brackish (15 ppt) and/or salt (30 ppt) water. Herbaceous cores were treated with both 15 ppt and 30 ppt, while transition cores were only treated with 30 ppt. Bulk density, moisture content, pH, soil extractable and surface water nutrients (phosphate, nitrate, and ammonium), total carbon/total nitrogen, organic matter content, total phosphorous, and extracellular enzyme activity corresponding to carbon and nitrogen demand in the soil were measured before and after the incubation period. Over the course of the manipulation, soil respiration (CO2) was measured twice per week during high tide and low tide. Over the course of the experiment, CO2 flux decreased. Herbaceous cores treated with brackish and salt water had consistently higher CO2 flux than the herbaceous control.

Understanding microbial community dynamics could inform predictions on how coastal ecosystems will respond to stressors such as saltwater intrusion. Coastal habitat switching could result in increases or decreases in carbon storage. Maintenance of these stable, long-term carbon pools can mitigate climate change.

PRESENTER BIO: Sarah Harttung is a second year PhD student at the University of Central Florida in the Aquatic Biogeochemistry Lab. She researches soil carbon dynamics and microbial community shifts under new anthropogenic environmental conditions.

FORECASTING THE RESTORATION OF A FREE-FLOWING EVERGLADES BASED ON THE DPM LARGE-SCALE HIGH-FLOW EXPERIMENTS

***Jud Harvey*[1]**, *C. Saunders[2], S. Newman[2], J. Choi[1], B. Rosen[3], J. Trexler[4], L. Larsen[5], D. Ho[6], F. Sklar[2], C. Zweig[2], E. Tate-Boldt[2], C. Coronado-Molina[2], F. Santamaria[2], E. Cline[2], R. Jaffé[4], P. Regier[4], N. Schmadel[1]*

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In its pre-drainage state the Everglades had well-connected deep-water sloughs interspersed between slightly higher ridges vegetated with dense sawgrass. The sloughs supported high primary and secondary productivity, pathways for animal dispersal, and edges for feeding and nursery habitats. Over large areas those deep-water sloughs have disappeared along with their important ecological functions. The amount of flow needed for effective restoration of the Everglades is still debated, in part because the ecological outcomes are difficult to forecast. The multi-agency DPM (Decompartmentalization Physical Model) team is directly evaluating the ecological effects of restored high flow across a large area (5 km^2) typified by levee blocking of sheetflow, diminished microtopography, and loss of sloughs. Beginning in 2010 the DPM team began directly observing the hydraulic, sedimentary, and ecological effects of high-flow restoration. Comparisons are being made between eight flow releases that lasted a month or more with three years of background measurements before flow releases began. Restored flow in the DPM occurs through culverts that create essentially a point input that disperses water radially into the experimental area - the strongest effects were localized within 500 m because of the radial dissipation of flow. We observed that high flow increased water velocities above a threshold that entrained and redistributed sediment from sloughs to ridges, which confirms important speculations made previously based on models and flume measurements. An important DPM finding was that sustained flows of 8-10 weeks were needed to maximize slough velocities and the redistribution of sediment to ridges. Furthermore, the field experiments revealed dynamics not revealed by modeling or flume measurements, including 1) the physical overturn of floating periphyton mats that sink to the bed in a manner of weeks, 2) an associated increase in flow velocity caused by lowered flow resistance, and 3) biogeochemical changes in flocculent organic bed sediment (floc) caused by increased mass transfer of oxygen and phosphorus to the bed that hastens the decomposition of bed floc. Together those biophysical changes quickened the physical breakdown, decomposition, entrainment, and redistribution of floc from sloughs to ridges. Investigations of aquatic food webs are ongoing and appear to show positive effects on food quality for small fish. The relative importance of the controls on downstream slough clearing and associated ecological benefits are currently being assessed with updated models and an active management program that kick-starts slough regeneration through selective herbicide applications in remnant sloughs choked with vegetation. At the same time DPM is moving into phase II of experimentation with year-round flow and with an expanded emphasis on tracking high flow through a large (3,000) gap in the levee at the downstream end of the experimental area. Attention is focused on how the style of canal backfilling (complete, partial or none) affects high-flow loading of sediment and phosphorus to locations further downstream.

<u>PRESENTER BIO</u>: Jud is a senior research hydrologist with the U.S. Geological Survey in Reston, VA who has lead investigations of Everglades groundwater-surface water interactions and landscape change for twenty-three years.

EVERGLADES SCIENCE COMMUNICATION EXPERTS – MOVING BEYOND DATA RICH, BUT INFORMATION POOR IN SCIENCE COMMUNICATION

Everglades Science Communication Experts

The breadth of science in the Greater Everglades is rich, and the opportunities to inform both restoration and natural resource management is impressive. However, a significant amount of science falls into the category of "information rich, but data poor", with science conclusions too often speaking to, "and can be used to inform restoration", but not necessarily tied to specific natural resource management, ecosystem restoration, or adaptive management decisions. A group of Everglades science communication experts have been convened to speak about strategic science communication, sharing important lessons on: articulating communication goals; strategic messaging; audience identification and engagement; the importance of communication vehicles; and the investment of time and resources needed for effective communication.

The Special Session, *Moving Beyond Data Rich, But Information Poor in Science Communication*, examines the issue of transfer of data into useful/useable knowledge, outlines the needs for serving up effective science from both a policy and resource management perspective, and explore best practices from a range of Greater Everglades applications. The end of the session is a focused dialog with these Everglades science communication experts and the audience. Steve Davis highlights communicating science with policy makers. Nick Aumen focuses on science communication with natural resource managers. Laura Brandt emphasizes advancing the integration of multiple reporting mechanisms for communicating restoration progress. Hiram Henriquez discusses the use of effective explanatory graphics (infographics) as an important source of effective science communication. Matt Harwell's emphasis is on encouraging restoration practitioners to adopt principles of strategic communication (focusing on message, audience, vehicles) for structuring science communication efforts.

This science communication session is targeted to several primary audiences, including agency managers and a range of scientists looking to present their important science in impactful ways to inform Greater Everglades ecosystem restoration and management. Please attend the full Special Session and engage this panel of Everglades science communication experts!

PRESENTER BIO: Dr. Matt Harwell is an ecologist with the US EPA. Matt spent a decade working on restoration science in multiple South Florida systems including Lake Okeechobee and the Greater Everglades. Matt's areas of specialization include ecosystem assessment, adaptive management, ecosystem restoration, and integration and communication of science for decision makers.

BLOOMS, NUTRIENTS AND CLIMATE CHANGE: WHAT'S IN THE FUTURE FOR FLORIDA LAKES AND ESTUARIES?

Karl E. Havens
Florida Sea Grant and UF/IFAS School of Forest Resources and Conservation, Gainesville, FL, USA

Massive cyanobacteria blooms occurred on Lake Okeechobee in 2018, 2016, 2010 and 2005, at spatial scales and intensities not seen in earlier years, and with associated high levels of cyanotoxins. The most recent events happened along the freshwater to marine continuum, with estuaries being seeded with nutrients and algae from the lake. The recent blooms differed from what was seen in past decades, by being dominated by a genus called Microcystis that requires nitrogen (N) that is dissolved in the water as highly available inorganic and organic forms. In the past, blooms in the lake were comprised mainly of Anabeana, which can 'fix' nitrogen gas (N2) from the atmosphere. The growing "glut" of biologically-available forms of N from agricultural fertilizers, urban runoff, and fossil fuel combustion appears to be responsible for a global expansion of Microcystis that has been documented from China to Europe and North America. There also is emerging evidence that watersheds can hold large quantities of 'legacy N' as organic N attached to the roots of plants, and that this legacy N can further fuel blooms of Microcystis in phosphorus (P)-enriched lakes, long after other N sources are reduced. This often happens following intense rain events, when legacy N is washed downstream. Microcystis blooms also are stimulated by warmer water, and over the next 50 years our surface waters will likely warm by 2o C. Legacy N in watersheds, warming of surface waters and the potential for future rainfall events to become more extreme all point toward a need to identify and control N sources and legacy N, with the same urgency that agencies have targeted P since the 1970's. The degree to which dual N and P control strategies happen expeditiously will determine whether the future is bright, or foreshadows a growing "nasty green" for Florida lakes and their downstream ecosystems.

<u>PRESENTER BIO</u>: Dr. Havens is Director of Florida Sea Grant and a Professor in UF/IFAS. He has worked on Florida lakes for over 25 years and currently is studying interactive effects of climate change and nutrients.

WATER DEPTH & ECOSYSTEM ATTRIBUTES IN LAKE OKEECHOBEE

Karl E. Havens
Florida Sea Grant and University of Florida Institute of Food and Agricultural Sciences, Gainesville, FL, USA

Lake Okeechobee is the largest surface water storage feature of the C&SF project, and the largest natural lake in the eastern United States. The lake currently is operated under a US Army Corps of Engineers (USACE) regulation schedule that is considerably lower than prior schedules - for safety reasons during repair of a levee surrounding the lake. Under this recent schedule, the potential amount of water storage in the lake is reduced by more than 500,000 acre feet. The USACE and South Florida Water Management District will soon evaluate new regulation schedules, and that process will consider a myriad of issues affected by how water is managed in the lake. Those include effects on ecological attributes of the lake itself, effects on the St. Lucie and Caloosahatchee Estuaries, effects on agricultural and urban water supply, and water supply for Everglades restoration. This presentation focuses on: effects of variation in depth on attributes within the lake: uncertainties; and suggestions for how science might be more integrated into the planning and implementation of a new schedule.

Lake Okeechobee is a complex ecosystem with three distinct zones – a central pelagic zone with relatively deep water and a soft mud bottom, a nearshore zone that can support over 50,000 acres of submerged plants, and a littoral zone that occupies about ¼ of the lake and has a diverse community of plants and animals. The littoral zone provides critical nesting and foraging habitat for wading birds and Everglades Snail Kites. Between the three zones there can be a tremendous nutrient gradient when water levels are low, going from over 100 ppb of TP in the pelagic zone to below 10 ppb of TP in the littoral zone. However, when the lake is high, counter-clockwise mixing of water can homogenize the lake, carrying nutrient-rich water into the nearshore and littoral zones.

High water events have multiple negative effects, including: loss of submerged plants in the nearshore zone due to light limitation; erosion of the edge of the littoral zone and associated emergent plants due to increased wave energy; transport of P into the littoral zone that stimulates the spread of cattail and loss of habitat quality. Rapidly rising water levels also can result in flooding of wading bird and kite nests, and are particularly of concern in the spring, when wading birds depend on predictably falling water levels for selecting nesting locations and for concentrating fish prey resources. Uncertainties include how antecedent conditions affect responses of submerged plants to increased depth, resilience of certain plant assemblages that provide important habitat for animals, and the ability of littoral zone areas that have switched over to cattail to recover, even after human intervention.

Comprehensive modeling and monitoring are needed to guide the selection of a new lake regulation schedule, and could include use of a Lake Okeechobee Environment Model that was not available when the earlier schedule was adopted. Adjustment of monitoring to allow for more frequent sampling at sentinel sites would also allow ecologists to inform water managers about the status of submerged plants, nearshore emergent plants, P incursion into the littoral zone and bird nesting patterns at a comparable timescale to water release decisions.

PRESENTER BIO: Dr. Havens is Director of Florida Sea Grant and a Professor in UF/IFAS. He has worked on Florida lakes for over 25 years and currently is studying interactive effects of climate change and nutrients.

BURROW USE AND SELECTION BY INVASIVE BURMESE PYTHONS IN FLORIDA

***Kodiak C. Hengstebeck*[1]**, *Christina M. Romagosa*[1], *Paul T. Andreadis*[2], *and Ian A. Bartoszek*[3]

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[3]The Conservancy of Southwest Florida, Naples, FL, USA

Burmese pythons are established invaders of natural ecosystems in southern Florida and are greatly affecting many native species with which they co-occur. They have been implicated in the severe declines of meso-mammal populations throughout the southern Everglades, and are also likely affecting populations of large mammals and birds. The python population has been expanding from the core population in the southern Everglades into other regions of southern Florida. In southwestern Florida, Burmese pythons have access to dry upland hammock and scrub habitats, which are uncommon throughout most of the python's Florida range. Pythons commonly use animal burrows within these upland habitats for refuge and reproductive purposes. This behavior is significant as it could negatively impact native burrow-dwelling species, including state-listed gopher tortoises. It could also affect the geographic range in the southeastern United States that pythons could establish, and could have significant implications on control and management of invasive pythons. We used radio telemetry-tagged pythons to assess and describe burrow use and selection by Burmese pythons in their southwestern Florida range.

<u>PRESENTER BIO</u>: Kodiak Hengstebeck is a graduate research assistant currently pursuing his PhD in the School of Natural Resources and Environment at the University of Florida. His research is centered around invasion ecology, focusing on invasive Burmese pythons and their impacts on Florida's ecosystems.

IMPROVING SCIENCE COMMUNICATION WITH INFOGRAPHICS

Hiram Henriquez
H2H Graphics & Design, Doral, FL, USA

Explanatory informational graphics are a form of visual storytelling combining layers of illustration, statistical data, and/or mapping with few words. They have been around for centuries and are widely used today by media such as National Geographic, Scientific American, Science, and Wired. They had become a popular medium used by U.S. newspapers and news magazines during the last decade of the 20th century, including large national stories such as the Space Shuttle Challenger disaster, Operation Desert Storm, and wind storm coverage of Hurricane Andrew and other climate stories. Although having a long, successful run in U.S. newspapers, in the past decade newspapers and news magazines have downsized their staffs and cut back on newsprint to counteract the effects of forces affecting the print news industry. Because of this, covering the news using infographics is being published less. Although abroad they still have a strong presence.

The popularity of infographics are an indication that they are an important and viable source of communication:
• According to Graphs.net, the usage of visualized information has increased by 400% since 1990.
• An explosion of popularity with visual content from platforms like Pinterest have led to over 15 million Google search results for the term 'Infographic.'
• Gathered by Nowsourcing, a social media marketing company, data shows infographic posts dwarf traditional posts when shared on social media.
• The social network Digg reveals that since 2007, infographics on Digg have increased by 250 times.

A great example that shows how infographics are important to readers is how a 2013 graphic for *The Miami Herald* story on Lake Okeechobee (showing how Florida's Herbert Hoover Dike is susceptible to failure and the state's efforts to repair it) helped drive readers to the story a month after the original story was published. The original story without the graphic was published on their Web site from Aug. 16-Sept. 19, and garnered 7,058 online hits. When the graphic was posted on their site from September 20-October 31, a total of 13,670 viewed it — almost twice as much.

The goal of any effective explanatory graphic is to convey the content in a clear and concise manner, so it can be absorbed quickly by the reader — but also be memorable — so that in turn the reader shares what he/she has learned with others. In my work with The Everglades Foundation, I have used my experience in effectively communicating explanatory graphics for publications such as *The Miami Herald*, the *South Florida Sun-Sentinel*, and *National Geographic*, to break down complicated scientific data and concepts to make them accessible to both policy makers and the general public. Using maps, charts, and 3D, vector and hand-drawn illustrations, the graphics I have created for the Foundation have layered content, packaged in ways that help the reader navigate complex topics and content, and designed to not only help them understand the material, but also possibly share it with others.

PRESENTER BIO: Hiram Henriquez is Creative Director for H2H Graphics & Design Inc., with more than 20 years of experience in creating infographics and explanatory graphics for *The Miami Herald*, *South Florida Sun-Sentinel*, *National Geographic*, and a host of organizations and corporations in the U.S., including The Everglades Foundation, the South Florida Water Management District, and Florida Power & Light. He also is a full-time lecturer at the University of Miami (Coral Gables, FL) where he teaches visual design, infographics and data visualization.

EVALUATING THE PERFORMANCE OF CLIMATE MODELS FOR REPRODUCING RAINFALL IN FLORIDA

*Jung-Hun Song[1], **Young Gu Her[1]** and Satbyeol Shin[2]*
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Future climate projections have been made using mathematical models developed on the basis of understandings about climate systems and assumptions on human activities. The Coupled Model Intercomparison Project (CMIP) has compared and assessed the performance and uncertainty of the projections made by multiple climate models since 1995. Although rainfall events are a factor that largely controls hydrological processes occurring on and in the ground, and their characteristics determine the severity and frequency of extreme hydrological events including flood and drought, climate models' performance in reproducing rainfall events has not been investigated enough to guide selection among the models when making hydrological projections. We compared the duration, amount, frequency, intensity, and pause duration of rainfall events observed at 78 rain gages located in Florida with those projected by 29 general circulation models (GCMs) to identify GCMs that provide rainfall characteristic projections close to the observations. Then, we projected the size of design storm events and the frequency and severity of hydrological drought using multi-model ensembles of climate projections made from selected GCMs. Results showed that rainfall and extreme hydrological event projections could significantly vary depending on climate model selection and locations, suggesting the need for performance evaluation in a routine hydrological analysis practice.

<u>PRESENTER BIO</u>: Dr. Her is an assistant professor of hydrology and agricultural engineering with extensive experience of monitoring and modeling hydrological processes and planning and designing water resources management practices. His current research focus on quantifying the impacts of projected changes in climate and sea level on agriculture and natural resources.

WHITE IBIS: A WETLAND SPECIALIST OR URBAN GENERALIST?

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Urbanization and its associated anthropogenic resources, particularly food, can alter species' ecology, health, and behavior. The American White Ibis (*Eudocimus albus*) is a great model species to study recent and ongoing urban adaptation. Approximately 20 yrs ago, a portion of the S Florida population shifted from a wetland specialist to a generalist. Currently, Ibises are commonly observed in urban areas where they forage on recently irrigated lawns, landfills and golf courses, but are also being hand-fed in urban parks.

We have been studying the effects of this recent urbanization on White Ibises since 2009, hypothesizing that ibises are spending more time in urban areas than in natural areas, showing higher site fidelity to urban parks and zoos where food handouts are abundant, and questioning the effects of the shift in behavior on their health (i.e. body condition, ectoparasite burdens, stress, immunity, and pathogen prevalence) where they consume largely carbohydrate-rich and protein-poor diets. Earlier work confirmed ibis are good reservoirs of salmonellae, which can have significance for public health, but which can be used as an indication of the environment ibis forage.

From 2015 to 2017, we captured ibises both within the urban landscape and natural wetlands, collected biological samples and attached GPS transmitters to a subset of adults. Our results suggest that ibises in urban areas show higher site fidelity throughout the non-breeding season and are heavily provisioned with anthropogenic food, which appears to offer a trade-off by providing low-quality, but easily accessible calories that may not support high mass but may increase time available for behaviors, such as preening, that decrease ectoparasites. Furthermore, urban ibises have a higher probability to be chronically stressed and higher *Salmonella* prevalence than birds captured at natural sites. *Salmonella* prevalence was also positively associated with side fidelity to sites from which we had isolated *Salmonella* spp and provisioned food. We examined the gastrointestinal microbiome of ibis and found that the diversity of bacterial genera detected was negatively associated with urbanization and bread consumption, positively associated with age, and lower diversity was associated with higher *Salmonella* prevalence. We also conducted experimental infections of ibis with low-pathogenic avian influenza viruses and found that they are susceptible, can shed viruses, develop antibodies, and have the ecological opportunity to be reservoirs for AIV. Our research to understand the trade-offs ibis face as they become more dependent on urban environments is important for future conservation and management of a variety of species in human-modified habitats.

<u>PRESENTER BIO</u>: Dr. Hernandez's research focuses on examining how anthropogenic activities influence wildlife ecology, health and pathogen dynamics. She obtained a DVM at LSU ('96), trained as a wildlife veterinarian at Cornell University (2001), and later acquired a PhD in ecology at UGA's Odum School of Ecology (2004).

WATER MANAGEMENT OPERATIONS AS A DRIVER OF SOLUTE TRANSPORT INTO SHARK SLOUGH

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Solute behavior in riparian systems is often used to make inferences about processes driving material flux across landscapes. Relationships between concentrations and discharge or stage can reflect a broad range of phenomena, including weathering, primary production, dilution, and human activities. In heavily managed environments such as the canal networks of south Florida, solute behavior can be affected by human control of flow regimes as much as by biogeochemical and physical processes. In this presentation, we explore seasonality in flows and concentrations of geogenic (Ca, Si, Mg, Na) and nutrient-related solutes (NO_3^-, NH_4^+, TP, chlorophyll *a*), and quantify the effects of water management operations on solute behavior along the northern boundary of Everglades National Park.

Biologically relevant solutes had higher variation and more pronounced seasonality than did geogenic solutes. Discharge was a poor predictor of all solute concentrations, in contrast to many natural riparian systems. Nonetheless, nutrient loads were primarily driven by variation in discharge rather than variation in solute concentrations. By simulating alternative flow regimes, we demonstrate the effect that structure operations can have on perceived water quality. An improved understanding of seasonality in solute concentrations and the role of operations in solute transport can be used to develop water management regimes that improve downstream water quality.

<u>PRESENTER BIO</u>: Dr. Hill is an environmental scientist at the South Florida Natural Resources Center. Dr. Hill joined the National Park Service following postdoctoral research positions with the USEPA's Office of Research and Development and the Louisiana Universities Marine Consortium. His research explores the role of human activities as drivers of the ecology and biogeochemistry of coastal and aquatic systems.

DEVELOPING REFERENCE VALUES FOR PALEOECOLOGICAL INTERPRETATION OF FLORIDA BAY: ANALYSIS OF STABLE CARBON AND NITROGEN ISOTOPE AND ELEMENTAL VALUES OF PLANTS AND ALGAE

Kristen Hoefke, *Miriam C. Jones, G. Lynn Wingard, Bethany Stackhouse*
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Florida Bay is a shallow (<1.5 m) carbonate estuary that has undergone major changes in sea level over the last 5000 years. Mangrove-rimmed islands, which attenuate storm surge to the mainland and provide habitat to fauna, emerged 2500-500 years ago under the lowest known Holocene rates of relative sea-level rise (RSLR). As RSLR increases, sediment cores can provide useful information on how these environments responded to past sea-level changes. Previous sea-level rise studies in Florida Bay have used paleoecological proxies such as pollen, diatoms, ostracodes, mollusks, and foraminifera to classify depositional environments and infer relative sea level changes based on transitions between these environments. However, assemblages of each of these proxies can be found across multiple depositional environments, resulting in challenges for isolating clear transitions in sea level. Stable isotope and elemental data can provide additional information for distinguishing the depositional environment of downcore sediments, particularly sediments from storm overwash or sea-level transgressions, as we hypothesize that submerged aquatic vegetation taxa have isotopically distinct signatures from terrestrial taxa.

We measured stable carbon and nitrogen isotopes ($\delta^{13}C$, $\delta^{15}N$) and elemental concentrations [total organic carbon (TOC), total nitrogen (N), ratio of carbon to nitrogen (C/N)] of modern plants and algae, storm sediment overwash from Hurricane Irma, and recent (2018) surface sediment samples from Florida Bay to serve as a reference for interpreting Holocene sediments. We grouped plants by their functional types (algae, estuarine vascular, and terrestrial vascular) and environment (subaquatic/estuarine, mangrove/berm, freshwater terrestrial, and island interior mudflat). Preliminary results suggest a relationship between plant functional type and $\delta^{13}C$ and C/N values when both values are considered together, despite overlapping ranges between some categories, and suggest a distinction between plants using the C3 and C4 photosynthetic pathways within the terrestrial vascular group. The findings reported here will help characterize the depositional environments of Holocene sediments on Florida Bay islands, including tracking changes in sea level and identification of overwash deposits from storms. Interpretation of centennial to millennial scale changes in the south Florida environment provides resource managers with tools to anticipate ecosystem response to future changes such as those related to sea-level rise and climate.

PRESENTER BIO: Kristen Hoefke is a Physical Science Pathways Intern at the U.S. Geological Survey. She holds degrees in Honors Biology and Environmental Science & Policy and has recently completed a certificate in Geographical Information Systems.

INTEGRATING MONITORING AND RESEARCH TO IMPROVE OUR UNDERSTANDING OF *KARENIA BREVIS* AND OTHER HARMFUL ALGAL BLOOM DYNAMICS IN FLORIDA'S MARINE WATERS

Katherine A. Hubbard
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Florida has more than 50 harmful algal bloom (HAB) species, several of which produce biotoxins that have the potential to cause negative impacts on the health of wildlife, humans, ecosystems, and/or economies. Three marine HABs (*Pyrodinium bahamense, Pseudo-nitzschia* spp., and *Karenia brevis*) produce neurotoxins that cause recurring issues on Florida's west coast. Other species also form ecosystem disruptive blooms but may not be associated with toxicity, such as the brown tide alga *Aureoumbra lagunensis* in the Indian River Lagoon, and the marine cyanobacterium *Synechococcus* in Florida Bay. These diverse and often overlapping bloom events necessitate a broad, adaptive, and highly integrated observation network. In a single year, thousands of seawater samples collected statewide are processed by state scientists using light microscopy. New genetic and microscopic tools that allow high throughput, sensitive, and/or in situ detection of cells are currently being validated and implemented as part of state monitoring efforts to help increase both spatial coverage and frequency of data that can inform predictive models of bloom dynamics. These new datastreams coupled with targeted physiological studies have the potential to provide novel insights into the diverse and complex factors hypothesized to impact bloom dynamics – from initiation to termination – for each type of HAB and across the distinct marine ecosystems in Florida where HABs commonly occur.

PRESENTER BIO: Dr. Hubbard leads FWC-FWRI's harmful algal bloom (HAB) program, serves on the US National HAB Committee, and has been working on HABs for more than 15 years. Her research unites molecular ecology and oceanography – using laboratory, field, and modeling studies – to better predict bloom dynamics and toxicity.

RESPONSE OF NON-TARGET ANIMALS TO A LARGE REPTILE LIVE TRAP AND TRAILING BEHAVIOR OF INVASIVE REPTILES

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The Burmese python is the highest profile reptile of the many invasive reptiles in Florida. Due to its large adult size that may exceed 5 m and the range of food items at risk to be eaten, the ecological impacts from this large invasive predator are yet to be fully understood. Burmese pythons in south Florida are already known to consume a wide variety of native wildlife, including endangered species. Live trapping is among the set of tools managers generally employ in integrated plans to remove unwanted wildlife populations. An often vexing limitation to wide deployment of live traps is the need for frequent (at least daily) trap checks to avoid impacting non-target animals. Frequent trap checks is particularly problematic in the Florida Everglades habitat, which is vast and difficult to access. Substantially reducing or eliminating the risk of non-target captures implies that large scale trap deployments would be possible at greatly reduced costs. The patented Large Reptile Trap (LRT) takes advantage of the Burmese python's long length and heavier weight and incorporates two spring loaded trip pans that need to be simultaneously depressed to trigger the trap; otherwise the trap remains open.

In collaboration with Loxahatchee National Wildlife Refuge staff/volunteers, we placed paired LRTs at 5 locations around the headquarters. Our objective was to determine the number of non-target species that encounter the trap and the number of these animals that were captured. At each of the sites, two traps were placed 20m apart, one un-baited, and one baited with a mixture of pierced sardine can, fish based dry cat food, and bird seed to attract the greatest variety of species. Reconyx® trail cameras were used to record activity at each trap. Two trapping bouts were run for three months each beginning in July 2017 (summer), and January 2018 (winter). Traps were checked and baited daily, and were closed during the weekend. Of 1,120 trap days (510 for summer, 610 for winter), 990 animals were photographed in, on, and under the LRT. Of those 990 animals, only 2 opossum were captured and in the same trap which was determined to be due to the trap not operating properly. Of those species, raccoon, opossum, and armadillo were seen the most at the traps (n= 469, 47.4%; n= 130, 13.1%; and n= 84, 8.5 % respectively). Also photographed were rats, mice, rabbit, squirrel, deer, bobcat, and birds. Our findings suggest the LRT is effective at nearly eliminating non-target captures.

Because most reptiles identify and follow potential mates in the natural environment by relying on sex-specific chemical signals (e.g., pheromones), these chemical signals have the potential to be utilized as a management tool (e.g., a trapping lure). Determining the extent to which Burmese pythons rely on these chemical signals in the Everglades can provide crucial information that can inform which management tools may work best during different seasons. We are currently assessing the mate trailing behavior of this species within and outside the breeding season by conducting controlled experiments in a Y-maze framework. Preliminary findings for pythons suggest male pythons consistently trail females, but do not trail male pythons. We are in the process of conducting additional behavioral trails to determine if an effective pheromone-based approach to invasive reptile management is possible.

PRESENTER BIO: John Humphrey is a Wildlife Biologist with the USDA National Wildlife Research Center's Field Station in Gainesville, FL with 26 years of experience researching wildlife damage/nuisance issues around the U.S., covering a broad area from birds, to invasive species including tegu lizards, Sacred ibis, and developing the patented Large Reptile Trap.

FRESHWATER INFLOWS TO THE BISCAYNE BAY COASTAL WETLANDS PROJECT AREA: ARE ALL FLOWS EQUAL?

Melody Hunt
South Florida Natural Resources Center, National Park Service, Homestead, FL, USA

The Biscayne Bay Coastal Wetlands Project (BBCW) is intended to improve the quantity, quality, timing and distribution of freshwater inflow to Biscayne Bay. The primary project benefits include improving habitat conditions for tidal wetlands and nearshore bay habitat by improving salinity conditions along the western areas of Biscayne Bay. This is important both for the protection of fish and wildlife and the natural resources as well as to achieve restoration of natural areas. One of the long-standing goals of the restoration program has been the addition of sufficient clean fresh water to maintain a minimum of 10,000 acres of mesohaline habitat within Biscayne National Park.

While hydrologic information can be readily evaluated on an annual basis, more effort is needed to assess the seasonal and inter-annual variability and integrate this information with hydrologic restoration targets. The spatial distribution of both inflow and rainfall also plays a key role in meeting hydrologic targets. In addition to the influences of regional water management, the project area is also subject to flow associated with local rainfall, which can vary significantly from regional patterns and add additional complexity when attempting to understand the influence of project features. An evaluation will be presented showing seasonal and inter-annual variability of past and present inflows in the context of rainfall and distribution of inflow.

PRESENTER BIO: Dr. Hunt is a hydrologist at the South Florida Natural Resource Center, which serves the National Parks in South Florida. She provides technical analyses in support of ecosystem restoration alternatives. Her work has focused on the effect of water management activities on South Florida ecosystems and restoration projects for more than 15 years.

POPULATION GENETICS AND ENVIRONMENTAL DNA TO INFORM MANAGEMENT DECISIONS

Margaret E. Hunter
U.S. Geological Survey, Wetland and Aquatic Research Center, Gainesville, FL, USA

Genetic monitoring using environmental DNA (eDNA) and phylogenetic analyses can be used to create a more comprehensive understanding of non-native species and to inform management decisions. Environmental DNA detection is a rapidly expanding technique used to non-invasively detect cryptic, low density, or logistically difficult-to-study invasive or imperiled species. Genetic material is shed into the environment through sloughed tissue and body fluids or by carcass decomposition. The eDNA is then concentrated from water, soil and air samples and analyzed for the identification of species or communities. Detection of invasive species can be used to delimit occupied habitat and geographic range limits, calculate detection and occurrence estimates, and identify invasion pathways. For example, we developed an eDNA occupancy model algorithm and found an increase in detection estimates for Burmese pythons as high as 80-90% using eDNA compared to <1% using visual surveys and trapping. High occurrence estimates were also found for Burmese pythons in Loxahatchee National Wildlife Refuge, which indicates the established population is further to the north than previously thought. Ground-truthing positive eDNA detections through traditional methods is recommended to verify that detections did not come from non-target sources such as transportation by boats or predators. This is not always easy, as some species, such as bullseye snakehead, are difficult to capture using traditional techniques. Environmental DNA methods can also be used following species removal procedures to determine whether the eradication process was successful, such as testing for African pythons following removal efforts in Bird Drive Basin in south Florida.

Population genetics tools such as taxonomic, phylogeographic and genetic diversity analyses are also useful to inform management and conservation decisions. Many invasive animals are released from the pet trade or through transportation mechanisms (e.g., shipping containers, ballast water) and often originate from unknown or hybridized sources. Genetic methods can be used to taxonomically identify species, subspecies, or hybrids of non-native populations, identifying invasion pathways that can be focused on for management actions. Identifying the point of origin for non-native species can shed light on required habitat and climactic conditions and characterize the geographic extent of the species' potential spread. Our work identified hybrids between Indian and Burmese pythons, potentially expanding the climatic range of the invasive populations. Further, delimiting population structure across the landscape can inform source and sink populations so that source populations can be targeted for eradication. It can also indicate how many different locations or sources contributed to the invasion, thereby informing management initiatives to reduce future introductions. In addition, we have identified the potential for multiple invasions in lionfish and black carp. Multiple introductions can contribute more and/or novel diversity, which in turn can increase the diversity, adaptability, and invasion potential of a non-native species, and management efforts are needed to limit these subsequent releases.

PRESENTER BIO: Dr. Margaret Hunter is a Research Geneticist with USGS. Her laboratory uses genetic and genomic tools to inform management of invasive and imperiled species. She specializes in the development and assessment of environmental DNA (eDNA) markers and methodologies.

CONSUMER-SPECIFIC ENERGETIC LANDSCAPES IN FLORIDA BAY: LINKING SEAGRASS DIE OFF TO ECONOMICALLY-VALUABLE FISHERIES

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Habitats are spatially heterogeneous and vary in resource quantity and quality. Resource use varies between consumers within a food web, and areas of high resource quality are not the same for each consumer. Consumers integrate resources over space to fulfill energetic demands. Disturbance influences the patchiness of resources, which may affect how consumers use habitats and forage. We constructed consumer-specific energetic landscapes by combining consumer source contributions derived from stable isotopes and SAV cover within Florida Bay. Maps were made of varying spatial resolution depending on the home range of the consumer and represent areas within the bay ecosystem with high resource quality for that consumer. These maps have the potential to explain the effect of the seagrass loss on the movement and spatial distribution of economically-valuable fisheries species due to changes of prey quality and quantity within Florida Bay.

PRESENTER BIO: W. Ryan James is a Doctoral Fellow in the Ecosystems Ecology Lab at the University of Louisiana Lafayette. His research focusses on energy flow in coastal ecosystems and how restoration affects ecosystem functioning with a focus on food webs.

THE EVERGLADES INVASIVE REPTILE AND AMPHIBIAN MONITORING PROGRAM AS A TOOL FOR REDUCING VULNERABILITY OF THE ARTHUR R. MARSHALL LOXAHATCHEE NATIONAL WILDLIFE REFUGE TO INVASION BY NONNATIVE REPTILES

Edward F. Metzger III, Michael R. Rochford, and Frank J. Mazzotti **Presented by: Nicole Jennings**
University of Florida IFAS Fort Lauderdale Research & Education Center, Davie, FL, USA

The number of nonnative reptiles and amphibians introduced in the state of Florida has increased exponentially since the 1800s. Today, Florida has more established species of nonnative herpetofauna than anywhere else in the world. Particularly destructive species such as the Burmese python (*Python bivittatus*) and the Argentine black and white tegu (*Salvator merianae*) are highly fecund diet generalists which compete with and prey upon native species and threaten the success of Everglades restoration.

In 2009 the Everglades Cooperative Invasive Species Management Area prepared a plan for early detection and rapid response to the presence of invasive species in Everglades ecosystems. One key gap identified was the lack of surveillance related to the spread of exotic animals. To address this need, we developed a program for regional surveillance of native and nonnative reptiles, amphibians, and mammals with a focus on early detection and rapid response (EDRR) to new introductions.

The Everglades Invasive Reptile and Amphibian Monitoring Program (EIRAMP) is a landscape-wide network of standardized road-cruising surveys, visual encounter surveys, and anuran vocalization surveys in and around natural areas on state and federal lands. We also conduct targeted outreach with the goal of encouraging the public to report invasive species sightings.

The Arthur R. Marshall Loxahatchee National Wildlife Refuge (ARMLNWR) is of particular importance for invasive species management because it is on the northern frontier of the Burmese python invasion and may still have intact populations of native mammals. We will present survey results on medium mammal declines and summarize Burmese python sightings around ARMLNWR during the same time period. A recent EDRR success was the discovery and possible eradication of a population of veiled chameleons (*Chamaeleo calyptratus*) directly adjacent to ARMLNWR.

Presenter Bio: Jennifer is a Wildlife Technician at the University of Florida - Fort Lauderdale Research and Education Center. Her areas of interest include Conservation and ecology of herpetofauna, invasive species research and management, endangered species research and conservation. She has a B.S. in Wildlife Ecology and Conservation from UF, and is currently involved with the Everglades Invasive Reptile and Amphibian Management Program (EIRAMP), where she conducts herpetofaunal surveys throughout southern Florida. She is also an active participant in the long-term population monitoring and assessment of American alligators and American crocodiles as indicators for Everglades restoration.

SUBMERGED AQUATIC VEGETATION BUILDS PHOSPHORUS-STABLE SOIL IN STORMWATER TREATMENT WETLANDS

Forrest E. Dierberg[1], ***Mike Jerauld***[1], *Kevin Grace*[1], *Thomas DeBusk*[1], *Nichole Larson*[1], *Nancy Chan*[1] *and Delia Ivanoff*[2]

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The Everglades Stormwater Treatment Areas (STAs) are globally unique not only in their ultra-low outflow total phosphorus (TP) targets, but also in their use of submerged aquatic vegetation (SAV) for enhancing low-level P removal. SAV can provide exceptionally effective P removal by inducing co-precipitation of inorganic P with calcium (Ca) carbonate, in addition to the more typical wetland P removal mechanisms like plant P uptake, and subsequent burial of organic matter. As a result, SAV builds highly calcareous soil (15-25% Ca by weight), with much of the soil P associated with Ca minerals. The P removed by treatment wetlands accrues in the soil and in certain instances, accumulating soils can become a source of P to the surface water, impairing P removal performance. Because of the novelty of the application of SAV for large-scale P removal, relatively little is known of the stability of SAV soil P and its role in the overall sustainability and longevity of effective P treatment by the STAs.

We measured several indicators of P stability on accrued soils from an STA SAV flow-way (STA-2 FW 3) along a fixed grid in 2005, 2010 and 2016, approximately 6, 10 and 17 years after the FW was initially flooded in 1999. All measured analytes, including HCl- and $NaHCO_3$-extractable soil P, porewater P concentrations, and potential soil P release rates in laboratory anoxic incubations, had established a decreasing longitudinal gradient from inflow to outflow by the 2005 measurement event. Importantly, measurements in 2010 and 2016 showed that the shape of and magnitudes along this profile remained largely invariant for all indices of P stability over the intervening 11 years of operation, despite the accumulation of an additional 9.8 g P/m^2 in the soil during that time. There was no indication that soil P concentrations, porewater P concentrations or diffusion rates, or potential P release rates from the accruing soil had increased in any region of the wetland. As is well known for emergent-vegetation-based treatment wetlands, our data indicate that this SAV wetland sequestered P by building new soil, not by enrichment (increasing concentration) of the soil, and the calcareous nature of SAV soils is not a detriment to soil P stability.

<u>PRESENTER BIO</u>: Mr. Jerauld is an associate scientist and has studied the biogeochemistry of treatment wetlands, including the Everglades STAs, for 10 years. He has developed guidance for many municipalities and state agencies to enhance the performance of treatment wetlands for water quality improvement.

APPLICATIONS OF LOEM-CW MODEL TO STAS

Kang-Ren Jin *and Matahel Ansar*
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The LOEM-CW (Lake Okeechobee Environment Model- Constructed Wetland) is developed to simulate STAs and Water Conservation Area (WCAs). The LOEM-CW has successfully been applied to the flow and nutrient transport simulations in STA-3/4 Cells 3A/3B (Jin and Ji 2005, Ji and Jin 2016). The enhancements include (i) adjusting the bottom friction coefficient over the vegetation area to meet the EAV mechanism; (ii) integrating the profile drag and skin friction into the motion equation; (iii) applying a comprehensive formulation of turbulent flow over the vegetation canopy; and (iv) reducing turbulent eddies and creating turbulent wake energy in the EAV formulation.

The above approach is intended to improve the vegetation stress formulation in the current wetland model. Also, it will be implemented in LOEM-CW to calculate the vegetation stress vertical impact in the water column and assess its influence on the accuracy of predicting mean flow. This enhanced formulation will also provide accurate surface elevation and retention time calculations during the wet/dry transition period.

This study accomplishes hydrodynamic calibration and verification simulations for STA2 with the two-layer flow approach. The LOEM-CW simulates water volume and stage in response to changes due to STA water control operations. STA inflows and outflows are adjusted in response to EAA runoff and to meet target depths in individual cells.

PRESENTER BIO: Dr. Jin is a Lead Scientist with more than 25 years of experience in hydrodynamics and environmental modeling. He is a charter member of the Engineering Mechanics Institute, ASCE and a Graduate Faculty Scholar at University of Central Florida. He has authored/co-authored 96 technical publications/manuscripts.

HYPERSALINITY AS A TRIGGER OF SEAGRASS (THALASSIA TESTUDINUM) DIE-OFF EVENTS IN FLORIDA BAY: EVIDENCE BASED ON LEAF AND MERISTEM O_2 AND H_2S DYNAMICS

***Christopher R. Johnson*[1]**, *Marguerite Koch*[1], *Ole Pedersen*[2] *and Christopher Madden*[3]
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The mechanisms initiating rapid, large-scale (> 50 km^2) seagrass die-off events globally remain elusive. *Thalassia testudinum*, a dominant habitat-forming tropical seagrass of the Caribbean and tropical Atlantic region, experiences recurrent die-off events in Florida Bay. Thus, *T. testudinum* provides an excellent case study to identify triggers of large-scale seagrass mortality. Presently, seagrass die-off events in Florida Bay are correlated to high total sulfide (H_2S, HS^-, S^{2-}) concentrations in the sediment porewater (≥2000 µM), water column hypoxia, high temperature and hypersalinity (salinity > 45). Because the mortality appears to be initiated at the shoot base within the meristem, we examined the response of shoot meristematic O_2 and H_2S dynamics using microsensors over a 5-hour nighttime simulation. Shoots were held at salinity 35 (ambient) or 65 (hypersaline) using microsensors in intact cores with plants from the field. The rate of H_2S intrusion in the dark and oxidation in the light were similar at 35 and 65 salinity. However, the tissue O_2 consumption rate was significantly higher under hypersaline conditions (−11.07 ± 4.32 kPa pO_2 h−1) compared to ambient (−3.93 ± 0.88 kPa pO_2 h−1) in the dark. Consequently, the meristematic pO_2 threshold (~1.5 kPa O_2) where H_2S intrusion occurred in the meristem was reached more rapidly, increasing the time H_2S accumulated (1.5 to 2.8 h). Longer H_2S accumulation time significantly increased maximum meristem H_2S levels at 65 (536 ± 330 µM H_2S) compared to 35 salinity (121 ± 62 µM H_2S). These results in *T. testudinum* provide evidence for a triggering mechanism that links an enhanced respiratory rate under hypersaline conditions to sulfide toxicity. We propose that hypersalinity in Florida Bay, or any stressor that significantly increases nighttime respiration rates, can subject seagrasses to longer and higher concentrations of sulfide, a known phytotoxin, within the shoot meristem. This mechanism likely explains large-scale mass mortality of *T. testudinum* in Florida Bay during periods of high salinity and elevated porewater sulfide levels, although field experiments are required to further validate this supposition

FROM DETECTION TO ACTION: A DECISION-ANALYTIC APPROACH TO CONTROLLING INVASIVE SPECIES

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Within the constraints of their budgets, responsible agencies must routinely make tradeoffs in controlling the spread of invasive species; e.g., monitoring abundance in well-established areas vs. monitoring potential sites for colonization, eradicating large infestations vs. eradicating newly colonized sites, and monitoring populations vs. implementing control measures. There are also temporal tradeoffs because decisions made now produce a legacy for the future. These tradeoffs can be investigated within the context of a sequential decision-making framework, which involves the specification of (1) unambiguous management objectives and constraints; (2) a set of available options for monitoring and control activities; (3) one or more models predicting the response of the invasive to control activities and uncontrolled environmental factors; and (4) a monitoring program to direct state-dependent actions and to assess management performance.

For example, suppose we have a landscape comprised of patches with known infestations and those that have the potential for infestation but where none has been observed. Assume that the manager can conduct reconnaissance surveys at periodic intervals to identify infested patches. Assume also that the manager has some idea of the probability of detecting an infested patch given it is infested (or falsely identifying infestations when none exists). Following each survey, the manager can choose to (a) do nothing until time for the next reconnaissance, (b) attempt control of the infested patches that were detected, or (3) re-survey apparently empty patches and control whatever infestations are found ("search & destroy"). The goal of the manager is to choose an action after each reconnaissance survey that is expected to minimize the number of infested patches over time, given a budget constraint.

To solve the decision problem, we require the probability of observing n_{t+1} infested patches at time $t+1$, conditioned on n_t observed infestations, the assumed detection probabilityd_t, and the action taken a_t at time t:

$$p(n_{t+1}|n_t, d_t, a_t) = \sum_{n_{t+1}} \sum_{n_t} f(N\psi_t|n_t, d_t) p\left(N\psi_{t+1}\middle|N\psi_t, a_{t,} z_t\right) \acute{f}(n_{t+1}|N\psi_{t+1}, d_{t+1})$$

where N is the total number of landscape patches and ψ is the conditional probability that a patch is infested. The transition of the landscape from time t to $t+1$ depends on the true state of the patches and the action taken at time t. And the expected number of observed infestations at time $t+1$ depends on the true state of the landscape and the detection probability of the survey at time $t+1$. We can thus describe decision making as a partially observable Markov decision process (POMDP), which can be solved using stochastic dynamic programming for an exact solution or heuristics for an approximate solution. Solving the POMDP for a range of budget constraints will allow the decision maker to rely on the concept of Pareto efficiency to evaluate tradeoffs between management cost and effectiveness.

<u>PRESENTER BIO</u>: Dr. Johnson is a Research Wildlife Biologist with 30 years over experience in application of decision analysis to problems in conservation. Dr. Johnson is particularly active in migratory bird management and his scientific expertise is mostly in the areas of population ecology, statistical inference, dynamic systems modeling, and optimal decision making.

IDENTIFYING THE SOURCE OF HYBRIDIZATION IN THE FLORIDA PYTHON POPULATION TO AID INVASIVE SPECIES MANAGEMENT AND EVERGLADES RESTORATION EFFORTS

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Since the discovery of Florida's invasive pythons in the 1980s, the population has been assumed to be comprised of a single species, the Burmese python (*Python bivittatus*). Recent molecular research revealed strong evidence of hybridization between two python species, the Burmese and Indian python (*Python molurus*), within the Florida population. Initial evaluation of mtDNA in the invasive population only detected *P. bivittatus* haplotypes. Larger samples sizes (n=426) uncovered *P. molurus* mtDNA haplotypes in the invasive population. Subsequent work focused on nDNA markers (microsatellites) to assess population structuring and geographic differentiation showed minimal differentiation relating to hybrid individuals. These findings indicate nuclear introgression of separate mtDNA lineages, a phenomenon known as cytonuclear discordance, and suggest greater standing variation for adaptation and higher potential for invasion into a range of habitat conditions. The introgressive hybridization likely occurred prior to the invasion, but genetic information from the native range and commercial trade is needed for clarification.

Determining the source of hybridization in Florida's python population will provide managers with tools to: 1) identify whether new sightings in the invasive range represent new releases or range expansions of existing populations; 2) detect and differentiate between hybrids and pure *P. bivittatus* or *P. molurus* using refined eDNA markers; 3) predict the response of invasive pythons to selective pressures in novel environments; 4) provide reliable predictions using ecological niche modeling to better characterize the potential range expansion of invasive pythons in the U.S.; and 5) help resolve longstanding taxonomic confusion in the *Python molurus* species complex needed to develop effective conservation and recovery strategies in the species' native range. We will discuss our vision for this project, including our goals to identify, develop, and propose effective management strategies for invasive pythons that include innovative research and stakeholder engagement.

PRESENTER BIO: Dr. Johnson is a research biologist with 20+ years of experience conducting applied conservation research with a focus on molecular systematics, ecology, life history, and physiology. His most recent publication is titled, "Integrative taxonomy resolves taxonomic uncertainty for freshwater mussels being considered for protection under the US Endangered Species Act."

NATIONAL ACADEMIES' 2018 REVIEW OF RESTORATION PROGRESS

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The National Academies of Sciences, Engineering, and Medicine established the Committee on Independent Scientific Review of Everglades Restoration Progress in 2004 in response to a request from the U.S. Army Corps of Engineers with support from the South Florida Water Management District and the U.S. Department of the Interior, based on Congress's mandate in the Water Resources Development Act of 2000. The committee is charged to submit biennial reports that review the Comprehensive Everglades Restoration Plan's (CERP's) progress in restoring the natural ecosystem. In October 2018, the committee released its seventh biennial review, which includes an update on natural system restoration progress and describes substantive recent accomplishments.

During the past 2 years, there have been impressive efforts toward project planning associated with four new projects. A vision for planned CERP storage, at least in the northern portion of the system, is now becoming clear, although the future storage to be provided by Lake Okeechobee remains unresolved. Recent analysis has shown that coordination of operations can make more effective use of available water, potentially reducing the amount of CERP storage needed to achieve successful restoration. However, the systemwide implications of the new projects, which have been in planning concurrently, have not been assessed. Construction continues on five CERP projects (Figure S-1), and state funding for CERP project construction has increased, while two major non-CERP projects have been completed.

The committee reviewed available data and analysis on natural system restoration progress associated with three early CERP projects in which substantial project components are now in place and operating: Picayune Strand Restoration Project, C-111 Spreader Canal (Western Project), and Biscayne Bay Coastal Wetlands. Incremental restoration progress from these early CERP projects is difficult to evaluate because of a lack of rigorous assessment of outcomes relative to project goals and some limitations in existing monitoring plans.

<u>PRESENTER BIO</u>: Dr. Johnson is a senior program officer and has served as study director for the Committee on Independent Scientific Review of Everglades Restoration Progress since 2004. At the National Academies, she has worked on a range of water-related issues, including desalination, water reuse, coal combustion waste disposal, and uranium mining.

STORM AND SEA-LEVEL RISE IMPACTS ON CARBONATE ISLANDS IN FLORIDA BAY

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Carbonate mud islands in Florida Bay are vulnerable to the combined impacts of increasing rates of sea-level rise and storm surges. These islands provide habitat, including vital nesting grounds, to several species, and attenuate storm surge to the mainland. The islands, whose centers lie below sea level and are protected only by the outer mangrove-ringed berm, which itself only lies 1-2 m above sea level, are at increasing risk of destruction. A near-direct hit from category-4 Hurricane Irma in September 2017 provided the opportunity to study the impacts of an intense hurricane to islands in Florida Bay, while radiometric dating of short (50 cm) cores from island berms helps determine how recent (<100 years) accretion rates compare to rates of relative sea-level rise. In January 2018, we sampled storm overwash deposits, measured elevation, collected 50-cm long sediment cores from four island interiors and berms, and ground-truthed observations from pre- and post-Irma aerial imagery. Cores and overwash deposits were processed for Pb-210, loss-on-ignition (LOI), stable carbon and nitrogen stable isotopes, and grain size, and overwash deposits, in conjunction with the aforementioned parameters, were measured for thickness as a basis to characterize storm-related sediments as well as storm-related island accretion. Field observations showed a denudation of mangrove trees on the islands, and the western-most island (Jim Foot) lost most of the mangroves from the narrow berm on the east side of the island. Berm erosion was visible on Bob Allen and Jim Foot Keys, and the berms at Jim Foot and Russell Keys are breached, allowing for tidal exchange in the island interiors. Overwash deposits on island interiors ranged from ~0.5 to ~6.5 cm in thickness, where thicknesses were measured. Satellite imagery shows a decrease in vegetated area on all four islands, with the most significant impact being on the western-most island (Jim Foot, 9.3%) and the least on the eastern-most island (Russell, 1.9%). The eastern berm of Jim Foot lost 32-42% of its width. Elevation decreased from the eastern Russell Key berm from 2014 to 2018 by -0.389 ± 0.0014 m, likely due to erosion. Preliminary results from Pb-210 data show the average berm accretion rate from Bob Allen Key for the last ~60 years (1.7 ± 0.3 mm/yr) falls below the mean rate of relative sea-level rise (2.4 ± 1.5 mm/yr, Key West, 105 years; 3.69 ±0.46 mm/yr, Vaca Key, 47 years), while the berm accretion rate at Russell Key (4.6 ± 1.8 mm/yr) falls within the range of sea-level rise over the same time period. Based on these preliminary results, berm erosion from storms, coupled with the elevated rate of sea-level rise of the last 50-100 years, suggests that substantial island loss is likely in the coming decades to centuries. These results suggest that while storms can deposit sediment to portions of these islands, the loss of mangroves from the island interiors and erosion from island berms deleteriously impact the extent of these islands in the future.

PRESENTER BIO: Miriam Jones is a Research Geologist and has studied the role of wetlands in the global carbon cycle and wetland response to perturbations, such as sea-level rise and permafrost thaw from the Arctic to the subtropics, on geologic timescales.

LAKE OKEECHOBEE KEY FINDINGS BASED ON MONITORING AND ANALYSIS DURING WATER YEARS 2013-2017

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Lake Okeechobee key findings during water years (WYs) 2013-2017 are based on hydrology, water quality, emergent and submerged aquatic vegetation, two sportfish and two wading bird indicators. Hydrologic performance was assessed by comparing average monthly lake stages with the seasonally-variable ecological stage envelope. Stages were within the envelope 45% of the time, though exceedances above the envelope were much more common than exceedances below, at 40% vs 15% of the time, respectively. Water quality was assessed as a function of clarity, nutrients, and phytoplankton communities. Water clarity target of complete water column light penetration at all nearshore sites during summer months was met only 32% of the time. Average total phosphorus load to the lake, as well as nearshore and pelagic zone water column concentrations were all well above targets of 140 mt (metric tons) and 40 µg/L, respectively, at 531 mt, 89 µg/L and 129 µg/L, respectively. The average total nitrogen to total phosphorus ratio of 10.6:1 was well below the target of >22:1, while the dissolved inorganic nitrogen to soluble reactive phosphorus ratio was 4.7:1, also well below the target of >10:1. The average frequency of algal blooms (*chlorophyll a* >40 µg/L) at pelagic zone monitoring stations was 9.1%, well above the target of <5%. The average pelagic zone diatom to cyanobacteria ratio was 2.1:1, better than the target of >1.5:1, while the nearshore zone was slightly below the target at 1.4:1. The nearshore zone ratio was below the target for three years, resulting from periodic widespread cyanobacterial blooms on the lake during those summers. Emergent aquatic vegetation, measured in WYs 2016-2017 with aerial imagery, showed coverage of most desirable native vegetation (bulrush, sawgrass, rushes) were below targets, while several other groups that are desirable at minimal coverages (cattail, willow, floating leaf), exceeded their targets. Submerged aquatic vegetation in the nearshore was below the target of 50,000 ac in every WY, though the interim target of 35,000 ac was met in WY2013. Large declines in coverage occurred between WYs 2013-2014 and 2016-2017, coincident with higher lake stages. Indicator sportfish species (largemouth bass and black crappie) showed declines in catch rates of juvenile fish towards the end of the period, while adult catch rates remained at moderate levels. Declines were attributed to reductions in nearshore vegetation habitat and prey availability due to increases in turbidity and high lake stages. Three wading bird indicator species had variable nesting trends, with two showing declines in nesting activity while the third species increased, especially in the first four, wettest breeding seasons. Decreases in nesting activity were attributed to slow or too small stage recessions or reversals that failed to concentrate prey and increases were attributed to higher lake stages and not needing a prey concentrate.

<u>PRESENTER BIO</u>: Paul R. Jones Ph.D. is a marine and environmental scientist with 15 years of experience planning, designing and implementing research and monitoring projects in South Florida. After working at the University of Miami for over a decade, he recently joined the Lake Okeechobee research group at SFWMD.

ON THE USE OF MOVEMENT ECOLOGY FOR CONSERVATION

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The movement of organisms is a key component of ecosystem dynamics, and is thus critical in developing effective conservation measures. Movement affects population dynamics, biodiversity, and consequently, the structure of ecosystems. With the recent development of sophisticated tracking technology, software and analyses, research in movement ecology has significantly increased in the last decade, generating abundant knowledge to be used for conservation purposes. However, there are still challenges in the use of movement ecology for conservation, notably to incorporate this body of knowledge into conservation and management planning, and translate it into regulatory policies. This work provides a synthetic and quantitative review of the scientific literature in movement ecology for conservation, management, and restoration purposes, since the seminal work of Nathan *et al.* in 2008, which formally introduced the movement ecology framework. We searched the Web of Science to select publications in the field of movement ecology related to conservation by applying a hierarchy of keyword-based filters. The resulting database consisted of 1060 peer-reviewed papers. We then used a text mining approach to extract publication content, and assessed the number of papers which have attempted to investigate core components of the movement ecology framework—that is, motion, navigation, internal state and external factors—as well as the biologging devices used, the focal taxon, the analytical methods applied and the software used. Motion and navigation, which are key to understanding movement processes, were studied in few of the publications (12% and 4%, respectively), while the external and internal factors conditioning movement were studied in 79% and 25% of the cases. Habitat (77% of the papers), anthropogenic activity (13%) and predation (10%), were the main studied factors. Mammals (36%) were studied twice as much as fish (20%) and birds (19%), and four times more than insects (9%) and reptiles (7%). GPS was the most used device (49%) for those studies. Based on these findings, we provide an integrative overview of what has been achieved, current directions of the field, and the topics, species or methods that are being neglected.

<u>PRESENTER BIO</u>: Dr. Joo works as a postdoc at the University of Florida in movement ecology. Her research is focused on the quantitative analysis of the spatial behavior of organisms. Her current research is part of the Seabird Sound project, investigating the use of infrasound on seabird navigation.

USE OF SOIL INVERSION TO CONTROL PHOSPHORUS FLUX IN THE EVERGLADES STORMWATER TREATMENT AREAS

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The Everglades Stormwater Treatment Areas (STAs) have been constructed south of the Everglades Agricultural Area (EAA) and are being operated to reduce total phosphorus (TP) concentrations in surface water runoff from Lake Okeechobee and EAA before discharging into the Everglades Protection Area. Stormwater Treatment Area 1 West (STA-1W), the oldest of the five Everglades STAs, has currently ≈6544 acres of an effective treatment area and is currently undergoing expansion, with an additional ≈4600 acres. While STA-1W has been very effective in reducing the load and concentrations of phosphorus (P) in runoff water, i.e., retaining 677 metric tons of TP and achieving flow weighed outflow concentration of 46 µg/L for its period of record, the expansion is a critical part of the Restoration Strategies to further improve STA performance to meet stringent water quality-based effluent limits. STA-1W Expansion 1 area is located west of STA-1W and is composed of three new cells: 6, 7, and 8, which are anticipated to provide additional treatment capacity. Historically cultivated organic soils, such as those found in STA-1W and the expansion areas, have the potential to release high amounts of P to the water column once flooded, which may affect the performance of the STA. The impacts of P flux could be greater in the expansion areas, due to the already low P (≤30 µg/L) water that will enter the expansion areas from existing STA-1W flow-ways. In this study, we examined the potential benefits of soil inversion to reduce internal loading of P by burying P-enriched soil and bringing up P deficient and calcium (Ca)-enriched soil into the surface. Soil inversion was done using specially designed plows tilling up to 36 inches deep. A pilot soil inversion study conducted in a parcel of Cell 7 brought underlying peat and marl layers to the surface, which has significantly lower ($p < 0.05$) TP concentrations than the farmed muck soil. After 42 days of soil core incubation, post inversion, with low P water from the STA, the soil cores with marl as a dominant surface layer released the least amount of soluble reactive P (SRP), whereas untilled soil cores obtained from adjoining Cell 6 continued to release higher rates of SRP. A soil profile survey of the untilled area of Cell 6 revealed the presence of peat and marl layers with an average thickness of 23 and 19 cm, respectively. The marl layer had the least amount of TP (median = 147 mg/kg) and higher amounts of calcium (median = 194,164 mg/kg) than the surface muck soil (median TP = 819 mg/kg and Ca = 48,875 mg/kg). Overall, the findings suggested that soil inversion is beneficial to reduce P flux to the water column. Long-term evaluation of the benefits of soil inversion will also be investigated.

PRESENTER BIO: Dr. Josan is a senior environmental scientist and currently developing ecological monitoring plans for research studies, tracking performance of storm water treatment areas (STA), and making operational recommendations to optimize STA performance.

CHARACTERIZATION OF BURMESE PYTHON HATCHLING GROWTH IN CAPTIVITY

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The Burmese python (*Python bivittatus*) is an invasive apex predator in the Greater Everglades Ecosystem that has been implicated in the decline of several prey species. Little is known about the basic biology of these snakes, especially hatchlings and juveniles. Various factors may impact immediate and long-term fitness, so we sought to characterize how size (i.e., mass and length) and shape (i.e., mass/length) of young Burmese pythons might be affected by time since hatching, size and shape at hatching, clutch, sex, and the amount of food they consume during the first three months of their lives. We used 60 Burmese pythons collected from the clutches of two wild females, fed them varied amounts of food, and measured their mass and snout-to-vent length (SVL) weekly for 12 weeks. We found that hatchlings relied predominantly on residual yolk stores during the first few weeks of their lives, during which time they continued to grow in length. Prey mass has a strong impact on snake growth, but differences in hatch size, sex, and parentage may also have an effect. These results have implications for the population biology of these invasive snakes.

PRESENTER BIO: Ms. Josimovich is a biologist for the US Geological Survey Invasive Species Science Branch. She is stationed in Everglades National Park and is assisting with ongoing research on the control and containment of invasive herpetofauna in southern Florida.

HYDROLOGIC RESTORATION OF A SHALLOW OLIGOTROPHIC MARL WETLAND. WHAT IS THE SOIL TELLING US?

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Restoration of the Florida Everglades has been occurring for the better part of three decades. Alteration of ecosystem hydrology and anthropogenic pressures upstream have resulted in the degradation of water quality within the Everglades ecosystem which in turn compromises the systems ecology. High nutrient waters from agriculture and development coupled with variation in water management practices from 1960-2000 resulted in variable phosphorus (P) loading into Taylor Slough (TS) in Everglades National Park. This loading and hydrologic manipulation has contributed to the enrichment soils in this ultra-oligotrophic wetland allowing the proliferation of *Typha domingensis* (cattail). This study aims to assess P enrichment and cattail proliferation temporally after the onset of restoration efforts by evaluating soil biogeochemical properties and species composition within TS. A total of three soil sampling events were conducted in 2007, 2012 and 2018 to assess soil nutrient concentrations. Soil enrichment of P decreased in the main channel of TS with marl/mineral soil accretion contributing to a reduction in soil nutrient concentrations. A decline in soil P concentrations in the main channel lead to a plateau in cattail presence over a ~10-year period. However, analysis of vegetative communities displays species shifts between dominant communities and declining species richness. With soil P decreasing at a rate faster than previously thought, this study could indicate that restoration efforts are effectively decreasing soil P enrichment within a 10-year period.

HURRICANE IRMA EFFECTS ON HORIZONTAL WATER QUALITY GRADIENTS ALONG THE NORTHERN EVERGLADES NORTHERN ESTUARIES, FLORIDA

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Extreme disturbances can disrupt horizontal water quality gradients, important characteristics of estuarine systems. This study used a flow-through system to collect continuous, georeferenced water quality data along St. Lucie Estuary (SLE) and Caloosahatchee River Estuary (CRE) to provide a synaptic snapshot of conditions, with a focus on salinity and light attenuation components- turbidity, chromophoric dissolved organic matter (CDOM), and chlorophyll *a* signatures. Cruises were conducted before and after Hurricane Irma, to assess duration and spatial extent of estuarine gradient disturbance. Each estuary has a relatively large watershed to estuary ratio and is highly anthropogenically-modified, with a water management structure connection to Lake Okeechobee via a canal system. Hurricane Irma on September 10th, 2017 brought ~26 cm of rain to Ft. Myers on the CRE and over 40 cm to St. Lucie. Resultant high freshwater inflows disrupted the horizontal salinity gradient along both estuaries producing system-wide oligohaline conditions lasting >1 month post- hurricane and subsequent run-off also increased CDOM throughout each system. SLE exhibited a high turbidity signature from the St. Lucie South Fork, observed for two months post-hurricane as releases from the Lake transported waters high in resuspended sediment from the Lake and canal system. Due to the location of the estuary relative to the hurricane's landfall, high turbidity post-hurricane in CRE was likely a combination of storm-induced sediment resuspension within the estuary and offshore waters, and inflow through the structure connected to the Lake. Chlorophyll *a* generally establishes higher concentrations in the upper relative to lower reaches of the estuary, but post-hurricane this gradient was disrupted in each estuary with low, uniform chlorophyll throughout the system. While severely reduced light levels may have limited algal production, the driving factor was likely decreased estuarine residence time during periods of high inflows the weeks following the hurricane. Having routine cruises in place, we had pre-storm baseline data and could readily deploy post-storm. Attaining data for baseline conditions and tracking ecosystem conditions after disturbance events are key to understanding ecosystems stress thresholds and system resilience to help inform future management and restoration efforts.

PRESENTER BIO: Dr. Kahn has 18 years of research experience along coastal Florida. Previously faculty at University of North Florida and North Carolina Wilmington, she has been with SFWMD for two years and focuses on CERP RECOVER Northern Estuaries seagrass monitoring program, and macrophyte responses to changes in salinity and light environment.

FLORIDA BAY ALGAL BLOOMS: CURRENT STATUS AND PAST OBSERVATIONS

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Florida Bay water quality monitoring has shown significant deviations from long-term conditions in recent years. One metric of the status and health of Florida Bay is the concentration of phytoplankton in the water column, represented by a measure of the chlorophyll content of water samples. Higher levels of phytoplankton chlorophyll and resultant opaque green water have become more common in recent years, and may be related to regional scale events, such as the extensive seagrass die-off in summer 2015 and hurricane Irma in 2017. Chlorophyll-a pigment concentrations measured from water samples collected from locations across the bay have documented the concentration and distribution of phytoplankton. Monitoring of chlorophyll-a along with other parameters such as dissolved oxygen, turbidity, and nutrients have been conducted by discrete and continuous sampling. Bloom maps show high chlorophyll concentrations in the central northern basins and bights of Florida Bay, which have encompassed other areas intermittently.

PRESENTER BIO: Christopher Kavanagh is a marine ecologist with Everglades National Park. He has studied coastal estuarine and ocean processes for over 20 years. His interests are in marine biology at all scales. His focus for the last four years has been on the water quality and ecology of Florida Bay.

TRENDS IN JUVENILE SPORTFISH RECRUITMENT IN FLORIDA BAY

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Sportfish are an important economic and ecological component of coastal ecosystems downstream from the Everglades. Assessing and evaluating how Everglades Restoration has and will affect juvenile sportfish populations is essential to understanding how Restoration will affect costal ecology and economies that represent the vast majority of economic activity in the greater Everglades ecosystem. Recruitment of juvenile sportfish in Florida Bay has been systematically monitored since 2004. Juvenile recruits have survived the first and most severe bottleneck, but do not have as strong confounding factors, especially fishing mortality, associated with adult populations. This makes them better suited for understanding how fish populations respond to environmental conditions, such as freshwater runoff.

The long-time series of juvenile sportfish recruitment allows us to understand how both long-term impacts such as climate change with slow, gradual effects and short-term impacts such as tropical cyclones with short, intense effects affect recruits. Understanding both short-term intense variability and long-term gradual variability are necessary to be able to assess the impacts from Everglades Restoration and develop models that incorporate the likely environmental changes that will occur over the same time-scale as Everglades Restoration.

We will present short-term and long-term trends in juvenile sportfish recruitment to show how they respond to short- and long-term impacts. Tropical cyclones, specifically hurricanes, can provide benefits to juvenile sportfish recruitment both immediately and in the ensuing year. In the short-term, hurricanes provide a recruitment pulse likely due to reduced predation on larvae and eggs shortly after the hurricane passes. Moreover, hurricanes provide significant freshwater via increased precipitation and runoff to Florida Bay, which is starved for freshwater, providing improved estuarine salinities and increased recruitment in the ensuing year as well. We have developed relationships between temperature and salinity with sportfish recruitment that help explain long-term trends in recruitment. Moreover, we have used these relationships along with predicted changes in temperature and salinity due to climate change to examine how climate change is likely to impact juvenile sportfish recruitment and habitat quality. Lastly, we will present how we combine these results with the likely impacts of Everglades Restoration to better predict how Everglades Restoration will affect juvenile sportfish recruitment under various climate change and hurricane scenarios.

PRESENTER BIO: Dr. Kelble is a supervisory oceanographer with 20-years of experience conducting ecological research in Florida Bay. He has extensive experience in coastal ecology, water quality, and investigating how environmental factors affect living marine resource populations. He has participated in various national and international scientific committees on ecosystem indicators and management.

PROLIFERATION OF ENTEROCOCCI AND CYANOBACTERIA IN THE PRESENCE OF SPECIFIC NUTRIENTS AND RAINFALL IN THE ST. LUCIE, LOXAHATCHEE, AND LAKE OKEECHOBEE WATERSHEDS

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Florida's recreational beaches have experienced cyanobacteria blooms and enterococci exceedances for many years, especially the beaches that receive runoff from Lake Okeechobee. We hypothesized that the drivers of both the blooms and enterococci exceedances are related to excess nutrients. We evaluated sites on Lake Okeechobee, downstream of the lake in the St. Lucie River, and in the Loxahatchee River, a control site not subject to flow from the lake. We evaluated physical-chemical measures, nutrients, and weather conditions to understand the patterns of bloom and exceedance at each site. This was achieved through three study components: 1) historical analysis of the available local environmental data sets, 2) monthly sampling for chlorophyll (a measurement of cyanobacteria biomass), enterococci, physical-chemical data and nutrients, and 3) microcosm experiments that altered water conditions.

Results support the hypothesis that nutrients play a role in both chlorophyll and enterococci levels, but the specific nutrient components differ between sites. In the Loxahatchee River, phosphorus and nitrite-nitrate had weak correlations with enterococci ($\rho\sim 0.80$; $p=0.04$) and chlorophyll ($\rho\sim 0.69$; $p=0.05$); at St. Lucie, significant correlations were found between enterococci and TKN, orthophosphorus, phosphorus, and water temperature ($\rho\sim 0.97$; $p=.01$) and between chlorophyll and pheophytin, enterococci, and humidity ($\rho\sim 0.99$; $p=<.0001$). At Lake Okeechobee, enterococci significantly correlated with orthophosphorus and nitrite-nitrate ($\rho\sim 0.61$; $p=.01$); chlorophyll correlated significantly with sample depth, salinity, and pH ($\rho\sim 0.61$; $p=.01$). Average environmental (depth, pH, salinity, dissolved oxygen, turbidity) and nutrient (nitrogen and phosphorus) concentrations differed between watersheds, yet there are similarities in associations of enterococci and cyanobacteria with nutrients. These results suggest that inputs from Lake Okeechobee with nutrient-rich runoff may contribute to the elevated enterococci and cyanobacteria within the Lake and the St. Lucie River. Positive relationships of rainfall with nutrients and chlorophyll suggest that meteorological conditions can further modify the influence of nutrients on enterococci counts. The results of this study have implication for monitoring and surveillance of recreational beaches that have been subject to nutrient-rich runoff and changing meteorological conditions which may exacerbate the effects of nutrient load on beach water quality.

PRESENTER BIO: Elizabeth Kelly is a sixth-year doctoral student at the University of Miami's Abess Center for Ecosystem Science and Policy. Her goal is to evaluate water quality inland and at the beaches to explore the relationship between inland nutrient contributions, cyanobacteria, and FIBs in rivers, canals, estuaries/bays, and beaches.

EXAMINING THE EFFECTS OF SEA-LEVEL RISE ON EVERGLADES COASTAL MARSHES USING COUPLED MESOCOSM AND IN-SITU FIELD MANIPULATIONS: DESIGN AND IMPLEMENTATION

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Peat soils are of critical importance to South Florida and the Greater Everglades Ecosystem. Peat accretion is a large carbon (C) reservoir that is crucial to maintaining wetland elevation relative to rising sea level in the face of climate change. However, peat soils of the coastal Everglades appear vulnerable to salinity inundation that can reduce the productivity of freshwater marsh plant species reducing additional C inputs and increasing microbial respiration of the peat substrate on which remaining marshes persist. This can result in conversion of the soil-carbon sink to a carbon source, and with it a conversion of peat marsh to open water as a result of peat collapse. Reduced freshwater flow through the Everglades combined with sea level rise has resulted in an accelerated intrusion of saltwater into freshwater coastal wetlands.

To evaluate the potential for and mechanisms of peat collapse, integrated in-situ field and mesocosm manipulations have been ongoing since 2014 to examine the effects of elevated salinity and inundation on coastal fresh and brackish water marshes. Both manipulations involved measuring a suite of response variables under control (ambient) and elevated salinity levels. Additionally, our mesocosm manipulations included a simulated dry-down/drought manipulation. These results could then be compared to the naturally occurring dry-down/drought events that took place during the course of our in-situ field experiments. Response variables include surface and pore water chemistry (C, nutrient constituents, sulfide), macrophytes (plant productivity, biomass, root dynamics), soil microbes (extracellular enzyme activity), periphyton (community composition and nutrient content), C cycling (gas exchange, net and gross ecosystem exchange and production, plant and ecosystem respiration), and sediment erosion and/or deposition.

This presentation will focus on the experimental design including details of both the mesocosm facility and the in-situ field manipulation sites. In general, the mesocosm experimental design consisted of manipulating the salinity (ambient 10 psu or elevated 20 psu) and inundation depth (submerged 4 cm or exposed 4 cm) on 24 plant-soil monoliths collected from the brackish water site using a randomized split-plot design with repeated measurements. The field manipulations were carried out at both the fresh and brackish water sites on 12 plots. The plots at each site included 6 controls (ambient salinity) and 6 treatments (elevated salinity). Differences between the control and treatment plots for most of the variables measured were evaluated at each site and compared between sites. Some findings to date will also be presented as an introduction to subsequent talks in the session.

<u>PRESENTER BIO</u>: Stephen Kelly is a Senior Scientist with almost 40 years of experimental research experience including the last 25 years with the District. Research interests include estuarine and coastal water quality, and most recently, planning, design and implementation of this coastal marsh research program.

EARLY DETECTION, RAPID RESPONSE, AND CONTAINMENT OF INVASIVE REPTILES ALONG A SUBURBAN/NATURAL AREA INTERFACE: PROTECTING EVERGLADES NATIONAL PARK FROM THE ARGENTINE BLACK AND WHITE TEGU

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The Argentine black and white tegu (*Salvator merianae*) is a large lizard native to South America that has become established in and around parts of the southern Everglades. Argentine tegus are habitat and diet generalists with a sustaining population across a variety of natural and disturbed habitats immediately adjacent to Everglades National Park (ENP). They are omnivores that consume eggs, putting native ground-nesting birds and reptiles at risk. These lizards are vagile and more cold tolerant than other invasive reptile species in the Greater Everglades, so they could spread to more locations throughout Florida if left unchecked.

Local managers are working to control the tegu population both to contain them to a manageable area and to prevent them from becoming established inside ENP. These efforts are taking place over a variety of habitats along the interface between the Everglades and the Redlands Agricultural Area (RAA) and the adjacent communities of Florida City and Homestead. Removing tegus with box traps in the C-111 basin, where tegus may be concentrated in the upland habitats along the roads and levees adjacent to the marsh, may be effective in that area. But, controlling tegus in the contiguous stretches of upland areas of the RAA and in the suburban neighborhoods is challenging because: 1) tegus may have more habitat and food options; 2) accessing private lands for trapping can be problematic; and 3) tegus may use the habitats in these areas in different ways than in the C-111 basin, where habitat use is better understood.

Managers and researchers are utilizing a variety of techniques to better understand this population and more effectively target removal efforts in the different habitat types. Live and camera traps have been set in South Florida Water Management District, Miami-Dade County, and National Park Service properties across the landscape to contain the population and provide early detection and rapid response capacity if the population expands to a new area. Besides attending local events to educate the public through outreach, door hangers and direct mailers have been used in neighborhoods of interest to generate reports. Managers have responded to those and other reports by the public with a trap-loan program. Additional methods, such as detector dogs and radio telemetry, may improve understanding of how tegu habitat use and population density may vary over the landscape. This multi-pronged approach relies on cooperation and coordination across many boundaries and, if it is to be successful, will likely require more effort sustained over many years.

<u>PRESENTER BIO</u>: Jenny Ketterlin is an Invasive Species Biologist at Everglades National Park with 15 years of experience working in the Florida Everglades. She has worked on invasive plant and animal issues with the National Park Service, the University of Florida, Miami-Dade County, and the Florida Fish and Wildlife Conservation Commission.

ECONOMIC ASSESSMENT OF THE IMPACTS OF OUTDOOR WATER USE RESTRICTIONS (OWR) IN FLORIDA: A PENALTY FUNCTION APPROACH

*Pallab Mozumder, **Lara Kiesau**, Mahadev Bhat*
Florida International University, Miami, FL, USA

With accelerated climate change, ongoing population growth and increasing freshwater demand, water management options for coastal communities has become more contentious than ever before. In the residential sector, outdoor water use can be attributed to significant amount of water consumption. Over the years, the outdoor water use restriction (OWR) has become a common demand-side management (DSM) tool, which has been implemented in many cities and municipalities in the USA and beyond. While it has become effective in demand reduction, recent studies suggest that OWR may lead to negative impacts on social welfare. The objective of this research is to assess economic impacts of OWR. With that objective, we first attempt to monetize the value that residents ascribe unrestricted water use by stating their willingness to pay (WTP) to avoid OWR and then extrapolate that value to affected customers in South Florida. The required data of willingness to pay to avoid OWR comes from a stated preference discrete choice experiment among South Florida residents (Seeteram, Engel & Mozumder, 2018) on different restoration scenarios for the Everglades, which play a significant role for regional freshwater supply. Then we develop a penalty function that considers a set of environmental and biophysical attributes in addition to household willingness to pay to avoid OWR. By calculating the discrepancy between target and actual water flow in the water supply system, the penalty function can measure the extent of welfare loss/gain caused by the OWR. The results from the estimated penalty function will allow us to do the economic assessment which can serve as a decision-support tool for water resource managers in South Florida.

PRESENTER BIO: Mrs. Kiesau is a M.S. graduate student in the Environmental Studies Program at FIU. Her study focus is sustainability/sustainable resource use. The abstract topic is part of her Master Thesis that she plans to complete in 2020.

THE EFFECT OF HURRICANE IRMA STORM SURGE ON THE FRESHWATER LENS IN BIG PINE KEY, FLORIDA USING ELECTRICAL RESISTIVITY TOMOGRAPHY

Michael Eyob. Kiflai[1], *Dean Whitman*[1], *Danielle Ogurcak*[2] *and Michael Ross*[1, 3]
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On September 10, 2017, Hurricane Irma made landfall in the Florida Keys as a category 3 storm. Storm surge inundation heights in the lower Keys were in excess of 2 m. In this study, we investigate the effect of the Hurricane Irma storm surge on the freshwater lens of Big Pine Key, FL using Electrical Resistivity Tomography (ERT) on three profiles ranging between 220 and 280 m length. We compare ERT imaging results and well data collected six years before Irma (November 2011) with data collected three to four months (November, 2017/January, 2018) and eight months (May 2018) after the storm. The data was inverted using a difference inversion algorithm which uses the previous inversion results as a starting model. The resistivity models were then converted to pore fluid resistivity by applying an electrical formation factor and then converted to salinity models for each time period.

All three profiles experienced storm surge flooding from Irma. The resistivity models show low resistivity/high salinity zones in the upper 2 m corresponding to saline water emplaced on top of the freshwater lens by the storm surge. The increase in salinity is most pronounced in the low elevation portions of the profiles. The May 2018 data were collected at the end of the climatological dry season but were collected immediately after two weeks of intense precipitation. These data show some limited recovery of the freshwater lens and this is most pronounced in the lower elevation portions of the profiles. This suggests that both the impact of storm surge and the freshwater recovery due to precipitation are most pronounced in low elevation regions where both saline and fresh water can collect at the surface.

PRESENTER BIO: Mr. Kiflai is a PhD candidate from Florida International University focusing in Hydrogeophysics with more than 3 years of experience in Everglades restoration projects. Moreover, he has assessed the impact of Hurricane Irma on the freshwater lens in Big Pine Key. He also instructs water resource assessment and environmental science lab courses for undergraduate students.

IMPLICATIONS OF TEMPORAL AND SPATIAL VEGETATION PATTERNS ON PERFORMANCE OF THE EVERGLADES STORMWATER TREATMENT AREAS

Jill King *and Jake Dombrowski*
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Aquatic vegetation is a key component to understanding the reduction of Total Phosphorus and other nutrients in the Everglades Stormwater Treatment Areas (STAs). The STAs consist of various configurations and vegetation patterns that are managed and maintained to ensure the most effective treatment performance throughout these systems. Historically, these systems have been classified as emergent aquatic vegetation cells (EAV) or submerged aquatic vegetation cells (SAV).

While a vast amount of data has been collected in the STAs, there has been little information focused on vegetation biomass and nutrient storage. This presentation will provide insights into nutrient concentrations and storages in STA vegetation and will provide comparisons between the two main vegetation types (EAV and SAV). Data for biomass, total phosphorus, total carbon, total nitrogen, and ash content will be included in the presentation. Vegetation biomass was sampled over a three-year period in STA-2 Flow-way 1 (emergent aquatic vegetation) and STA-2 Flow-way 3 (submerged aquatic vegetation) that have historically achieved a flow weighted mean TP concentration of 20 ug/L at the outflow.

Preliminary findings show a distinct decreasing gradient in tissue P concentrations for both EAV and SAV, consistent with other components (mainly soils and water) of a larger Restoration Strategies Science study. This trend was also found for P storage, indicating higher P uptake in the region closest to the inflow structures, where P loading is highest, and lower uptake at the backend of the flow-way where P loading is lowest. Trends for the other parameters tested were not as distinct. STA-2 Flow-way 3 saw a substantial decline in SAV biomass throughout the flow-way as well as a shift in species composition at the inflow location. The study has shifted focus now to other flow-ways, which will provide further insights into the role of vegetation in these systems. This vegetation information shall be compiled and integrated into the overall assessment of the P cycling mechanisms and will help with assessing short-term and long-term storage of P within the STAs.

PRESENTER BIO: Jill King is a science supervisor with the South Florida Water Management District. She is currently the project manager for one of the larger Restoration Strategies Science Plan studies in the STAs. She was previously with the Department of Environmental Protection for 10 years as the manager of the Environmental Resources Program and has extensive experience working in the Everglades and coastal ecosystems.

HIGH DISCHARGE EVENTS: EFFECTS ON ST LUCIE ESTUARY AND AN ESTUARINE PREDATOR

***Lauren Kircher*[1]**, *Delaney Frazier*[1], *Joy Young*[2], *and John Baldwin*[1]
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Over 1300 control structures, 64 pump stations, and 2600 miles of canals have redirected and drained the swampy habitat of Southern Florida. Alterations of natural flow allow water managers to allocate for recreational, agricultural, and environmental needs. Managers discharge large amounts of freshwater during periods of high precipitation to prevent upstream flooding from Lake Okeechobee, drastically changing the salinity, turbidity, current, and biota of the system. In particular, increases in suspended sediments have been shown to shade seagrasses and smother oysters causing dieoffs in both organisms. Less research has examined how these changes affect the movement behaviors of more mobile and salinity-tolerant species.

Common snook (*Centropomus undecimalis*) serve as a model of a large euryhaline predator that encounter large water discharge events annually. The majority of these discharge events, which typically occur during the rainy season, coincide with snook's protracted spawning season. Snook likely use temperature and freshwater flow cues to initiate movement to the spawning aggregation in higher salinity waters. Discharge events from managed waterways may alter the timing of spawning movement resulting in a temporal mismatch of ideal food supply, spawning conditions, or normal dispersal movement patterns. This has potential consequences for recruitment in years with high discharge occurring at vital times.

This research utilizes online environmental databases (dbHydro, NWIS) for daily temperature, salinity, and flow data. These parameters were analyzed at four locations throughout St. Lucie estuary during four high discharge events (>2000 cfs), offering a temporal and spatial assessment of how discharge alters the estuary. Passive acoustic telemetry was used to track the movements of 280 snook during discharges from 2008-2014. Examining movement of snook during high discharges can help determine the severity of these events on the behavior of mobile organisms. Our robust sample size will minimize the effects of individual variation in the analysis. If our research can identify flow regimes and vulnerable times during the year, we can improve the management of both estuarine fish and waterways, further protecting mobile species and sustaining the recreations that depend on them.

<u>PRESENTER BIO</u>: Lauren Kircher is a Ph.D. candidate at Florida Atlantic University working under Dr. John Baldwin. She is researching environmental influences on snook movement and mentoring undergraduate students working on snook research.

CERP RESTORATION, COORDINATION, VERIFICATION (RECOVER) PROGRAM 2019 SYSTEM STATUS REPORT KEY FINDINGS FROM THE NORTHERN ESTUARIES

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The REstoration, COordination, VERification (RECOVER) Program, the science arm of the Comprehensive Everglades Restoration Plan (CERP), evaluates and assesses CERP performance using an applied science strategy which includes a system-wide Monitoring and Assessment Plan (MAP). The MAP provides a template for the monitoring of key indicator species (ecological indicators), identifying uncertainties, and how to apply best science to adaptive management and guidance of restoration activities in CERP.

The 2019 System Status Report (SSR) provides a synthesis of five years of monitoring data across the greater Everglades ecosystem by region (Water Years (WY) 2013-2017 (May 2012 – April 2017)). The Northern Estuaries (NE) region comprises the St. Lucie Estuary (SLE)/South Indian River Lagoon (S-IRL) and Loxahatchee River and Estuary (LRE) on the Atlantic coast, and the Caloosahatchee River and Estuary (CRE) on the Gulf coast of Florida, USA. The NE have been impacted by the altered volume, distribution, circulation, and temporal patterns of freshwater inflows which effect salinity. During the period of record, the region also experienced several extreme environmental events including El Niño, harmful algal blooms, and hurricanes. The ecological indicators monitored in the NE include the eastern oyster, submerged aquatic vegetation (SAV), and benthic infauna. Chlorophyll *a* was also evaluated.

Mean salinity by WY was rarely within the optimum range. Periods of extremely low salinity in the SLE during WY 2014 resulted in acute damage to oyster populations, while periods of higher salinity overall in the LRE and CRE resulted in higher infection rates of the protozoan parasite *Perkinsus marinus*. SAV generally declined or remained stable in low densities throughout the NE. There are clear, separate benthic infaunal communities between the SLE and SIRL as a function of salinity and sediment type. And finally, changes from the long-term median of chlorophyll *a*, a proxy for phytoplankton abundance, were scored very poor to moderate especially following high-precipitation events.

Looking to the future, CERP projects north and south of Lake Okeechobee (e.g. Lake O Watershed Restoration Project and Central Everglades Planning Project, respectively) will allow for operational flexibility by providing additional system-wide water storage. This includes diverting water sent to tide, consequently protecting the estuaries from critically-low salinity after high precipitation events; and providing supplementary flows during drought to prevent saltwater intrusion. The C-43 and Indian River Lagoon-South projects will decrease runoff into the CRE and S-IRL, respectively, from their local watersheds. In addition, an updated Salinity Envelope Performance Measure will be complete by 2019 to better inform CERP performance in the NE, and will be applied to the upcoming Lake O Regulatory Schedule update to evaluate project alternatives and their effects on NE ecology.

PRESENTER BIO: Phyllis is a scientist with the Applied Science Bureau at the SFWMD, and a Regional Coordinator for the Northern Estuaries module of the CERP RECOVER Program. She is early-career with several years' academic and professional experience in estuarine ecology, restoration, and natural resource management.

HOW DOES FRESHWATER RESTORATION CHANGE MARSH ECOSYSTEM BIOGEOCHEMISTRY? A NORTHEAST SHARK RIVER SLOUGH CASE STUDY

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Restoration is a fundamental challenge in ecology primarily because ecosystems are dynamic, and their resilience is often uncertain. Freshwater ecosystems are threatened worldwide by reductions in water quantity and quality, and these legacy impacts may constrain restoration. Using the Everglades as an example, we tested the long-term (2006-2018) effects of the Modified Water Deliveries of the Comprehensive Everglades Restoration Plan on changes in biogeochemical cycling in freshwater marshes of Northeast Shark River Slough, Everglades National Park. We measured surface water, periphyton, flocculent matter (floc), *Cladium jamaicense* (sawgrass), and soil total phosphorus (TP) concentrations, total carbon (TC) to TP stoichiometric ratios (C:P), and soil and floc microbial process (rates of respiration and alkaline phosphatase activities). We compared before (2006-2008, 2012) and during restoration efforts associated with the bridging of Tamiami Trail (2015-2018) on TP. From 2006-2018, median concentrations of TP for surface water, periphyton, floc, sawgrass, and soil were highest near canal and culvert discharge locations. We measured large differences in C:P among periphyton (1000-25,000), soil (1000-3,500), floc (800-2,500), and sawgrass components (51-120). C:P increased with distance from canals and culverts, except values of sawgrass C:P that were more uniformly distributed. We measured up to a 2× reduction in surface water TP where water depth has increased with restoration at sites within 3 km of bridging. Changes in periphyton, floc, and soil TP were spatiotemporally variable and less clearly explained by increases in water quantity and quality with restoration. Microbial respiration rates were higher on floc than soils (0.1 – 6 > 0.1 – 0.8 μmol g dry mass^{-1} h^{-1}) and unrelated to distance from canals and culverts. Alkaline phosphatase activities were similarly higher on floc than soils (0.1 – 100 > 0.1 – 5 μmol g dry mass^{-1} h^{-1}) and also unrelated to distance from canals and culverts. Enhanced freshwater restoration is increasing water depth and reducing surface water nutrient concentrations in marshes downstream of Tamiami Trail, and biogeochemical shifts in plants, organic matter, and soils will likely be detected into the future. Continued long-term research during restoration is critical to quantifying integrated ecosystem responses to changing environmental conditions as well as differential constraints of legacies among ecosystem components.

<u>PRESENTER BIO</u>: Dr. Kominoski is an ecosystem ecologist and co-PI of the Florida Coastal Everglades Long Term Ecological Research Program. His research focuses on subsidy-stress effects on organic matter processing and biogeochemical cycling in ecosystems. His lab studies terrestrial, aquatic, and wetland ecosystems throughout the Southeastern U.S., including the Florida Everglades.

BIOGEOCHEMICAL CONTROLS ON MERCURY SPECIATION AND TRANSPORT ALONG HYDROLOGIC GRADIENTS IN THE EVERGLADES

David P. Krabbenhoft[1], *Christopher Babiarz*[1], *Michael Tate*[1], *John DeWild*[1], *Jacob Ogorek*[1], *Sarah Janssen*[1], *Brett Poulin*[2], *and William Orem*[3]

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[3]U.S. Geological Survey, Reston, VA, USA

Elevated levels of mercury (Hg) in the food web of the Everglades were first revealed in the 1980s, and since that time researchers have provided detailed information on sources, transport, bioaccumulation, and the drivers of important chemical transformations. A key transformation process is formation of methylmercury (MeHg), the most toxic and bioaccumulative form of mercury in the environment, and in the Everglades ecosystem results primarily from microbial sulfate reduction. Previous studies have shown there are several ecological factors that directly relate to MeHg production, including: hydrology (e.g., droughts resulting in drying and/or fire events, and man-related management of water levels and flows through pump stations and an intricate system of canals); surface-water chemistry (particularly the concentrations of sulfate, dissolved organic carbon (DOC)); and, while not directly related to the restoration efforts, external loading of inorganic Hg from atmospheric deposition. Whole-ecosystem changes to the hydrology of the Everglades resulting from the restoration efforts have had a significant effect on the spatial and temporal variability of the nutrient and major ion chemistry of surface waters. Notably, where ever sulfate and DOC rich canal waters are released to the wetlands, strong biogeochemical gradients setup and have a profound impact on Hg speciation and bioaccumulation. The primary goal of this study was to conduct detailed assessments of the evolution of biogeochemical conditions along three hydrologic transects originating from locations of canal water releases in Water Conservation Areas 1, 2A, and 3A. Sampling for surface water, porewater, sediment and Gambusia was conducted yearly from 2012-2018. For this study, we specifically examined the spatial relations of sulfate, DOC, Hg, and MeHg. In addition, we also apply high-precision stable Hg isotope measurements, a relatively new application in Hg research that can provide significant insights into the sources, transport pathways, and the influence of key biogeochemical processes.

All three studied transects revealed similar trends in sulfate and DOC, with the highest concentrations of both observed near the point of canal water release followed by subsequent steady declines. It is important to note, however, that the magnitude of the sulfate and DOC concentrations among the transects varied considerably, with WCA2A concentrations being about 20-30x greater than WCA3A. MeHg concentrations trends, on the other hand, showed little correspondence among the transects, but were consistent from year to year. This complex response is consistent with the nonlinear relation between MeHg production and sulfate levels, which has been previously shown by our project in the Everglades and other researchers globally. Mercury stable isotope results show depleted signatures in canal-water that are likely Hg derived from the watershed; this signal then becomes increasingly positive (enriched) along the transect which we attribute to a shift in source profile related to accumulation of Hg from atmospheric deposition.

PRESENTER BIO: David Krabbenhoft is a senior research scientist with USGS, and has been studying mercury contamination of the environment for over 31 years.

EFFECTS OF HURRICANE IRMA ON AQUATIC MICROBIAL COMMUNITIES OF THE EVERGLADES

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Currently, composition and metabolic capabilities of the microbial communities in the waters of the Florida Coastal Everglades are highly underexplored, although these microbes have impact functions for organic matter degradation, recycling of nutrients, transport of nutrients to higher trophic levels, and potentially for the resilience of the ecosystem. Therefore, we also lack critical knowledge on responses and changes of structure and function of microbial communities to most relevant current environmental threats to this ecosystem, like P enrichment, sea-level rise, saltwater intrusion and natural disturbance events like hurricanes or fires. This study delivers the high-resolution phylogenetic profiles of the pico-, nano- and microplankton communities along two main water flows (Shark River Slough (SRS) and Taylor Slough (TS)), and Florida Bay (FB). Samples were collected before and after Hurricane Irma in Fall 2017.

The microbial community compositions varied significantly along the salinity gradient between different habitats, evident already on higher taxonomic levels. Both transects started off with relatively similar freshwater communities. The bacterioplankton community composition (BCC) in the freshwater marshes was dominated by members of family *Burkholderiaceae* (Betaproteobacteria). The most abundant group that we detected, *Polynucleobacter*, is known to utilize photodegradation products of humic substances, which presumably contribute to turn-over of dissolved organic carbon (DOC) in the Everglades. Members of *Cryptophyta* were most relevant among eukaryotic communities. The dominant taxon, *Cryptomonas*, has been shown to exhibit mixotrophic (heterotrophic or phototrophic) lifestyle and could potentially prey on Betaproteobacteria, which might be important niche-adaptation in this oligotrophic ecosystem.

In the ecotone (transition between freshwater and marine environments), diatoms and ciliates became more prominent. The BCC had an increase in relative abundance of Bacteroidetes and Alphaproteobacteria that are associated with diatoms, as well Gammaproteobacteria that could be linked to exudates of the mangrove rhizosphere.

The BCC in Florida Bay is composed mainly by marine taxa that have previously reported in high abundance in the Gulf of Mexico (Alphaproteobacteria, Gammaproteobacteria, Flavobacteriia, Cyanobacteria). Diatoms and dinoflagellates were most abundant groups among eukaryotic communities.

Hurricane Irma impacted the microbial communities throughout both transects, and especially drastic changes were observed in the ecotone and Florida Bay. The DOC concentrations were notably higher after the hurricane, and there was a corresponding increase of relative abundance of heterotrophic bacteria, with the exception of the north-eastern part of FB, where unicellular cyanobacteria of the genus *Synecchococcus* formed a bloom (over 40% in TS9 after Irma). The responses in eukaryotic communities were more variable between the transects, mainly because patchy occurrence of ciliates.

<u>PRESENTER BIO</u>: Dr. Laas has been working as a Postdoctoral Researcher in Stingl lab since summer of 2017. He has a gene technology background and has been utilizing the next-generation sequencing techniques to study structure and functions of aquatic microbial communities.

HABITAT USE AND FORAGING FLIGHTS OF ROSEATE SPOONBILLS IN FLORIDA BAY

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Roseate spoonbills (Platalea ajaja) are an indicator species for the Everglades restoration due to their response to hydrological changes and corresponding changes in prey abundance and availability. When breeding in Florida Bay, roseate spoonbills rely on shallow marine, estuarine, or freshwater sites along the estuarine-freshwater ecotone of southern Everglades including distant inland dwarf mangrove as foraging habitats. High quality foraging habitats are produced when fishes are in high abundance and water levels drop to prey-concentration threshold (PCT). These foraging locations can vary between years due to environmental conditions and water management. If water levels do not reach and stay below the PCT, spoonbills may be forced to forage farther from their nests leading to low nest success.

More than a decade ago, twenty roseate spoonbills were tracked using satellite transmitters during the 2006 and 2007 breeding season. During the 2006 breeding season, water levels in Taylor Slough and C-111 canals were ideal, falling below the PCT throughout the breeding season and resulting in higher nest success rates than the 2007 season, when water levels did not reach the PCT until the late hatching period and then experienced a reversal. This study examines how habitat use and foraging flights differed between these two breeding seasons. We hypothesize that roseate spoonbills differed in habitat use within these two years, utilizing Taylor Slough less during the 2007 breeding season, and increased their foraging flight distance to reach high quality foraging habitats.

A second satellite tracking study is currently being conducted to monitor roseate spoonbill habitat use. During the last decade, sea level rise has been negatively affecting historical spoonbill foraging habitats. Comparing spoonbill habitat use and foraging flight patterns from these studies will give insight on future water management decisions for roseate spoonbills nesting in Florida Bay.

PRESENTER BIO: Elizabeth Lago is a master's student in the Environmental Science program at Florida Atlantic University. She has field experience monitoring indicator avian species in Everglades National Park and her research focuses on the habitat use and foraging flight behavior of roseate spoonbills in Florida Bay.

WINNERS AND LOSERS AFTER HURRICANE IRMA IN THE EVERGLADES MANGROVE FORESTS: A NASA PERSPECTIVE

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Mangrove forests in South Florida are in a constant state of change. With an average return interval of every 12 years, major hurricanes of Category 3 or greater can reset the clock for South Florida shorelines. The combination of powerful winds and high storm surge affect both the physical structure of the ecosystem as well as induce biogeochemical stress. After catastrophic events, it can take more than five years for the forests to recover to pre-storm productivity. Where flooding and wind damage are severe, mangrove mortality may continue in the months to years after the hurricane. Under these circumstances, the frequency and intensity of future hurricanes can push the resilience of coastal wetlands beyond their environmental thresholds. One specific challenge for determining the resiliency and vulnerability of coastal wetlands after hurricanes is to identify the changes in ecosystem structure following catastrophic storm events. These changes in canopy cover and vertical canopy structure will ultimately influence the stability of the forest and the effectiveness of storm surge reduction.

In response to the Hurricane Irma in 2017, we conducted a rapid response campaign to collect repeat lidar data from NASA Goddard's Lidar, Hyperspectral, and Thermal (G-LiHT) Airborne Imager over Southwest Florida to directly quantify ecosystem damages and coastal erosion from Hurricane Irma using pre and post-storm data. Rapid assessment of storm impacts was critical to characterize sedimentation, erosion, and changes in ecosystem structure and composition. In November of 2017, our team quickly mobilized to collect G-LiHT data in the beginning of December, nearly three months after Hurricane Irma. As a follow on to help calibrate and validate our airborne data, we also conducted a field campaign in January of 2018 to collect on the ground measurements across gradients of storm surge, wind speeds, and ecosystem damage**.**

Our team has combined airborne and satellite data to estimate mangrove damage and recovery in the year following Hurricane Irma. Lidar data from collected before (April 2017) and after (December 2017) the storm provided estimates of the three-dimensional (3D) changes in vegetation structure. Time series analyses of Landsat satellite data were then used to track the recovery of coastal ecosystems with differing degrees of structural damage in the year following the storm. High-resolution reconstructions of surface winds (NASA's Global Modeling and Assimilation Office), and storm surge (Coastal Emergency Risks Assessment) were used to stratify storm impacts. Together, these data provided an unprecedented look at the spatial and temporal patterns of mangrove damage and recovery in south Florida following a major hurricane. These findings offer specific guidance for regional planning efforts to increase the resilience of coastal ecosystems that could be used to alleviate damages from future storm events.

PRESENTER BIO: Dr. Lagomasino is a remote sensing scientist with a strong background in coastal ecogeomorphology. His interests combine land use change, disturbance events on ecosystems, water-carbon cycle science in transitional environments at the land-sea interface. He has been working in coastal wetlands for 13 years and has been involved in NASA, USDA, and USAID-funded projects.

CONVERGENCE OF THE PRINCIPLES OF WETLAND HYDROLOGY AND HILLSLOPE HYDROLOGY: IMPLICATIONS FOR WETLAND (STA) MANAGEMENT AND RSM DEVELOPMENT

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Research carried out during the past decades show that the hydrologic principles governing flow through wetlands and hillslopes are very similar. Both hillslope and wetland disciplines deal with issues related to scale and heterogeneity, where the physical processes related to the local scale of soil grains or plant stems do not easily scale up to represent bulk scale parameters explaining meaningful physical processes. The difference between the two disciplines however is in the advances made in the understanding, conceptualizing and parametrization of hillslope hydrology when compared with the advances made in wetland hydrology. This is despite the obvious differences in factors such as the overall slope.

The most significant similarity between the disciplines is due to the key dimensionless parameter referred to as the hillslope number by Brutsaert (1994) or the Peclet number by Troch, et al. (2002). The same number was used by Lal (2017) for wetlands. This number determines if the partial differential equation governing problem is hyperbolic or parabolic. It determines if the flow is kinematic or diffusive, and if the numerical method used is upwind based or centrally differenced. When this number is used to characterize flow behavior, it is helpful to note that wetlands and hillslopes can be treated as hydraulically similar if the Peclet numbers are similar disregarding other differences. This also implies that a numerical solution method such as the implicit total variation diminishing Lax Friedrichs method (TVDLF) can be used to solve both these problems in regional the simulation model RSM developed by SFWMD.

Hillslope research during the past two decades have contributed to the development of the hillslope storage Boussinesq equation (Brutsaert, 1994), and various other process-based methods. New methods are also introduced to explain matrix flow and piping using “perceptual models”. These concepts that are firmly established in the field of hillslope hydrology seem to be relevant to wetland hydrology too. They are also capable of explaining hydrologic processes at different scales. Some of the contributions to hillslope hydrology were made during the studies of dominant controls in hillslope hydrology (Harman and Sivapalan, 2009), transient response functions (Brutsaert, 1994), and the use of representative elementary watersheds (Reggiani, 1998). In hillslope hydrology, the goal is to control erosion and nutrient transport. Forest managers and proponents of sustainable logging industries benefited from the work. Coincidentally, the goals behind studying wetland hydrology are also not too different.

<u>PRESENTER BIO</u>: Wasantha Lal is a principle engineer with more than 20 years at SFWMD developing regional hydrologic and hydraulic models for south Florida. Recently, he has developed field tests to study hydraulic behaviors and map vegetation density in wetlands using generated waves.

AN EMERGING TOOL TO ASSESS PEAT LOSS AND WETLAND VULNERABILITY IN THE FLORIDA EVERGLADES

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Coastal wetlands are predicted to experience many environmental and ecological consequences related to sea level rise. Within the Florida Coastal Everglades (FCE), rising sea levels are pushing saltwater further inland and increasing soil salinization. A community type at significant risk of degradation due to soil salinization are coastal peat marshes dominated by sawgrass (*Cladium jamaicense)*, a marsh plant that is only weakly salt-tolerant. Experimental evidence suggests that increasing salinities within sawgrass marshes contribute to a process known as “peat collapse”. Peat collapse causes rapid declines in soil surface elevation and a net loss in organic carbon, culminating in the conversion of vegetated marsh to open water. Loss of coastal marshes is a significant concern for coastal management efforts as it has the potential to hinder inland transgression of mangrove forests with sea level rise and saltwater intrusion. While our mechanistic understanding of peat collapse in coastal marshes has grown, we still lack an integrated method to evaluate coastal wetland vulnerability to collapse.

As an initial assessment of areas within the FCE most vulnerable to peat collapse, we have developed a tool, the coastal vulnerability index (CVI), that uses techniques in geospatial analysis to classify coastal habitats based on their (1) environmental characteristics that characterize the Everglades system and are relevant to peat collapse and (2) ecological risk indicators that characterize the risk of peat collapse. Environmental indicators include soil type and depth and dominant vegetation while ecological risk indicators include annual metrics for median water depth, number of dry days, and shallow groundwater salinity (<2 m depth). Hydrologic parameters are outputs of the US Geological Survey BISECT numerical model that simulates the coupled surface water-groundwater dynamics of South Florida, allowing for water surfaces to be generated for the full extent of Everglades National Park. The CVI conveys how hydrologic variables vary across community types and where the risk of losing deep carbon-rich peat deposits is greatest, if communities cannot adapt to the consequences of climate change. By using BISECT water surfaces at an annual timestep beginning in 1996, we are also able to convey how vulnerabilities change through time, given changes in water management and sea-level rise. The CVI is being developed as a science management tool that supports Everglades restoration planning efforts aimed at protecting peat soils and coastal wetlands. It will also provide an opportunity to communicate broadly the impacts of sea-level rise and reduced freshwater flow as well as the value of coastal Everglades ecosystem services.

<u>PRESENTER BIO:</u> Lukas Lamb-Wotton is a graduate student at FIU working under the supervision of Dr. Tiffany Troxler. His work aims at highlighting vulnerable areas along the Everglades coastline to sea-level rise, particularly those marshes most at-risk for peat collapse. Lukas is currently president of the FCE-LTER graduate student group and is an officer of the ESA Student Section.

SIMULATING THE TUG OF WAR BETWEEN TRANSPORT AND NUTRIENT UPTAKE IN LOW FLOW TREATMENT WETLANDS DEMONSTRATES THE NEED TO MODEL BIOGEOCHEMISTRY

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The Everglades Stormwater Treatment Areas (STAs) are large-scale freshwater wetlands constructed to reduce total phosphorus (P) concentrations in runoff to support restoration of the Everglades. Flow and transport in treatment wetlands affect the nutrient cycling among plants, microbes, and the soil, which consequently affects downstream water quality. The relationships among velocity, residence time (contact time), and treatment efficiency have resulted in a greater focus on modeling hydrology than wetland nutrient removal. However, processes such as diffusion, uptake, sorption, and storage in various biogeochemical compartments become more apparent in low flow oligotrophic wetland systems. To evaluate the importance of hydrology vs wetland nutrient removal, we evaluated simulations of two hydrologic transport models in combination with three biogeochemistry nutrient models. The hydrologic transport models were a simple advection model (plug and flow system), and a more realistic hydrologic transport model where variable flow velocities were approximated by draws from a probability density function. The three biogeochemistry models were a first order uptake model, a transient storage model, and a more complex spiraling model. The first order uptake model lumped all wetland components into one TP parameter. The transient storage model included a zone of delayed TP downstream transport. The spiraling model described TP cycling among various wetland components (water column, plants, microbes, litter, root litter, floc, recently accreted soil). Data from the Everglades' STA 2 Flow Way 1 were used as model inputs for inflow and TP concentration. Small differences were observed in simulated outlet TP concentrations between the two transport models when coupled with the same biogeochemistry model. We found greater differences in outlet TP concentrations when comparing among the biogeochemistry models (1st order uptake, transient storage, and spiraling). We conclude that modeling phosphorus biogeochemistry of the various wetland components is as important, if not more critical, than modeling hydrology in low flow wetland systems.

PRESENTER BIO: Kalindhi is a PhD student under the supervision of Dr. Stefan Gerber in the Department of Soil and Water Sciences, UF. She is aspiring to be a biogeochemistry modeler and a scientist who works with big data. Her current work is modeling phosphorus biogeochemistry in the Everglades Stormwater Treatment Areas.

LASTING SALT AND PHOSPHORUS EFFECTS LIMIT THE CAPACITY OF RESTORED FRESHWATER WETLANDS TO RECOVER CARBON LOSSES

***Dong Yoon Lee*[1, 2]**, *Sean Charles*[1], *Benjamin Wilson*[1], *Shelby Servais*[1], *Stephen Davis*[3], *Tiffany Troxler*[1], *Evelyn Gaiser*[1], *John Kominoski*[1]

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Seawater intrusion is altering carbon (C) and nutrient (phosphorus, P) cycling in coastal wetlands worldwide. This shift in biogeochemical cycling can reduce plant biomass and soil C, which increases coastal wetland vulnerability to sea-level rise. Active management practices, such as a removal of canal/levee or dense vegetation to increase freshwater flow, have been implemented. However, it is uncertain how potential legacies of seawater intrusion might be offset by freshwater restoration. In experimental wetland mesocosms, we continuously elevated salinity (~6.9 g salt d^{-1}) and P (~0.5 mg P d^{-1}) in *Cladium jamaicense* peat monoliths for two years (2015-2017) to quantify changes in C partitioning. Elevated salinity inhibited and elevated P increased sawgrass growth and metabolism. With elevated salinity, we measured rapid soil elevation loss (with and without added P), higher organic matter decomposition, and decreased belowground biomass. Following the manipulation experiment, we experimentally restored freshwater to all treatments and control mesocosms for 17 months (2017-2018). Porewater salinity decreased from 10 to <3 ppt, and porewater P concentrations were not different from freshwater controls. Freshwater restoration offset inhibitory effects of seawater on belowground biomass, and belowground P concentrations (both root and soil) were reduced with added freshwater. Sawgrass litter decomposition rates remained higher from prior elevated salinity (with or without P). Legacies of seawater continued to increase dissolved organic C and dissolved inorganic nitrogen in porewater, possibly due to stimulated microbial decomposition. Gross ecosystem productivity and ecosystem respiration remained also higher from legacy elevated P, and legacy effects of elevated salinity continued to increase ecosystem respiration. Collectively, ecosystem metabolism was net heterotrophic in all wetlands previously exposed to elevated salinity and/or P. Therefore, our results suggest that even with continued freshwater restoration, seawater intrusion legacies may limit the capacity of restored wetlands to recover C losses during the early stage (<2 years) of freshwater restoration.

PRESENTER BIO: Dr. Lee is ecosystem ecologist with broad experience in estuarine and wetlands biogeochemistry. With expertise in the assessment of anthropogenic drivers on microbial carbon and nutrient cycling, he has improved the understanding of ecosystem responses to the changes in eutrophic (Chesapeake Bay) and oligotrophic (Florida Everglades) ecosystems.

SPACE-BASED MONITORING OF WATER LEVEL CHANGES IN EVERGLADES WITH SENTINEL-1 INSAR OBSERVATION

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Monitoring water flow in south Florida Everglades has a great significance for the purposes of flood control, land drainage, water supply and ecosystem restoration. Interferometric Synthetic Aperture Radar (InSAR) has been demonstrated to be an effective tool for monitoring water level change in Everglades and other wetlands. The Sentinel-1 missions, launched by the European Space Agency (ESA) in 2014, provides freely accessible Synthetic Aperture Radar (SAR) datasets with large coverage (a width of 250 km in its nominal Interferometric Wide (IW) swath mode) and short repeat observation cycle of 6/12 days. These combined advantages provide a great opportunity for shorter temporal water level dynamics monitoring over large-scale wetlands with high spatial resolution (10s of meter), compared with previous studies using data from previous generation satellites, as ERS, RADARSAT, ALOS, which were limited in coverage area, longer repeat cycle, and limited accessibility.

We collected all available Sentinel-1 data over the Everglades in south Florida and formed ~60 interferograms with good quality. Through our preliminary analysis, the Sentinel interferograms successfully detect water level changes in the various water bodies (WCA1, WCA2A, WCA2B, WCA3, ENP, BCNP), which are separated and shaped by canals and levees and, consequently, present distinct patterns of water level changes in the interferograms. The quality of the InSAR water level measurements are validated against EDEN gage water level and found to be below 3 cm for the different water bodies. Our multi-temporal interferograms provide great insight of the water level changes and surface flow dynamics over periods of 6 or 12 days that were not possible with previous SAR missions. The interferograms contain interesting elongated fringes aligning well with the boundary between the Everglades freshwater and brackish water along the coast reflecting diurnal water level changes induced by tidal flow.

Our preliminary results show the ability and potential of using Sentinel-1 InSAR observations for monitoring water level changes and infer flow dynamics over the large area in the everglades. Further analysis deciphering the prominent seasonal and long-term hydroperiods signals along the transition zone between the freshwater and the brackish water along the coast will be conducted by analyzing the coastal-aligned fringe variability in space and time.

<u>PRESENTER BIO</u>: Heming Liao is a Postdoc working with Dr. Wdowinski at FIU. Currently, he is working on using remote sensing data for quantifying water level dynamics over the Everglades in Florida and monitoring the sea level rise effect on the coastal transition migration.

CURRENT AND FUTURE WATER TABLE AND CARBON DYNAMICS OF EVERGLADES WETLANDS IN AN EARTH SYSTEM MODEL

***Yan Liao**, and Stefan Gerber*
University of Florida, Gainesville, FL, USA

The South Florida and Everglades ecosystem, the largest subtropical wetland in the United States plays an irreplaceable role in global and regional carbon cycles. Carbon flux in wetlands distinguishes from that in other ecosystems because of the limited oxygen supply under inundation causing anoxic soils conditions. Changes in water table depth can affect the wetland's net CO_2 and CH_4 exchange. On the other hand, the variations of water table may alter plant oxygen stress and nutrient availability, resulting in trade-offs between primary productivity and heterotrophic respiration. Thus, understanding of the interactions among vegetation, soil carbon, hydrology and environmental factors at the ecosystem level is essential to restoration strategies, particularly also in light of future climate change. Biogeochemical models offer to quantify such interaction and allow to evaluate future climate scenarios.

In this study, we modified a land surface model (CLM4.5) such that it able to simulate reasonable carbon exchange and hydrology in the Everglades, specifically in a long hydroperiod sawgrass marsh and a short hydroperiod cypress swamp. First, vegetation, soil property and microtopographic features were defined to represent different wetland vegetation and either slough-ridge or flat land surface. Second, the original hydrology of CLM4.5 was modified to simulate realistic local scale seasonal inundation and the water table fluctuations, by allowing for lateral flow and reducing subsurface drainage. Phenology, and photosynthesis parameters were revised to better reproduce the seasonal change of leaf area index (LAI) and net ecosystem carbon exchange (NEE). After the calibration with the current measured water table depth, CO_2 flux data and LAI, we predicted the carbon dynamic of the two study sites under several future climate scenarios. Our results indicate the modified hydrology has greatly improved modeled water table depths compared to the generic model settings, and we find that 75% of the daily water table variations can now be explained by the model. Both simulated LAI and NEE show a significant improvement with adjusted parameter choices. Under the current conditions, the marsh wetland is almost carbon neutral but a carbon source when water table drops below the surface. The cypress swamp is a significant carbon sink with less variations between wet and dry seasons. The future scenario simulations show that the wetlands' carbon cycle is more sensitive to the increased temperature (T +2 ^{o}C) than the evenly reduced precipitation (P -20%). Dryer conditions (P -20%) lead to similar effect as warmer and wetter (T +2 ^{o}C and P +20%) condition on the ecosystem NEE but releasing less methane. Changes in rain frequency have stronger effects than changes in precipitation amounts. In the long run, the cypress wetland is more adaptive to the warmer and dryer future compared to the marsh wetland, although, there is carbon loss associated with the transition to the new climate regime.

PRESENTER BIO: Yan Liao is a PhD candidate at the University of Florida with expertise in modelling biogeochemical cycles at ecosystem level, focusing on carbon sequestration, GHG emissions and the potential effects of climate change.

STATUS, TRENDS, IMMIGRATION AND HABITAT USE OF AMERICAN FLAMINGOS (*PHOENICOPTERUS RUBER*) IN SOUTHERN FLORIDA

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American Flamingos (*Phoenicopterus ruber*) are a cultural icon of Florida, USA, yet their status in Florida has been controversial for nearly a century. There is uncertainty regarding historical baselines and long-term trends in flamingo populations, whether flamingo nesting has occurred in Florida, and whether recent observations are wild birds or escapees from captive populations. We review historical and contemporary information to clarify the status and trends of flamingos in Florida and to lay a scientific foundation for their management. We compile historical information from early naturalists and museum records to describe historical abundance, distribution, and phenology. We show definitive evidence for 19th-century flamingo flocks numbering hundreds to thousands of individuals, with large flocks recorded throughout the year in The Florida Keys, Florida Bay and the coastal habitats of Everglades National Park. Historical flocks were heavily hunted, and there is strong evidence that hunting led to extirpation of the historical population by ~1900. One plausible description of nesting and 4 egg specimens apparently collected in Florida in the 1880s suggest that flamingos probably nested in Florida, though the evidence is not irrefutable. Citizen science data from 1950 to 2015 reveal directional population increases over this period - patterns best explained by immigration from expanding nesting populations in the Caribbean, rather than increased numbers of escaped individuals. Further, two flamingos banded as chicks in the Yucatan were photographed as adults in Florida Bay - proving that immigration to Florida from other population in the Caribbean and the Bahamas is possible. In 2015, we captured a flamingo (Conchy) and equipped him with a NorthStar GPS satellite transmitter programmed to return 4 daily GPS coordinates. Conchy remained within Florida Bay for at least 661 days until transmitter failure. Core area analyses indicated heavy reliance on four major areas (Snake Bight, Stake Key, South Jimmie Key, and Club Key). Most resightings of Conchy on eBird were from Snake Bight with much lower detection rates in the other core areas. These data indicate that American Flamingos were native to Florida prior to 1900, can emigrate to Florida from other population's in the Caribbean and Bahamas, that recent observations in Florida exhibit characteristics of a recovering population, that current conditions in Florida Bay are suitable to sustaining at least a transient population and that Flamingos may spend long periods of time in Florida without being detected. A recovering flamingo population will be dependent upon, and be an indicator of, successful Everglades restoration. Resolving the long-standing controversy over the status and origin of Florida's flamingos will help develop appropriate evidence-based management strategies for this species—a culturally significant component of Florida's avifauna. To this end there is a petition before the Florida Fish and Wildlife Conservation Commission to place this species on the state's Threatened and Endangered Species List

PRESENTER BIO: Dr. Lorenz is the State Research Director for Audubon Florida's Everglades Science Center and has studied southern Florida Ecosystems for more than 25 years with a focus on Florida Bay.

VEGETATION STATUS OF THE KISSIMMEE RIVER HEADWATERS LAKES

Craig Mallison
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The Florida Fish and Wildlife Conservation Commission hired professional mapping contractors to map littoral vegetation within the Kissimmee Chain of Lakes during 2007-2016. Methods included photo-interpretation of color-infrared aerial photography (one-foot pixel resolution) with ground-truthing to attain classification accuracy of 90% or more. Data for Lake Tohopekaliga (2007, 2009, 2012, and 2016) and Lake Kissimmee (2009, 2012, and 2015) were evaluated to identify changes or trends in the aquatic plant communities. Analyses included comparison of total lake-wide area dominated by each plant community and community-specific shifts to evaluate successional patterns.

On Lake Toho, maidencane/Egyptian paspalidium was the most abundant plant community in all mapping years. However, area dominated by these grasses declined by 679 acres (-31%) over the study period. The greatest expansion was observed for area dominated by pads (spatterdock and/or water lily), which increased by 1,257 acres (670%) from 2007 to 2016. Pads primarily replaced maidencane/Egyptian paspalidium, open water, mixed maidencane/Egyptian paspalidium-pads, and lotus. Area co-dominated by pads also expanded by 715 acres (127%). Most of the changes in grasses and pads occurred between 2012 and 2016. Cattail and/or pickerelweed increased by 697 acres (216%) over the study period, primarily before 2012.

On Lake Kissimmee, the most abundant plant community was maidencane/Egyptian paspalidium in 2009 and pads in 2012 and 2015. Area dominated by maidencane/Egyptian paspalidium declined by 822 acres (-39%) over the study period, primarily between 2012 and 2015. The greatest expansion was observed for area dominated by pads, which increased by 2,043 acres (156%) from 2009 to 2015. Pads primarily replaced open water, maidencane/Egyptian paspalidium, and mixed maidencane/Egyptian paspalidium-pads. Area co-dominated by pads also expanded by 721 acres (101%) over the study period.

PRESENTER BIO: Craig Mallison is an Associate Research Scientist with 29 years of experience working for the Florida Fish and Wildlife Conservation Commission (FWC). He has led FWC's littoral vegetation mapping in lakes project since 2005. He has been a member of FWC's Kissimmee Chain of Lakes Working Group since 2004 and served as project manager for several aquatic plant management projects on the Kissimmee Chain of Lakes.

IMPORTANCE OF SEQUENCE: WHAT ORDER OF VEGETATION MANAGEMENT METHODS IS MOST EFFECTIVE IN CONTROLLING CATTAIL WHILE REHABILITATING IMPACTED EVERGLADES RIDGE AND SLOUGHS?

Michael Manna[1]*, Sue Newman*[1]*, Mark Cook*[1]*, LeRoy Rodgers*[1]*, Christen Mason*[1]*, Christa Zweig*[1]*and Kelsey Pollack*[2]

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Our habitat restoration efforts in the northern Everglades (WCA-2A), have focused on methods to accelerate the recovery of cattail (*Typha domingensis* Pers.) impacted areas. Early experimentation involved a spray-then-burn method using herbicides: Glyphosate and Imazapyr. This resulted in submersed aquatic vegetation (SAV) open-water marshes of Chara spp. within 2 years. However, some experimental plots required additional treatment to maintain a competitive advantage against cattail, resulting in the loss of desirable ridge and slough species. Five years after initial treatment a new study demonstrated that the herbicide, Imazamox, was more selective towards cattail than other Everglades species. Switching to Imazamox, we were able to maintain the established SAV community and support the development of wet prairie species. Further study showed that applying Imazamox before burning, like our early experimentation, controlled cattail and promoted SAV, yet provided additional benefits: conservation of desirable vegetation keeping ridge and slough spatial structure intact while promoting diversity. However, as with Glyphosate, maintenance applications were needed to keep re-invasion in check.

In this study, we examined approaches to refine our treatment strategy with Imazamox; specifically, comparing the sequence of herbicide application to prescription burning. We hypothesized that burning before, as opposed to after, spraying, would provide better herbicide coverage and result in greater spatial control of cattail thus reducing maintenance frequency. Two years after application of these active marsh improvement strategies, we present cattail control efficacy and ecological recovery data from ridge and slough communities impacted by cattail.

PRESENTER BIO: Michael Manna is a research ecologist with 19 years of experience working on vegetation projects in marshes and tree islands in the Everglades. He has extensive experience with plant taxonomy and ecology of plants in Florida.

EVALUATING THE EFFECTS OF PROPAGULE TYPE, SEASONALITY AND PLANT SPACING ON ESTABLISHMENT OF GIANT BULRUSH

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Much of Florida's natural resources are being degraded as a result of development, agricultural activities and various other pressures. A healthy aquatic system needs to have a wide variety of native plants, both submersed and emergent. This can be accomplished by having restoration projects that include planting native species. Giant bulrush [*Schoenoplectus* (formerly *Scirpus*) *californicus*] plays a crucial role in Florida's diverse ecosystems. Resource managers install many thousands of bulrush plants each year, but they often experience poor establishment and high mortality rates. The purpose of this experiment was to determine whether seasonality, plant spacing, and propagule type affected establishment of bulrush. Each planting consisted of 15 treatments (5 propagule types x 3 spacings) with 4 replicates of each combination of treatments, for a total of 60 plots. Treatments were randomized within each of 4 rows (reps). There were three plantings each year (fall, spring, and summer) for two years, with stem counts performed 2, 4, 6, and 12 months after planting. These experiments revealed that the most important main effect was spacing; plants on 3' centers had the greatest x-fold increase but the lowest number of plants per square foot 12 months after planting. Propagule type also influenced establishment; there were differences between nursery plugs and field-collected rhizomes, but there was no difference among the 4 types of field-collected propagules. Greatest x-fold increase and number of plants per square foot occurred in plantings that took place in spring and summer.

<u>PRESENTER BIO</u>: Ian Markovich is a MS graduate student in Dr. Gettys' Aquatic Plant Science Lab. He has been part of the lab for three years and has taken part in many herbicide efficacy trials, contact exposure trials, and habitat creation and restoration projects.

CORROBORATION OF EARLIER ESTIMATES OF LATE 19TH CENTURY FRESHWATER FLOW IN THE EVERGLADES

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Restoration of the Greater Everglades Ecosystem requires an understanding of the natural system prior to water management and land use changes beginning around 1900 CE. Agencies responsible for restoration of the Everglades frequently use the Natural Systems Model 4.6.2 (NSM) as the basis for setting restoration targets. However, paleoecologic data and limited observational data from the beginning of the 20th century indicate that the NSM underestimates the amount of freshwater in the system at that time. Prior work (Marshall et al. 2014) used paleosalinity estimates from Florida Bay in conjunction with linear-regression models to adjust the NSM and estimate circa 1900 water levels and flow. The purpose of this study was to use a different proxy (pollen) in a different part of the system (freshwater marshes) to compare to the 2014 estuarine-based estimates of flow and water level, which used mollusks as the proxy for salinity in Florida Bay.

For this study, three sediment cores were selected from the freshwater system in relative proximity to water monitoring stations. The pollen assemblages were analyzed and the annual average water level and hydroperiod for each core segment was estimated, based on the known preferences of the living plant species. The difference between the paleo-estimated water level and the median bias-adjusted NSM average water level for each core just prior to 1900 was used to provide a constant adjustment to the NSM 4.6.2. Flow models were developed using the observed data from the water monitoring stations in proximity to the cores, then the paleo-adjusted NSM 4.6.2 data were used as input to the flow models to estimate circa 1900 flow.

A comparison of the NSM output to the paleo-adjusted NSM output indicated that water levels ranged from 7.4 to 21.4 cm higher and hydroperiods from 11 to 74 days longer at the three locations within the freshwater Everglades. The output from the paleo-based flow models estimated the circa 1900 flow to be 2.2 times greater than observed conditions for Shark River Slough (SRS) and 3.8 times greater than observed conditions at Taylor Slough Bridge (TSB). The results of this study agree with the previous Marshall et al. (2014) estuarine-based estimates of flow (2.1 times greater for SRS and 3.7 for TSB). These results provide resource managers with a second estimate of circa 1900 flow that corroborates the original estimates. Two different sets of proxy data from two different parts of the ecosystem have indicated that the NSM 4.6.2 underestimates the historic flow. These methods provide a mechanism for calibrating the NSM 4.6.2 output, thereby improving the utility of the model for establishing targets based on empirical data.

<u>PRESENTER BIO</u>: Dr. Marshall is a coastal hydrologist with significant research experience in Florida, including 15+ years working on the Everglades. He has studied the connection between the freshwater wetlands and the estuarine receiving waters in south Florida and the impact of changes to hydrology on the biota, including climate change.

RESOURCE SELECTION BY SMALL HERONS IN A SUBTROPICAL INTERTIDAL MUDFLAT

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In freshwater systems, seasonal water-level fluctuations constrain the availability of aquatic prey for wading birds, and thus regulate foraging patterns. In intertidal systems, daily tide cycles place harsher restrictions on when and where wading birds can feed, particularly for shorter-legged, daytime foragers like the Little Blue Heron (*Egretta caerulea*). To investigate how small herons respond to hydrologic changes in a tidal-driven environment, we developed a modeling framework to predict foraging abundance, prey abundance, and habitat selection.

From 2016 to 2018 we measured Little Blue Heron foraging abundance and prey availability within Florida Bay and Great White Heron National Wildlife Refuge (GWH) during the breeding season (February – July). We tested hydrologic and temporal variables as predictors of Little Blue Heron abundance through external validation of a published model. The model suggested good fit ($R^2 = 0.44$) but severely over-predicted lower and upper values of abundance. To improve model fit, we incorporated breeding stage as a random effect in our generalized linear mixed models accounting for changes in abundance over the breeding season. Variation in foraging abundance was best explained by shallow-water availability (i.e., spatial area [km^2] x temporal availability [hr]) which predicted a 1.10 to 2.81-fold change in abundance. The effect of shallow-water availability was strongest during the late breeding season when every 1 km^2-hr increase results in a 1.6-fold increase in predicted abundance. While abundance is a useful metric for coarsely evaluating habitat use patterns, it does not address underlying variation in the spatial distribution of resources such as prey availability.

To address habitat associations of Little Blue Heron prey, we performed a generalized linear mixed model approach to identify relationships between key prey species biomass and submerged aquatic vegetation (SAV) parameters. We found that prawns (*Penaeus* spp.) were positively associated with seagrass density (β=0.593), Gulf Toadfish (*Opsanus beta*) were positively associated with algae (β=0.380), and pipefish (Syngnathinae) were negatively associated with algae (β=-0.511). We used this information to improve a resource selection function framework testing for nonrandom use of foraging sites varying in habitat attributes. On average, Little Blue Herons foraged in areas with lower water depths and greater SAV cover than were available. Used and available sites were similar in key prey species biomass and proximity to mangrove islands. We expect that shallow-water availability, water depth, and SAV cover will best explain habitat selection patterns and best predict probability of use in intertidal systems. A resource selection function framework will provide a tool for resource managers to monitor high-use wading bird foraging areas, assess inter- and intra-annual resource fluctuations based on real-time environmental conditions, and evaluate impacts of hydrologic restoration regimes and sea-level rise scenarios on coastal wading bird habitat.

PRESENTER BIO: Marisa T. Martinez is a graduate research assistant pursuing her Ph.D. under the advisement of Dr. Gawlik at Florida Atlantic University. She received her M.S. at Texas A&M University in Wildlife and Fisheries Science and her dual B.S. at Cornell University in Natural Resources and Animal Science.

STOPPING THE SPREAD: PREDICTING MOVEMENT CORRIDORS OF INVASIVE ARGENTINE BLACK AND WHITE TEGUS

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The Argentine black and white tegu (*Salvator merianae*) is a large, omnivorous, invasive lizard established in Hillsborough and Miami-Dade Counties, Florida where they potentially negatively impact native species through competition, alteration of the ecosystem, and direct predation of small mammals, snakes, and eggs of birds, turtles, and American alligators (*Alligator mississippiensis*). Tegus are native to South America and occupy savannas, forests, beaches, and rocky coasts up to 2000 m elevation and temperatures between -2 and 45^{o}C. Due to the variety of habitats occupied by tegus in their native range, their habitat preference and movement in South Florida is not intuitive. Our study site is in the Southern Glades of Miami-Dade County, in a disturbed environment comprised mostly of marsh with small, elevated tree islands. Artificially elevated, interconnected berms and levees transect the area. Our study site contains a breeding population of tegus and is located about 10km east from the entrance to the Everglades National Park and 10km west from Turkey Point Power Plant. In both locations, tegus have been sighted but are not yet established. Everglades National Park contains a variety of native wildlife such as alligators, wading birds, snakes, and mammals that could be impacted from the introduction of Tegus. Likewise, Turkey Point Power Plant and the surrounding area contains American crocodile (*Crocodylus acutus*) nesting habitat that could be threatened from the introduction of tegus. An analysis of tegu movement corridors will inform managers where removal efforts will be most impactful in stopping the spread of tegus into these sensitive habitats. Our objectives are to (1) determine habitat selection of telemetry study tegus and (2) determine movement corridors towards the Everglades National park and Turkey Point Power Plant.

We determined tegu habitat selection using GPS telemetry data that we collected from 15 mature individuals between April 2016 and November 2018 with points taken every 90 minutes. We assigned habitat categories using the South Florida Water Management District 2008-2009 land cover/land use GIS layer. The three habitat types considered in our analysis are marsh, tree and shrub, and road habitat. We quantified tegu habitat selection using Type III Manly selectivity measure within a 99% Minimum Convex Polygon home range as an average of all telemetry study tegus. From this information, we decided on least cost corridor resistance classes: 1 for tree or shrub, 5 for marsh, and 25 for road. We conducted least cost corridor analyses and summed them together to determine movement corridors out of our system. Start points were locations of likely tegu dispersal out of our study area, such as the underpasses along US 1 or splits in the levee. The end points were locations of tegu sightings in vulnerable areas such as the entrance to the Everglades National Park and east towards Turkey Point Power Plant where there is a network of raised and connected tree and shrub habitat.

Tegus significantly select tree and shrub habitat and avoid marsh habitat. In our system, artificially raised land provides and connects tree and shrub habitat, facilitating tegu movement. Our findings are supported by a similar study by Klug et al. that found that tegu movement in the Southern Glades is facilitated by artificially raised land. Our least cost corridor map should inform managers where to focus removal efforts. Particular attention should be paid to the northwestern extent of our map where there is a large corridor for tegu movement into the Everglades National Park and to the raised and connected land that leads to Turkey Point Power Plant. We also believe that removal of artificially created raised and connected habitat would decrease the spread of tegus.

PRESENTER BIO: Brittany Mason is a Master's student at the University of Florida's Institute of Food and Agricultural Sciences, Department of Wildlife Ecology and Conservation. She is a member of the University of Florida's Croc Docs, where she is involved in tegu telemetry and removal, herpetofaunal surveys, and crocodilian surveys.

EFFECTS OF PHOSPHORUS ON DIATOM ASSEMBLAGE NETWORKS

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The Florida Everglades possesses extensive mat-forming microbial communities (periphyton) with a great influence on basic attributes of the ecosystem. In the Everglades, periphyton mats are a major component of the base of the food web and are responsible for as much as 50% of net primary productivity. Additionally, mats provide habitat structure and regulate the availability of nutrients and gases within the water column. Periphyton is highly sensitive to changes in nutrient availability and can dissociate as conditions change. The exact mechanism behind mat dissociation remains unknown, but it may be due to changes in co-dependencies between species. Resource limitation often determines the presence and strength of species co-dependencies. Several works by other authors have identified aspects of community dynamics that are analogous to the behavior demonstrated by complex mathematical networks and have demonstrated the ability to predict shifts in community structure in response to changes in one or more environmental variables, which has implications for environmental management and restoration projects. As diatom species data is already used to measure water quality, we are exploring the use of networks constructed from diatom abundance data to measure the health of periphyton in the Everglades.

PRESENTER BIO: Eric Massa is a M.Sc. student at Florida International University with studying mutualist network ecology in wetlands. He has experience in diatom taxonomy and in working with historical datasets. His research is partially funded by the Everglades Foundation's FIU ForEverglades Scholarship.

HURRICANE-DRIVEN MOVEMENTS OF COMMON SNOOK IN THE SHARK RIVER: AN EXAMINATION OF FISH REDISTRIBUTION AND ENVIRONMENTAL DRIVERS

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Extreme climate events such as tropical storms have been shown to elicit large-scale movements in coastal fish populations, however, our knowledge of the mechanisms and specific environmental cues driving these movements remains incomplete. Hurricane Irma made landfall in South Florida on September 10th, 2017, with the eye of the storm passing within 60 km of a long-term research site in the Shark River (SR) of Everglades National Park. In this study, we use acoustic telemetry data from an extensive array of receivers in the SR to examine the timing, direction, and magnitude of storm-driven movements of Common Snook (*Centropomus undecimalis)* in relation to the hurricane. We hypothesized that the storm resulted in rapid shifts in distribution, and that these movements may have been driven by environmental cues stemming from low barometric pressure associated with hurricane conditions, fluctuations in water levels (stage) characterizing altered riverine conditions, or a combination of both hurricane and riverine factors. Analysis of the telemetry data revealed large-scale Snook movements out of the upper SR in the time period surrounding hurricane landfall. Furthermore, regression models indicated that these movements were best explained by a combination of both hurricane and riverine conditions. The intensity of extreme climate events has increased in recent years, a trend that is predicted to continue, and shedding light on the responses of recreationally important species can help to formulate predictions on how fish might respond to future events. Understanding when, where, and why fish move can provide information that allows scientists and natural resource agencies to make informed decisions regarding how to manage fish stocks and maintain angling opportunities in disturbance prone coastal regions.

<u>PRESENTER BIO</u>: Jordan Massie is a PhD student studying movement ecology and the community dynamics of fish populations in the Shark River. His research focuses on how hydroclimatic variability and disturbance shape the behavior and distribution of riverine fishes, and the consequences of movement for food webs and recreational fisheries.

COMMUNITY-LEVEL MODELING OF PERIPHYTIC DIATOMS IN RESPONSE TO CHANGING SALINITY AND PHOSPHORUS GRADIENTS USING THE EVERGLADES LANDSCAPE MODEL

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The Florida Everglades is a low-lying, karstic wetland exceptionally vulnerable to sea level rise and saltwater intrusion. Uncertainty about the degree to which freshwater restoration will mitigate saltwater intrusion, and its impact on natural resources, has prompted the development of ecosystem modeling projects, such as the Everglades Landscape Model (ELM). The ELM is a (largely) process-based, spatially distributed hydro-ecological model that has been used in a range of projects, showing how patterns of water, nutrients, soils and vegetation change under multi-decadal modifications to water management or environmental forcings. In this study, we add a diatom community module to the General Ecosystem Conceptual Model, the backbone of the dynamic equations that comprise the ELM, to strengthen ecosystem predictions. Diatoms are particularly effective bioindicators and represent an enormous untapped potential for tracking saltwater intrusion into vulnerable coastal ecosystems.

We used existing diatom community and environmental data collected from 7 transects in the southern Everglades during a wet and a dry season in 2014 and 2015 to develop quantitative models for diatom assemblages in response to conductivity and phosphorus, two of the most dominant drivers of periphyton dynamics in the Everglades. Sampling sites were classified into diatom assemblage categories (i.e., freshwater, transitional, brackish) based on hierarchical cluster analysis, and indicator species analysis was performed to identify species most strongly associated with each community type. A multinomial logistic regression (MLR) was performed to predict diatom assemblage categories as a function of conductivity and mat total phosphorus (TP) for the dry and wet season.

The cluster analysis identified 3 significantly dissimilar diatom assemblages in the dry season and 4 in the wet season. The misclassification error for dry and wet season MLR models was under 15%; and conductivity and mat TP were significant predictors ($p < 0.1$) for dry and wet season probability equations. The MLR probability equation results for community type responses to the environment were encoded into a simple empirical ELM module. Under future scenarios including sea level rise, the ELM-calculated that hydrology, conductivity and mat TP concentration were drivers of the diatom community probability responses, showing how landscape patterns of diatom communities generally shifted inland in response to sea level rise, and changes in upstream freshwater flows altered those community patterns depending on seasonal rainfall and water management decisions. This research shows how diatom assemblages can be used to predict the future location of ecotone boundaries in coastal ecosystems, an issue of concern in coastal wetlands worldwide.

PRESENTER BIO: Dr. Mazzei is a postdoctoral research associate studying the effects of changing salinity and phosphorus gradients, associated with saltwater intrusion, on the function and algal composition of Everglades periphyton. She is currently working on community-level modeling of periphytic diatoms under simulated ecosystem scenarios, as well as molecular studies of periphytic algae.

RELATIONS OF TOTAL PHOSPHORUS AND ORTHOPHOSPHORUS CONCENTRATIONS WITH RAINFALL, SURFACE-WATER DISCHARGE AND WATER-QUALITY PARAMETERS IN BIG CYPRESS SEMINOLE INDIAN RESERVATION, FLORIDA, 2014–16

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The U.S. Geological Survey, in cooperation with the Seminole Tribe of Florida, used water-quality data collected between October 2014 and September 2016 by the Tribe and the South Florida Water Management District to (1) examine the relations between local hydrology and measured total phosphorus and orthophosphorus concentrations and (2) identify predictive variables for total phosphorus concentrations within the Big Cypress Seminole Indian Reservation.

The highest total phosphorus and orthophosphorus concentrations occurred during peak surface-water flows in the canals following long dry periods. Concentrations of total phosphorus and orthophosphorus increased in the western half of the Big Cypress Seminole Indian Reservation during wet periods, but increased concentrations tended to lag behind rainfall events, likely because control structures upstream of sampling sites do not release flows until the water levels in the canals reach predetermined control elevations. This pattern may indicate that bed sediments in the canals contain high concentrations of phosphorus that become resuspended during high flows or that phosphorus salts that had accumulated on dry land during dry periods are carried into the canals by runoff. The largest total phosphorus spikes usually occurred at the beginning of high-flow events, but then quickly tapered off even when flows remained high.

From October 2014 to September 2016, concentrations of total phosphorus tended to decrease as surface-water inflows moved across the Big Cypress Seminole Indian Reservation from north to south. In both the western and eastern halves of the reservation, the mean concentration of total phosphorus was lower in the surface-water outflows from the Big Cypress Seminole Indian Reservation than in the inflows. The mean concentration of total phosphorus in the inflows to the western reservation was 0.04 milligrams per liter, whereas the mean concentration of total phosphorus in the outflows was 0.03 milligrams per liter. In the eastern reservation, the mean concentration of total phosphorus in the inflows was 0.07 milligrams per liter, whereas the mean concentration of total phosphorus in the outflows was 0.04 milligrams per liter.
Total phosphorus concentrations were evaluated relative to other water-quality parameters, including turbidity, suspended solids, nitrate plus nitrite, dissolved oxygen, pH, and specific conductance, to determine if any relations existed between phosphorus and other variables. Weak relations (R-squared greater than 0.5) were indicated for turbidity and suspended solids at two sites, which indicates that there may be a relation of increased total phosphorus to mobilization of sediment.

PRESENTER BIO: Mr. McBride is a hydrologist with nearly 30 years of water quality experience in both the laboratory and field. Since 2005, he has participated in and managed several watershed studies in west-central Florida. He is currently studying the sources and ages of flow in the Lower Floridan aquifer.

ASSESSING FISH MOVEMENT THROUGH TIME IN EVERGLADES NATIONAL PARK USING DRIFT FENCES

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Water delivery to the eastern boundary of Everglades National Park (ENP) and the headwaters of Taylor Slough has been an important focus of management and planning since the construction of the L31W canal, but management has been a major focus since implementation of the Interim Operating Plan (IOP) in 2000. In 2003, we began a monitoring program of fishes and macroinvertebrates along the eastern ENP boundary to track impacts of changing water deliveries. The timing and flow of the water can alter fish species distribution and movement and our work as focused on how water delivery affects exchange of fishes between the L31W, Aerojet, and C-111 canals and the adjacent marshes. We have used drift fences with minnow traps to capture fish as they move through the marsh, sampling with reference to distance from these canals. Canals on the border of ENP act as a dry-season refuge for many species, including non-native fishes. Since 2003, we have collected over 2,500 drift-fence samples (four minnow traps per fence, over 10,000 minnow trap samples) from twelve short-hydroperiod study sites located from Context Road in the north to the southern end of L-31W canal, and east to the southern tip of the Aerojet Canal and south of the C-111 canal and five long-hydroperiod reference sites in the Shark River Slough. Over the 14 years of study, hydroperiod averaged 109 days (ranged from 41 days to 199 days) at our canal-margin study sites and close to 365 at our long-hydroperiod sites. Fences were sampled monthly or bi-monthly when water depth exceeded 25 cm, so the number of samples varied among years.

In 2017-2018, hydroperiods were short at all sites from S332B south to the L-31W area, in part because of operations related to construction for the Upper Taylor Slough project that will ultimately increase water deliveries. We completed five sets of samples from September, 2017, through August, 2018, and collected fish and macroinvertebrates from 126 drift-fence sets with 451 minnow trap samples (4 traps per fence set). This yielded 1,279 fish and 1,063 aquatic invertebrates (mostly grass shrimp). We have collected 29 species of fish over the course of the study, of which 9 are non-native. African Jewelfish, Bluefin Killifish, Eastern Mosquitofish, Mayan Cichlids, Golden Topminnows, and Sailfin Mollies were the 6 most frequently collected fish species this project year at short-hydroperiod sites along the border of ENP. There have been marked changes in patterns of non-native fishes in the three study regions of this project in the past two years. Collections at the long-hydroperiod references sites in Shark River Slough have been dominated by African Jewelfish since 2012, but their relative abundance dropped in 2017 and Bluefin Killifish increased. Eastern Mosquitofish and Sailfin Mollies dominate our Rocky Glades sites (UTS, Context Road, S332B, C, D, and L31W sites). Our sites in the C-111 basin (C-111 and Aerojet) also have a high representation of non-native fishes, but Eastern Mosquitofish and Sailfin Mollies were the dominant taxa there. Grass Shrimp were by far the most commonly collected invertebrate in both short and long-hydroperiod sites in this study. As changes are made to the management and delivery of water to eastern ENP and Taylor Slough, we will continue to monitor fish movement and connectivity associated with the boundary canals.

PRESENTER BIO: Erin McCarthy is a research technician in the Aquatic Ecology Lab at Florida International University. She graduated in May 2018 with her Master’s in Marine Science from the University of North Carolina Wilmington.

IDENTIFYING FACTORS AFFECTING PROTANDRIC REVERSAL IN COMMON SNOOK

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The common snook (*Centropomus undecimalis)* is a protandric hermaphrodite that spans both the fresh and marine near shore areas of Southern Florida. They typically occupy a diversity of estuarine and nearshore habitats until spawning migrations concentrate them in the mouths of inlets and bays. Management, however, is difficult because all female snook originally mature as males, yet our understanding of why most male snook become female is limited. Utilizing passive acoustic telemetry data obtained from FWC, kernel density was determined to identify the home ranges of 247 snook. This study is pairing these home ranges with the sex ratios within them, to highlight and correlate variations in the environmental conditions at the age and size of transition of individual fish. The aim of this research is to improve upon existing predictive models of the age and size at which male snook become females to improve the management of hermaphroditic species and our understanding of what triggers this unique biological trait.

<u>PRESENTER BIO</u>: Brent McKenna is a Master's of Science student in marine science and oceanography at Florida Atlantic University working under Dr. John Baldwin. He is researching the causes and predictors of the protandric change in snook.

CERP RECOVER PROGRAM 2019 SYSTEM STATUS REPORT KEY FINDINGS FROM THE GREATER EVERGLADES FOR WATER YEARS 2013-2017

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The REstoration, COordination, and VERification (RECOVER) Program provides scientific and technical support to the Comprehensive Everglades Restoration Plan (CERP) in meeting its goals and purposes by applying a system-wide perspective to the planning and implementation of CERP. The primary tool by which RECOVER assesses the performance of CERP is RECOVER's Monitoring and Assessment Plan (MAP). The MAP provides sound information from the monitoring of ecological indicators, identification and resolution of restoration uncertainties, application of adaptive management strategies, and employment of best scientific knowledge and practices.

The 2019 System Status Report (SSR) provides a synthesis of five years of monitoring data across the greater Everglades ecosystem by region (Water Years (WY) 2013-2017). The Greater Everglades RECOVER module encompasses the freshwater wetlands of the Everglades from the A.R.M Loxahatchee National Wildlife Refuge, through Water Conservation Areas 2 and 3, and Everglades National Park. The Greater Everglades relies on clean freshwater entering the system from the north in order to restore, preserve and protect its iconic ridge – slough – tree island – marl prairie mosaic. Historically, large volumes of freshwater sheet-flowed south from Lake Okeechobee through the Everglades marshes to Florida Bay. Reduced flows and habitat fragmentation since early drainage projects in the 1930s have significantly degraded microtopographic habitat heterogeneity and reduced regional habitat available to important floral and faunal species. Evaluation of the Greater Everglades between WY 2013-2017 utilized a suite of ecological indicators including periphyton; wading birds; prey abundance and availability; ridge-slough, tree island and marl prairie landscapes; alligators; and non-native/invasive animals.

In the Greater Everglades region conditions varied throughout the five-year reporting period, with indicator scores ranging from good to very poor. Conditions for periphyton were good despite legacy and high-water effects correlated with a shift in community structure. Tree islands were also in the good range due to resilience of the islands in the Water Conservation Areas. Non-native fishes and invasive reptiles, continue to increase in number and expand their range. Multiple years of wet conditions impacted prey availability, and as a result, most wading bird targets were not met. Prey abundance and alligator indicators remain impaired. Marl prairie and ridge and slough habitat in many areas remain degraded, however some areas of marl prairie habitat have shown improvement which has been linked to water management actions.

PRESENTER BIO: At ENP, for the last 12-1/2 years, Agnes has coordinated the efforts of staff in the various RECOVER activities and was the ENP technical lead for the CEPP. Agnes is currently the ecological sub-team lead for the Combined Operational Plan.

DETECTION OF NON-NATIVE BULLSEYE SNAKEHEAD, *CHANNA MARULIUS*, IN SOUTH FLORIDA USING ENVIRONMENTAL DNA

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The bullseye snakehead, *Channa marulius*, is a large, fast-growing predator native to southeastern Asia. It was first collected in Tamarac, Florida in 2000 and has rapidly spread to cover more than 830 km^2. The species has primarily been found in residential canals in Palm Beach and Broward counties; however, as it expands its range across south Florida, it could invade more natural areas such as Loxahatchee National Wildlife Refuge, the other Water Conservation Areas, and Everglades National Park. We used Environmental DNA (eDNA) to track the expansion of this species in south Florida. Environmental DNA detection is a rapidly-expanding genetic technique used to non-invasively detect cryptic, low density, or logistically difficult-to-study species. Environmental DNA is shed into the environment through skin cells and bodily fluids and is primarily detected in water samples collected from seawater, lakes, rivers, and swamps. Environmental DNA detection of invasive species can be used to inform management decisions by delimiting occupied ranges and estimating detection probabilities in areas where these species are not easily observed visually, allowing managers to monitor their movements.

We have developed and validated a species-specific eDNA assay for use on both quantitative and state-of-the-art digital PCR to assist with detection and tracking of the snakehead's current geographic range. This assay was tested on water samples in areas where snakehead is known to be present and along possible invasion pathways in south Florida where presence had not previously been determined. We collected 254 samples across southeast Florida from 2015 to 2018. Palm Beach and Broward county water samples had positive eDNA detections for snakehead at all collection locations, whereas samples collected in Miami-Dade and Collier counties were positive at two locations where they had not been visually detected previously. One of the positive detections was on the northern border of Everglades National Park (canal L-67), about 40 km from the known range. The water samples tested from the interior of Loxahatchee National Wildlife Refuge had few positive detections and low snakehead eDNA concentrations. Using preliminary data, we have estimated occupancy and detection probabilities to be in range of 38-79% and 47-67%, respectively, for the positive samples in south Florida. Our environmental DNA assay can be used to help natural resource managers track the spread of this invasive species within their jurisdictions.

PRESENTER BIO: Ms. Meigs-Friend is a biologist with over 10 years working with the U.S. Geological Survey. Ongoing research projects involve genetic analysis of a variety of invasive and endangered species, and most recently, use of eDNA to study these species.

MAPPING TREE ISLAND VEGETATION IN THE WATER CONSERVATION AREA 3B USING WORLDVIEW2 AND LIDAR DATA

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Tree islands are essential and complex components of the Everglades ecosystem. Within them, plant communities are arranged along hydrologic and nutrient gradients. Compartmentalization of the Everglades and modifications of hydrologic regimes have caused changes to the vegetation structure and composition of tree islands, and even the loss of tree islands. As a result of the implementation of the Comprehensive Everglades Restoration Plan (CERP), it is hoped that tree island recovery will ensue. To understand how the structure of plant communities in tree islands respond to hydrologic change, accurate mapping techniques that represent the expected scale of tree island change are needed. When using remote sensing methods to monitor vegetation change, spectral signature extension from one island to another is a challenge, because vegetation structure and composition of tree islands vary throughout the Everglades landscape.

We evaluated mapping accuracy of tree island plant communities on eight islands within the greater Everglades system using a variety of subsets of single season and bi-seasonal spectral reflectance data from Digital Globe's Worldview 2 (WV2) sensor in combination with local spectral texture variables of mean and range derived from each spectral band. Where Light Detection and Ranging (LiDAR) data was available, we included vegetation height estimates, including local mean, minimum and maximum derived from NASA Goddard's (LiDAR) data. Plant community classes were initially defined at a 2 m spatial scale at the species level whenever possible, but species-specific plant communities with similar spectral signatures were iteratively grouped under more generic classes to reduce classifier confusion. Of the final 16 vegetation classes, trees and shrubs were dominant in six and present in nine, graminoid and broadleaved species dominated the other classes. We tested spectral separability among the 16 plant-community classes using random forest classifiers trained with different spatial subsets of training samples across tree islands to detect the communities across the larger landscape extent. We conducted a design-based accuracy assessment, evaluating the stratified random samples from aerial images, ground field visits, and helicopter surveillance flights.

Plant communities were successfully mapped across all eight islands with an overall mean accuracy of 94%. On average, bi-seasonal data added 6% accuracy over single-season results. Inclusion of LiDAR data increased accuracy by an additional 1% for most classes, for tree and shrub classes, however, accuracies increased by an additional 5%. Spectral- signature extension of multi-spectral reflectance data across islands showed that using a classifier trained only on one island resulted in an internal map accuracy of 95.1 ± 2.2%, and 92.7 ± 2.5% when applied to a nearby island. Accuracy increased to 97.3 ± 0.97% and 94.9 ± 1.6% when training sample points from both islands were included. Preliminary results show that the methodology has the ability to detect vegetation classes with high spatial precision, accuracy and confidence, which is a basic requirement for detection of small changes in vegetation composition that can provide valuable feedback for adaptive management strategies.

<u>PRESENTER BIO</u>: Ms. Ximena Mesa is a research associate at the Southeast Environmental Research Center with a strong background in geographic information systems, spatial analysis and remote sensing.

SPATIAL ECOLOGY AND GENERAL LIFE HISTORY OF THE EASTERN INDIGO SNAKE (*DRYMARCHON COUPERI*) IN SOUTHWEST FLORIDA

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The eastern indigo snake (*Drymarchon couperi*) is a large, non-venomous snake endemic to the southeastern Coastal Plains of the United States. Due to habitat loss, fragmentation, and collection for the pet trade, this species is listed as federally threatened under the Endangered Species Act. We must better understand life history and dispersal patterns of this species throughout its range to implement effective management strategies. However, previous studies have focused on the central and northern portions of their range, effectively ignoring the southernmost populations. South Florida differs drastically in climate and habitat features from more northern areas of the species' distribution and may require alternate management approaches. The present research addresses these knowledge gaps by utilizing radio telemetry to study *D. couperi* detectability, home range sizes, seasonal variations, habitat and refugia use, and general behavior in southwest Florida.

This study examined *D. couperi* at the Rookery Bay National Estuarine Research Reserve in Collier County, Florida - an environment that includes comparatively stable year-round temperatures, higher hydrological variations, and prominent saline environments (e.g. mangrove swamplands) relative to other areas in the snakes' range. Unlike northern populations, *D. couperi* in the Rookery Bay Reserve were more active during the mid-day hours and breeding seasons, despite ambient air temperatures. We also found these snakes to prioritize upland features dominated by tortoise burrows, roads, and open trails; but would occasionally use wetland habitats including mangrove swamps. In addition, these snakes maintained large home ranges similar to the most northern populations. Understanding the diverse behaviors of *D. couperi* is essential to the overall conservation of the species throughout its range.

PRESENTER BIO: Matthew Metcalf received his B.Sc. from Auburn University in Zoology and completed his M.Sc. in Environmental Sciences from Florida Gulf Coast University. His research focuses on the ecological impacts of invasive species, as well as conservation biology for tropical amphibians and reptiles.

SEA LEVEL RISE AND FUTURE ENVIRONMENTAL TRENDS – BIG PINE KEY CASE STUDY

***Lori Miller*[1], *and Steve Traxler*[2]**
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Environmental trends along the Florida coast are climatologic and hydrologic in nature, which will have huge effects on the ecology of the region. Many areas of Florida are going underwater due to sea level rise. All sea level rise scenarios agree and depict this to happen. The only questions, or uncertainties, are not about *if* but *when* this will occur and to what extent. When a sea level rise projection identifies a certain future sea water elevation at some time in the future, we can be certain that this sea water elevation will be reached well before then. This will occur with increasing frequency during short-term extreme events, such as king tides and storm surge. This presentation will focus on one example, Big Pine Key in the lower Florida Keys, where habitat modification, including plant death, from salt water intrusion of the fresh water lens below the island is already occurring. Future environment trend effects to the terrestrial plant and animal life, especially from sea level rise, will be devastating. Interim adaptation strategies have been developed, but beyond 3 feet of sea level rise, there are very few options with only 7 percent of the island remaining above water. Depending on future greenhouse gas emission rates, current sea level rise scenarios indicate that salt water will begin to negatively affect the root zone of the island's last upland vegetation between 2040 and 2060 and the island will be mostly underwater by 2060 to 2080.

<u>PRESENTER BIO</u>: Lori Miller is the Senior Hydrologist for USFWS South Florida Ecological Services Office. She has a B.S. in climate/meteorology and a M.S. in Environmental Engineering from University of Florida. She received the national "Climate Champion" award in 2014 from USFWS and the national "Environmental Leadership" award from DOI in 2015.

A MULTIFACITED APPROACH FOR MANAGEMENT OF INVASIVE BURMESE PYTHONS

Melissa A. Miller
Florida Fish and Wildlife Conservation Commission, Davie, FL, USA

The Burmese python (*Python bivittatus*), a large constrictor snake native to southeast Asia, has established throughout southern Florida, south of Lake Okeechobee, west to Collier County and into the northern Keys. Invasive Burmese pythons prey on Florida's native wildlife, threatening Florida's natural resources. Management can be challenging as pythons are large, cryptic, apex predators established in largely inaccessible habitat throughout a mosaic of geopolitical boundaries. The Florida Fish and Wildlife Conservation Commission (FWC) utilizes a multifaceted approach for addressing these obstacles with management objectives aimed to increase python detection and removal, facilitate public involvement, coordinate management activities with our partners, and promote outreach and education. An overview of FWC python management, including python removal programs, supported research, and outreach and education efforts are presented.

PRESENTER BIO: Dr. Miller completed her PhD at Auburn University where she examined the indirect effect of invasive Burmese pythons on native snakes through parasite spillover. Currently, she is the Python Management Coordinator with the Florida Fish and Wildlife Conservation Commission where she is tasked with python management in collaboration with partners.

HIGHLY COMPETENT NATIVE SNAKE HOSTS EXTEND THE RANGE OF AN INTRODUCED PARASITE BEYOND ITS INVASIVE BURMESE PYTHON HOST

***Melissa A. Miller**[1]*, John M. Kinsella[2], Ray W. Snow[3], Bryan G. Falk[4]; Robert N. Reed[4]; Scott M. Goetz[1], Frank J. Mazzotti[5], Craig Guyer[1] and Christina M. Romagosa[6]*

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Invasive Burmese pythons (*Python bivittatus*) have introduced a non-native pentastomid parasite (*Raillietiella orientalis*) to southern Florida that has spilled over to infect native snakes. However, the extent of spillover, regarding prevalence and intensity, is unknown. We examined native snakes collected from Florida to determine the degree to which parasite spillover is occurring. We found *R. orientalis* has infected 13 species of native snakes collected from areas of sympatry with pythons. Prevalence and infection intensity of *R. orientalis* were significantly higher among native snakes compared with pythons. Moreover, adult female pentastomes achieved larger sizes and represented a greater proportion of the overall parasite population in native snakes versus pythons, indicating native snakes are more competent hosts of *R. orientalis* than pythons. We also examined native snakes from regions of allopatry with pythons to determine how far *R. orientalis* has spread. We found an infected native snake 348 km north of the northernmost infected python. Our data show that native snakes are highly competent hosts of *R. orientalis* and have facilitated the rapid spread of this non-native pentastome beyond the range of its non-native host.

<u>PRESENTER BIO</u>: Dr. Miller completed her PhD at Auburn University where she examined the indirect effect of invasive Burmese pythons on native snakes through parasite spillover. Currently, she is the Python Management Coordinator with the Florida Fish and Wildlife Conservation Commission where she is tasked with python management in collaboration with partners.

SUSTAINABLY SOLVING LEGACY PHOSPHORUS IN LANDSCAPES WITH WETLANDS AND WETLACULTURE

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The world is faced with unprecedented threats to our aquatic ecosystems from excessive nutrients caused especially by agricultural and urban runoff. More than 750 aquatic ecosystems in the world suffer from degraded ecosystem services with impairments described as hypoxia, dead zones, and harmful algal blooms, most due to pollution caused by excessive nitrogen and phosphorus. At the same time, it has been estimated that, on a global scale, we have lost half of our original wetlands to our current extent of 8 to 12 million km^2, with most of that loss in the 20th century. We are proposing here a sizeable increase in the wetland resources around the world to solve the diminishing wetland problem but with the strategic purpose of mitigating the excess phosphorus and nitrogen in a sustainable fashion. Examples include minimizing phosphorus inflows to the Florida Everglades with treatment wetlands and reducing nutrient inflows to Lake Erie in the Laurentian Great Lakes by restoring parts of the Great Black Swamp, formerly a 400,000-ha wetland west of Lake Erie.

We have developed an approach referred to as “wetlaculture” (wetlands + agriculture) that uses a landscape of alternating wetlands and agriculture to solves downstream nutrient pollution problems while decreasing the amount of fertilizers added to landscapes every year by recycling. We have established three *physical models* (sets of twenty-eight 1-m^2 mesocosms), two in temperate Ohio and one in subtropical south Florida, for estimating the amount of time that is needed for land to be wetland nutrient sinks for a given number of years as agriculture—a concept we refer to as landscape *flipping*. Early phosphorus results from our mesocosm wetlands in southeast Ohio started in 2016 (polluted Buckeye Lake in Ohio River basin), in northwest Ohio started in 2017 (near polluted Lake Erie), and south Florida in 2018 (analog of the Florida Everglades) will be presented. In addition to early water quality results and nutrient retention rates of wetlands in these 3 locations, we will present the first version of our *business model* that suggests an approach where farmers could make profits comparable to crop income if current or anticipated government subsidies, e.g. wetland reserve program (WRP) or payment for ecosystem services (PES) were coupled with Environmental Impact Bonds sold to investors.

PRESENTER BIO: Dr. Mitsch has been a professor for 43 years at 4 universities, most at Ohio State University. He has 700 publications in wetlands/water including 5 editions of *Wetlands*. He received his Ph.D. in systems ecology at University of Florida and has advised, with thesis or dissertation 79 graduate students.

CLEAN WATER MACHINE CHANNELBOX™ REACTIVE FILTRATION: A NATURE MIMICRY APPROACH TO DISTRIBUTED SURFACE WATER TREATMENT FOR ULTRALOW P AND HG

*Martin Baker[1], C.J. Strain[2], Daniel Strawn[1] and **Gregory Möller**[1]*
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In this work, we report on the development of a novel, distributed reactive filtration approach to managing dissolved and particulate phosphorus and mercury pollution in high-flow surface water. Modeled on how soils clean water in nature, the proprietary reactive filtration process uses a continuously renewable hydrous ferric oxide sand coating in an up-flow, slowly moving sand bed to remove contaminants. While municipal and industrial end-of-pipe installations of reactive filtration at scale have demonstrated 99+% total phosphorus removal to 11 µg/L and the ability to achieve the ultralow 1.3 ng/L total mercury discharge criteria of the Great Lakes Initiative, fluctuating water quality and variable hydrograph surface waters with very high flow regimes require process adaptation.

South Florida water management is a highly engineered system that involves 2,100 miles of canals, 2,000 miles of levees/berms, 600+ water control structures, 620 project culverts, and 77 pump stations. Constructed wetlands encompassing 57,000 acres remove nutrients as water flows south through the Everglades. These constructed wetlands, the Everglades Region Storm Water Treatment Areas (STAs), have the demonstrated ability to remove phosphorus from water at substantial land-footprint cost. Additional cost in maintaining operations, especially after severe weather events, is significant and requires a long development time to repair and regenerate the wetland flora and concomitant nutrient removal capability. Although successful in most metrics of operation, these STAs have not shown the ability to achieve the ultralow total P levels of 0.008 mg/L considered to be the historical background of this oligotrophic aquatic ecosystem. Also, Everglades Hg biomagnification has led to widespread fish consumption advisories. Sediment floc and water have been shown to be vectors of mercury transport.

We explore a ChannelBox™ distributed reactive filtration concept, wherein airlift sand filters using the reactive filtration are deployed in mobile, converted shipping containers, each capable of about 4000 cubic meters per day flows in a compact footprint. Engineering analyses survey CAPEX/OPEX economics for this approach along with the potential for operational advantages and disadvantages. Initial designs scope the possibility of "in channel" installations, scaled to substantial flow in parallel and serial configurations. Our work examines the potential for harnessing the motive force of water in drainage canals to overcome the hydraulic head requirements of filtration, in addition to the potential for renewable energy operations of these distributed surface water treatment installations. The potential for "dripless" solids separations from the treated water is examined, along with possible solids utilization and management approaches. For the autonomous operation of a ChannelBox™ distributed reactive filtration network, we describe a Kalman filter-based statistical approach, where in-situ measurable water quality variables (e.g., turbidity, pH), are used for computing minimum uncertainty estimates of final process water quality for system control, specifically targeting ultralow P and Hg.

<u>PRESENTER BIO</u>: Greg Möller is a professor of environmental chemistry and toxicology at the University of Idaho and Washington State University. He is a fellow of the National Academy of Inventors, a Fulbright scholar, a fellow of the International Union of Pure and Applied Chemistry, and a recipient of the Eddy Medal from the Water Environment and Reuse Foundation.

RATE OF ORTHOPHOSPHATE UPTAKE BY PERIPHYTON IN THE EVERGLADES

Kiersten W. Monahan *and J. Matthew Hoch*
Nova Southeastern University, Fort Lauderdale, FL USA

Periphyton is an essential source of primary productivity and plays a major role in the removal and short-term storage of phosphorus in the Florida Everglades. In recent decades, runoff from the Everglades Agricultural Area has caused a serious nutrient pollution problem. In the oligotrophic wetlands, the increase of phosphorus leads to the growth of species that disrupts the ecosystem. In order to gauge the response of periphyton to these environmental changes, the rate of phosphorus uptake by epipelon, metaphyton, and epiphyton mats are measured following spikes of varying concentrations of potassium phosphate. The concentration of orthophosphate in the water samples is determined through the ascorbic acid method and a UV-Vis spectrophotometer. Dry weight of each periphyton mat is used to standardize the uptake rates of orthophosphate. Results indicate that epipelon, benthic periphyton mats, have higher rates of phosphorus uptake. In addition, the South Florida Water Management District DBHydro database is used to monitor potential sources of phosphorus fluxes such as precipitation and canal openings. This allows translation of experimental results to practical implications, providing insight to the response of periphyton to changes within the Everglades ecosystem.

PRESENTER BIO: Kiersten Monahan is an undergraduate at Nova Southeastern University majoring in marine biology and working to complete her Honors Thesis.

SUCCESION OF PLANT SPECIES FOLLOWING INVASIVE BRAZILIAN PEPPER (*S. TEREBINTHIFOLIUS)* REMOVAL

Tadeo Monterrubio*, Kenton Finkbiner, Gregory Evans, Russell G. Billie and Marcel Bozas*
Miccosukee Tribe of Indians of Florida, Miami, FL, USA

Tree islands in the central Everglades are susceptible to invasion by exotic plants species. Brazilian pepper is a widespread invasive species often forming dense monotypic stands covering hundreds of thousands of acres in South Florida. Brazilian pepper is a pioneer of disturbed sites, but it is also successful in many undisturbed natural areas displacing native plants due to their rapid growth, easy dispersal mechanisms and allelophatic effects. Controlling this invasive plant is an important issue for the overall ecological health of conservation lands. In this study we monitor the succession of plant species following treatment. We've been treating tree islands with a high % coverage of Brazilian pepper by mechanical and chemical methods, aiming to eradicate this exotic plant for restoration purposes. One year post-treatment we observed the succession of native species, and pepper seedlings and sapling re-grow.

PRESENTER BIO: Tadeo Monterrubio is a biologist at the Miccosukee Tribe, working with invasive species, mainly with exotic plants. He has experience on snake population ecology, participating for a few years with the reptile ecology lab. at the National Autonomous University of Mexico.

APPLICATION OF CHEMICAL BIOMARKERS IN STORMWATER TREATMENT AREAS

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The Stormwater Treatment Areas (STAs) have been successful at decreasing total phosphorus (TP) concentrations from inflow waters, with an average 84% reduction in TP concentrations in Water Year 2017. However, there is still uncertainty as to the extent of internal contributions to TP concentrations, and the processes that drive these fluxes. Internally-produced organic matter (OM) from various sources, including emergent aquatic vegetation (EAV), submerged aquatic vegetation (SAV), algae, and microorganisms, may influence TP concentrations, particularly organic phosphorus (Po) concentrations. Here we investigate the relationships between OM and phosphorus (P) within an EAV and SAV cell in STA 3/4, with two reference sites in Water Conservation Area 2A (WCA-2A). Five components of the system (water column particulate organic matter (POM), vertical sediment traps, surficial sediment flocculent material (floc), periphyton, and 0-5 cm soil) were used to determine the quality of OM from different sources, and to assess OM transformations both down-profile (i.e. water column to soil) and between sites. *The objective of this project is to understand the sources and fate of OM within the STAs and to evaluate the relationships between OM and P within the Everglades.* We analyzed amino acids, pigments, and lignin phenols as key biomarkers to evaluate OM sources and linkages between OM and P. Degradation indices (DI) showed progressive degradation of OM along a vertical gradient from POM to soils at each sampling location. There was a positive correlation between the amino acid DI and the concentration of two bacterial biomarkers, MurA (Gram positive) and DAPA (Gram negative), suggesting that microbial abundance and activity may be associated with 'fresher' POM. The bacterial biomarkers were also positively correlated with total Po within the STAs, suggesting that further investigation into the relationship between bacteria and P should be conducted to determine the prevalence and bioavailability of bacterially derived P within the STAs. Overall these findings indicate that biomarkers are a refined tool to investigate OM dynamics within the STA/WCA systems, and that they provide a comprehensive perspective on the turnover and source of OM within these systems.

PRESENTER BIO: Elise Morrison is a post-doctoral research associate in the Bianchi Laboratory at the University of Florida's Department of Geological Sciences. She received her PhD from the Soil and Water Sciences Department at the University of Florida, and her B.Sc. from the University of California, Davis.

EXPLORING PATTERNS IN TARGETED SURVEYS FOR BURMESE PYTHONS IN THE GREATER EVERGLADES ECOSYSTEM

Jennifer H. Nestler[1], *Brian J. Smith*[2], *Jennifer K. Ketterlin*[1], *Michael R. Rochford*[1], *Melissa A. Miller*[3], *and Frank J. Mazzotti*[1]

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The Burmese python (*Python bivittatus*) is a large constricting snake native to South Asia that is now widely established across the Greater Everglades ecosystem and portions of the Florida Keys. Despite being one of the largest snakes in the world, this species has proven difficult to detect in the landscape, confounding removal efforts. To increase the rate of python removal from the Everglades, the Florida Fish and Wildlife Conservation Commission (FWC) initiated the Python Removal Contractor Program (PRCP). This program aimed to incentivize the public to participate in the removal of Burmese pythons through hiring contractors to conduct surveys and remove wild pythons. Beginning April 2017, the FWC paid contractors an hourly rate to survey several Wildlife Management Areas (WMAs) in southern Florida, including Everglades and Francis S. Taylor, Holey Land, Rotenberger, Big Cypress, and Picayune Strand WMAs. In July 2018 the PRCP expanded survey locations to include Everglades National Park. In addition to receiving payment for time spent surveying for pythons, contractors received payment for each python removed and submitted to the FWC.

In addition to removing invasive pythons, the PRCP has potential to serve as an important source of data on when and where pythons are mostly likely to be removed. The relative dearth of python detections in relation to their purported population size indicates information associated with both detection and removal is valuable. However, collection of additional data related to search effort makes it possible to better elucidate patterns of python removals, ultimately contributing to improved management of this species in Florida. In this regard, the PRCP can serve as an effective, large-scale citizen science project.

We used field and capture data from the PRCP from April 2017 to January 2018 to fit a logistic regression in which python captures served as a binary response variable. This allowed incorporation of absence data, or data for surveys during which pythons were not captured. We fit models using a series of environmental variables, including daily temperature and precipitation, time of day, survey duration, and time of year, and compared them to a null model using Akaike Information Criterion (AIC).

Over the time period analyzed, 20 active PRCP contractors performed 484 surveys totaling 2,125 survey hours. They encountered 72 live pythons and successfully removed 69 of them. The top ranked model estimates a capture probability of 0.5%. High performing model variables include time of day, survey length, and daily temperature.

PRESENTER BIO: Jennifer Nestler is a Project Manager for the Croc Docs, a research lab based at the University of Florida Ft. Lauderdale Research and Education Center in Davie, Florida.

DEVELOPING RAPID RESPONSE TOOLS, CONTROL MEASURES, AND REFINING INVASIBILITY MODELS FOR INVASIVE PYTHONS IN THE FLORIDA EVERGLADES

***James C. Nifong*[1]**, *Nathan Johnson*[2], *and Margaret Hunter*[2]
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Recently detected hybridization between two ecologically distinct python species within the invasive Florida Everglades python population has the potential to affect more natural areas and infrastructure (i.e., water control structures) throughout the US than is currently anticipated. Moreover, current early detection and rapid response methods (specifically eDNA) do not account for the potential effect hybridization may have on positive detection of hybrid individuals. Expanded genetic analyses of pythons to include specimens from their native ranges and potential source populations (i.e., pet trade and zoos) in comparison to established invasive populations will allow biologists and managers to 1) make better management decisions to mitigate the spread of these aggressively invasive snakes throughout the southern tier of the United States, 2) increase early detection and rapid response capabilities, 3) refine habitat suitability modelling efforts, and 4) determine whether pythons in new areas are the product of subsequent releases or range expansion of established populations. Here, we present a conceptual framework being developed to advance our control and response capabilities to better manage and eradicate invasive pythons as well as halt their expansion to new areas.

Further, we showcase potential avenues for collaboration between researchers as well as managers working in the Everglades and scientists at the US Army Engineer Research and Development Center.

PRESENTER BIO: Dr. Nifong is a research ecologist with > 10 years of experience working with reptile and amphibians in Florida as well as Central and South America.

EVERGLADES REPORT CARD PROVIDES SYNTHESIS OF SYSTEM STATUS REPORT

William Nuttle[1]*, Alexandra Fries*[1]*, Emily Nastase*[1]*, Caroline Donnovan*[1]*, Jack Gentile*[2] *and Heath Kelsey*[1]
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The 2019 System Status Report includes, for the first time, an ecosystem health report card for the Everglades. RECOVER adopted the report card format in the 2019 System Status Report (SSR) to better communicate the results to the diverse target audience for the SSR.

Similar to school report cards, ecosystem health report cards compare performance-driven metrics to a goal or ecologically relevant threshold. Report cards integrate large, complex datasets into a single score that's easily understood. Report cards are an important component of conservation and restoration planning in south Florida, as they are designed to clearly communicate the status of ecosystem health of the Florida Everglades to a spectrum of audiences.

The process of creating an ecosystem health report card can be broken down into the following steps:

1) A conceptual framework is developed to identify indicators of valued ecosystem components and ecosystem processes that will be used to assess the health of the system.
2) Response thresholds are identified; these which can be derived from regulatory or management guidelines, biological limits, or reference conditions.
3) Indicator scores characterize conditions as "good", "fair", or "poor"; scores and are based on a comparison of response thresholds to measured values of the indicators.
4) Communication of results is aided by the use visual elements, including photos, maps, figures, and conceptual diagrams.

Conducting a comprehensive assessment on a system with the size and complexity of the Greater Everglades presents unique challenges. The SSR provides an overview of ecological restoration in each of four distinct regions that span the extent of south Florida: Lake Okeechobee, Northern Estuaries, Greater Everglades, and Southern Coastal Systems. To do so requires assembling the results of data and analysis from dozens of principal investigators. The report must document the analysis of data and interpret the results for audiences that include managers, decision-makers, and the public.

The report card serves primarily as a communication tool that synthesizes the results into a form that effectively reaches this diverse audience. The series of workshops used to implement the process of building the report card also served to facilitate the task of producing the system status report by organizing the work of the large group of contributors. Developing and scoring the indicators used in the report card required the acquisition and analysis of a vast amount of data, and this helped to focus the writing on reporting conditions in the Everglades' ecosystems. The value of this approach was evident in the greater engagement and feedback from scientists, NGO's, public and managers during the review process.

<ins>PRESENTER BIO</ins>: William K. Nuttle has 25 years of experience working with water managers, engineers, Earth scientists and ecologists in planning eco-hydrology research and to applying the results of this research to ecosystem restoration and management of natural resources.

GROUNDWATER SALIZATION IN THE LOWER FLORIDA KEYS FOLLOWING HURRICANE IRMA STORM SURGE

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Hurricane storm surge can have long-lasting impacts on coastal and island freshwater resources. These impacts can be substantial on low-lying oceanic islands where lower density freshwater exists as a floating lens on underlying salt water. In the lower Florida Keys, plants and wildlife rely on a freshwater lens recharged by precipitation to meet their freshwater requirements. Here we report on the effects of groundwater salinization due to storm surge from Hurricane Irma's landfall in the Florida Keys on September 10, 2017. Maximum sustained winds were estimated at 115 knots and storm surge water levels reached 2.4 m above Mean Higher High Water, flooding the low-elevation islands of Big Pine and Upper Sugarloaf Key with salt water.

We sampled groundwater salinity across a gradient of coastal proximity and elevation in 24 1-meter deep wells on the island 2 weeks, 12 weeks, and 8 months post-hurricane. Beginning in June 2018, we installed a Solinst LTC Levelogger Edge in the 6 of the wells and in 1 surface water location on Big Pine Key to further track recovery of the groundwater and determine the influence of recharge from wet-season precipitation. Loggers recorded conductivity, temperature, and water level at 30-minute intervals. Rainfall data was obtained from the climate station located on the island. We compare results to baseline data collected in the same network during a year of groundwater monitoring prior to the hurricane (May 2011 – April 2012).

Immediately following the storm, more than half of the well network had elevated groundwater salinity compared to baseline values. The largest increases in salinity were observed on the east side of the island associated with the highest storm surge. Most locations recovered to baseline salinity values over the next 8 months of sampling. However, we did not observe this for the man-made freshwater lake located in the center of the island, nor in several groundwater monitoring wells to the east side of the island. More than 1 year after Hurricane Irma, salinity of the surface water remains elevated at 7 ppt (prior to the storm it was ~1 ppt). The results suggest areas of salinization remain on the island, despite periods of heavy precipitation during the 2018 wet season, and the lens may require several years to return to pre-storm surge conditions.

PRESENTER BIO: Dr. Ogurcak is a postdoctoral associate with a degree in Earth Systems Science from Florida International University. She has over 10 years of experience in ecological research in the Everglades and the Florida Keys.

OPTIMIZATION OF LIDAR DATA PROCESSING ALGORITHMS FOR WETLAND GRAMINOID MARSH AND PRAIRIE VEGETATION

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Light Detection and Ranging (LiDAR) processing algorithms are optimized for global applications, which can be affected by topography and vegetation. Vegetation structure can interact with LiDAR angle of incidence and affect the accuracy of LiDAR-derived data products. Generally, the LiDAR interaction with vegetation can cause terrain elevation to be overestimated in digital terrain models (DTM) and vegetation height to be underestimated in digital surface models (DSM). For applications in flat terrain, this loss in ground elevation accuracy is significant because subtle differences in elevation affect many ecological processes. In low-relief wetland landscapes such as the Florida Everglades, small changes in elevation can produce considerable changes in water flow and hydroperiod length, which in turn affects vegetation composition. Specific challenges in the interpretation and processing of LiDAR data are posed by graminoid wetland vegetation canopy structure. We explored the relationships of LiDAR scan angle and the vegetation characteristics of plant morphology, density and height to develop an algorithm that increases accuracy of DTM and DSM. The National Park Service (NPS), US Geological Survey (USGS), and South Florida Water Management District (SFWMD) have invested in the acquisition of a spatially exhaustive (continuous) elevation data set for the entire Everglades National Park marsh and marl prairie ecosystems. In April 2017, a new LiDAR data set that includes raw data by flight line, tiled classified point files, digital terrain models (DTMs) and digital surface models (DSMs) was generated with standard processing procedures. We have developed a data processing algorithm for use with this LIDAR data that is optimized for wetland marsh vegetation applications; the algorithm takes into account structural characteristics of different vegetation types to significantly improve DTM and DSM accuracy. The algorithm considers primarily LiDAR-inherent information, so that it can be applied without ancillary data, but we included ancillary data in the form of spectral indices of other remotely sensed data. These ancillary data significantly improved DTM accuracies. We will present preliminary results of our analysis.

<u>PRESENTER BIO</u>: Dr. Paulo Olivas has been working in the Everglades for almost ten years. He has been using LiDAR data for multiple applications including 3D models to assess coastal erosion and digital, elevation and canopy models for vegetation classification.

CHANGES IN HABITAT CONNECTIVITY AFFECT HABITAT USE OF FISH IN THE DECOMP PHYSICAL MODEL (DPM)

***Alex T. Ontkos**, and Joel C. Trexler*
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The freshwater marshes of the Florida Everglades present a model setting for studying animal-habitat relationships in a dynamic landscape that is heavily influenced by seasonal hydrology and water management. We used dynamic, high-resolution vegetation classification maps and radio-telemetry to examine the movement patterns and habitat preference of Largemouth Bass (*Micropterus salmoides*), Bowfin (*Amia calva*), and Florida Gar (*Lepisosteus platyrhincus*) to assess how restoration efforts will affect ecological processes and recreational fisheries. This study was conducted in the area associated with the DECOMP Physical Model (DPM), allowing us to examine the impact of restoring habitat connectivity and flow to an area lacking flow and divided by a canal and levee for over 60 years. We used population-level selection ratios to determine if vegetation communities were used more frequently than expected by their availability within the landscape. We used generalized linear mixed-effects models to determine if selection ratios were influenced by environmental factors, fluctuating hydrology, or factors associated with the DPM project. All three species were observed using the canal habitat, which represents a minor component of the submerged landscape even in dry conditions, more frequently than expected by its areal coverage. Bowfin and Florida Gar were more likely to be relocated in marsh habitats and exhibited more drastic seasonal shifts in canal use than Largemouth Bass. For Largemouth Bass and Bowfin, preference for the canal habitat increased after landscape alteration, indicating greater influence of landscape manipulation on habitat use than environmental or hydrological factors. This study highlights the importance of restoration-driven landscape alteration on animal-habitat relationships in a dynamic aquatic ecosystem.

<u>PRESENTER BIO</u>: Alex Ontkos defended his Master’s thesis at Florida International University in September 2018. Alex has been a technician and research assistant in Joel Trexler’s Aquatic Ecology Laboratory since January 2015.

STABLE ISOTOPE SIGNATURES AND SULFUR BIOGEOCHEMISTRY IN THE FLORIDA EVERGLADES

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Sulfur is an important element in the biogeochemistry of aquatic ecosystems because of its role (as sulfate) in microbial sulfate reduction (MSR). MSR reduces sulfate to other sulfur species (e.g., sulfite, thiosulfate, sulfide, and elemental sulfur). Highly reactive sulfide can combine with dissolved or solid phase organic matter to produce organic sulfur species. Sulfide also reacts with metals (e.g. iron) to produce insoluble metal sulfides (e.g. Mackinawite, Pyrite). In the Everglades, MSR also is a key control on the production of methylmercury, a highly neurotoxic, endocrine disrupting, and bioaccumulative contaminant. Because of the complexity of sulfur biogeochemistry, innovative methods are needed to understand the sources, sinks, and cycling of sulfur. Stable isotope geochemistry combined with measurements of sulfur forms provides an effective tool for understanding sulfur biogeochemistry.

Both the concentration and isotopic signature of sulfur species vary widely in the Everglades. Sulfate concentrations range from >200 mg/L in canals (episodically) to <0.05 mg/L in marshes. Overall, sulfate concentrations are higher in the northern Everglades and lower in the southern Everglades. Canals have the highest sulfate concentrations within the ecosystem and canal water discharge is the major source of sulfate to the Everglades. Average sulfate concentrations in canals are about 60-70 mg/L, with little variation since the mid-1990s except during episodes of extremely low or high rainfall. Marsh areas generally have higher sulfate concentrations nearer to inputs of canal water. The sulfur isotopic signature ($\delta^{34}S$) of sulfate in Everglades marshes varies widely from +15 to +30 ‰, indicative of a range of sulfur sources and reactions. However, as sulfate concentration increases (especially in canals within the Everglades Agricultural Area or EAA) this variability decreases to values of +16 to +21 ‰, suggesting a single source of sulfate is becoming dominant. In this regard, it is noteworthy that sulfur fertilizer used in the EAA has a $\delta^{34}S$ value of +17-23 ‰, suggesting that it is a major determinant of sulfate present in canals and discharged into the ecosystem. In contrast, shallow groundwater (4 m) has a sulfate concentration of 0.5 mg/L and isotopic composition of +25‰; and deep groundwater (10 m) has a concentration of 150-200 mg/L and a $\delta^{34}S$ value of +12‰. Rainwater has a concentration of 2-3 mg/L and $\delta^{34}S$ of +5 ‰. In the marsh, sulfate concentrations decrease and $\delta^{34}S$ values increase from points of canal discharge toward the center of the marsh. This may reflect removal of sulfate by microbial sulfate reduction with fractionation (preferential use of the lighter isotope) as well as dilution.

Corresponding oxygen isotope data show that the $\delta^{18}O$ of sulfate decreases toward the center of the marsh from the point of canal water discharge and begins to approach the $\delta^{18}O$ of the marsh water. This suggests some contribution to sulfate through oxidation of sulfide (a product of microbial sulfate reduction in marsh soils) as it diffuses into surface water from the soil. Results of these studies and other work using sulfur species measurements and sulfur isotopic composition in the Everglades will be presented.

PRESENTER BIO: Dr. Orem is a Supervisory Research Chemist with the USGS in Reston, VA with 20+ years of experience working on Everglades contaminant issues. His current research focuses on environmental health impacts of energy development, microbial methanogenesis, and mercury methylation.

YEAR ONE OF AN ARTHROPOD BIODIVERSITY SURVEY OF FERN FOREST NATURE CENTER, A UNIQUE HABITAT IN THE GREATER EVERGLADES ECOSYSTEM.

Giovanna Ortiz[1]*, Dr. David Serrano*[2]*, Chris Stauffer*[1]*, Joseph Sigmon*[1]*, Jennifer Bishop*[3]

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Historically, Broward County has been overlooked as a survey area for insect fauna. Student researchers from Broward College's Environmental Science Bachelors Program surveyed Fern Forest Nature Center to assess biodiversity among insect fauna and their associated flora in its various habitats that make it "the last remaining stronghold of ferns in southeastern Florida". Students utilized a variety of collection methods including but not limited to, hand, SLAM, and light trapping to gather data with collection efforts being focused on disturbed and undisturbed areas in the dry prairie, and the Maple Oak and Cabbage Palm forest during the first year. The data collected will be used to establish the environmental health of these areas in an effort to gain an understanding of current and/or future restoration and conservation needs. Students will upload the record of collected insects and associated data to SCAN/iDigBio where it will be accessible to other students and researchers worldwide, with up to date data being presented.

PRESENTER BIO: Giovanna is a junior in Broward College's Environmental Science Bachelors Program and the current student lead/collection manager for the Broward College Insect Collection. Her undergrad research focuses on insect biodiversity throughout the greater Everglades ecosystem, with a focus on Fern Forest Nature Center.

A HURRICANE-INDUCED ECOLOGICAL REGIME SHIFT: MANGROVE CONVERSION TO MUDFLAT

Michael J. Osland[1], *Laura C. Feher*[1], *Gordon H. Anderson*[2], *William C. Vervaeke*[1], *Ken W. Krauss*[1], *Kevin R.T. Whelan*[3], *Karen M. Balentine*[4], *Ginger Tiling-Range*[5], *Thomas J. Smith III*[6], *Donald R. Cahoon*[7]

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Hurricanes are major ecological disturbances that can have a tremendous impact on low-lying, coastal ecosystems. The storm surge, saltwater intrusion, wind, and extreme rainfall produced by hurricanes can knock down forests, induce peat collapse, deposit thick sediment layers, lead to erosion, and transform plant communities. Some hurricane effects can be positive; for example, the addition of valuable sediment and nutrient subsidies that increase elevation and promote plant growth. However, in extreme cases, hurricanes can lead to abrupt and irreversible ecological transformations. Along a southwestern section of Everglades National Park near Big Sable Creek, the 1935 Labor Day Hurricane contributed to the conversion of mangrove forests to mudflats. For almost twenty years (1998-2018), USGS scientists have been measuring surface elevation change in mangrove forests and the adjacent mudflats using Surface Elevation Table-Marker Horizon (SET-MH) methods. This period of data collection includes the impacts of Hurricane Wilma in 2005 and Hurricane Irma in 2017. Here, we examine the effects of these hurricanes as well as the impacts of mangrove forest conversion to mudflat upon surface elevation change processes that affect the ability of coastal wetlands to persist with hurricanes and rising sea levels. We used historical sea-level rise rates and future sea-level rise scenarios to estimate surface elevation changes in the past (1930-1998) and to illustrate elevation gains needed for adaptation to future change. Our calculations estimate that conversion of mangrove forests to mudflats following the 1935 Labor Day Hurricane has triggered an elevation loss of approximately 76 cm within mudflats. Between 1998-2018, rates of elevation change in mudflats and mangrove forests were variable and greatly influenced by Hurricanes Wilma (2005) and Irma (2017), in the form of elevation gains due to sedimentation and elevation losses due to erosion and/or subsurface compaction. Collectively, our findings advance understanding of the long-term effects of hurricane-induced ecological regime shifts. As hurricanes become more intense and sea-level rise accelerates, there is increasing potential for hurricane-induced ecological regime shifts due to forest mortality, peat collapse, and conversion of mangrove forests to mudflats.

PRESENTER BIO: Michael Osland is a Research Ecologist at the U.S. Geological Survey's Wetland and Aquatic Research Center. In broad terms, his research examines the response of ecosystem to changing conditions including the implications for conservation and restoration.

PLASTIC SINKS OR SOURCES: CHARACTERIZING CYCLING OF MARINE DEBRIS ON MANGROVE SHORELINES IN BISCAYNE BAY

Melinda Paduani
Florida International University, Miami, FL, USA

The invention and subsequent mass production of plastic has left massive amounts of improperly disposed plastic in our oceans as 'marine debris'. Meanwhile, plastic continues to wash up in coastal ecosystems. Some of the debris remains on the surface, and in estuaries and mangrove swamps, plastics can also become buried in sediments. Over time, these plastics physically degrade into their insidious, microscopic form known as microplastics, typically considered <5mm in size. A growing body of literature has been dedicated to the study of how microplastics fragment and are transported throughout the marine environment, but fluxes of plastic debris in and out of estuarine sediments are less understood.

The uncertainty regarding this issue highlights the lack of long-term data on marine debris in mangrove forests and prevents land managers from effectively addressing plastic pollution. To understand the mechanisms for debris retention in mangrove forests of Biscayne Bay, 1) forest structure and surficial meso- (5mm-2.5cm) and macroplastics (>2.5cm) will be surveyed at distances perpendicular from the water's edge to characterize how far marine debris is transported into mangrove forests, 2) buried microplastics will be sieved from sediment strata of known age to recreate a historical imprint of plastic accumulation throughout the soil profile, and 3) the potential for citizen science to facilitate mangrove debris research will be explored.

Debris and vegetation will be surveyed in 2-m radius plots at 0m, 5m, and every 10m thereafter along transects perpendicular to shore. Debris will be counted by size class and type. I expect smaller plastics further inland whereas larger plastics will remain nearer the water as they become entangled in the prop roots of fringe red mangroves. For analysis of buried plastic, fragments will be extracted via flotation to separate particles of different densities. Spectroscopy will be used to characterize chemical composition of a subsample of fragments which will then be analyzed for degrees of degradation. The depth and condition of buried plastics will be a proxy for time since burial based on the local sediment deposition rate. It is expected that larger, newer fragments will be near the surface versus smaller, older fragments that became buried deeper in the soil profile over time. Debris abundance will be compared with movement patterns of GPS-tracked debris from the *Bay Drift* study conducted by the Consortium for Advanced Research on Transport of Hydrocarbon in the Environment (CARTHE). Collaboration with clean-up groups to develop standardized data collection methods will facilitate long-term datasets on the deposition of marine debris in the mangroves. My study will be an important step toward distinguishing mangrove forests as long-term plastic sinks or sources while promoting awareness of the marine debris issue through engagement of the Greater Everglades community.

<u>PRESENTER BIO</u>: Melinda Paduani is a PhD student at Florida International University pursuing her degree in natural resource science and management. She began mangrove research in Florida while earning her Bachelor of Science in biology and environmental studies minor from the University of Central Florida.

PREDICTING THE EVERGLADES ECOSYSTEM RESPONSE TO CHANGES IN KEY HYDROLOGIC RESTORATION COMPONENTS

***Rajendra Paudel**, Thomas van Lent, Ruscena Wiederholt, Yogesh Khare, Stephen Davis, Melodie Naja*
Everglades Foundation, Palmetto Bay, FL USA

The Everglades is a complex, highly managed ecosystem, and its natural hydrologic properties, water quality, soils, and flora and fauna have been altered by the Central & Southern Florida Project and decades of nutrient pollution. Water storage capacity has been reduced due to drainage and landscape modifications, depriving the southern Everglades of freshwater during dry years and resulting in regulatory discharges to the Northern Estuaries during wet years. A substantial change in habitats including the degradation of the ridge and slough landscape pattern and loss of tree islands has also been documented due to the combined effects of altered hydrologic patterns, loss of sheetflow, and diminished storage.

In this study, we identified and evaluated main restoration components (e.g., water storage, decompartmentalization, seepage control barrier, Lake Okeechobee regulation schedule, and environmental demand) that most affected hydrologic and ecological responses in different regions of the Everglades. We used the output of the South Florida Water Management Model (SFWMM) to evaluate system-wide ecological conditions with a suite of tools specific to different regions of the system (e.g., wading birds, crocodiles, oysters). Next, we developed tools to use the ecological model performance to determine how the main restoration components interact to affect the ecological response, and used that information to modify and refine hydrologic components.

Our results suggest that increased storage capacity generally improves the ecological functionality in the Everglades landscape, although it does not produce benefits across all regions of the Everglades. There are clear trade-offs among different basins and regions. Results show that increased decompartmentalization is essential to restoring the frequency and timing of water depth in some areas in southern Water Conservation Area-3A and Everglades National Park (ENP). Location of storage features and environmental demand are important components providing drought benefits to ENP. These findings are relevant to Everglades restoration especially in light of recent and emerging science on storage feasibility and climate change.

PRESENTER BIO: Dr. Paudel is a senior hydrologist at the Everglades Foundation. He has over 20 years of experience as a researcher and engineer at universities, non-profit organizations and consulting firms and has worked on several water resources planning and management projects including Everglades restoration projects.

PROBABILISTIC MODELING OF COASTAL VEGETATION SUCCESSION WITH SEA LEVEL RISE

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Everglades National Park (ENP) coastal marsh communities are experiencing vegetation community changes associated with altered hydrological conditions and salt-water intrusion from sea level rise (SLR) and concomitant increases in storm surge. The low topographic relief of the southern coast of Florida adds to coastal vegetation vulnerability and the potential for loss of freshwater and coastal peat soil elevation from increased salinity and inundation. Two critical concerns for the management of coastal wetland habitats exposed to increasing SLR are the potential for salinization of freshwater marshes resulting in peat substrate collapse with subsequent loss of inland marsh habitat and whether mangrove communities will be sustained, either in-place or by moving inland. Regime shift from freshwater marsh to mangroves is sensitive to the duration and rate of soil salinization. Mangrove responses to salinity, flooding, and nutrient availability is highly plastic, however, mangroves will become progressively drowned if relative SLR is higher than the rate of land accretion. In those conditions, mangroves may displace landward, where habitat for them is suitable and rates of SLR are not so intense as to prevent new saplings from getting established. Significant coastal wetland loss will occur if salt-tolerant communities are unable to adapt to increasing sea levels and if inland marshes collapse prior to displacement by mangrove.

To examine potential freshwater marsh and mangrove community spatial distribution changes and impacts from SLR we have refined and linked a hydrodynamic model with a vegetation succession model. The US Geological Survey BISECT numerical model couples surface-water and groundwater hydrologic conditions while representing the transient nature of the low-gradient flow and transport of dissolved salt at the coast in south Florida. BISECT was used to simulate future SLR conditions matching US Army Corps of Engineers' projections. Recent ENP topo-bathymetric LiDAR was used with BISECT results to increase the spatial resolution of projected water depths. Vegetation response to those changing conditions was modeled with an ENP spatially-explicit, Bayesian probabilistic vegetation dynamics model (ELVeS_B) parameterized for the marsh-mangrove coastal region of ENP. The model uses empirically-based Bayesian logistic regression probabilistic functions of vegetation community niche space and temporal response lags to evaluate expected community shifts within the model's domain. The BISECT-ELVeS_B integration has been developed to provide scientists, planners, and decision makers a simulation tool for landscape-scale analysis, planning, and decision making.

PRESENTER BIO: Dr. Leonard Pearlstine is Landscape Ecologist at Everglades National Park. Leonard has 30 years' multi-disciplinary experience with spatial analysis, ecological modeling and wetland natural resource management. His current interests and activities support Everglades' restoration goals with modeling of community spatial patterns resulting from natural and anthropogenic disturbance and how these relate to sustainable wildlife communities, maintenance of natural processes, and habitat change.

FLORISTIC INVENTORY OF THE MICCOSUKEE INDIAN RESERVATION AREAS

***Yunelis Perez**, and Craig van der Heiden*
Miccosukee Tribe of Indians of Florida, Miami, FL, USA

The Miccosukee Tribe of Indians of Florida owns and manages several conservation lands in South Florida where eleven main vegetation communities are recognized. Within the Miccosukee Indian Reservation (Alligator Alley, Sherrod Ranch, Cherry Ranch, Miccosukee Reserved Area, SEMA property, 80 Acres and Big Cypress Bend), individuals of 94 families, 233 genera and 324 species of vascular plants have been documented during the Miccosukee Wildlife Program's 2018 botanical inventory. Of the 324 taxa currently known, 282 (87.0%) are native to Florida. Fourteen state listed species have been recorded. Six species are listed as Endangered and eight are listed as Threatened. Additionally, two species are listed as Rare and one species is listed as Critically Imperiled for South Florida.

PRESENTER BIO: Yunelis Perez, M.S., is a botanist who's working for the Miccosukee Fish and Wildlife Department and is currently conducting native plant research. She has 10 years of experience with Cuban orchid conservation through field work and in vitro techniques.

MODELING TROPIC LINKAGES USING A MUTILSCALE APPROACH

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The key trophic hypothesis underlying the Everglades restoration is that restored hydrology will produce higher wading bird (Ciconiiformes, Pelecaniformes) prey availability leading to higher nesting effort. Prey availability is not just fish population size. It also incorporates factors that reorganize fish populations in to small patches of dense prey that are highly vulnerable to capture by wading birds.

We quantified prey availability throughout the Everglades (9759 km^2) during the dry seasons of 2005 – 2017, which differed in hydrological conditions and levels of wading bird nesting. We collected prey at 1,894 random sites in a multi-stage design, using a 1-m^2 throw-trap. We captured 124,222 prey animals representing 54 species. We modeled total wading bird nest abundance [Great Egret (*Ardea alba*), Snowy Egret (*Egretta thula*, Tricolored Heron (*Egretta tricolor*, White Ibis (*Eudocimus albus*), and Wood Stork (*Mycteria americana*)] from 2005 – 2017 as a function of habitat availability, prey densities, and timing of prey availability. An information-theoretic approach was conducted using Akaike Information Criterion (AIC) to investigate competing models.

High nest abundance of wading birds is positively associated with amount of foraging habitat that becomes available during the breeding season and increasing prey availability in Everglades National Park throughout the breeding season. This first quantitative attempt to develop a wading bird food availability predictive model suggests that although system-wide prey densities in foraging pools are related to wading bird nesting, so is the total amount of foraging habitat that becomes available to birds. Results from the model selection analysis shows that timing of high prey concentrations in Everglades National Park occurring later in the breeding season coupled with system-wide foraging habitat availability are important contributors of wading bird nest abundance.

<u>PRESENTER BIO</u>: Michelle Petersen is a postdoc at Florida Atlantic University. Her research focuses on ecological modeling of long-term data sets. Specifically, determining hydrologic drivers of wading bird nest abundance, foraging distribution, and foraging-habitat selection to aid in Everglades restoration.

IDENTIFICATION OF MERCURY-METHYLATING ORGANISMS ALONG A TROPHIC GRADIENT

***Benjamin D. Peterson**[1], Brett A. Poulin[2], Katherine D. McMahon[3], David P. Krabbenhoft[4]*
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Methylmercury is the toxic, bioaccumulative form of mercury produced by microorganisms living in anoxic environments. In freshwater systems, such environments include anoxic hypolimnia and sediments. Mercury-methylating organisms can be identified by the presence of the *hgcAB* gene cluster, which is necessary for methylmercury production. The presence of *hgcAB* has been confirmed in sulfate-reducing bacteria, iron-reducing bacteria, syntrophic bacteria, and methanogenic archaea, but some evidence suggests that the distribution is more widespread and extends to other metabolic guilds. Our understanding of the relative abundance, distribution, identity, and metabolic potential of these organisms in natural systems remains limited. By identifying the *hgcAB*-containing organisms and their metabolic potential, we can predict how different biogeochemical cycles drive the production of methylmercury.

In this study, we used molecular sequencing techniques to characterize the microbial community across a large trophic gradient in the Everglades. This gradient coincides with changes in methylmercury production, which is partially attributed to variations in limiting substrate and mercury bioavailability. We collected porewater and surface water samples along this trophic gradient for DNA sequencing to determine if there are corresponding changes in the microbial community. We performed shotgun metagenomic sequencing and conducted assembly-based analyses to identify the microbial community composition and to characterize the distribution of mercury-methylating organisms, using the *hgcAB* gene cluster as a marker. Through these methods, we identified shifts along the trophic gradient in both the microbial community composition and in the relative abundance of methylating organisms. Combining this information with biogeochemical data, our work provides new insights into the influence of biogeochemical and redox conditions on microbial community composition and how this subsequently impacts the production of methylmercury in the Everglades.

<u>PRESENTER BIO</u>: Benjamin Peterson is a Ph.D. student at the University of Wisconsin – Madison in the Environmental Chemistry and Technology program. His Ph.D. work focuses on combining molecular techniques, including nucleic acid sequencing and incubations, with biogeochemical measurements to understand how the metabolism of microorganisms can link biogeochemical cycling to methylmercury production.

COASTAL SALINITY INDEX DISSEMINATION FOR MONITORING DROUGHT ALONG THE GULF OF MEXICO AND THE SOUTHEASTERN ATLANTIC COAST, 1983 TO 2018

***Matthew D. Petkewich*[1]**, *Bryan J. McCloskey*[2], *Kirsten Lackstrom*[2], *Lauren Rouen*[2], *and Paul A. Conrads (deceased)*[1]

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Coastal droughts have a different dynamic than upland droughts, which are typically characterized by agricultural, hydrologic, meteorological, and (or) socio-economic impacts. Drought uniquely affects coastal ecosystems due to changes in salinity conditions of estuarine creeks and rivers. The location of the freshwater-saltwater interface in surface-water bodies is an important factor in the ecological and socio-economic dynamics of coastal communities. The location of the interface determines the freshwater and saltwater aquatic communities, fisheries spawning habitat, and the freshwater availability for municipal and industrial water intakes. The severity of coastal drought may explain changes in *Vibrio* bacteria impacts on shellfish harvesting and occurrence of wound infection, fish kills, harmful algal blooms, hypoxia, and beach closures. To address the data and information gap for characterizing coastal drought, a coastal salinity index (CSI) was developed using salinity data. The CSI uses a computational approach similar to the Standardized Precipitation Index (SPI). The CSI is computed for unique time intervals (for example 1-, 6-, 12-, and 24-month) that can characterize the onset and recovery of short- and long-term drought. Evaluation of the CSI indicates that the index can be used for different estuary types (for example: brackish, oligohaline, or mesohaline), for regional comparison between estuaries, and as an index of wet conditions (high freshwater inflow) in addition to drought (saline) conditions. The following three activities being completed in 2019 that enhance the use and application of the CSI will be presented:

1) A software package was developed for the consistent computation of the CSI that includes preprocessing of salinity data, filling missing data, computing the CSI, post-processing, and generating the supporting metadata.
2) The CSI has been computed at sites along the Gulf of Mexico (Texas to Florida) and the Southeastern Atlantic Ocean (Florida to North Carolina); and
3) Using telemetered salinity data, the real-time computation of the CSI has been prototyped and disseminated on the web.

PRESENTER BIO: Matthew Petkewich is a hydrologist with the U.S. Geological Survey, South Atlantic Water Science Center. During his 26 years with the USGS, he has participated in a broad variety of water-quality investigations related to surface- and ground-water resources. For the past 10 years, he has been a part of the Everglades Depth Estimation Network (EDEN) team that supports ecological and biological assessments within the Greater Everglades.

ESTIMATING WOOD STORK REPRODUCTIVE OUTCOME FROM MOVEMENT DATA

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Wood Storks in the Everglades are used as indicators of ecosystem functioning. Thus, their population trends are of particular interest for conservation of the entire ecosystem. Reproductive success is an important component of wading bird population trends, yet information on it is often difficult to obtain. Being able to estimate reproductive outcome from telemetry data would allow to establish direct links with individual movement and fine-scale environmental conditions. We developed a method to locate Wood Stork nesting attempts and estimate their outcome based on movement data only. Using GPS tracking data at 1-hour resolution, we identified nesting attempts along 417 individual-year tracks based on patterns of location revisit, described using a set of numerical parameters. Using tracks for which the nest location was known a-priori, we used classification and regression trees (CART) to compare patterns of revisit at known nests versus locations that were repeatedly visited but known not to be nests, and identified an optimal set of parameter values to tell them apart. Based on external validation, we estimated error rates to be 0.02 and 0.06 for type I (false positive) and type II (false negative), respectively. We then applied the resulting set of parameters to identify attempts within tracks for which the location of the nest was unknown. We estimated the outcome (success or failure) of identified nesting attempts by using a Bayesian hierarchical modeling approach that accounts for temporally variable patterns of nest revisit, probability of visit detection, and missing data. We obtained robust statistical estimation of reproductive outcome for each nesting attempt. We demonstrate that GPS tracking data can be used to infer information on individual reproduction in Wood Storks. The resulting data can be coupled with fine-scale information on individual movement and environmental conditions, particularly hydrology, to investigate their effects on fitness at the individual level. Our method can be adjusted for broad application to other bird species for which high resolution tracking data is available.

<u>PRESENTER BIO</u>: Simona Picardi is a PhD Candidate at the University of Florida FLREC. Her research focuses on movement ecology of large vertebrates. She has extensive experience in the use of cutting edge statistical tools to analyze GPS-tracking data. Currently, Simona is conducting research on the migratory ecology of Wood Storks in the southeastern U.S.

HOW DOES FLOW AFFECT PERIPHYTON ENZYMATIC ACTIVITY IN THE EVERGLADES STORMWATER TREATMENT AREAS?

Kathleen Pietro
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The Stormwater Treatment Areas (STAs) are a vital component of the Everglades Restoration effort and were constructed to decrease total phosphorus (TP) concentrations in waters entering the Everglades Protection Area. Within well-performing STAs, TP concentrations decrease along a nutrient gradient in the flow-ways. At the mid to outflow regions, most of the available P has been assimilated and the remaining TP is in dissolved organic or particulate forms. In these regions, the microbial communities can play an important role in nutrient cycling through their ability to release nutrients from the organic fraction. Periphyton, which is a conglomerate of algae, bacteria, and fungi and is abundant in the STAs, can play a significant role in organic matter breakdown via the production of exoenzymes. The activity of the exoenzymes provides insight into the nutrient assimilation processes within the marsh since exoenzymes are primarily produced when nutrient limiting conditions exist.

To better understand microbial role in nutrient cycling in the STAs, enzyme activity in periphyton has been measured in selected flow-ways of well-performing STAs along the nutrient gradient and within the dominant vegetation communities (i.e., emergent aquatic vegetation (EAV) or submerged aquatic vegetation (SAV). These measurements were conducted under a range of flow conditions to evaluate the effects or flows on the biogeochemical processes. The potential enzyme activity were assayed for alkaline phosphatase and BIS-phosphodiesterase (P-acquisition), leucine aminopeptidase (nitrogen (N) acquisition), and β-glucosidase (carbon (C) acquisition).

The response of the level of enzyme activity to flow or no flow conditions was variable as were the trends in activity between the dominant vegetation communities. Generally, there was increased variability in enzyme activity for all the enzymes during flow compared to no flow conditions. For the P-acquiring enzymes in both vegetation communities, a gradient effect was observed where activity was highest at the outflow locations, although activity at the mid locations differed between the vegetation communities. At the outflows, activity was elevated during periods of flow compared to no flow. There was also a transect effect observed for the N-acquiring enzyme, but this effect was observed only in the SAV dominated flowway. In the SAV flowway, activity was highest at the outflow site and the response in activity to flowing conditions was opposite from that observed for the P-acquiring enzymes and activity was lower during flow compared no flow conditions. Additionally, in the EAV dominated flowway the activity for the N-acquiring enzyme along the transect was reversed from what was observed in the SAV flowway. In the EAV dominated flowway, greatest activity was observed at the inflow and mid locations compared to the outflow and not always elevated during flow. For the C-acquiring enzyme, there were similar trends between the vegetation and along the transect, except for a single sampling event where high activity was measured at the outflow in the EAV dominated flowway. These results demonstrate the complex role of microbial activities in nutrient cycling in the STAs as affected by flow condition.

PRESENTER BIO: Ms. Pietro is a professional wetland scientist with over 31 years of experience working in south Florida.

MITIGATION AND REMEDIATION OF HARMFUL ALGAL BLOOMS THROUGH NUTRIENT REMOVAL AS INTACT CELLUAR ALGAE BIOMASS

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Despite implementation of multiple policies, strategies, and practices to reduce nutrient (nitrogen and phosphors) accumulation in surface waters throughout Florida, harmful algae blooms (HABs) continue to occur. On July 9, 2018 Florida's Governor Rick Scott issued Executive Order 18-191 to provide relief to seven South Florida counties impacted from the discharge of water from Lake Okeechobee into the Caloosahatchee River, the St. Lucie Canal and their respective downstream receiving waters and estuaries. The Executive Order further instructed the Florida Department of Environmental Protection (FDEP) and the South Florida Water Management District to take emergency action. Furthermore, through increasing support to FDEP, Florida's newly elected Governor Ron DeSantis is committed to long-term Everglades restoration, better management of Lake Okeechobee and investing in innovative technology strategies in the short term to protect communities from blue-green algae

Under a Work Plan approved by FDEP, AECOM implemented an approximate three month long Emergency Response Clean-up of harmful cyanobacteria (blue-green algae) blooms in Lee and Martin counties from late July to early October 2018. The clean-up response was comprised of two components, the algae collection or harvesting operation and the off-site treatment operation. The technical approach utilized in Lee County for the off-site liquid-solid separation treatment process was Dissolved Air Flotation, a clarification process that targets intact algae cells along with associated nutrients and toxins for removal. The Dissolved Air Flotation technology deployed for this emergency response action had been previously and now subsequently demonstrated to be effective in nutrient removal from surface waters yielding 75% to 95% reductions in Total Phosphorus and Total Nitrogen accompanied by 85% to 95% reduction in Chlorophyll-a. Additionally, Chlorophyll-a concentrations have been reduced by > 90%. These data suggest that the Dissolved Air Flotation process can be immediately deployed and scaled up to play a substantial role in helping mitigate HABs by lowering nutrient concentrations in surface waters such as Lake Okeechobee and similar water bodies that are source waters for major waterways and The Everglades. Furthermore; beneficial use of recovered algae biomass has been demonstrated and new uses continue to emerge.

<ins>PRESENTER BIO</ins>: David Pinelli is a liquid-solids separation specialist with more than 35 years of experience in Dissolved Air Flotation applications primarily in the industrial arena having participated in well over 100 projects. His focus the last five years has been in the area of algae biomass recovery, most recently for mitigation of eutrophic surface waters and Harmful Algae Bloom remediation.

NEW OUTCOMES OF ENVIRONMENTAL VOLUNTEER PROGRAMS

Nicole Pinson

University of Florida/Institute of Food and Agricultural Sciences Extension Hillsborough County, Seffner, FL, USA

Public and private entities enlist well-trained volunteers to help with essential programs. These volunteers and citizen scientists enhance the local community and increase program outreach. Formal volunteer programs such as these benefit Florida residents. Volunteer programs allow county and state governments, non-profits, businesses and other organizations to extend or expand services to clientele at a relatively low cost. Traditionally, volunteers' contributions are measured by calculating the number of volunteer hours and the value of those hours as determined by organizations such as the Independent Sector. However, research exists to support the value of volunteer programs beyond economic indicators and organizations may provide greater return on investment to stakeholders. The objectives of this presentation are to 1) provide professionals and volunteer coordinators with examples of how to quantify their volunteer programs beyond economic value, 2) use research-based resources and data garnered from peer-reviewed journals, reports, and studies that enable participants to form linkages with national, regional, and state reporting agencies, and 3) share resources and volunteer survey data results from the UF/IFAS Extension Hillsborough County. Moving beyond hours served and dollar value of those hours enables volunteer coordinators and project leaders to better define the impacts of their work, and to report program impacts and long-term outcomes, such as health outcomes, civic engagement, and retention rates, in order to improve relationships, convey relevance, and provide measurable program results to stakeholders such as universities, local governments, peers, and the public.

PRESENTER BIO: Nicole Pinson is the Urban Horticulture Agent and Master Gardener Coordinator for the UF/IFAS Extension Hillsborough County. Working with 100+ volunteers annually, she understands how volunteers help teach environmental stewardship, create resilient communities, and foster civic engagement.

MOVEMENT PATTERNS OF POST-FLEDGING SNAIL KITES IMPROVE UNDERSTANDING OF A KEY BOTTLENECK IN RECOVERY OF THE SPECIES

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Survival of Snail Kites (*Rostrhamus sociabilis*) from fledging to 1-year is important for growth and recovery of the endangered population in south Florida. However, current understanding of the timing, drivers, and consequences of movement is currently limited. We therefore sought to determine post-fledging survival and movement patterns of Snail Kites across the Greater Everglades Ecosystem. We GPS-tracked 29 fledgling Snail Kites across six wetlands, 2016-2018 to understand relationships between two key environmental drivers of post-fledging movement: hydrology and snail density. We also used 16 years of mark-recapture information (2002-2018) to quantify hydrologic conditions at the nest that are likely to lead to post-fledging survival. We found that movement patterns varied substantially within and between individuals, but that birds remained within 900 meters of the nest site for up to 58 days post-fledging, a time period previously shown to be important for first year survival. During that time, birds explored surrounding wetlands using occasional foray flights that began and ended at the natal wetland, and were characterized by rapid, moderate-distance movements. The relationship between movement patterns during the first 60 days post-fledging and water depth, water recession, and snail density at the nest site was inconsistent and varied by site. These results provide insight for maintaining suitable hydrologic conditions for successful survival and dispersal in this species.

<u>PRESENTER BIO</u>: Caroline is an Ecologist with 16 years of experience in the field and a MS from Clemson University. She is currently a PhD candidate and her work focuses on conservation and movement ecology of the endangered Snail Kite.

THE BIOGEOCHEMISTRY OF MERCURY, SULFUR, AND ORGANIC CARBON IN THE FLORIDA EVERGLADES

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Mercury (Hg) speciation, transport, and bioavailability in the Florida Everglades are intimately linked to sulfur (S) cycling and interactions with dissolved organic carbon (DOC). Information on mercury-sulfur-organic carbon interactions provides a framework to evaluate the interrelated processes controlling mercury availability to methylation in the Florida Everglades, and predict the impacts of ecosystem restoration efforts on mercury cycling. This presentation will highlight the current state-of-the-science on mercury-sulfur-organic carbon interactions, and discuss how geochemical factors controlling mercury methylation vary spatially in Everglades wetlands.

A primary factor governing the geochemical speciation of mercury in the Everglades is the presence of inorganic sulfide, which is formed by sulfate reducing bacteria in response to inputs of inorganic sulfate from agricultural lands. In sulfide-free waters, representative of pristine Everglades wetlands and oxic surface waters, mercury speciation is controlled by complexation with DOC. DOC contains reduced sulfur groups (i.e., thiols) that form exceptionally strong complexes with divalent mercury (Hg(II)). Under sulfate reducing conditions, inorganic sulfide reacts with Hg(II) to form nanocolloidal mercuric sulfide (nano-HgS). DOC interacts with nucleating nano-HgS to stabilize HgS clusters and slow particle growth kinetics. Further, the size or crystalline order of nano-HgS increases with increasing Hg(II):DOC ratio and sulfide concentration, and decreases with increasing aromaticity of the DOC. The geochemical nature of nano-HgS has implications for the bioavailability of Hg(II) to methylating organisms. Under conditions where nano-HgS dominates mercury speciation, Hg(II) methylation is enhanced in the presence of DOC that is more aromatic and has higher reduced sulfur content.

To translate how these processes might influence Hg(II) methylation in the Everglades, we show how DOC aromaticity and reduced sulfur content in Water Conservation Areas (WCA) 1, 2A, and 3A vary spatially. Canals that drain agricultural areas transport water containing DOC that is highly aromatic and elevated in inorganic sulfate. In the marshes, DOC aromaticity decreases from the location of canal inputs along surface water flow paths, reflecting the combined influence of DOC mineralization and autochthonous DOC production. In wetland sediments, inorganic sulfide is incorporated into DOC predominantly as reduced sulfur species (i.e., thiols). Sulfur-enriched DOC in sediment pore waters exchanges with overlying surface waters and is transported down-gradient in the marshes. These field observations that influence Hg(II) methylation are discussed in the context of wetland restoration efforts and their potential implications to mercury cycling.

PRESENTER BIO: Dr. Poulin is an organic geochemist at the U.S. Geological Survey in Boulder, Colorado. His research focuses on understanding how the chemical nature of dissolved organic carbon influences the environmental cycling of major elements (e.g., carbon, sulfur) and trace metal contaminants (e.g., mercury).

EVALUATION OF POTENTIAL FOR ROOTED FLOATING AQUATIC VEGETATION TO FURTHER REDUCE LOW-LEVEL PHOSPHORUS CONCENTRATIONS IN THE EVERGLADES STORMWATER TREATMENT AREAS

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The Everglades Stormwater Treatment Areas (STAs) are large-scale freshwater wetlands constructed to reduce phosphorus (P) concentrations in runoff to support restoration of the Everglades. The combined flow-weighted mean concentration from the STAs for the period of record is approximately 30 µg P/L, with some STAs achieving 20 µg P/L and less on an annual basis. Further enhancement of vegetation-based treatment may assist the STAs to achieve the regulatory target of 13 µg P/L in the outflow concentrations. This study examines the potential of rooted floating aquatic vegetation (rFAV) communities growing in low P conditions to reduce TP concentrations to ultra-low levels.

The rFAV species *Nymphaea odorata* (white water lily), *Nelumbo lutea* (American lotus), and *Nuphar lutea* (spatterdock), frequently are found in STAs where P concentrations are near 20 µg/L. To evaluate their effectiveness in P reduction, areas of rFAV were compared to areas of submerged aquatic vegetation (SAV), a prominent component of the outflow region of the STAs. Sites were selected in STA cells where natural recruitment of rFAV had occurred and low-level P concentrations were typical. Each monitoring location consisted of two collocated sites, one in a patch of mixed rFAV and SAV and a second with SAV alone. Analysis of water samples from these patches found equal or higher P concentrations at the rFAV sites than at the SAV sites. The major contributor to these differences was higher concentrations of particulate P at the rFAV sites. Mechanisms contributing to increased water P concentrations were investigated further by assessing soil characteristics, nutrient exchange following sediment resuspension, and anoxic P release from soils. Results from this study showed no direct benefit to P reduction from rFAV species suggesting that their removal from outflow regions may be beneficial.

<u>PRESENTER BIO</u>: Matt Powers is a professional wetland scientist with the South Florida Water Management District with over 12 years of experience in the fields of water quality monitoring and water quality treatment.

HYDRODYNAMICS OF CONSTRUCTED EVERGLADES TREE ISLANDS

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Tree islands were once an abundant component of the ridge and slough landscape of the natural Everglades and provided a slighter drier refuge for wildlife and woody plants. In order to test various tree island habitat management and restoration techniques, the Loxahatchee Impoundment Landscape Assessment (LILA) was constructed in Boynton Beach, Florida as a collaborative effort between the SFWMD, the Army Corp. of Engineers and the U.S. Fish and Wildlife Service. LILA contains 8 constructed tree islands, 4 composed of peat and 4 with a limestone core surrounded by peat. Tree saplings were planted on the tree islands in 2006 and 2007. Our objective was to determine the response in groundwater levels and chemistry of the LILA tree islands with the growth of the trees through time.

Groundwater levels were monitored in wells located in the center and edge of the tree islands using pressure transducers. Surface water levels were also monitored in the slough adjacent to the tree islands. Groundwater and surface water samples were collected twice a year (May and October). The field parameters pH, temperature, and specific conductance were monitored at the time of sampling. Water samples were analyzed for major cations (calcium, magnesium, sodium and potassium), anions (bicarbonate, chloride and sulfate), the stable isotopes of oxygen and hydrogen as well as for total concentrations of nitrogen, phosphorus and carbon. This presentation will include data collected across 10 years from 2007 to 2017.

During year one, groundwater levels in the tree islands were higher in the center compared to the edge and slough, typical of an island setting. Within 2 years, the groundwater table in the islands was influenced by tree transpiration in two ways. First, the groundwater table experienced a daily drawdown followed by a partial night-time recovery. Secondly, over time the groundwater table in the center of some of the islands remained below that of the edge wells at least on a seasonal basis. Those islands with a long-term drawdown in the groundwater table were also characterized as having geologic materials of lower permeability such as clays and limestone with peat, as opposed to sandy peat.

Over the 10 year study, groundwater chemistry in the center of the tree islands differed from the edge groundwater in response to tree transpiration. Concentrations of nitrogen, phosphorus and potassium all decreased in concentration as the trees took up those nutrients. Conversely, concentrations of the major ions calcium, bicarbonate and chloride all increased in the center groundwater as those ions were excluded during tree transpiration. Stable isotopes of oxygen and hydrogen confirmed that the center groundwater was recharged more from rainfall, while the edge groundwater was recharged more from the adjacent surface water. The results of this investigation concluded that trees have a relatively rapid and ongoing influence on the hydrodynamics and geochemistry of constructed tree islands as a function of soil hydraulic properties.

PRESENTER BIO: Dr. Rene´ Price is a Professor of hydrogeology at Florida International University in the Department of Earth and Environment and the Southeast Environmental Research Center. Dr. Price has been studying Everglades hydrology for over 25 years and has published over 50 journal articles and conference proceedings.

HIGH-FLOW RESTORATION INTERACTIONS WITH DECONSTRUCTED LEVEES AND REPURPOSED CANALS

Jordan Psaltakis[1], *Jud Harvey*[1], *Jay Choi*[1], *Jennifer Lewis*[1], *Colin Saunders*[2], *Carlos Coronado-Molina*[2], *Sue Newman*[2], *and Fabiola Santamaria*[2]
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In the Everglades, drainage and barriers to flow have reduced natural sheet flow and contributed to loss of deepwater sloughs and associated ecological benefits. Increased phosphorous (P) loading to the naturally oligotrophic system is also an important stressor, causing harmful degradation of a well-functioning ridge and slough landscape. The Decomp Physical Model (DPM) experiment is addressing scientific uncertainties regarding how removing levees to improve sheet flow affects sediment transport and P loading to downstream ecosystems. The objective was to quantify the effects of increased flow across a deconstructed levee on movement of sediment and Total P (TP), and to assess the possible benefits of different canal backfilling options, e.g. complete, partial, and no backfill. Mass balances of water, suspended sediment, and TP were calculated by measuring water depths and flow speeds, TP concentrations, and suspended sediment concentrations at sites in and around the canal backfill area and levee gap, including in the adjacent wetlands of DPM and WCA 3B. Measurements were made during both low- and high-sheet flow conditions in November and December 2015 and were aligned to represent waters flowing through the canal backfill treatment areas. Water, TP, and suspended sediment fluxes across the L67-C levee gap increased in response to high-flow conditions. A high percentage of the water released during high-flow conditions from the upstream S-152 control structure flowed eastward and entered the L67-C canal northeast of the backfill treatments. Water flowed southwest through the canal, entered the canal backfill treatment area, and then passed through the deconstructed levee into WCA-3B. It appeared that the L67-C canal backfill treatment area may act as a source of TP to downstream areas during high flow, as 59% more TP exited the deconstructed levee and canal control volume by flowing downstream into WCA-3B compared to what entered from upstream. Suspended sediment settling was retained in the canal control volume during high-flow, suggesting that excess TP may be mobilized in a soluble form from areas of reducing redox conditions in the canal bottom. In contrast, during low -flow, the input of TP from upstream was 21% greater than effluxes to downstream areas, indicating retention of TP, and pointing to the possible importance of settling of sediment-associated TP during low-flow conditions. During both flow conditions, the majority of water moving into the deconstructed levee and canal control volume moved through the no backfill treatment segment due to water entering the L67-C canal northeast of the control volume, as described above. Water efflux differed, however, with most water exiting via the no backfill and complete backfill treatment segments, 76% and 24% respectively during low flow, and 52% and 45% via the partial backfill and no backfill treatment areas, respectively, during high-flow. This study has provided preliminary but useful information about the effects of reconnecting floodplains through levee removal and increased flows on the fluxes of water, TP, and suspended sediments. Importantly, it provides a mechanistic basis to understanding potential impacts of canals and levee removal on downstream water quality. Improved measurements are required to better understand the detailed effects of canal backfill treatments.

PRESENTER BIO: Jordan is a research associate with the USGS in Reston, Virginia with 2 years of experience in supporting Everglades restoration efforts as part of the Decomp Physical Model Science Team research. He received an MS from the University of Maryland, Baltimore County in Geography and Environmental Systems in 2017.

DISTRIBUTION OF WOODY VEGETATION IN THE SHORT-HYDROPERIOD MARL PRAIRIE GRASSLANDS

***Carlos Pulido*[1]**, *Jay Sah*[2], *Michael Ross*[3], *Susana Stoffella and Pablo Ruiz*[1]
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In the Everglades, short hydroperiod marl prairies that occupy the lateral fringes of both Shark River and Taylor Sloughs are dominated by C_4 grasses. The marl prairie landscape is the habitat of the Cape Sable Seaside Sparrow (CSSS), a federally listed endangered species, and thus in the center of hydrologic restoration activities within the Everglades. However, hydrological restoration should not be the only focus of Everglades restoration; the fire regimes, a natural process in the Everglades ecosystem that serves to maintain vegetation composition along marl prairie-slough gradient, should also be restored. A threat to the integrity of marl prairies is an increase in woody (C_3) vegetation, which has negative impacts on the CSSS habitat. Because the sparrow prefers non-woody vegetation for nesting, too much or too little water, in conjunction with a lack of a fire, results in an increase in woody vegetation that may adversely affect the sparrow population. Research has shown that prescribed burns reduce woody vegetation encroachment in the marshes and wet prairies. Our objective was to create a comprehensive map of woody patches present within the marl prairie landscape and relate their distribution with recent flooding and fire regimes.

Aerial imagery was used to create a high-resolution map of woody vegetation patches, with a minimium mapping unit (MMU) of 36 m^2, within the habitat of six CSSS subpopulations. Normalized Difference Vegetation Index (NDVI), a reliable predictor of photosynthetic activity and production in the landscape, was used to differentiate between woody patches and the surrounding marsh vegetation. In the mapping process, raster pixels with an NDVI value ≥ 0.35 were classified as woody vegetation and NDVI values < 0.35were classified as marsh. Utilizing Geographic Information System (GIS), a comprehensive geodatabase of woody vegetation was created and combined with historical fire and hydroperiod data. This procedure has potential to inform managers on how hydrological regimes and fire impact distribution of woody vegetation patches in marl prairies. It also offers an opportunity to study how hydrologic changes resulting from the Comprehensive Everglades Restoration Project (CERP) components, especially the Tamiami bridges and C111 Spreader Canal Western Projects, will impact the marl prairies on both sides of Shark River Slough and within the Taylor Slough basin, respectively.

PRESENTER BIO: Carlos Pulido is a McNair Scholar who graduated from Florida International University with degrees in Biology (2015) and Environmental Science (2017). He is involved in research work related to wetland ecology, as uses GIS, remote sensing, and machine learning as analytical tools. He plans on pursing a Ph.D. in the fall 2019.

COMPLETING MODIFIED WATER DELIVERIES – TREE ISLANDS AS A PERFORMANCE INDICATOR FOR COMBINED OPERATIONS PLANNING

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Tree islands are a highly valued component of the ridge-slough-tree island landscape throughout the Everglades watershed. The health, persistence, and sustainable development of tree island habitats are thought to be driven by frequency and depths of inundation relative to tree island elevations. Unfortunately, the number and total acreage of tree islands have been consistently declining since the 1950's. Comprehensive Everglades restoration (CERP) is focused on halting this declining trend. By redesigning the infrastructure and operations of the regional system CERP hopes to restore the landscape-scale functions that support tree island establishment and sustainability. The tree island performance indicator presented here is designed precisely with restoration of tree islands in mind. As information from CERP monitoring efforts have accumulated over the past two decades, we now have a critical mass of 379 tree islands with explicitly mapped elevations. The tree island performance indicator uses this information coupled with daily water stage estimates to evaluate simulated water conditions over multiple decades. This indicator can also be adapted to describe how frequently the whole population of tree islands has been inundated under observed conditions by using daily water surfaces produced by the Everglades Depth Estimation Network (EDEN). When this indicator is applied to Combined Operations Planning (COP) simulations we see major increases in the frequency of tree islands that are inundated less than 10% of the period of record. While we have observed only 24% of these 379 tree islands inundated less than 10% of the time since 1991, COP simulations predict that 37-46% of the 379 tree island will be inundated less than 10% of the time over a 41 year period of climate records. This result suggests a meaningful improvement for many tree islands that have struggled to cope with excessive inundation. Continued use of this performance indicator tool over the next few decades is likely. It is important to note that there are other indicators designed to protect against the consequences of over-drying and related soil fire risks to ensure that tree islands are not impacted by soil oxidation and subsidence or destroyed by intense, soil consuming fires. Development of the tree island performance indicator should continue as we map elevations of more tree islands, and enhance the precision of our interpretation of hydrological correlates of tree island health.

PRESENTER BIO: Dr. Redwine is a science coordinator with the National Park Service, and has worked on ecological management of natural resources in South Florida since his first visit to ENP in 1994.

DECADAL DYNAMICS OF FISH AND FISHERIES IN THE SHARK RIVER: WHAT HAVE WE LEARNED ABOUT RESPONSES TO HYDROCLIMATE VARIATION?

JS Rehage, *Rolando O Santos, Jordan Massie, and Natasha Viadero*
Florida International University, Miami, FL

Management of environmental flows into the future necessitates a better understanding of how ecological attributes respond to changing flows, i.e., *flow–ecology* relationships. Of interest are the slope, intercept, the presence of nonlinearity, as well the location of any threshold for nonlinear relationships. Freshwater flows can have a major influence on the ecology of fish, including patterns of diversity, abundance, space use, movements and distributions. Alterations to flow regime components such as magnitude, frequency, duration, timing, and rate-of-change should thus drive the ecology of fishes. These effects may result via alterations to salinity regimes, nutrient fluxes, and other important physio-chemical regimes (e.g., oxygen), as well as via changes to habitat quality and quantity, and/or influences on resources. Of particular interest is the effect of freshwater inflows on economically-valuable coastal fish and fisheries that are estuarine-dependent. The role and directionality of operating mechanisms underlying the effects of freshwater inflows remains poorly understood, and are critical to adaptive management strategies, especially in the face of projected changes in freshwater availability with climate change and increasing anthropogenic water demands. In this study, we examined dynamics of fish communities and recreational fisheries in the upper Shark River in relation to temporal variation in freshwater flows across seasons of years of varying hydrology. An assessment of the sensitivity of these flow-ecology relationships to environmental change is key to developing management systems that are robust to nonstationarity in climate and other environmental conditions, and to the evaluation of socioecological tradeoffs in water usage.

PRESENTER BIO: Dr. Rehage is a fish ecologists with over 15 yrs of experience working on the fishes and fisheries in the Everglades. She has several ongoing project examining the ecology of coastal fisheries in the Everglades & their dependencies on hydrological parameters.

HYDROLOGIC CHANGES IN EVERGLADES NATIONAL PARK AS A RESULT OF THE MODIFIED WATER DELIVERY PROJECT

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The Modified Water Deliveries Project is intended to redistribute existing inflows to Everglades National Park spatially and seasonally. The objective is to increase the percentage of inflows directed to Northeast Shark River Slough (NESS) and allow those flows to continue throughout the year. This objective can be achieved by raising the operational stage limit in the L29 borrow canal from 7.5 feet to 8.5 feet and removing the marsh water level constraint that stops inflows during the wet season. However, these changes have required the construction of several features to move water under US41 and control the additional seepage caused by the higher water levels. Most of the project features have been constructed since the project was authorized in 1989; including removing the lower L67E canal (2003), constructing the S356 pump station (1997), the S357 pump station and C357 canal (2009), and the 1 mile (2013) and 2.6 mile (2019) bridges on Tamiami Trail. Preparation for the new operational plan to raise stage in the L29 began in 2015 with a series of field tests. Temporary emergency operations as a result of large rainfall events in 2015 and 2017 further increased the stage and discharge into the L29 canal.

Observed data was analyzed to evaluate the hydrologic response to the newly constructed features and the operational changes in NESS. The analysis includes spatial and temporal changes in flow distribution as a result of the project, changes to hydropattern, and an assessment of other intended and unintended consequences of the project on the natural and built systems in and around Everglades National Park. Preliminary results indicate that the changes to operations have increased the flow into NESS, the average annual flow approximately doubled after the implementation of increased stage in the L29 canal. Higher than average rainfall over the last several years has made it difficult to assess the effects of the additional flow on the hydrologic conditions, however stage at several stations has been in the 95th percentile for the period of record and the hydroperiod of the marshes has increased. Unfortunately, the distribution of flow into the park from the north has not improved; the northeastern area continues to receive less inflow than western Shark Slough and the stage at several stations remains far below restoration targets.

PRESENTER BIO: Amy Renshaw is a Hydrologist at the South Florida Natural Resource Center at Everglades National Park.

FUTURE IMPACTS ON BISCAYNE BAY OF EXTENDED OPERATION OF TURKEY POINT COOLING CANALS

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Florida Power and Light (FPL) has applied to extend operations of its Turkey Point power plants until the early 2050s. Currently, FPL is under orders from regulators to correct problems stemming from the canals that cool the water used to run the steam turbines. Among these, the cooling canals discharge nutrient-rich, hypersaline water into Biscayne Bay and the Biscayne aquifer. The Interceptor Ditch has failed its intended function to prevent contamination of the aquifer, and its continued operation comes at the cost of extracting around 3 mgd of freshwater from the wetlands in the Model Lands area. What are the consequences for the health of the bay and success of the C-111 and Biscayne Bay Coastal Wetlands Restoration projects if the cooling canals operate for another 30 years?

Results from an expanded monitoring program, initiated in 2009, reveal how the cooling canals interact with Biscayne Bay and the regional groundwater system through an active exchange of water between the canals and the aquifer. The cooling canals were constructed in the 1970s to prevent damaging discharge of heated water directly into the bay from the Turkey Point power plants. Until about 2009 it was widely assumed that the canals had little impact on the bay and adjacent wetlands. However, by 2012, investigations demonstrated the canals were the source of a plume of hypersaline groundwater extending several miles west, and nutrient-rich water from the canals was found in the bay.

Water in the canals is hypersaline as a consequence of high rates of evaporation. Evaporation is one of the primary mechanisms that cools the heated water as it circulates through the canals from the point of discharge on the west side of the power plants, returning to the water intake on the east side of the plant. For the first 40 years of operation, an inflow of saline water from Biscayne Bay made up the difference between losses from evaporation and water added by rainfall, pumping from the Interceptor Ditch and other minor sources. As a result, salt accumulated in the canals. Since 2010, the salinity of water in the canals has averaged around 60 psu. Seepage out of the canals provides a steady supply of hypersaline water to feed the growth of the groundwater plume.

In 2016, FPL initiated actions to remediate the discharge of hypersaline water into the aquifer. In particular, fresher water is being added to the canals from the Upper Floridan aquifer to decrease the average salinity to 34 psu. And, water is being withdrawn from the groundwater plume through a series of recovery wells and pumped into a deep injection well. These actions address the factors involved in the formation and westward migration of the saline groundwater plume. However, these measures do little to mitigate the discharge of water into Biscayne Bay. Monitoring results indicate that adding water to lower salinity has had the effect of increasing discharge toward Biscayne Bay. Discharge to the bay occurs intermittently in response to changes in plant operations, heavy rainfall, and fluctuations in bay water levels, the last two being also affected by climate change and accelerated sea level rise.

PRESENTER BIO: Laura Reynolds is a biologist with over 20 years' experience working in and protecting Florida's ecosystems. With Conservation Concepts LLC she helps nonprofits bring environmental issues into the public eye and bridge the gap between science and policy to better protect Florida's ecosystems and resources.

PATTERNS OF VEGETATION CHANGE IN NORTHEAST SHARK RIVER SLOUGH, 2010-2016

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Vegetation in Everglades National Park's Northeast Shark River Slough (NESRS) is expected to respond to on-going restoration modifications affecting water flow into the area. Two major modifications were completed in 2012/13. A 2-mi-long seepage barrier, expected to retain water in NESRS, was installed between the L-31N canal and NESRS, extending south from Tamiami Trail; the barrier was completed in July, 2012. The Tamiami Trail 1-mi bridge, expected to increase water delivery and provide sheet flow into NESRS, was completed in May, 2013. Both of these restoration projects should increase water depth and prolong the wet season in NESRS, driving vegetation to become more hydric.

We used bi-seasonal WorldView-2 (WV2) satellite data from 2010 wet and 2013 dry seasons and from 2016 wet and 2017 dry seasons to map vegetation in a 15.8 x 11.4 km (146 km^2) region of interest (ROI) in the northeast corner of NESRS. WV2 data has a spatial resolution of 2x2 m and eight spectral bands ranging from short-wavelength blue to near infrared. Data was processed in R using a random forest classifier trained by spectral reflectance patterns of > 35,000 training samples. The classifier predicted vegetation types for all raster cells in the ROI. Twenty-two vegetation classes were mapped. The resulting 2010 and 2016 maps were then cross-tabulated to establish type and location of vegetation changes. We also monitored vegetation in the field at six sites, each with six radially-arranged 150 m transects; vegetation classes were recorded every 10 m along the transects. These sites were established and sampled in 2012/13, then resampled in 2016.

NESRS is dominated by sawgrass vegetation classes, which covered 71% of the ROI in 2010 and 73% in 2016 (sparse, regular, and dense sawgrass densities aggregated). Short-graminoid marsh classes (all densities aggregated) represent 13% (2010) and 11% (2016) of the landscape. The northern region has prominent halos of woody tree and shrub vegetation centered on culverts that historically delivered water below the Tamiami Trail. Woody vegetation increased from 2010 to 2016, reflected in an increase from 2% to 3% total cover in shrub/tall-graminoid vegetation. Marl prairie is dominant in the southeastern corner of the ROI. The central and southcentral/southwestern areas of the ROI have sawgrass and short-graminoid marshes with historical flow reflected in the southwesterly orientation of tree islands. These general landscape features for the ROI were similar from 2010 and 2016, but vegetation densities changed greatly. The largest category of change across the mapped area was a decrease in sawgrass density. Regular sawgrass decreased from 43 to 37% cover, while sparse sawgrass increased from 23 to 38% cover. Dense sawgrass decreased from 5% to 4%. These changes were especially apparent in the western region of the ROI where the northwestern 2011 Afternoon and Shanty fires and southwestern 2012 EE 1 Rx fire occurred; they were also reflected in the central western transect data. This type of change suggests that fire has interacted with increasing hydroperiods to reduce density of vegetation in sawgrass ridges and points to the possibility that fire can be used to systematically thin marsh vegetation over many square kilometers. An increase in sparse sawgrass, however, was also seen on the eastern edge of NESRS. This region had no major fires between 2010 and 2016, so change in this area could reflect increased hydrology from the seepage barrier and Tamiami Trail bridge.

PRESENTER BIO: Dr. Richards is a professor of Biological Sciences at FIU with more than 30 years of experience in wetlands, esp. the Everglades, researching plant responses to their environment.

DISTURBANCE-DRIVEN SEASCAPE CHANGE IN FLORIDA BAY: A REMOTE SENSING APPROACH

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Physical and biological disturbances play a crucial role in changing the spatial structure of coastal habitats. In particular, seagrass habitats tend to display very dynamic spatial characteristics due to such disturbances operating at different spatiotemporal scales. Seagrass beds provide many ecological services, such as coastal nutrient cycling, carbon sequestration, and habitats for commercially and recreationally important fish and invertebrate species that may be influenced by the spatial pattern of seagrass seascapes. Florida Bay experienced a seagrass die-off event in the summer of 2015 and Hurricane Irma two years later. The large extent of these recent disturbance events could have major implications in the spatial structure of the Florida Bay seagrass seascape. However, while extensive *in situ* seagrass measurement efforts have been made in response to these disturbances, the presence of broad scale seascape characterization through remote sensing is lacking even though it has the potential to help understand ecosystem level processes. The aim of this study is to map and categorize changes in seagrass cover in north-central Florida Bay (Rankin, South Rankin, Whipray, and Johnson Basins) using various satellite and aerial image sources. We categorized seagrass loss and fragmentation due to the 2015 seagrass die-off and Hurricane Irma, highlighting areas of drastic change. Information gathered on how physical and biological disturbances have impacted the seagrass habitats of Florida Bay will enable future research assessing seascape level effects on upper trophic dynamics and other ecosystem functions. The large scale nature of this study provides an opportunity to better understand processes at a seascape or ecosystem level, which is important for effective restoration and management.

PRESENTER BIO: Jonathan Rodemann is a Doctoral student in the Coastal Fisheries Lab at Florida International University. His research interests include movement and behavioral ecology of recreationally important fishes, which he is putting to work in Florida Bay looking at movement of fishes in response to seascape change.

DESIGNING A MONITORING FRAMEWORK TO INFORM INVASIVE PLANT MANAGEMENT STRATEGIES—LESSONS FROM THE A.R.M. LOXAHATCHEE NATIONAL WILDLIFE REFUGE

***LeRoy Rodgers*[1]*, Christen Mason*[1]*, and Tony Pernas*[2]

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Obtaining spatially explicit, cost-effective, and management relevant data on invasive plant distributions across large natural areas represents a significant challenge to invasive weed management. This is especially true when multiple monitoring objectives exist, because the utility of different monitoring methodologies varies with scale, logistical considerations, and information needs. The A.R.M. Loxahatchee National Wildlife Refuge (Refuge) is a 57,324 ha wetland system in Palm Beach County, FL. The Refuge landscape consists of a complex mosaic of sawgrass marsh, aquatic sloughs, wet prairie, and tree islands. Two highly invasive non-native plant species—melaleuca (*Melaleuca quinquenervia*) and Old World climbing fern (*Lygodium microphyllum*)—are well established with the Refuge and threaten to degrade significant portions of this unique natural resource. Ongoing invasive plant management efforts at the Refuge have relied on various monitoring methods to quantify the abundance and distributions of priority species. These methods include landscape scale systematic reconnaissance flights (SRF), targeted aerial mapping to assist ground-based herbicide applicators, and detailed mapping of invasions in tree islands. This presentation will provide an overview of the current invasive plant monitoring framework at the Refuge, summarize decadal changes in the landscape-level distribution and abundance of melaleuca and Old World climbing fern from 1995 to present, and provide recent estimates on the status of these two species in the Refuge's larger "strand" tree islands.

PRESENTER BIO: LeRoy Rodgers is a Lead Scientist in the Land Resources Bureau at the South Florida Water Management District. LeRoy holds a BS in Botany from the University of Florida and a Masters in Biology from Old Dominion University. He has over 20 years of experience working on invasive species management issues in Florida. LeRoy oversees the Everglades invasive plant monitoring program and leads a team of biologists focused on numerous natural area invasive plant research and management programs.

PARTNERING WITH PREK-12 STEM EDUCATION TO PROPAGATE, TRACK ESTABLISHMENT AND MONITOR SURVIVORSHIP OF NATIVE PLANTS IN FLORIDA

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The link between mycorrhizae, symbiotic fungi, and their host plants is well documented in many systems. Mycorrhizae provide direct physiological benefits to their hosts and also impact local soil conditions. In some families, such as orchids, the presence of mycorrhizae are critical even at the early stage of seed germination. In Florida, native orchid species are rapidly declining, largely due to habitat loss. The Florida Atlantic University (FAU) Pine Jog Environmental Education Center is using published micropropagation methods to grow and re-introduce native orchids into urban and natural areas across south Florida. As these orchids are re-established, mycorrhizal growth and morphotypes among species and planting conditions are monitored and studied. As a teaching tool, and to establish community activism, orchids are placed in local schools, including FAU's onsite lab school, A.D. Henderson, for students to propagate, study, and outplant. Students are active partners, cultivating plants and preparing them for distribution into urban and natural areas within their established native ranges. FAU High School students are learning microscopy techniques to quantify differences in mycorrhizal communities and overall plant conditions from orchids transplanted in natural compared to urban locations. These experiments engage students of all ages and expose them to hypothesis testing, experimental design, and propagation techniques. This project also encourages students to interact with the natural environment and consider the ecological consequences of urban development while re-establishing a declining native species.

PREY SPECIES COMPOSITION AND SPATIAL DIETARY SHIFTS OF THE BURMESE PYTHON IN FLORIDA

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The impact of invasive species has emerged as a high-priority issue in planning the restoration and conservation of the Greater Everglades Ecosystem. Invasive predators provide an opportunity to understand the direct trophic effects that predation can have on prey populations. The Burmese python, an invasive predator found in the Greater Everglades Ecosystem, has drastically changed the mammal community in the southern core region of its invaded range. This species is expanding its range north to other protected areas, as well as south to the Florida Keys, where predation on the endangered Key Largo Wood Rat has already occurred.

While key data have been collected on the Burmese python diet in the Everglades, there are still several unanswered questions about spatial, temporal, and/or size-related shifts in their prey species composition. We identified prey species from the digestive tract contents of more than 1000 pythons collected from 2006 to the present using a morphological approach (i.e., using hair, feather, and scale morphology). These data were subdivided into regions that reflect the expansion of the range from the southern Everglades, north to Water Conservation Area 3A, and west to Collier County.

To date, over 1,300 individual prey items from 40 bird, 25 mammal, and one reptile species have been recovered from python diet contents. These prey items span many taxonomic groups, and the proportion of these taxa consumed by pythons differs across the Everglades ecosystem. We found spatial differences in diet composition for pythons collected from within the southern part of Everglades National Park (ENP) boundaries compared to pythons collected in the northern (Water Conservation Area 3) and western (western Collier County) parts of its range. The mammalian component of the diet for pythons collected within southern ENP consisted of primarily rodents (~75%). The mammalian component north and west of ENP was more diverse, and rodents composed roughly 50% and 25% of the diet, respectively. Avian prey comprised only 10% of the diet in the western part of the range, and the percentage was 24% in southern ENP and 31% in the northern part of the range. These results suggest spatial shifts in prey species composition for pythons throughout their range, which supports previous studies showing declining trends for some mammal species throughout the Greater Everglades. Strategic collection of python diet data from the northern and western parts of the Burmese python's invaded range will allow for an assessment of temporal shifts. The documentation of dietary shifts in this common invasive species may help inform ecosystem resilience, and may have implications for Everglades restoration.

PRESENTER BIO: Dr. Romagosa is a Research Assistant Professor at the University of Florida. Her research focus falls into four overlapping aspects of biological invasions: process through the influence of wildlife trade, prevention through risk assessment, ecological impacts, and policy and management.

DESIGNING THE EVERGLADES HEADWATERS NATIONAL WILDLIFE REFUGE TO SAFEGUARD IMPERILED SPECIES FROM URBANIZATION

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The U.S. Fish and Wildlife Service's (FWS) Everglades Headwaters National Wildlife Refuge (EHNWR) is strategically located between Lakes Kissimmee and Okeechobee to protect the upland and wetland habitats of the Kissimmee River Basin. The location of the new refuge was targeted to: address pressures from urbanization and climate change, provide improved quality of water flowing southward to the Greater Everglades, and protect habitat for species of concern (e.g., Florida panther, Florida grasshopper sparrow, Everglades snail kite). Acquiring land for a large protected area such as the EHNWR comes with challenges because it typically takes many years to gather the funds to purchase all necessary parcels of land and could be complicated by future conditions such as climate and urbanization changes across the landscape.

To meet the FWS-defined objectives for the EHNWR, including the protection of five target habitats (dry prairie, pine flatwoods, scrub/sandhill, wet prairie/marsh, forested wetlands), we used Marxan with Zones as a decision tool to select configurations of parcels under different scenarios of urbanization and protection. We allocated the target habitats into two "zones" representing different methods of protection: fee-simple purchase (up to 50,000 acres authorized), and conservation easement agreements (up to 100,000 acres). A further innovation of our approach is the use of projections from two, independent urbanization models, allowing us to explore resulting EHNWR design differences.

In all scenarios, we found an increase in costs as the proportion of fee-simple purchases was increased, reflecting the lesser cost of easements. The number of parcels required for protection differed little among scenarios. The two urbanization models showed considerable agreement over which habitat patches they forecasted to remain undeveloped, and some agreement over which parcels might become developed. The FWS may benefit from focusing on parcels that our analyses select frequently under both urban scenarios because these parcels are more likely to be in areas where there are fewer urbanization threats and a lower demand for land. The designs we generated met FWS habitat goals within fee and easement zone restrictions, and we found refuge configurations that fell well below the mandated size limit.

PRESENTER BIO: Stephanie Romañach has worked on restoration and conservation planning at the U.S. Geological Survey for over a decade. Her work aids decision makers with complex problems that inform national and international conservation and restoration planning. Her portfolio spans Florida's Everglades, Gulf of Mexico, and East Africa.

ALGAL INDICATORS OF ECOSYSTEM RESPONSE IN THE DECOMP PHYSICAL MODEL HIGH-FLOW EXPERIMENT

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The base of the food-web in the Everglades includes a vast array of photosynthetic organisms. Bacillariophyceae (diatoms), Cyanobacteria (blue-greens), Chlorophyta (green algae) are the most abundant primary producers, however, the community also consists of Cryptophyta (cryptomonds), Chrysophyceae (golden-brown algae), Pyrrhophyta (dinoflagellates) and Euglenophyta (euglenoids). These organisms form periphytic mats, colonize the stems and leaves of aquatic plants and live planktonically in sloughs, sawgrass marshes, and canals. As photosynthetic organisms, they rely on sunlight as an energy source and utilize carbon (as carbon dioxide or bicarbonate) and inorganic nutrients for growth and reproduction, and certain cyanobacteria are also able to fix atmospheric nitrogen.

In the oligotrophic portions of the Everglades, the dominant organisms in the periphytic community are adapted to low nutrient conditions, with a few species of diatoms and cyanobacteria being the most abundant. The community in these oligotrophic habitats also have “rare” members; just one or more individuals amongst the tens of thousands of the dominant organisms. These rare members may exist in alternate morphological states; normal versus resting stages, but are still viable. For example, the filamentous green algae, both *Spirogyra* and *Mougeotia*, are found in these oligotrophic habitats as single or two-celled filaments. In more nutrient-rich waters, these organisms form multi-cellular filaments that are many millimeters in length. Following a perturbation, such as the introduction of flow and/or nutrients in the Decomp Physical Model project, we observed rare or morphologically-reduced organisms increased in abundance and size, which altered community measures such as species richness. Green algae were particularly responsive; single-celled and colonial forms infrequently encountered under oligotrophic conditions reproduce and become more common when nutrients and flow increase. By contrast, the oligotrophic Cyanobacteria are diminished and revert to being a rare member of the community.

The dynamic nature of the algal and cyanobacterial community, with its diversity of organisms that readily respond to changing conditions, allows certain members of the community to thrive while others “retreat.” These changes in the community structure and associated nutritional value also have implications for the Everglades primary consumers.

PRESENTER BIO: Dr. Rosen is an algal physiologist, with emphasis on the ecophysiology of organisms in a variety of habitats, especially the Everglades. He is documenting the microscopic organisms that he encounters: *Catalog of microscopic organisms of the Everglades, Part 1—The cyanobacteria:* U.S.G.S. Open-File Report 2016 –1114, 108 p., http://dx.doi.org/10.3133/ofr20161114

TENACIOUS TREE ISLANDS OF FLORIDA'S SOUTHERN COASTAL SWAMP

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As sea level rise has accelerated over the last few decades, mangroves have encroached into coastal prairies of the southern Everglades, with ecosystem-level effects that are becoming better-recognized. Less well known are the effects of mangrove invasion into the myriad tree islands that dot the coastal landscape. In 2016-17 we sampled vegetation and soils in tree islands and the adjacent coastal wetland matrix east of Shark River Slough, including sites in the Southeast Saline Everglades previously sampled by our research team in 1996. One objective of the work was therefore to determine whether mangrove encroachment into the marsh was paralleled by mangrove invasion into the tree islands. A second objective was to gain a better understanding of tree island soils and physiography across the coastal landscape; more specifically, we wanted to know whether these forests lived up to their nutrient "hot spot" reputation. To this end, after probing for soil depth along cross-island transects and describing vertical soil profiles in tree island and wetland matrix, we analyzed soil chemistry by stratum and assessed leaf nutrient content in resident plants. Regarding the first objective, we found that in the two decades between surveys red mangrove (*Rhizophora mangle)* had become established in nearly all islands, but tropical hardwoods characteristic of mesic forests (e.g., *Metopium toxiferum, Calyptranthes pallens, Swietenia mahogani*) persisted. Many of these species produce fleshy fruit that are a critical resource for species such as the white-crowned pigeon. As for the second objective, soil salinity was not very different in tree islands and adjacent wetlands, but organic matter content and phosphorus concentrations were elevated in the forest soils. Leaf N:P ratios were also significantly lower in the leaves of red mangrove in the tree islands than the marsh, indicating that the phosphorus limitation that characterizes many Everglades wetlands was ameliorated in these environments. A question that will become more pertinent as time goes on is the influence of mangrove invasion on carbon storage, nutrient cycling, and provision of wildlife habitat by these tenacious coastal tree islands.

PRESENTER BIO: Dr. Ross is a plant community ecologist in the FIU's Department of Earth and Environment, and a long-time associate in the Southeast Environmental Research Center. Since 1988, his research has targeted ecological and management questions of the forest and wetland landscapes of the Florida Keys, Everglades, and urbanized Miami-Dade County.

THE EVERGLADES NATIONAL PARK AND BIG CYPRESS NATIONAL PRESERVE VEGETATION MAPPING PROJECT

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The Everglades National Park (EVER) and Big Cypress National Preserve (BICY) vegetation mapping project is a cooperative effort between the South Florida Water Management District, the United States Army Corps of Engineers, and the National Park Service. This project employs a grid-based mapping approach as opposed to the traditional vector-based methodology. Photo-interpretation is performed by superimposing a 50 m x 50 m grid network over stereoscopic, color-infrared, aerial imagery on a digital photogrammetric workstation. Photo-interpreters identify the dominant vegetation community in each grid-cell based on community specific spectral signatures and extensive ground-truth data.

Due to the spatial extent of this project (7,444 km2), the mapping area is divided into seven regions; Regions 1 through 4 are located in EVER and Regions 5 through 7 are located in BICY. Approximately 96% of the entire mapping area within EVER and BICY has been mapped. Final products are available for Region 2 (https://irma.nps.gov/DataStore/Reference/Profile/2243281) and Region 3 (https://irma.nps.gov/DataStore/Reference/Profile/2256787) with final products for the remaining Regions 1 and 4-7 expected in the winter of 2019. Map accuracy for Region 2, 3 and 7, based on a random draw of approximately 250 grid-cells per region, is 88.6%, 89.4%, and 85.0% respectively.

This project provides baseline information essential for documenting changes in the spatial extent, pattern, and proportion of plant communities within EVER and BICY as they respond to hydrological modifications resulting from restoration efforts and/or climate change. Additional ancillary products generated from this mapping project include a landscape level network of spatially specific vegetation data, which includes species level relative abundance, georeferenced photographic documentation, and landscape level distribution and cover maps for cattail and exotic species.

PRESENTER BIO: Pablo L. Ruiz is the Vegetation Mapping Project Manager for the South Florida Caribbean Network, National Park Service. He has 25 years of experience in vegetation mapping and plant community ecology within South Florida and the Everglades.

OVERSTORY-UNDERSTORY INTERACTIONS ALONG FLOODING GRADIENTS IN EVERGLADES TREE ISLANDS

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In a forest ecosystem, where vegetation composition is represented by different strata, overstory structure usually has a strong influence on understory plant community composition. However, the strength of such an effect varies in space and time, resulting in distinct understory vegetation assemblages along existing environmental gradients. Tree islands, an integral component of the Everglades, are isolated woody vegetation patches within a matrix of marshes and wet prairie. In these islands, plant community structure and composition vary along topographic gradients, and they are impacted by periodic disturbances, such as tropical storms and fire. Therefore, natural or management-induced changes in hydrologic conditions or disturbances are likely to cause vegetation changes that cascade downward from canopy to understory, resulting in long-term impacts on tree composition. In this study, our objectives were to determine the relationship between overstory structure and understory vegetation composition in Everglades tree islands, and to examine if understory vegetation composition on tree islands can be a leading indicator of hydrologic changes. Our research questions were, a) How do the canopy cover and hydrology interact to influence understory species composition and diversity along a flooding gradient?, and b) Is there a shift in their relative importance in affecting understory vegetation along the gradient? We hypothesized that, a) Variation in understory plant community composition along a hydrologic gradient will also depend on the overstory structure and composition, and b) Canopy cover (shade) influences understory species composition more in elevated portions of the topographic gradient, with shorter periods of inundation, than in areas with prolonged hydroperiod.

We used vegetation composition data collected in a series of nested plots on transects in 12 tree islands and in 24 permanent plots representing different hydrologic regimes on 16 islands to examine overstory and understory vegetation interaction. Variance partitioning in Redundancy Analysis (RDA) followed by correlation analysis between environmental variables and the major axis of RDA were used to determine the relative importance of hydrology and canopy cover on understory vegetation composition. The understory vegetation composition changed along the hydrologic gradient from the forbs- to the graminoid-dominated herbaceous vegetation. The interaction between canopy cover and hydrology significantly affected understory composition. In the elevated portion of the islands, changes in canopy cover were relatively impervious to hydrologic variation, and thus the tree cover had strong effects on understory, whereas in the frequently flooded portions of the islands, where tree cover is minimum, herbaceous vegetation was mostly determined by hydrology. Rapid changes in understory vegetation in response to hydrologic variations and canopy disturbance suggest their importance in tree island dynamics. Our study has important implications for maintenance and restoration of ecologically imperiled Everglades tree islands.

<u>PRESENTER BIO</u>: Dr. Jay Sah is a vegetation ecologist with three and half decades of experience in studying plant communities of which 17 years are in the Everglades. Dr. Sah has extensively studied tree island vegetation responses to hydrologic changes in Everglades.

INCREASED TREE MORTALITY WITHIN TREE ISLANDS POST-HURRICANE DISTURBANCE

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The Everglades is a landscape of grassy ridges and sloughs, spotted by woody dominated tree islands. Tree islands are a vital component of the complex Everglades ecosystem as biogeochemical hot spots for phosphorus accumulation, keystone habitats as refugia for marsh plant and animal species, and culturally important archeological sites. These islands often include different plant communities along a hydrologic gradient. These communities are hardwood hammocks, bayhead, and bayhead swamp forests. They are sensitive to hydrologic changes, natural as well as those related to the Comprehensive Everglades Restoration Plan (CERP). Natural disturbances can also influence the dynamics of these tree islands. Among the major disturbances, hurricanes are perhaps most frequent and have a greater influence. Previous results have shown higher mortality 3-4 years after a hurricane disturbance. In 2017, Hurricane Irma hit the Everglades affecting several tree islands. The objectives of this study were to explore the relationship between hurricane-induced tree damage and structural variables, and to assess the vegetation recovery during the first year after the hurricane.

Tree layer vegetation was sampled in the hardwood hammock plots within eight tree islands in Everglades National Park. Those plots had also been sampled 1-6 years prior to the hurricane, and the post-hurricane sampling was done 3 and 14 months after the hurricane. The sampling included recording the status (live and dead) and hurricane damage class (uprooted, broken main stem, broken branch, and defoliation) of tagged trees within these plots. In addition, we recorded the height and diameter at breast height (DBH), along with any new ingrowth trees. Annual tree mortality for the period 2010-2018 was summarized and compared among the eight tree islands. We used logistic regression to explore the relationship between tree mortality along with the types of tree damage and different structural variables.

Preliminary results have shown that Hurricane Irma caused a high amount of tree damage and an immediate increase in tree mortality. The mortality was particularly high among trees with below average DBH, and some species such as *Bursera simaruba* and *Eugenia axillaris* suffered more damage than others. This study provides insight on the susceptibility of tree islands to hurricane disturbances, and resilience of islands to recover after such a disturbance. The results from this study could aid in planning for future tree island restoration.

<u>PRESENTER BIO</u>: Josue Sandoval, B.A. in Sustainability and the Environment, works as the Sr. Lab Technician at Southeast Environmental Research Center (SERC), Florida International University. He has been involved in Everglades research for two years.

LANDSCAPE BUDGET MODELS OF WATER, SEDIMENT, AND SEDIMENT-P ACROSS THE L67C CANAL-BACKFILL TREATMENT AREAS

***Fabiola Santamaria*[1]**, *Colin. J. Saunders*[1], *Carlos Coronado*[1], *Fred. Sklar*[1], *Sue Newman*[1], *Jud Harvey*[2], *Jay Choi*[2], *Jennifer Lewis*[2], *and Jordan Psaltakis*[2]

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The Decomp Physical Model-DPM is a landscape experiment to evaluate the impacts of restoring flows between WCA-3A and WCA-3B and the role of sheetflow in restoring the degraded ridge and slough patterning and topography. The landscape experimental site is located between the L67A and L67C levees known as "the pocket" in the Everglades. Increased freshwater flow was attained using ten gated culverts (S-152) on the L67A and the creation of a 3,000-ft gap in the L67C levee). Three canal backfilling treatments (adjacent to the levee gap) were implemented as part of a BACI (Before-After-Control-Impact) experiment.

The purpose of this presentation is to report preliminary water, sediment, and sediment-P mass budgets specific to the L67C canal and levee gap feature, spanning the upstream ridge and slough areas, the canal backfilling treatments, and the marshes downstream (DB areas) of the canal and levee gap. Water, sediment, and sediment-P budgets will be compared under different hydrologic flow (high and low) conditions. The overall goal is to evaluate how high and low flow conditions reach, redistribute sediments in the landscape, backfilling effects on the source/sink dynamics of sediments and P in and around the canal area, and how that may impact transport of P-enriched (canal-derived) or natural (ridge- or slough-derived) sediments in the marshes downstream of the levee gap.

Field measurements and sample collections were done every three or six weeks depending on flow (high and low, respectively) operational conditions of the S-152. Water fluxes were estimated from mid-water column velocities and water cross sectional area of an input/output boundary. Within the canal, sediment deposition (g m^{-2} d^{-1}) was captured using vertical PVC traps deployed at the treatment and control sites. Sediment-P in the canal was estimated from sediment accumulation in traps and water column particulate-P concentrations.

Water budgets, sediments, and P accumulation presented here indicated that there is a disproportionately higher flow of water entering the canal backfill area via the north canal control area into the open canal treatment (CB1), which flows into the marsh site (DB1) directly downstream of CB1. This hydrologic connectivity, CCN-CB1-DB1, suggests changes in sediment fluxes and sediment-P content also follow that pathway. Among all canal sites, higher sediment-TP was found in traps from CCN and CB1. In turn increased floc TP was also observed at DB1 after the first three flow events. Floc TP within the partial-DB2 and complete-DB3 backfilling areas remains low suggesting the potential ecological interactions and benefits of backfilling and flow restoration projects in the Everglades.

<u>PRESENTER BIO</u>: F. Santamaria is a scientist with experience focused on wetland monitoring, water and soil quality, ecological research and restoration in the Southern Everglades and Florida Bay areas.

COMPREHENSIVE ASSESSMENT OF COASTAL FISHERIES RESPONSES TO EXTREME CLIMATE EVENTS: LESSONS FROM 40 YEARS OF CATCH-DATA IN THE COASTAL EVERGLADES

***Rolando O. Santos**[1, 2], Jennifer Rehage[1, 2], Mahadev Bhat[1], Geoffrey Cook[3], Ray Huffaker[4], Adyan Rios[5], Jason Osborne[6], Christopher Kavanagh[7]*

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In association with climate change, extreme climate events (ECEs) such as hurricane, droughts, floods and temperature anomalies, are likely to become a stronger driver of coastal and marine ecosystem dynamics, with important long-term implications for the fisheries, fishing communities and economies that rely on these ecosystems. The projected increase of ECEs highlights the need for resource managers to understand the vulnerability, resilience, and adaptive capacity of coastal systems and their fisheries, to be able to assess and mitigate risks to future events. Florida is one of the regions in the US that has been repeatedly impacted by a variety of ECEs, but we lack an understanding of the effects of these events on its valuable recreational fisheries. Recreational fishing is a core socioeconomic activity throughout the state and the Everglades. Despite this high socioeconomic value, the degree to which ECE and altered freshwater flows may unsustainably impact recreational fisheries, and the degree to which restoration efforts may counteract these effects remain poorly understood. Our main goal here is to examine how recreational fishing catch structures respond to ECE and associated disturbances (e.g., seagrass die-off, algae blooms), and illustrate spatial-specific recovery trajectory dynamics of major recreational fisheries in the coastal Everglades. To address this, we implemented multivariate and non-linear statistics on fishing guide reports for the dominant recreational species using Everglades National Park (ENP)'s creel and guide records for 1980-2017. We are hypothesizing significant shifts in the catch structure occur after major ECEs, suggesting a high sensitivity of fish populations and fisheries in the region to ECEs. We are also hypothesizing species-specific responses to ECEs in association with distinct phylogenetic and ecological traits, and spatially distinct responses in association to the magnitude and spatial scale of ECEs. Our study will provide a detailed assessment of the resilience of the recreational fisheries in the coastal Everglades and will contribute to the understanding of the vulnerability of US fisheries to climate change.

PRESENTER BIO: Dr. Santos is a distinguished postdoctoral scholar at FIU. His research concentrates on the forefront application of landscape ecology concepts in marine ecosystems. Also, his research work applies modeling and quantitative methods that integrate multiple catch and environmental datasets to identify the underlying drivers of fisheries dynamics in South Florida.

LANDSCAPE EFFECTS OF PEAT COLLAPSE: EXAMPLES FROM THE TEN THOUSAND ISLANDS NWR AND EVERGLADES NP

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The collapse of graminoid marsh peat can significantly alter the biotic composition and ecology of brackish wetlands. More significantly, however, peat collapse can drastically alter landscape geomorphology and hydrology. Such effects may be difficult to anticipate or prevent, and, if fully realized, require radically different management strategies or complex restoration efforts.

Our work in the Ten Thousand Islands National Wildlife Refuge and in Everglades National Park has revealed one incipient and one previous landscape-scale alteration of wetland geomorphology as a consequence of peat collapse. The phenomenon, termed "pocking", involves the death of graminoid vegetation, most commonly *Spartina bakeri*, due to sea-level rise-induced salinity stress. A vegetative clonal plant, which can cover a significantly large area of marshland, dies, exposing its root mass to high rates of aerobic decay, causing the marsh elevation to drop (over months to years) an amount equal to the thickness of the peat (as much as 30 cm). The resulting depression or pock is commonly circular in outline, mimicking the shape of the dying clone, which then functionally becomes a pond. Pocks enlarge overtime and merge with neighbors, creating larger clover-leaf-shaped bodies of water. From high altitude, the graminoid marsh resembles a cookie-cut carpet of merged pocks. Pocking is currently occurring in the Ten Thousand Islands NWR between Collier-Seminole State Park and the Faka Union Canal. The phenomenon is occurring east of the Faka Union Canal, but with significantly less severity. Our research has demonstrated that the naturally occurring sheetflow existing in this region is of great enough magnitude to offset the salinity-induced stress of sea-level rise (SLR), at least under the current SLR rate. Here, graminoid marsh is more likely to succeed to mangrove forest, rather than to pock. The hydrologic restoration of sheetflow to Picayune Strand (in the region of extensive pocking) should slow the rate of pocking and promote mangrove invasion. The interior bays of the northwest region of Everglades National Park (Chevelier, Cannon, Alligator, and Dads Bays), between Chatham and Lostmans Rivers, represent an earlier and more thorough history of pocking. These bays are large in area, have a similar clover-leaf shape, and a sub-bay stratigraphy demonstrating that they existed as graminoid marshes before becoming subaqueous. The current landscape here resulted from a radical geomorphic transformation, presumably caused by late Holocene SLR (the precise date is uncertain), altering the system's hydrology and ecology. The graminoid marshes of the Ten Thousand Islands NWR have the potential to transform similarly.

Strategies to manage a pocked landscape or strategies to restore incipiently pocking marshes require innovative and creative designs. The Greater Everglades' scientific and management community must continue to address these challenges as SLR rates continue to accelerate.

PRESENTER BIO: Dr. Savarese is a Professor of Marine Science with research and teaching experience in coastal geology, conservation paleobiology, and climate-change-induced sea-level rise. More currently, he has been working as a liaison with urban and natural resource planners for climate change preparedness.

TREE ISLANDS: RECORDS OF HUMAN AND ECOLOGICAL RECURSIVE RELATIONSHIPS THROUGH TIME

Margo Schwadron
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Many previous researchers working on South Florida tree islands have encountered a hardened, mineralized layer, but few have ever sampled below it or explained its origin, and it was often misinterpreted as limestone bedrock. National Park Service Archaeologists studying Everglades tree islands in 2005 used concrete saws and other methods to excavate through and below the hardened layers, where they found underneath deeply-buried sediments dating back to ~5000 cal yr BP, and that this buried, hardened calcrete layer is likely to be present throughout the Everglades. Due to the difficulty of breaking through this horizon, few investigators have ever sampled below it, and an incomplete picture of tree island history remained.

Fifteen years later, multiple additional investigators working throughout South Florida have confirmed the presence of the calcrete layer within tree islands and other landforms, confirming its regional presence. This paper summarizes available regional data and argues that tree islands are essential paleo-ecological records of a recursive prehistoric human and ecological relationship through time that influenced the origin, development and persistence of tree islands. Integrating new and existing archeological, paleo-ecological and environmental data, this paper explores the relationships and effects between prehistoric human occupation, soils, vegetation, climatic variability, and water levels on tree island development. Tree islands are viewed as key indicators of successful restoration in conceptual ecological models, are sensitive to external drivers and ecological stressors such as water management practices, and are special targets for Everglades restoration efforts. Understanding the historical ecology and prehistoric human influence on tree island origins and development will serve to better inform restoration efforts on the potential effects of water management operations and climactic variability.

PRESENTER BIO: An Archeologist for the National Park Service since 1991, Dr. Schwadron specializes in wetlands and coastal archeology in south Florida. Her research takes a landscape-centered approach to archeology, incorporating paleo-environmental and paleo-climate research into understanding historical ecology and the interaction of humans and environment through time.

MODELING GREEN IGUANA POPULATIONS BEFORE AND AFTER REMOVALS

***Nathan P. Schwartz*[1]**, *Jennifer H. Nestler*[1], *Brian J. Smith*[2], *Jennifer K. Ketterlin*[1], *Michael R. Rochford*[1], *Edward F. Metzger III*[1], *and Frank J. Mazzotti*[1]

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Green iguanas (*Iguana iguana*) are a widely established invasive species in southern Florida. They can have negative impacts on vegetation and wildlife by foraging and water management infrastructure such as canals by increasing erosion with their burrowing. The C-11 is a canal located in southern Broward County, Florida. It begins at the eastern edge of Water Conservation Area 3 and flows east to the coast. We conducted a removal study along a 4.4-km stretch of the canal in which we modeled the population before removals and at two points in time after removals to track the effect removals had on the population.

The study divided the study area into a control transect and a removal transect, each of which was divided into approximately 100-meter segments. Prior to removing iguanas, we conducted 5 surveys in which we counted the number of iguanas we encountered. We then removed iguanas from the removal transect over a period of 3 months. We conducted 5 surveys immediately after removals ceased, and 5 surveys after an additional 3 months.

To model iguana abundance, we fit an N-mixture model which estimates abundance while accounting for imperfect detection. Each time period surveys occurred (hereafter T-1, T-2, and T-3) was modeled as a site covariate. We modeled additive and interactive effects of time period and treatment on detection (p) and abundance (λ) and compared this to a null model using Akaike's Information Criterion (AIC). We calculated abundance estimates and detection probabilities with 95% confidence intervals.

We saw 1,890 total iguanas in T-1, with 937 in the control and 953 in the treatment. After T-1 we removed 808 green iguanas. We then saw 1,089 total iguanas in T-2, with 761 in the control and 328 in the treatment. We saw 914 total iguanas in T-3 with 547 in the control and 367 occurred in the treatment.

The top-performing abundance model included an additive effect of treatment and time period on detection, and an interactive effect of treatment and period on abundance. The estimated abundance per 100m segment at T-1 is 22.05 (95% CI 19.02, 25.58) in the control and 24.58 (20.92, 29.90) in the treatment. At T-2 estimated abundance rises to 30.08 (23.72 38.14) in the control and drops to 15.35 (11.60, 20.31) in the treatment. At T-3 estimated abundance drops slightly to 23.64 (17.40, 32.10) in the control and rises slightly to 18.50 (12.99, 26.34) in the treatment. Detection probabilities drop in both the control and treatment transects over time.

The abundance model reflects the success that a removal effort can have in reducing iguana abundance, even in an area with a high population density. Estimated abundance between the control and treatment transects was fairly comparable at T-1 (22.05 and 24.58 animals per segment respectively), but that changes substantially at T-2 (30.08 and 15.35 animals per segment). Although no removals occurred between T-2 and T-3, estimated abundance in the treatment transect remains lower than it was at T-1, at 18.50 animals per segment.

The drop in detection probability may reflect iguanas becoming more wary, moving among transects between time periods, or foliage and grass growth. Additionally, the total number of iguanas counted between T-1 and T-2 dropped in the control, but the estimated abundance increased.

The ability to decrease their density may be a necessary tool to prevent widespread and costly damage to infrastructure.

PRESENTER BIO: Nathan Schwartz is a wildlife researcher with seven years of herpetological research experience in the southeastern U.S. He works for the Croc Docs at the University of Florida.

DEVELOPING A MECHANISTIC UNDERSTANDING OF TREE ISLANDS: LESSONS LEARNED FROM NEARLY A DECADE OF STUDYING AN EVERGLADES PHYSICAL MODEL

Leonard J. Scinto[1], *Shimelis Dessu*[1], *René M. Price*[1], *Michael S. Ross*[1], *Jay P. Sah*[1], *Pamela L. Sullivan*[2], *Alexandra Serna*[3], *Susana L. Stoffella*[1], *Eric Cline*[3], *Thomas W. Dreschel*[3], *and Fred H. Sklar*[3].

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Tree islands are important components of many wetlands around the world. These mounds, typically elevated only slightly above the surrounding marsh, have greater importance to the functioning of the larger wetland system than expected by their relatively small spatial extent. Tree islands have been identified as nutrient hotspots in oligotrophic wetlands, “dry” refugia for wildlife, rookeries for wading birds, the sites for flood-intolerant woody vegetation, and, in some cases, sites of archeological importance.

Despite their ecological importance, tree islands have been lost from many areas. For example, hydrologic modifications of the Florida Greater Everglades Ecosystem (GEE) for agricultural and urban development led, in some areas, to decades of impoundment and sustained high water levels that flooded existing tree islands. An example of extreme loss of tree islands has occurred in Water Conservation Area 2 (WCA2) where as much as 90% of the tree islands have been lost.

We hypothesize that the development and persistence of functioning tree islands in wetland ecosystems is a result of self-organizing feedback mechanisms, especially involving biomass production, fluxes of water and nutrients, and soil formation) operating at local as well as landscape scales. Elucidating these mechanisms can enable informed ecosystem management and ultimately assist in the restoration of Everglades tree islands.

Since 2005, an interdisciplinary team of hydrogeologists, biogeochemists, and plant ecologists have studied the development of eight tree islands constructed at the Loxahatchee Impoundment Landscape Assessment (LILA), a unique physical model specifically designed for Everglades experimentation. In 2006 and 2007 over 5,700 seedlings (717 seedling/island) of 10 species of trees endemic to Everglades tree islands were planted on eight sculpted mounds. Here we develop a conceptual model of emerging tree island behavior based on observed relationships among tree island hydrology, vegetation dynamics, biogeochemistry, and soil development. Our model suggests that hydrologic conditions (water depth and duration) leads to preferential tree growth at the higher elevation of the tree islands. Transpiration by the developing tree canopy increases groundwater and nutrient uptake, and ion exclusion. Through tree growth, nutrients are immobilized in plant biomass. Some biomass is deposited as litter or root production, adding to the surface soil, increasing soil organic matter and nutrient content, and tree island elevation through soil accretion. The model that arises from this analysis supports the establishment of positive feedback mechanisms within a decade of initial tree growth and development.

<u>PRESENTER BIO</u>: Dr. Len Scinto is an associate professor in the Department of Earth and Environment and Southeast Environmental Research Center at FIU. Working in the Everglades system for >25yr his research focuses largely on the effects of hydrologic and nutrient variation on biogeochemical processes.

HURRICANE IRMA IMPACTS ON SUBMERGED AQUATIC VEGETATION (SAV) OF NEAR SHORE BISCAYNE BAY: CHANGES IN DIVERSITY IN RESTORED AND PROTECTED AREAS

***Kathleen Sullivan Sealey**, Jacob Patus, Zoi Thanopoulou, Krystle Young and Caitlin Camarena*
University of Miami, Coral Gables, FL, USA

The restoration of Biscayne Bay Coastal Wetlands is a key component of the larger Comprehensive Everglades Restoration Plan (CERP). Wetland restoration is designed to address the unrestricted flow of fresh water into Biscayne Bay, particularly the southern Bay in Biscayne National Park, and restore marine conditions to a now-estuarine lagoon. Run-off of freshwater from canals can alter marine plants by both changing salinities, and increasing nutrient loading. Near shore marine plants (seagrasses and benthic macro-algae) were monitored from 2015 to 2018 at four protected area locations in the Bay with special attention to the changes in the SAV community after the passing of Hurricanes Matthew (2016) and Irma (2018). SAV communities changed dramatically in locations adjacent to discharging canals, but diversity remain high is areas adjacent to restored wetlands and with reduced storm water run-off. In addition to the assessment of the SAV communities, a Hurricane –Rapid Ecological Assessment was carried out at the sites to document coastal erosion, coastal vegetation damage, flooding and solid waste accumulated in the coastal vegetation (mangroves) and near shore waters. Hurricane Irma had significantly greater impacts on coastal environments still recovering from flooding and wave damage from Hurricane Matthew. Assessments of coastal biological diversity and documenting storm impacts is critical to understanding the overall recovery of coastal systems being restored under CERP initiatives.

PRESENTER BIO: Dr. Sullivan Sealey is an associate professor of Biology at the University of Miami with over 30 years' experience in coral reef and coastal ecology. Her work had focused on land-based sources of pollution and coastal protection strategies. Jacob Patus and Zoi Thanopoulou are doctoral students at University of Miami; Krystle Young is completing her Masters of Science, and Caitlin Camarena is an undergraduate Ecosystem Science and Policy major at University of Miami.

ESTABLISHMENT OF THE BROWARD COLLEGE HERBARIUM: MISSION GOALS & TIMELINE

*Adam Pitcher, **David Serrano**, Elizabeth Lavely, & Christopher Stauffer*
Broward College, Davie, FL, USA

The Broward College Herbarium (BCH) was established in 2018 with the mission of inventorying & cataloging the plant diversity in what little remains of Broward County's natural areas. The BCH collection will serve as a long-term open access repository to aid the scientific community indefinitely. Broward County has received relatively little attention from local herbaria with many species either missing or not collected in decades. Specimens will be curated to museum standards so they may have long term scientific value. All specimen data (including field data/notes) will be uploaded to iDigBio so that biogeography studies may be conducted at any time. Selected specimens will be digitally imaged so that worldwide experts may utilize data in taxonomic/systematic/ecological studies. The inventory will also supply a baseline for environmental health, conservation & restoration assessments.

Our focused, intensive inventory of Broward County's flora has begun at Hugh Taylor Birch State Park, an ideal maritime hammock & estuarine tidal swamp in eastern Ft. Lauderdale. This particular natural area has important preservation implications both for its historical significance to the county as well as its proximity to the coast, being imminently threatened by rising sea levels. Preserved plant specimens will provide a baseline for future comparisons & be a useful tool for evaluating conservation efforts & monitoring system health. Identification of undetected exotic/invasive plant species may allow for timely containment strategies that may lead to protection of park resources. This is especially useful for Hugh Taylor Birch where major international ports of entry are in close proximity. Future goals will include collections throughout Broward's remaining natural areas.

PRESENTER BIO: David Serrano is an associate Professor and the BS in Environmental Science program manager at Broward College. David is also the director of the Broward College Insect Collection and Broward College Herbarium.

MODELING OF ALLIGATOR NEST SIGHTING FOR RESOURCE MANAGEMENT IN EVERGLADES NATIONAL PARK

***Dilip Shinde**[1], Leonard Pearlstine[1], Amy Nail[2], and Mark Parry[1]*
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The American alligator, a keystone species within Everglades marsh systems, is dependent on spatial and temporal patterns of water fluctuations that affect courtship and mating, nesting, and habitat use. Alligator abundance, nesting effort, nest success, growth, survival, and body condition serve as indicators of health of the Everglades marsh system. The spatial pattern of habitat use by alligators has changed as a result of land use change and water management practices in South Florida. Historically most abundant in wetland habitat areas fringing the deeper slough and in freshwater mangrove areas, alligators now are most abundant in the central sloughs and canals of the current Everglades landscape. They are mostly absent or rare in the peripheral wetlands, which have been lost to development or altered hydrologically.

To reverse past environmental degradation Comprehensive Everglades Restoration Plan is being implemented using an applied science strategy framework that links alternative plan evaluation with ecological models, monitoring, and research to provide more effective scientific support to Everglades restoration. Development of ecological modeling tools that can evaluate the effects of restoration on key components of the Everglades ecosystem, including alligators' habitat and their abundance, thus is of keen interest to natural resource managers, restoration, and conservation planners.

Earlier modeling efforts- Alligator Production Suitability Index Model (Shinde et al. 2014) and other habitat suitability models of alligator (TIEM 2003, Rice et al. 2004) based on expert knowledge, judgment and some empirical data provide a deterministic response (0-1 index) of productivity and habitat suitability over the spatial domain. These models do not inform of the uncertainty associated with index. Higher scores from these models indicate better conditions, but the relationship between a specific score and expected number of nests has not been established.

This work shows application of a multivariate logistic-regression generalized additive model to explore probability of nest building under different hydrologic restoration scenarios. Data from annual systematic reconnaissance flight nest surveys within the park was used to develop the model. Other independent predictor variables used are classified into alligator hole variables, space-time variables, distance variables (from canals and roads; anthropogenic effects), hydrological variables (water depths during breeding, courtship and mating, nest building periods), meteorological variables (rain and temperature), and habitat variables (canals, water edge, marsh, upland etc.). This model build on 24 years of data will generate probability surface of nest building over the spatial domain. This will allow natural resource managers to have confidence in their decisions impacting alligator abundance.

<u>PRESENTER BIO</u>: Dr. Shinde is an ecologist with more than 10 years of experience managing ecological, water quality, and system modeling research projects with Everglades National Park related to Everglades restoration efforts.

USE OF URBAN HABITATS BY THE THREATENED WOOD STORK MAY AID IN POPULATION-LEVEL RECOVERY

***Katherine R. Shlepr**, Betsy A. Evans, and Dale E. Gawlik*
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Robust models developed through intensive study of the Everglades system demonstrated the ecological linkages between Wood Storks (*Mycteria americana*), fish communities, and hydrological conditions. These linkages facilitated the use of storks as indicators of Everglades restoration efforts under the assumption that as historical hydrological conditions are restored, stork numbers will increase. However, as linkages between storks, fish communities, and hydrological conditions change over time, the suitability of storks as indicators for ecosystem restoration becomes diminished. For example, if storks learn to forage outside natural marsh habitats, then an observed increase in the stork population is potentially unrelated to a change in Everglades health. Therefore, consistent monitoring and revision of model parameters is crucial to ensure that indicator species are truly linked to ecological drivers of the ecosystem.

>90% of the U.S. breeding population of storks historically nested in the southern Everglades. Storks were federally listed as an endangered species in 1984 after population declines which resulted from large-scale alterations to Everglades habitat. However, in 2014, the species was down-listed to threatened status as storks increased in number and expanded their range to the north even without the recovery of nesting activity in the Everglades. Urbanization is one factor recently affecting the diet and distribution of breeding storks that is not explicitly accounted for in ecosystem models. Bolus (i.e. regurgitant) samples collected from stork nestlings in South Florida 2013-2018 suggest a prey shift from small marsh fishes in the 1970s to larger-bodied fishes, particularly non-native cichlids. Non-native fishes are expected to continue invading the Everglades system, but the ecological impacts of these species are unknown. Additionally, storks have begun nesting in urban areas (e.g. golf courses, county parks) and have moved as far north as North Carolina where they were historically absent. More than half of U.S. storks now nest north of Florida but in exceptionally good years in the Everglades, e.g. 2018, the bulk of storks returned to the Everglades system to breed, as current models would have predicted. This example highlights the importance of restoring the Everglades for the long-term health of the population, and also that when conditions in the Everglades are favorable, storks will respond quickly. Still, colony monitoring data suggest that new urban settlement by storks may be an important safeguard for the population against suboptimal hydrological conditions in the Everglades. In good years (i.e. high water levels early in the breeding season followed by a steady, uninterrupted dry-down), storks that nested in historically active Everglades colonies (n=2) had reproductive success similar to that of storks in urban colonies (n=3). However, in poor years of dry conditions or major water-level reversals, urban-nesting storks produced more fledglings than storks that nested in the Everglades. Whether continued urbanization and exotic fish invasions are now positive, negative, or neutral drivers in stork population recovery remains untested. This area of research will be key to revising the stork recovery plan and updating Everglades restoration models which use storks as an indicator species.

<u>PRESENTER BIO</u>: Kate is a PhD candidate in the Department of Biological Sciences, FAU. She spent the 8 years prior studying seabirds in coastal Maine and Atlantic Canada.

CERP RECOVER PROGRAM 2019 SYSTEM STATUS REPORT KEY FINDINGS FROM THE SOUTHERN COASTAL SYSTEMS FOR WATER YEARS 2013-2017

***Michael T. Simmons**[1], Patrick A. Pitts[2], Amanda A. McDonald[3], David T. Rudnick[4]*

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The REstoration, COordination, and VERification (RECOVER) Program provides essential support to the Comprehensive Everglades Restoration Plan (CERP) in meeting its goals and purposes by applying a system-wide perspective to the planning and implementation of CERP. The primary tool by which RECOVER assesses the performance of CERP is RECOVER's Monitoring and Assessment Plan (MAP). The MAP provides scientific and technical information from the monitoring of ecological indicators, identification and resolution of restoration uncertainties, application of adaptive management strategies, and employment of best scientific knowledge and practices.

The 2019 System Status Report (SSR) provides a synthesis of five years of monitoring data across the greater Everglades ecosystem by region (Water Years (WY) 2013-2017). The Southern Coastal Systems (SCS) RECOVER module encompasses the coastal and estuarine regions of the Everglades from Miami, FL. around the southern tip of Florida to Naples, FL including Biscayne Bay, Florida Bay, and the Southwest Coast of Florida. The SCS Region relies on freshwater entering the Greater Everglades' southern estuaries in order to maintain ideal conditions for submerged aquatic vegetation and associated estuarine species. Historically, large volumes of freshwater flowed south through the Everglades via Shark River Slough, Taylor Slough, and historic rivers and creeks. However, reduced flows since the 1940s have significantly increased salinity, thereby degrading habitat and reducing regionally important floral and faunal species. Evaluation of the SCS between WY 2013-2017 utilized a suite of ecological indicators including salinity, fish, crocodilians, submerged aquatic vegetation, among others. Chlorophyll a was evaluated as well.

Salinity was less than optimal within the various SCS sub-regions during this reporting period. Within Biscayne Bay, freshwater flows have been lacking in both volume and duration prompting a significant change in biological communities along the shoreline and nearshore areas. Salinity throughout Florida Bay continues to remain high regardless of season. The lack of freshwater flow to Florida Bay, combined with sea level rise, has resulted in a prey base shift composed of less freshwater species. Salinity in the Upper Southwest Coast remains diverse due to the channelization of water flow resulting in continued pulse discharges. Most of the SCS ecological indicators rely on salinity, making salinity one of the most important variables throughout the entire region.

Several CERP projects are currently in the implementation phase which will result in increased volume, distribution, and timing of freshwater flows. Along the Southwest Coast, the Picayune Strand Restoration will restore sheetflow to approximately 55,247 acres of disturbed land with additional improvements to adjacent public lands and downstream estuarine communities. The C-111 projects will move more water to Florida Bay improving the volume, distribution, and timing of freshwater flows improving conditions for biota. The Central Everglades Planning Project also aims to improve the quantity, quality, timing, and distribution of water to Florida Bay. The Biscayne Bay Coastal Wetlands Project will rehydrate 190 acres of freshwater wetlands while improving estuarine conditions for 6,396 acres of saltwater wetlands.

<u>PRESENTER BIO</u>: Michael Simmons is a biologist with the Restoration and Resources Section of USACE, Jacksonville District and a RECOVER Regional Coordinator for the Southern Coastal Systems. He has 15 years of natural resource management experience across federal, state, and local government agencies, focusing on coastal biology and ecology.

CHARACTERIZING INFLUENCES OF PULSE-DISTURBANCE EVENTS ON BIOGENIC GAS DYNAMICS IN EVERGLADES PEAT SOILS

***Matthew Sirianni**, and Xavier Comas*
Florida Atlantic University, Boca Raton, FL, USA

Wetland methane emissions are highly variable both in space and time and are controlled by changes in certain biogeochemical controls (e.g. organic matter availability; redox potential), environmental factors (e.g. soil temperature; water level; barometric pressure), and/or unique physical properties of the peat matrix (e.g. porosity). Consequently, hot spots (areas with disproportionally high emissions) may develop where biogeochemical and environmental conditions are especially conducive for enhancing certain microbial processes such as methanogenesis. The Big Cypress National Preserve (BCNP) is a collection of subtropical wetlands in southwestern Florida, including extensive forested (cypress, pine, hardwood) and sawgrass ecosystems that dry and flood annually in response to rainfall. Currently, the U.S. Geological Survey employs eddy covariance methods within BCNP to quantify carbon and methane exchanges over several spatially extensive vegetation communities. While eddy covariance towers are a convenient tool for measuring gas exchanges at the ecosystem scale, their spatially extensive footprint (hundreds of meters) may mask smaller scale spatial variabilities that may be conducive to the development of hot spots. Similarly, temporal resolution (i.e. sampling effort) at scales smaller that the eddy covariance measurement footprint is important since low resolution data may overlook rapid emission events and the temporal variability of discrete hot spots. In this work, we investigate small-scale contributions of organic and calcitic soils to gas exchanges measured by the eddy covariance towers using a unique combination of capacitance probes, gas traps, and time-lapse photography. By using an array of methods that vary in spatio-temporal resolution, we can better understand the uncertainties associated with measuring wetland methane fluxes across different spatial and temporal scales, and how short-term pulse disturbance events (e.g. Hurricane Irma; barometric pressure) may be resolved across these scales. Our results have implications for characterizing and refining methane flux estimates in subtropical peat soils that could be used for climate models.

PRESENTER BIO: Matthew Sirianni is a Ph.D. candidate working with Dr. Xavier Comas in the Environmental Geophysics Lab at Florida Atlantic University.

EVALUATING THE INFLUENCE OF SEAGRASS STRUCTURE AND SALINITY ON SEAGRASS-ASSOCIATED EPIFAUNA USING ARTIFICAL SEAGRASS UNITS (ASUS)

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The need to understand possible relationships between faunal communities, seagrass morphology, and abiotic influences is important for Comprehensive Everglades Restoration Plan (CERP) implementation, which will modify freshwater deliveries to nearshore habitats. Although shifts in the seagrass community are expected, there is little information on how seagrass structural changes will alter associated epifauna assemblages. This research used artificial seagrass units (ASUs) to manipulate physical structure within and between two salinity regimes to evaluate potential effects on nearshore epifaunal assemblages. ASUs were built to model patches of *T. testudinum*, *H. wrightii* and a homogenous mixture of these two seagrass species. By deploying ASUs in high and low salinity environments, I experimentally examined interactions between seagrass structure and salinity regime on the structure and composition of epifauna on ASUs, I used four replicates of the four ASU types (*T. testudinum*, *H. wrightii*, seagrass mix, and non-vegetated control) deployed at two high and two low salinity sites (n = 16 per site, N = 64) within Biscayne Bay. The experiment was conducted over three months during the wet season. Ephiphytes and epifaunal communities were collected at the termination of the project. Preliminary observations suggest higher epifaunal abundance and biodiversity at high-salinity sites.

<u>PRESENTER BIO</u>: Ryan Sirota is a Master's Student in Dr. Diego Lirman's benthic ecology lab at the University of Miami. He has worked on a wide range of projects from regeneration studies in polychaete worms, to assisting with coral gardening for Rescue a Reef.

THE EVERGLADES: AT THE CUSP OF TRANSITION

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The freshwater and coastal ecosystems of the Everglades provide many socio-economic benefits including important recreational and tourism opportunities, key fishery habitat, water quality improvements, flood and erosion mitigation, and mitigation of greenhouse gases through carbon storage and sequestration. Increasing pressures from sea level rise will influence the number, types and value of ecosystem services expected in the future. These pressures combined with the geological history of Florida put the Everglades at the "forefront of transition." In the peat-based portions of the Everglades, where water depths can be altered either by changes in water elevation due to sea level and rainfall or by changes in elevation of the peat surface due to biophysical processes, slight changes in the depth and period of inundation can influence the presence and distributions of plant species and communities. The present global rate of SLR is estimated at 3.4 mm yr^{-1}, but the south Florida regional rate could be as high as 9 mm yr^{-1}. As a flat, low-lying landscape, the conventional thinking is that Everglades coastal habitats will gradually migrate upslope with increases in sea level as a transgressive transition of saltwater into freshwater sawgrass marshes. Inland transgression of mangroves has been suggested as a means by which sub-tropical and tropical coastal landscapes will "adapt" to increasing SLR. However, erosion of coastal peats, inundation ponding and overstep (salt water encroachment too fast for all communities to retreat) has already been observed in the southeast saline Everglades. In several areas of coastal Everglades National Park, freshwater and oligohaline Everglades wetlands are expected to be exposed to increased duration and inundation of seawater, impacting processes that may lead to peat collapse. In some cases, the freshwater marsh has collapsed by some 0.5 m over a period of a few decades and have converted to an open-water, mangrove-free environment. If coastal communities cannot adapt to the salinity changes associated with increasing sea levels, then significant coastal wetland loss may occur, dramatically altering and increasing the vulnerability of the south Florida coastline. Without restoration of freshwater flow to the Everglades, saltwater intrusion-induced peat collapse may be enhanced and landward migration of mangroves into freshwater peat soils stymied.

PRESENTER BIO: Fred H. Sklar has a Masters in Oceanography and a Ph.D. in Wetland Ecology. He is the Director of the Everglades Systems Assessment Section of the South Florida Water Management District in West Palm Beach, FL. Dr. Sklar is an Associate Editor for the journal: Frontiers in Ecology and the Environment; a member of the National Environmental Advisory Board to the Chief of the US. Army Corps of Engineers; a member of the Louisiana Science and Engineering Advisory Committee for the Water Institute of the Gulf; and an executive member of the steering committee for the Florida Coastal Ecosystem LTER Program. His research is focused on adaptive management for coastal and wetland ecosystems, mangrove biogeochemistry, Everglades restoration, tree island ecology and landscape modeling. Dr. Sklar has published 100+ articles and reports on the impacts of hydrology on aquatic soil, plant and animal processes

A SYNTHESIS OF OVER A DECADE OF BURMESE PYTHON SPATIAL ECOLOGY RESEARCH

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Burmese pythons became established in the Greater Everglades Ecosystem (GEE) three decades ago, but this was not widely recognized until the early 2000s, when annual python removals from Everglades National Park (ENP) began to grow into the hundreds. The first formal research began just a few years later in late 2005, with the release of the first VHF radio-tagged individuals, and scientists from various academic, government, and non-government organizations have been studying the spatial ecology of Burmese pythons in the GEE ever since.

There are several reasons why understanding the ecology of an invasive species is important. For an established and wide-spread invasive species, the most efficient management strategy depends on the spatial scale and configuration of the population. Spatial variation from the individual- to the population-level can dictate the appropriate level of effort, control tactics and tools, and management goals. Studying resource selection by the invader is important for predicting interactions with and effects on native populations.

We have gained numerous insights in over a decade of Burmese python spatial ecology research. Our investigations of the landscape-scale removals over time has informed us about spread, habitat use, and impacts to the mammal community. Conventional radio-tracking has informed us on diverse aspects of python basic biology, including navigational ability, breeding phenology, and even cold tolerance. It has shown us even more about resource use in terms of landcover, elevation, and hydrology. Following tagged animals has even been used as a management tool, the so-called Judas technique, where a single tagged individual can lead us to a breeding aggregation of up to seven untagged individuals. Cutting-edge biologging tools are pushing this knowledge even further, with new applications of GPS tags and accelerometers giving us a finer-scale look into the life of a python, and this cutting-edge research has expanded out of ENP and into other parts of the GEE.

Understanding the spatial ecology of Burmese pythons has been a key part of the science effort surrounding Burmese pythons so far, and it will clearly play an important role in the future as we try to find ways to control the species and protect our natural resources. In this talk, we will synthesize all the efforts to date and paint a picture of the new directions that scientists are taking this field in the near future.

PRESENTER BIO: Brian is a Scientist III at Cherokee Nation Technologies, contracted to the U.S. Geological Survey, and based out of Davie, FL. He has been working on Burmese python spatial ecology for over eight years, including his M.S. research at the University of Florida.

CERP MONITORING: CAN WE GET MORE FOR LESS?

Eric P. Smith
Virginia Tech, Blacksburg, VA, USA

The evaluation of restoration projects has been criticized for a variety of reasons including administrative issues (inadequate funding or staffing), lack of a conceptual model, lack of clear questions and an inadequate evaluation of restoration progress at the project level. Despite the availability of agency-based guidelines for the design of monitoring programs, there is often a lack of a standard and consistent approach for the development of monitoring programs for evaluation of restoration. Best practices for designing a restoration monitoring program are presented. Monitoring programs for three CERP Everglades restoration projects, the C-111 Spreader Canal Western Project, Picayune Strand, and Biscayne Bay Coastal Wetlands were evaluated on a variety of criteria related to the monitoring best practices. The National Academies 2018 biennial review of Everglades restoration progress concluded that there has been an inadequate evaluation of restoration progress at the project level. Based on the evaluations, recommendations are made to improve the consistency and quality of Everglades restoration monitoring and to support monitoring programs that can evaluate the degree of restoration success with known confidence. Recommendations include using a conceptual model, identifying spatial, temporal and other constraints, using a method such as power analysis to support sampling choices and developing a data management plan to support restoration evaluation and decision making.

PRESENTER BIO: Dr. Smith is a professor in the Department of Statistics at Virginia Tech. He has been involved in the design and analysis of Everglades studies since the mid 1990s. His research interests include sampling design, restoration monitoring and analysis, and multivariate analysis.

FATE OF COASTAL WETLANDS UNDER RISING SEA LEVEL AND PUNCTUATED BY MAJOR HURRICANES

Joseph M. Smoak[1], *Joshua L. Breithaupt*[2], *Kara R. Radabaugh*[3], *David Lagomasino*[4], *Ryan P. Moyer*[3], *Brad E. Rosenheim*[1], *Carolyn Schafer*[1], *Lisa G. Chambers*[2], *Sarah Harttung*[2], *James C. Lynch*[5], *and Donald R. Cahoon*[6]

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Over the past several millennia, mangrove forests have expanded under relatively stable sea-level conditions, and have provided myriad ecosystem services of high socio-economic and ecological significance including carbon sequestration. Mangrove forests store large stocks of organic carbon in settings that are highly vulnerable to sea-level rise and tropical cyclones. These forests evolve through feedbacks between vegetative growth (above- and below-ground) and sedimentary processes. Whether mangrove forests will survive given accelerating sea-level rise mainly depends on their ability to gain and maintain soil elevation and/or migrate landward. Soil elevation, which in southwestern Florida is driven by carbon storage, can be influenced by changes in above-ground vegetation structure induced by disturbance events such as tropical cyclones as well as sea-level rise. Twelve years after Hurricane Wilma made landfall on the southwestern coast of Florida, Hurricane Irma impacted the same mangrove forests. Clearly, these important habitats are vulnerable to low-frequency, high-impact disturbance events, and it is important to understand the recovery trajectory of coastal habitats as well as their vulnerability to future storm events.

In May 2017 (pre-Hurricane Irma) our research team conducted above-ground vegetation surveys, flew G-LiHT (NASA Goddard's LiDAR, Hyperspectral and Thermal airborne imager), measured Surface Elevation Tables (SET) that were first deployed in the 1990s, and completed soil coring to determine soil accretion rates in mangrove forests of southwestern Florida. On 10 September 2017, Hurricane Irma's eyewall passed directly over our sites. Post-Irma, we repeated these measurements and have completed vegetation monitoring for delayed mangrove mortality and regrowth every 3-4 months. Post-storm examination indicated a reduction in mangrove canopy cover in some locations from typical 70-90% cover pre-storm to 40% post-Irma and an average reduction in tree height of approximately 1.2 m. The canopy recovered to 60% cover 3-6 months after the storm but did not increase any further 9 months post-storm. Sedimentary deposits consisting of marine carbonate up to 9-cm thick were imported into the mangroves and SETs recorded up to 4.7 cm of elevation change. While inorganic carbon deposition was greater than organic carbon within the storm layer, organic carbon deposition was still 10 times more in this one event than the region normally receives annually. In addition to increases in the deposition of organic matter, the storm layer may suppress CO_2 efflux by up to 30% during low tide.

Mangrove forests in southwestern Florida are ecosystems primarily built through the accumulation of autochthonous organic matter. Understanding above- and below-ground carbon dynamics is of primary importance in determining how mangrove systems respond to disturbance events. Post-Irma surveys indicate the importance of storm deposits as well as substantial damage to the mangrove canopy that has set yet to recover to pre-storm conditions.

<u>PRESENTER BIO</u>: Joseph M. Smoak is a professor of biogeochemistry at the University of South Florida in St. Petersburg.

LANDSCAPE-SCALE AQUATIC FAUNA MONITORING FOR CERP 2005-2017

Somers Smott *and Joel C. Trexler*
Florida International University, North Miami, FL USA

The Comprehensive Everglades Restoration Plan (CERP) Monitoring and Assessment and Planning (MAP) project has completed thirteen years of data collection as of 2017. Every wet season, 146 sites are visited throughout the Greater Everglades to obtain data on small fish and macroinvertebrates, in addition to periphyton. The focus of this project is to track wading bird prey, including small fish, grass shrimp, and crayfish density and biomass at the site, region, and landscape. System-wide, the relative abundance of biomass of fish and crayfish is inversely related to hydroperiod in the 365 days prior to wet-season sampling. As the areal coverage of drying in the preceding dry season increases, the relative proportion of wading-bird prey biomass coming from crayfish increases. There is a spatial gradient in this effect, with the southern Everglades (primarily in Everglades National Park) contributing more crayfish prey than areas to the north (Water Conservations Areas 3, 2, and Loxahatchee National Wildlife Refuge). We have found that the system-wide average of small-fish density is diminished in years with extreme hydrology, dry or wet. In contrast, system-wide crayfish density generally increases as years are progressively drier. Grass shrimp, a prey item most important for small wading birds such as Little Blue Herons, displayed no system-wide patterns of biomass or density associated with hydrology. This project also documents spatial and temporal patterns of non-native fish, notably, a dramatic increase their density and biomass in the Shark River Slough and Taylor Slough starting in 2012 and continuing through 2017.

Even though there was above average rainfall during the wet season in 2017, this particular sampling period was moderately dry because of a lack of rain in the dry season (December through May). Of the 134 primary sampling units (PSUs) we sampled this year, 66% dried to 5cm or less in the 365 days before sampling. The system-wide average density of fish in the 2017 wet season was just over 5 fish/m^2, which was second from the lowest of the study. This was the third year of declining fish density since 2014, when the system-wide density was among the highest of the study (approximately 17 fish/m^2). In 2014, the incidence of non-native fish peaked at approximately 25% of PSU's sampled. That frequency dropped to 15% in 2015, increased to 20% in 2016, and decreased again to 15% in 2017. Crayfish density in 2017 was down from the previous year, with densities decreasing in every surveyed area. Grass shrimp density was also low throughout the study area in 2017, continuing the trend of decreasing densities that began in 2009. As we continue sampling with this project, information on hydrological effects on prey density and biomass may assist with estimating wading bird nesting success.

PRESENTER BIO: Somers Smott is a Research Technician at the Southeast Environmental Research Center at Florida International University with 2 years of experience assisting with Everglades restoration monitoring and research projects. In 2016, she earned her Master of Professional Science degree from the Rosenstiel School of Marine and Atmospheric Science at the University of Miami.

GO HYDROLOGY: A TEN YEAR RETROSPECTIVE

Robert V. Sobczak
Big Cypress National Preserve, Ochopee, FL, USA

For the past ten years, the *Go Hydrology* website has chronicled the water cycle of the Big Cypress and surrounding Everglades to a wide ranging professional and lay audience using what many may consider an unorthodox, yet effective, approach. Eschewing technical jargon in favor of a more colloquial style, *Go Hydrology* unfolds chronologically on a semi-daily basis as a series of relatively succinct entries where visual imagery – whether a photo, animation, short video or graph (some quite complex, although usually easy to read) – conveys a simple idea or concept; and also, over time, tells a larger story, too. But what is *Go Hydrology* really? Join Robert V. Sobczak, its creator and sole contributor, as he explains the online journal's origin story, its major underlying principles, lessons learned and charts its future course.

WESMOTTTLAND RESTORATION OUTCOMES IN CENTRAL FLORIDA: AN EXAMPLE FROM TWO CONSERVATION EASEMENTS ON RANCHLAND

Grégory Sonnie[1]*, Elizabeth H. Boughton, Betsie B. Rothermel, and Hilary M. Swain*
Archbold Biological Station, Venus, FL, USA

Wetlands are critically endangered ecosystems worldwide. In the central Florida landscape, wetlands are often embedded within ranchlands. Ranchland management practices affect plant community structure and composition as well as wetland function and services. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) has now restored millions of acres of wetlands through its Wetland Reserve Easement (WRE) program (formerly the Wetland Reserve Program, WRP), with Florida having one of the highest number of acres enrolled nationwide.

In this study, we evaluated the effects of restoration on seasonal depressional wetlands (SDWs) in two USDA WRE conservation easements located on the Archbold Reserve in central Florida. Prior to conversion to improved pasture in 1969-1981, the sites were characterized by seepage slope hydrology and native wet prairie and pine flatwoods communities. During land conversion, the sites were ditched, fertilized and planted with productive non-native species, particularly Bahia grass (*Paspalum notatum*). Our objectives were twofold: First, we asked if hydrological restoration (completed in 2010-2011) increased water levels in SDWs by comparing restored wetlands to nearby unrestored wetlands. Second, we asked if diversity and the cover of obligate wetland species increased following restoration and if upland species correspondingly decreased.

We studied a total of 15 SDWs, 5 of which were unrestored and grazed, 5 were restored and grazed, and 5 were restored and ungrazed. We found that, on average, restored wetlands had higher water levels during the wet season (31.0±7.8cm) compared to unrestored wetlands (16.4±8.9cm) and independently of grazing treatment. Although we did not find a significant increase in species richness following restoration with on average 28.7±7 species per SDWs, we observed a slight increase in the cover of wetland obligate species and a slight decrease in upland species. Because of the variability in baseline condition between the two easements and the slight changes in floristic composition observed in this study, a longer time period is needed to assess the impact of restoration and cattle grazing.

<u>PRESENTER BIO</u>: Dr. Sonnier is a postdoctoral fellow with expertise in plant community ecology and plant functional ecology.

HEMATOLOGY OF EVERGLADES CROCODILIANS

Michiko A. Squires[1]*, Caitlin Hackett Farris*[1]*, Seth Farris*[1]*, Christopher D. Smith*[2]*, Laura A. Brandt*[3]*, and Frank J. Mazzotti*[1]

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The Greater Everglades is home to two native crocodilian species, the American alligator (*Alligator mississippiensis*) and American crocodile (*Crocodylus acutus*). Both species play important ecological roles within the Greater Everglades and are indicator species for Everglades restoration. Together they can inform us of the health and productivity of interior and coastal Everglades habitats. Body condition index Fulton's K is currently used to assess how well a crocodilian is coping with their environment. To refine our ability to evaluate crocodilian responses to Everglades restoration, we developed baseline blood chemistry reference intervals for Everglades crocodilians and correlated blood parameters with body condition. Although well-studied, little information is known of blood and plasma biochemistry of wild populations for both species in southern Florida, and none exist for any wild populations of the American crocodile.

Blood chemistry reference values were obtained from wild populations of American alligators in A.R.M. Loxahatchee National Wildlife Refuge, Water Conservation Area 3, Everglades National Park (ENP), and Florida Panther National Wildlife Refuge in southwestern Florida. Samples were also collected from crocodiles in the estuaries and coastlines of ENP and Biscayne Bay Complex. All samples were collected within 12 minutes of capture to minimize effects of capture stress and analyzed for blood and plasma analytes informative of stress and health. Establishing health in wild populations of crocodilians is challenging, thus we minimized variation in our blood panels by collecting samples within 12 minutes from capture and analyzing them within 12 hours from collection. Body condition factor Fulton's K was calculated for all individuals. Individuals with major injury were excluded from analysis.

Reference intervals were generated using guidelines described for determination of de novo reference intervals. Our results show that there are significant correlations between body condition and blood parameters linked to health, including creatine phosphokinase (CPK), aspartate aminotransferase (AST), alpha and beta globulins. With a growing dataset, we can continue to develop and refine reference intervals for the populations of healthy Everglades crocodilians to use as a baseline as Everglades restoration continues and further investigate the relationship between hematological patterns with body condition.

<u>PRESENTER BIO</u>: A University of Florida Croc Doc, Michiko's interests include herpetology, natural history and volunteered geographic information projects. She is a steward of Everglades restoration since 2006, and a recipient of the Jack A. Falk III scholarship for Everglades conservation, restoration, and sustainability for her commitment to Everglades research and education.

MOLLUSCAN AND SEAGRASS RESPONSE POST 2015 DIE-OFF EVENT IN FLORIDA BAY

***Bethany Stackhouse*[1]*, and Andre Daniels*[2]**
[1]U.S. Geological Survey, Reston, VA, USA
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A localized drought in South Florida during the wet season of 2015, led to a massive seagrass die-off event in late summer of that year. The lack of freshwater influx into Florida Bay caused salinity levels to increase drastically in July 2015, reaching 70 psu in some areas. The increased salinity contributed to the rapid and widespread death of *Thalassia testudinum* and other seagrasses in western and central Florida Bay. During a two-year period (September 2015 – October 2017), we surveyed the ecological conditions in the following areas of concern: 1) Rabbit Key Basin, 2) Whipray Basin, 3) Johnson Key Basin, and 4) Rankin Basin. Along with assessing water quality, we focused on the molluscan and seagrass response to the die-off event. We collected samples to identify molluscan species abundance and diversity from the grasses and the substrate. This included live and what appeared to be recently dead mollusks. The Braun-Blanquet method was implemented to evaluate the seagrass species, canopy height, coverage estimates, and overall health of the grasses and algae.

Each site showed different responses following the event. 1) Of the four sites, Rabbit Key Basin was the most stable and least affected by the seagrass die-off. Throughout the two years, the seagrass here continued to be dense and healthy and water quality remained high. The average live mollusk species diversity was highest here. 2) We did not start monitoring Whipray Basin until it became an area of concern in January 2016. The seagrass beds here started showing potential signs of die-off in October 2016, but then appeared to stabilize with moderate to sparse grasses throughout 2017. 3) By the end of 2015, the seagrass die-off was low to moderate at Johnson Key Basin. The site maintained sparse heathy patches of *Thalassia testudinum* and a large die-off zone throughout 2016. Site visits in February and June of 2017 showed an increase of healthy vegetation around our sampling location. During the first visit post-Hurricane Irma in October 2017, the grasses appeared to be decomposing and there were thick layers of detritus on the substrate. 4) Rankin Basin was the most affected of the four sites and was showing signs of complete seagrass die-off by the end of 2015. Poor conditions such as large bare areas, very sparse vegetation, and massive mats of floating seagrass slowly improved during 2016. By late 2017, the seagrass coverage had noticeably increased and there were little to no bare patches.

We found very low numbers of live mollusks in our samples from fall of 2015. This appeared to be a direct result of the seagrass die-off. Molluscan abundance increased and remained high through most of 2016; however, in October 2016 the live count estimates decreased drastically at all four sites to an average of 43 live/m^2. Our following set of samples in February 2017, showed the live molluscan population rebound to an average estimate of 241 live/m^2 and the numbers remained high throughout 2017. The cause of this population decline in October 2016 is currently unknown.

<u>PRESENTER BIO</u>: Bethany Stackhouse is a physical science technician working at the USGS since 2009 on the Greater Everglades Ecosystem Restoration using paleoecologic techniques to interpret Holocene estuarine ecosystems.

VALUING ECOLOGICAL OUTCOMES FOR EVERGLADES RESTORATION DECISION-MAKING

G. Andrew Stainback[1], *John H. Lai*[2], *Elizabeth Pienaar*[2], *Ruscena Wiederholt*[1], *Rajendra Paudel*[1] *Chloe' Vorseth*[3], *Damian Adams*[4] *and Mahadev Bhat*[3]

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The Everglades is one of the world's largest wetland ecosystems in the world covering almost 18,000 square miles from central Florida southward to Florida Bay. Over the 20th century efforts to drain the Everglades severely damaged the ecosystem so that today roughly 50% of the historic flow of water through the Everglades has been diverted elsewhere. In an attempt to restore the Everglades, Congress authorized the Comprehensive Everglades Restoration Plan (CERP) in 2000. Decision-makers tasked with implementing Everglades restoration require accurate information about the predicted impacts of their choices. To this end, there has been a substantial amount of research devoted to understanding the hydrological and biological responses of the Everglades ecosystem to potential restoration decisions. However, decision-makers should also have information regarding how the public values the specific ecological changes expected from restoration.

In an effort to provide some of this information, a discrete choice experiment survey of 2,100 Florida households was administered to measure attitudes towards and willingness to pay for several ecological outcomes connected to CERP System-wide Performance Measures - increase in populations of wading birds, Everglade snail kites, American alligators, and reduction of polluted discharges from Lake Okeechobee to the St. Lucie and Caloosahatchee estuaries. Results from the survey will be examined in the context of existing hydrological and ecological models to explore how this information can be used in assessing different restoration choices. The general role of public values in restoration decisions will also be discussed.

PRESENTER BIO: G. Andrew Stainback is an economist for the Everglades Foundation. He has expertise in economics, social science, and environmental policy. His research interests include the economics and policy of ecosystem services, the human dimensions of natural resource management, and sustainable development.

RE-MODELLING OF FOLIAR LIPIDS IN *THALASSIA TESTUDINUM* (TURTLEGRASS) ALLOWS FOR GROWTH IN PHOSPHOROUS DEPLETE CONDITIONS

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Seagrass beds are in worldwide decline, mostly due to anthropogenically induced changes in the nutrient concentrations of coastal waters. Since more than 30 years, it has been known that many seagrass species can modify their foliar elemental phosphorus content dependent on environmental phosphate concentrations in the water, an adaptation that allows them to grow in a wide range of habitats with divergent nutrient conditions. In *Thalassia testudinum* (turtlegrass), a species that is dominating coastal areas in South Florida, elemental C:P ratios can differ by more than 10 fold from around 200 to nearly 3000, dependent on available phosphate concentrations in the water. This change in foliar phosphorous content coincides with variations in production rates as well as in changes of the morphology of the leaves.

In this study, we used liquid chromatography - high-resolution - tandem mass spectrometry to analyze the total lipid content and composition (lipidome) of leaves of turtlegrass with extremely high P content versus leaves with extremely low P content. The samples were collected after a long-term fertilization experiment in Largo Sound, FL, which resulted in plants with significantly different P-content, C:P and C:N ratios. The total lipidome of the twelve tested plants grouped based on foliar phosphorous content, without any exceptions. Most classes of phospholipids were significantly down-regulated in P-deplete leaves including PC and PE, which were reported as the most abundant phospholipids in three species of seagrasses, whereas diacylglyceryltrimethylhomoserine (DGTS), triglycerides (TG), galactolipid digalactosyldiacylglycerol (DGDG), certain species of glucuronosyldiacylglycerols (GlcADG), and certain species of sulfoquinovosyl diacylglycerol (SQDG) were significantly upregulated and presumably replace phospholipids in the membrane.

In conclusion, these results not only explain the variability in P-content in turtlegrass, but also the change in leaf morphology as membrane fluidity and membrane structure are heavily impacted by the re-modelling of the membrane lipids.

PRESENTER BIO: Dr. Stingl is an Assistant Professor at the University of Florida. He has published more than 80 papers on microbial ecology and is currently focusing his work on impacts of environmental change on microbial communities in South Florida.

COLLIER COUNTY DESIGNS 8,000-ACRE BELLE MEADE FLOW-WAY RESTORATION

David L. Stites[1], *John Loper*[1], *Gary McAlpin*[2]
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Collier County, with assistance from Taylor Engineering, Inc., is designing and permitting the Belle Meade Flow-way Restoration project, which will rehydrate the western portion of the Picayune Strand State Forest (PSSF) and add wet season fresh water flows to Rookery Bay. Part of the Comprehensive Everglades Restoration Plan (CERP), Collier County adopted the project in its Comprehensive Watershed Improvement Plan, a series of county hydrologic and ecological restoration projects. The county is a leader in accomplishing projects more frequently the province of state and federal governments.

Development-related drainage in Collier County has dramatically altered county wetlands and estuaries. The Golden Gate Canal (GGC) network cuts off flows to the PSSF, adds freshwater discharges to Naples Bay, and reduces freshwater flows to Rookery Bay, causing ecosystem impacts to all three areas. Drier conditions in the PSSF have impacted wetlands in general and swamp forest in particular. Using wet season flows from the GGC, the Belle Meade project will improve wetland hydrology in 8,000 acres of the PSSF. The diverted water will drain south through a wetland water quality treatment area north of I-75, then under I-75 into the Belle Meade portion of the PSSF. The restoration area south of I-75 is bounded on the west by the City of Naples and on the east by the 55,000 acre USACE/SFWMD CERP Picayune Strand Restoration Project (PSRP), a hydrologic boundary defined by PSRP modeling. The 6Ls agricultural area forms most of the southern boundary. Forest restoration discharges are expected to flow west of 6Ls under US 41, into the Rookery Bay wetlands, adding needed wet-season freshwater to the bay.

The selected inflow regime will incorporate effects of the adjacent PSRP hydrologic restoration and avoid or minimize hydrologic changes that would drive community shifts impacting red-cockaded woodpecker (RCW) and Florida panther habitat (among others). The hydrologic design also considers the numerous outparcels within and adjacent to the PSSF, and protection of vital Florida Forest Service infrastructure and public recreation areas. Data from an intensive groundwater monitoring system linked with a habitat monitoring program will provide the basis for adaptive management to adjust inflows as necessary to achieve and maintain project goals.

Integrated groundwater-surface water models define the fate of GGC inflows to the Belle Meade Flow-way. A regional scale model produces input to the local fine grid model of the Belle Meade project area. Hydrologic model outputs provide the inputs to the wetland water quality treatment area design and GIS models assessing potential wetland community changes and listed species habitat effects. The current US Fish and Wildlife Service (FWS) panther habitat model parameters will provide the means to assess potential effects on panther habitat. A similar model is not available for RCW habitat, so with federal and state agencies, Taylor Engineering is developing a project-specific RCW habitat assessment.

PRESENTER BIO: Dr. Stites is Director of Environmental Services at Taylor Engineering, Inc. With more than 30 years' experience in ecological research, restoration, and permitting, he has extensive experience with wetland restoration and habitat creation. He has led numerous large scale restoration projects around the state of Florida.

AN EXPERIMENTAL ASSESSMENT OF NEIGHBORHOOD INTERFERENCE ON EVERGLADES' TREE SPECIES GROWTH AND SURVIVAL ALONG A FLOODING GRADIENT IN CONSTRUCTED TREE ISLANDS

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The competitive release hypothesis (CRH) proposes that intense competition at the most benign parts of the gradients exclude species with low competitive ability. Weaker competitors are viewed to be more tolerant to disturbance and find refuge at the most disturbed end of the gradient. CHR predicts that flood-tolerant plant species are weak competitors on well-drained sites, but benefit in the flooded part of the gradient, where competition is less important due to high mortality rates among mesic tree species. In this study, we tested this hypothesis in a meso-scale field experiment, examining species responses to flooding and neighbor size/proximity during Years 3-8 after initial planting.

In 2002 a landscape-scale physical model of the Everglades, the Loxahatchee Impoundment Landscape Assessment (LILA), was constructed at Loxahatchee National Wildlife Refuge. Control of hydrology and replication of landform structure at LILA allowed investigators to precisely assess ecosystem responses to important physical or biological drivers. One component of the landscape created at LILA was a set of forest patches (tree islands) that show a flooding gradient from drier center to wetter edges. Mean water depth was estimated at the location of each tree using elevation data from topographic surveys and water level data from nearby stage recorders. An interference index was used to characterize the competitive neighborhood of a target individual based on the proximity and size of neighbors. We applied a factorial regression analysis of survival and height growth of individuals as a function of hydrology and competition measured with the neighbor interference index.

Growth and survival response of most species decreased towards the wet end of the gradient indicating that waterlogging stress affected both flood-intolerant and flood-tolerant species. Neighborhood competition experienced by all species was stronger in the dry upper end of the gradient. However, during this early stage of stand development, higher neighborhood competition experienced by flood-tolerant species did not exclude them from more favorable elevated positions nor decrease their abundance relative to more waterlogged locations as predicted by the competitive release hypothesis.

<ins>PRESENTER BIO</ins>: Susana Stoffella is a research analyst with more than 10 years of experience in collecting and analyzing vegetation data in the Everglades and other South Florida ecosystems.

ENVIRONMENTAL TRENDS AND ECOLOGICAL RESPONSES TO WATER MANAGEMENT, RESTORATION, AND EXTREME EVENTS IN FLORIDA BAY

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In the southern Everglades, Florida Bay has an extensive submerged aquatic vegetation habitat that supports diverse aquatic and avian fauna. A program of water quality mapping has been conducted in the northern and central bay for over 20 years allowing us to characterize spatial and temporal patterns in water quality. We examine system responses to freshwater inflows, Everglades restoration and major disturbances such as hurricanes and episodic hypersalinity.

Effects of direct precipitation and runoff are most influential in the freshwater transition zone, where salinities can decrease to <5 psu nearshore but remain 38 psu in the western bay. Chlorophyll a (Chla), indicative of phytoplankton blooms, is usually low in this estuary (<10 µg/L); however, blooms sporadically occur in the central bay and the central lakes, where Chla can be elevated up to 125 µg/L.

Recently, several events have had notable impacts on Florida Bay, demonstrating the sensitivity of its ecology. The 2015 seagrass die-off in western and central Florida Bay was precipitated by a period of pronounced hypersalinity (>40 psu), as high as 75. Although precipitation during an ensuing El Niño in 2015-2016 curtailed this hypersalinity, algal blooms were observed in the areas of seagrass dieoff. In October 2016, Chla was 10x higher in the western bay than the east (33 and 3 µg/L, respectively). Based on historical seagrass die-off patterns in Florida Bay, dead leaves and decaying roots likely released nutrients over time, supporting localized algal blooms. These blooms subsided by early 2017 (<5 µg/L).

In August 2017, 72% of Florida Bay again became hypersaline (35-48 psu) from a lack of rain and freshwater inputs; however, 7" of direct precipitation from Hurricane Irma (Sept 10, 2017) decreased salinities baywide by up to 20 psu. In October, nearshore salinity declined further with continued freshwater inputs, reaching <5 psu. This system-wide disturbance appeared to "reset" salinity to the September average and likely prevented hypersalinity development into 2018. After Irma, Chla was up to 8x higher (≤57 ug/L) than just prior to the storm, indicating phytoplankton blooms across most of the bay. Physical shearing of vegetation and water and sediment mixing likely also recirculated remaining seagrass die-off detritus, supporting the blooms. However, Chla completely subsided in the east and declined notably in the central bay by June 2018, returning to average conditions <1 year after Irma.

Findings from this program demonstrate both the immediate and broader impacts of unique events on Florida Bay as well as the influence of successive disturbances (i.e., drought followed by Hurricane Irma). However, the program also highlights Florida Bay's resilience to extreme conditions, such as hypersalinity, which can be further bolstered through restoration and management activities that promote more consistent freshwater flows and stable conditions.

<u>PRESENTER BIO</u>: Theresa Strazisar is an Aquatic/Estuarine Ecologist at the South Florida Water Management District. Her primary research focus in seagrass/submerged aquatic vegetation ecology and modeling. She has been working in Florida Bay for almost a decade.

FINDING ALGAL BLOOMS IN THE GREATER EVERGLADES WITH SATELLITE IN LAKE OKEECHOBEE AND BEYOND

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[2]CSS Inc., Fairfax, VA, USA

Harmful algal blooms are a significant issue in south Florida, in both freshwater and marine water. Of particular concern is the cyanobacteria, *Microcystis aeruginosa*, which produces both dense scums and also microcystin toxins. *Microcystis* blooms have been a recurring problem in Lake Okeechobee and adjacent estuarine freshwaters for many years. Lake Okeechobee is some 50 km across, with an area of 1900 km^2, making routine monitoring of bloom extent quite difficult with any standard water sampling scheme. Similarly, understanding the presence and timing of dense blooms is important to examining the potential impact on the St. Lucie River and the Caloosahatchee River, both of which may receive water from the lake when lake levels are high. Routine satellite imagery sets can provide a key tool for identifying and quantifying the bloom intensity and extent.

A method for detecting cyanobacteria blooms was developed in the U.S. Great Lakes. The algorithm, cyanobacterial chlorophyll index (CI), provides an estimate of the near-surface chlorophyll concentration found within cyanobacteria. It has been shown to be applicable to blooms in Florida, as well as other parts of the country. This method was developed for the Medium Resolution Imaging Spectrometer (MERIS) which provided data from 2002 to early 2012, and works for the Ocean Land Colour Imager (OLCI) on the Copernicus Sentinel-3 (S3) satellites developed by the European Space Agency and first launched in 2016. OLCI provides 300 m repeat coverage 3-4 times a week with one satellite and with the recent launch of Sentinel-3b repeat coverage will be 1-2 times a week.

We processed OLCI data from S3 every day during 2017 and 2018. In June 2018, efforts to lower the water level in Lake Okeechobee led to an additional need to routinely monitor blooms across the lake. S3 identified and monitoring the rapid formation of a *Microcystis* bloom in late June. *Microcystis* tends to float to the surface in the day, producing scums in calm weather. While satellite can only detect surface concentrations, it can identify bloom presence even when scum is not obviously present. Wind speed strongly influences scum formation, and strong winds lead to mixing of the bloom through the water column, thereby limiting the ability of the satellite to detect all cyanobacteria biomass present in the lake. By monitoring the wind speed prior to the imagery, we can provide a more accurate interpretation of individual images. We are also examining the 2016 bloom (data was not available from the, then new, satellite until October), so the development of that bloom can now be described.

OLCI has more limited use for the local estuaries due to its spatial resolution. Another higher spatial resolution sensor, the Multispectral Imager (MSI) on the Sentinel-2a and 2b (S2) satellites, may provide data on the presence of dense algal blooms (currently cyanobacteria cannot be discriminated from other blooms) with 20 m data every 5 days. However, the S2 orbit results in images with intense sunglint for the Caloosahatchee River from late May to early August, limiting utility there.

PRESENTER BIO: Dr. Stumpf has over thirty years in developing methods to improve the use of satellite data in monitoring and modeling of coastal water quality, coastal habits, and harmful algal blooms (HABs). His research has led to monitoring capabilities around the country for both marine and freshwater HABs.

HARMFUL ALGAL BLOOM DYNAMICS IN SOUTH FLORIDA AND THE INDIAN RIVER LAGOON

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The Indian River Lagoon (IRL) is a large barrier island estuary on Florida's East coast. The IRL's associated watershed and waterways, e.g. the St. Lucie Estuary (SLE), constitute a complex and important ecosystem in the state of Florida. Overall, the IRL system spans 260 km or approximately 40% of Florida's east coast. The 5,700-km2 watershed includes parts of seven counties, and its original extent has been expanded considerably by canals that drain inland areas, including a major canal linking Lake Okeechobee to the SLE and IRL ecosystem. The IRL has been declared impaired due to excess nutrient inputs, and the location and geographical extent of the IRL place its ecosystem within an ecological zone particularly susceptible to climate change. Along with being large and complex, the IRL system is one of the nation's most biologically diverse, and is a major spawning and nursery ground for numerous species of fish and shellfish, and home to populations of dolphins and endangered Florida manatees. The IRL ecosystem has large tourism, commercial and recreational fishing, boating, and aquaculture interests with an annual economic value estimated at nearly $8B.

Over recent years, recurrent large scale harmful algal bloom (HAB) events have seriously threatened both the ecological and economic stability/value of the IRL. While HABs have been recorded in the IRL for more than 50 years, increasing stress on the system from factors including nutrient eutrophication, land use practices and climate change, have many wondering if the system has hit a critical tipping point, where the frequency and intensity of HABs will only continue to increase in the future. Scientifically, the biological-chemical-physical complexity of the IRL system presents a significant challenge to understanding its ecology and dynamics. This presentation will discuss IRL phytoplankton blooms, their complexities and repercussions to the ecosystem and human health, as well as developing scientific strategies and research programs for an improved understanding of their dynamics.

PRESENTER BIO: Dr. Sullivan is the Executive Director of Florida Atlantic University's Harbor Branch Oceanographic Institute and the Harbor Branch Research Pillar. He has more than 25 years of experience studying phytoplankton ecology and harmful algal blooms.

EVERGLADES NATIONAL PARK NUTRIENT PATTERNS AND RECENT OPERATIONAL CHANGES

Donatto Surratt[1], *and Tiffany Troxler*[2]
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The C-111 South Dade Project envisioned a number of modifications to the eastern boundary of Everglades National Park (Park) that will restore the natural hydrologic conditions in Taylor Slough and the eastern panhandle of the Everglades National Park. A major objective of the modification is to promote a hydrologic ridge that reduces the southeast loss of water from the Park to C-111 Canal system. The result of this operation should be increased hydroperiods in the Park west of the canal network and promotion of more flow into Taylor Slough and ultimately out to Florida Bay. Here we assess the influence of these physical modifications and associated operational changes on water quality, particularly total phosphorus and total nitrogen. Preliminary evaluation shows that marsh water levels and hydroperiods have increased significantly over the period of analysis (WY2003-WY18) with the greatest increase from WY2016 through WY2018, however, in the canal adjacent to these marsh areas, water levels have declined over the same period. These changes occurred even when rainfall was factored out of the time-series. Interestingly, for the surface water quality stations situated adjacent to the canal network on the eastern Park boundary, total phosphorus concentrations have increased since WY2015 based on change-point and Seasonal Kendall trend analyses. These recent changes in water quality are contrasted against findings following the last set of major changes to Taylor Slough water delivery in the early 2000s, when direct discharges were ceased and phosphorus concentrations declined.

<u>PRESENTER BIO:</u> Dr. Surratt is a senior ecologist with almost 20 years of biogeochemical evaluation for wetland and coastal ecosystems. He has extensive experience with wetland water quality and restoration. Dr. Surratt presently provides guidance for and performance of data analysis and technical summaries for water quality issues surrounding Everglades Restoration.

ADVANCEMENTS IN REPRESENTING EVERGLADES HYDROLOGY WITH DATA INTEGRATION AND PHYSICS-BASED MODELS

Eric Swain[1], *Leonard Pearlstine*[2], *Saira Haider*[3] *James Beerens*[3], *Tiffany Troxler*[4], *and Melinda Lohmann*[1]
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Hydrologic conditions in the Everglades National Park area strongly control landscape features and processes such as species habitat suitability, peat loss, salinity intrusion, and vegetation succession. Two tools developed to characterize hydrologic conditions, the Everglades Depth Estimation Network (EDEN) and the BIscayne and Southern Everglades Coastal Transport (BISECT) model incorporate considerable field data collected in the area and use computational techniques that interpolate known data and physics-based formulations. These tools are continually evolving, and new applications continue to be developed.

EDEN utilizes over 250 field stations to develop daily water-level surface representations for the greater Everglades. Besides serving hydrologic data online, such as water levels, rainfall, and evapotranspiration, EDEN includes multiple ecological applications that use this hydrologic information for habitat suitability analyses. Version 3 (V3) of EDEN incorporates 1) an R-programming language platform to access daily water-level data and output interpolation of water stage and depth, 2) changes to the network of field gages, 3) a representation of below-ground water-levels based on interpolation of available gages, and 4) updates of the EDEN ecological evaluation tools from V2. With this R-programming language platform, V3 is more portable and efficient, no longer relying on imbedded GIS software functions for water-level interpolation. The importance of shallow groundwater to Everglades ecology is recognized in V3, and the estimation of below-ground water levels is based on available gages. With these advancements, EDEN can continue to provide essential support for scientists and managers of the Everglades system.

While EDEN provides current and past water-level conditions based on interpolated monitoring-network data, estimates of other hydrologic conditions such as flow rates and salinity, as well as projections for future scenarios, are provided by the BISECT model. BISECT was developed to represent hydrodynamic surface-water and groundwater flow rates and budgets, and salinity transport. One application of the BISECT model in the Everglades National Park area is the simulation of inundation and salinity to investigate peat-loss in coastal wetlands. Simulation results are utilized with peat-loss measurements to identify mechanisms that cause peat collapse. The BISECT model projects hydrologic conditions for future sea-level rise, precipitation, and evapotranspiration scenarios. The computed inundation and salinity changes for these scenarios can be used to predict potential future peat loss, as well as effects of proposed remediation actions.

<ins>PRESENTER BIO</ins>: Dr. Swain is a research hydrologist at the USGS Caribbean-Florida Water Science Center office in Fort Lauderdale Florida. He has specialized in the development of numerical models of surface-water/groundwater flow as well as statistical analysis of hydrologic parameters and methodology for determining field parameters.

M3ENP MODEL OF FLOW AND TRANSPORT IN THE EVERGLADES NATIONAL PARK

***Georgio I. Tachiev*[1]**, *Amy Cook*[2], *Kiren Bahm*[3] *and Kevin Kotun*[4]
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This poster presents the water quality model of Everglades National Park for studying fate and transport of total phosphorus. The model is based on coupling of the hydrologic and hydrodynamic MIKE Marsh Model of Everglades National Park (M3ENP) with ECOLAB kinetic solver. A conceptual reactive box model was developed to represent total phosphorus uptake and release processes with emphasis on physical processes, including sorption and desorption on solids (suspended particles and sediments), particle sedimentation and re-suspension and advection-dispersion.

An ECOLAB template was developed to provide coupling of the conceptual reactive box model with the MIKE SHE and MIKE 11 hydrodynamic model and provide analysis of advection-dispersion and reactive transport processes. The reaction model was based on the available ECOLAB templates for Xenobiotics, developed by DHI Water and Environment Inc. The ECOLAB numerical model is based on 4 subdomains and describe generation, settling and resuspension of particles, sorption/desorption of TP on suspended solids and sediments and advection, diffusion and dispersion of TP in the water column and sediment pore water. The water quality model includes advection-dispersion processes and reaction kinetics processes implemented using the ECOLAB model. The ECOLAB provides coupling with the flow model to simulate the fate and transport of total phosphorus within the domain. The ECOLAB model specifies the relevant reactions and reaction parameters for each of the model domains: Open Channel (OC), Overland Flow (OL), Unsaturated Zone (UZ) and Saturated Zone (OC).

The ECOLAB reactive model was adapted for each of the model domains to account for dominant transport processes within the Open Channel, Overland Flow, Unsaturated and Saturated model subdomains. Calibration of the model was provided using available water quality data which included total suspended solids, total phosphorus and relevant water quality parameters collected for the period of 1999-2010. While observed stages and discharges are available as hourly and daily timeseries, total phosphorus concentrations are measured less frequently and in many cases on a weekly and monthly basis, and even at larger intervals. Considering the relative scarcity of timeseries of TP over the entire domain and the modeling period, statistical methods were applied to analyze and compare the sampling populations of observed and computed data. A series of Cumulative Density Functions was developed for all timeseries (observed and computed) and were used to determine performance of the water quality model. Hypothesis testing was applied to determine if computed and observed data belong to the same distribution. The equilibrium and reaction constants for transport processes were varied until the best match was observed between the computed and observed data. The model provides the daily distribution of simulated phosphorus transport within the surface, subsurface and canal domains.

PRESENTER BIO: Dr. Georgio Tachiev is Principal Engineer of GIT CONSULTING LLC with more than 27 years of experience in civil and environmental engineering, and water resources. He has led the development of hydrodynamic and hydrologic models related to planning, designing, and implementing Everglades restoration projects.

M3ENP_SF - AN INTEGRATED SURFACE AND SUBSURFACE HYDROLOGIC AND HYDRODYNAMIC MODEL OF THE EVERGLADES NATIONAL PARK

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This poster presents an integrated surface and subsurface hydrologic and hydrodynamic model of the Everglades National Park (ENP). The model objective is to analyze and assess the performance of proposed restoration projects in Central and Southern Florida. These projects are intended to re-introduce water flows into Northeastern Shark Slough and the Rocky Glades regions of ENP and consist of a series of levees, canals, gated spillways, pumps and water storage areas designed to achieve restoration benefits without increasing the potential for flooding in developed areas adjacent to the park. M3ENP_SF is an extension of the M3ENP hydrology model previously developed by a collaborative effort by NPS, FIU and GIT CONSULTING LLC. In addition to hydrology and hydrodynamics, a water quality model was developed for solute fate and transport processes within the M3ENP modeling domain.

To address additional broader range of new analytical objectives, the M3ENP_SF model has been spatially extended to 2,650 sq. miles mainly south of Canal L29 and west of L31N and C111 canals and includes the coastal areas. The model includes relevant hydrologic and hydrodynamic processes, and structural operations within the domain. The conceptual hydrologic model was updated to include significant hydrological feature of stratigraphy, boundaries, and infrastructure. The stratigraphy is based on a 5-layer subsurface model which provides improved representation of local variations of aquifer properties. The model implements detailed structure operations and provides possibilities to analyze alternative water supply and flood mitigation rules based on prescribed timeseries. New data for culverts and bridges along Loop Road, culverts for Tamiami Trail west of 40-Mile Bend and the Main Park Road were obtained from field work and GIS sources and were implemented in the M3ENP_SF model to provide better representation of surface flows. The MIKE 11 network was extended to include 630 miles of canals and streams. Two versions of the Detention Areas were developed based on the configurations in years 2002 and 2018.

The model uses variable timesteps, the maximum timesteps were set at 2-minute intervals for 1D Open Channel flow, 0.5 hours for 2D overland Flow, 1 hour for 1D unsaturated zone flow, and 6 hours for saturated zone flow. Output data are saved on an hourly basis for Overland and Open Channel Flow where tidal effects are significant and daily for the rest of the inland hydrologic components. The M3ENP_SF model provides improved representation of the surface flows, improved capabilities to analyze the effects of prescribed structure operations on flows and stages within the domain. The model provides capabilities for analysis of localized variations of hydrogeology (including seepage walls), and a better representation of the connectivity between tidal and inland hydrology.

PRESENTER BIO: Dr. Georgio Tachiev is Principal Engineer of GIT CONSULTING LLC with more than 27 years of experience in civil and environmental engineering, and water resources. He has led the development of hydrodynamic and hydrologic models related to planning, designing, and implementing Everglades restoration projects.

EVERGLADES WETLAND METABOLISM: LESSONS LEARNED FROM THE DECOMPARTMENTALIZATION PHYSICAL MODEL PROJECT

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The objective of this study is to determine the effects of restored sheet-flow on Everglades aquatic ecosystem metabolism within the Decompartmentalization Physical Model (DPM) project. The DPM is a landscape-scale field test evaluating hydrologic and biological responses to flow treatments, including low flow (baseline) and high flow (impact) conditions. The DPM uses an inflow structure (S-152) consisting of 10 gated culverts on the L67A to provide high flow velocities into an area between the L67A and L67C levees. Starting in 2012, dissolved oxygen (DO) and other water quality parameters were measured at 10 sites, including slough and sawgrass ridge habitats, within the DPM study area using water quality sondes. Sondes were deployed continuously for 5 days per month and gross and net primary productivity, as well as aquatic respiration, were calculated from diurnal changes in DO. Data analysis to date has documented significant changes in slough metabolism in response to increased water flow. In particular, increased ridge and slough production during increased water flow velocity was observed. The relative importance of these findings for restoration at the landscape level, and the implications for wetland metabolism methods will be discussed.

PRESENTER BIO: Erik Tate-Boldt is a wetland ecologist with the Marsh Ecology Research Group of the South Florida Water Management District and currently works on the implementation of scientific research on wetland biogeochemistry and ecology to support the Everglades restoration process and water management operational decisions

REYNOLDS-AVERAGED SIMULATION OF LANGMUIR CIRCULATION IN SHALLOW WATER

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Langmuir turbulence in estuaries, lakes and oceans is driven by winds and waves and is characterized by a wide range of Langmuir circulation (LC) scales, consisting of parallel counter rotating vortices or cells roughly aligned in the wind direction. Wind speeds greater than 3 m s^{-1} and winds and waves roughly aligned present conditions ideal for the generation of Langmuir turbulence and associated LC. The surface manifestation of LC are the so-called windrows which are lines of foam and floating debris that accumulate along the surface convergences of the cells. Spacing between windrows ranges between 2 and 300 m and downwind length scales can range between several meters and several kilometers.

In unstratified shallow water columns, the largest of the LC scales can span the full depth of the water column becoming more coherent and persistent than ordinary LC in a mixed layer setting. These full-depth cells have been termed Langmuir supercells because of their profound effect on sediment re-suspension and bottom boundary layer dynamics.

Traditionally, flows with LC are computed via either (1) large-eddy simulation (LES) in which a range of the Langmuir turbulence (or cells) is resolved or (2) Reynolds averaging in which none of the Langmuir scales are resolved and the effect of the Langmuir turbulence is accounted for through the turbulence model or closure. A new solution strategy based on Reynolds averaging is introduced, relying on the coherency and persistence of Langmuir supercells. Here these cells are treated as a secondary component to the wind and/or pressure gradient-driven primary flow. As such, the Reynolds-averaged governing flow equations and the mesh are designed to resolve both the primary flow and the Langmuir supercells with the turbulence model accounting for the smaller Langmuir scales. Popular turbulence models including the k-epsilon and k-omega models updated to account for the unresolved LC scales will be described. The Reynolds-averaged cells computed through the new solution strategy and associated statistics in terms of root mean square of resolved LC velocities will be compared with their counterparts in LES. The new solution strategy will also be used to simulate Langmuir supercells in domains with variable water column depth ranging between 5 and 10 meters over lateral distances spanning several kilometers. The goal is to understand the effect of water column depth, lateral boundaries, and cross-cell currents on the intensity, coherency and aspect ratio of the cells (cell height-to-cell width).

The newly proposed solution strategy offers the potential for the accurate resolution of full-depth Langmuir cells or Langmuir supercells and associated vertical mixing and horizontal dispersion in hydrodynamic models of estuaries, lakes and the coastal ocean.

<u>PRESENTER BIO</u>: Dr. Tejada-Martínez is an associate professor in Civil and Environmental Engineering at University of South Florida with more than 15 years of experience in turbulence resolving methodologies and turbulence subgrid-scale modeling for LES and Reynolds-averaged formulations.

SETTLING AND ENTRAINMENT PROPERTIES OF STORMWATER TREATMENT AREA PARTICULATES

*Leonard J. Scinto[1], **Serge Thomas[2]**, David C. Fugate[2], Shimelis B. Dessu[1], David W. Perkey[3], René M. Price[1], S. Jarrell Smith[3] and Colin J. Saunders[4]*

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The Stormwater Treatment Areas (STAs) receive phosphorus laden surficial water from canals draining the Everglades Agricultural Area (EAA). Multiple mechanisms including: i) plant and microbial uptake, ii) biologically mediated physicochemical changes enhancing P sequestration (e.g. co-precipitation with calcite), iii) particulate settling and entrapment, and iv) by chemical mechanisms (e.g. P sorption), reduce P levels. Despite P removal successes (> 85% reduction in P loads) additional efforts are needed to quantify, control, and reduce particulate P discharge.

This study focused on the characteristics of the particulate settling, resuspension and overall sediment entrainment in STA 2 and 3/4. Particle dynamics were studied: relative to applied shear stresses in core experiments and under variable flow conditions as affected by hydrologic operations, differential flow paths and meteorological conditions.

As expected, water TP decreased along submerged aquatic vegetation (SAV) flow ways from inflow to outflow with a concurrent build-up of recently accreted sediment (RAS). Since STA operations began in STA 2, RAS accretion was approximately 17 cm across the flow way with higher sediment TP and organic matter at the inflow compared to midflow and outflow flow way locations. RAS bulk density increased with depth at all locations. RAS accretion attests to particulate settling being an important mechanism in STA P removal. However, particulate matter comprised 64% of the water TP in STA 2 and 56% in STA 3/4 suggesting that a portion of particulate matter either does not settle or is resuspended. Therefore, the critical shear stress of RAS was measured to determine the forces needed, and the likelihood these forces during operations that would cause entrainment into the water column. Generally, operational flows do not create the shear stresses necessary to entrain settled material from the sediment bed. However, temporal variations in wind speed and the turbulence created, as well as localized differential flow paths; especially in proximity to water control structure (i.e. outflows) can cause instances of increased velocity and water column particulate material. Analysis of particulate settling velocities ranged from 1.0-2.2 mm s^{-1} and median aggregate spherical diameters ranged from 36-60 µm. There were two distinct particle populations, one larger low-density (likely sloughed algae/periphyton) and smaller high-density particles. Like water TP, the particle P concentration tended to decrease from inflow to outflow by about 20-60%. Particles were about 25-30% organic and, in STA2, particulate sizes increased by a factor 2-3 from inflow (average of about 120µm) to outflow (about 285µm). As the critical shear stress of the water column was shown to be much less than required to resuspend sediments, we suggest that water advection is suspending/detaching floc/periphyton from the surfaces of the SAV.

<u>PRESENTER BIO</u>: Dr. Thomas is an Associate Professor with over 22 years of experience dealing with the ecological study and the remediation of various culturally eutrophied subtropical shallow hydrosystems. Such a remediation involves especially the use of constructed wetlands (STAs) as well as stormwater retention/detention ponds in Florida.

PHOSPHORUS, NITROGEN AND MUCK REDUCTION BY BIO-ZYME

***Elroy Timmer*[1]*, and Trace Wolf*[2]**
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This PowerPoint addresses how large amounts of phosphorus and nitrogen are reduced in water and in muck by Bio-Zyme. Muck is also reduced or even eliminated in about 20,000 lakes.

Fifteen major aquatic companies are finding the use of Bio-Zyme effective and economical. Lakes with low nutrient input are naturally managed with bacteria but with excessive nutrients, lakes need additional probiotic bacteria.

The process consists of taking several species of natural probiotic bacteria that reduce nutrients and muck and incubating them on site. This on site incubation multiplies these beneficial bacteria by the billions. The live bacteria are then distributed into the lakes resulting in the reduction of the water's trophic status.
This is a continuous process as the bacteria are eaten by protozoa and end up in the food chain. Much of the muck, phosphorus and nitrogen therefore end up in the food chain.

Bio-Zyme could be used to perform nutrient reduction in Lake Okeechobee, STA's, and water exiting farms, nutrient rich lakes leading into Lake Okeechobee and to reduce nutrients in the city waterways. If reduction of phosphorus, nitrogen and muck can be accomplished in hundreds of the finest high nutrient golf course and homeowner lakes, it can be effective also in these areas.

This presentation highlights the 100 acre Peacock Lake where phosphorus has been reduced from 0.05 to less than 0.005 mg/l. It also highlights muck, nitrogen and phosphorus reduction in several lakes and an STA. Testing of the muck samples indicates no accumulation of phosphorus and nitrogen even though there is a large reduction or elimination of muck.

<u>PRESENTER BIO</u>: Elroy Timmer is the Senior Scientist of Aquatic Vegetation Control, Inc. He has 58 years of experience in aquatic management. Much of his research in the past 40 years has been on the use of natural, probiotic bacteria for phosphorus, nitrogen and muck reduction in the management of the aquatic environment. The research has changed the way many companies conduct aquatic management today.

ECOTYPIC VARIABILITY IN SALT TOLERANCE

***Mohsen Tootoonchi**, Lyn A Gettys, Kyle L Thayer and Ian J Markovich*
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As sea level rises, the coastal zone along the Everglades will be increasingly exposed to salinity and inundation. Increased salinity level can change Everglades vegetation to more salt-tolerant species and replace native vegetation with introduced invasive species. Aquatic plants play important roles in the Everglades by improving water quality, stabilizing substrate and providing food and habitat for native fauna. Native aquatic plants resistant to salt stress need to be established to help the Everglades cope with future salinity levels. Salt-tolerance variability among plant ecotypes has been reported for many plant species. However, there has not been enough research to show the mechanisms of salt tolerance for aquatic plants. We conducted a series of greenhouse experiments to assess salt tolerance variability among ecotypes of the native species *Valllisneria americana*. Plant ecotypes collected from 35 different regions within the United States were exposed to abrupt saline condition (0.2, 2.0, 4.0, 10.0 and 20.0 parts per thousand). Physiological responses such as plant stress signals (proline) were determined as well as growth rate, root, and shoot biomass. Preliminary results reveal that ecotypes with greater growth rate can tolerate higher salinity levels. Our findings will not only increase our understanding of salt tolerance mechanisms in aquatic plants but also provide knowledge for improving management strategies aimed at mitigating the negative effects of future climatic changes.

PRESENTER BIO: Mohsen Tootoonchi has a Master's degree in Soil and Water Science from the University of Florida. He is working on a PhD in Dr. Lyn Gettys' Aquatic Plant Science Lab at the same institution. His dissertation research examines the effect of saltwater encroachment into freshwater systems.

PALEOENVIRONMENTAL PERSPECTIVES ON SEA LEVEL RECONSTRUCTION FROM MANGROVE PEAT SEQUENCES

***Marguerite A. Toscano**[1], Juan L Gonzalez[2]*
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Thick mangrove peat sequences representing millennia of accumulation at pace with sea level rise (SLR) provide a broad view of the long-term sustainability of mangroves, in contrast with the modern event-based perspective and the effects of accelerating rates of SLR currently impacting peat forming ecosystems. Geologic records of mangrove peat accumulation undoubtedly contain hiatuses in peat production due to dieback/collapse, as well as net losses due to storms and erosion, which are not necessarily discernable from visual inspection or CT imaging of *Rhizophora mangle* cores. Post- and syn-depositional effects on paleo peat elevations include the general assumption of peat compaction and the opposing possibility of hydrology- and climate-driven peat expansion. Despite these complications, non-compacted, sediment-free, offshore peats can provide a potentially continuous proxy for reconstructing the record of sea-level rise at any site, if depositional, disturbance, geochemical and biotic processes affecting ^{14}C ages are taken into account. Accurate paleo sea-level reconstructions and calculated rates provide an essential linkage to modern tide gauge data and altimetry, and have the potential to reveal rates of SLR with which peat-forming systems have kept pace in the recent geologic past as predictors of the sustainability of such systems into the next 50-100 yrs under accelerating rates.

We present radiocarbon-dated core records from oceanic *R. mangle* peat sequences in Florida (6 m), Belize (12 m) and Panama (3.5 m), which indicate rates of SLR endured by mangroves in these settings for the past 9 kyrs through belowground biotic processes with minimal sediment inputs. We illustrate, through Computed Tomography and peat analysis, the lack of compaction in these sediment-free oceanic peat systems, and show sea level reconstructions from these areas which suggest other issues affecting the fidelity of fossil peat elevation as a tide-range limited sea-level indicator (including possible peat expansion). Assuming peat elevations are not lowered by compaction or collapse, the ubiquitous problem of ^{14}C age inconsistencies and reversals may be attributed to pervasive mixing and contamination of both older and younger peat through fine and larger root systems penetrating into underlying sections. Peat C/N ratios decline with depth as carbon is lost due to decomposition; anomalously high C/N ratios, occurring possibly as a result of mixing of younger material into older peat, may account for reversed ^{14}C ages and may be diagnostic of disturbed or mixed samples. While non-compacted peat elevations are most likely reliable, mangrove peat remains a complex proxy for paleo sea-level reconstructions. While the highest rates of reconstructed paleo SLR over the past 9 kyrs are slightly higher than the satellite altimetry-derived mean modern global rate, we caution that these paleo rates are the same order of magnitude and of lower resolution, leaving open the possibility that near-future accelerations may be unprecedented and will stress the sustainability of these ecosystems.

<u>PRESENTER BIO</u>: Dr. Toscano is a is a marine geoscientist who has studied records of sea level change preserved in Pleistocene and Holocene coral reefs and mangrove deposits. She is Editor of the Atoll Research Bulletin and is currently a Program Director in Geomorphology, Division of Earth Science, National Science Foundation.

A GEOLOGICAL PERSPECTIVE ON THE PRESERVATION AND RESTORATION OF FLORIDA'S CORAL REEFS

***Lauren T. Toth**, Ilsa B. Kuffner, and Anastasios Stathakopoulos*
U.S. Geological Survey, St. Petersburg Coastal and Marine Science Center, St. Petersburg, FL, USA

Over thousands of years, corals build complex geological structures that serve as the foundation for the myriad of critical ecosystem services. Coral reefs serve as a first line of defense against storm-related hazards in many coastal communities and provide habitat that supports fisheries and marine diversity. The ability of reefs to provide these important benefits to society, however, depends on the maintenance of a structurally complex reef surface and continued reef accretion, particularly as sea-level rise accelerates. Ensuring the persistence of ecological and geological reef functioning is critical to designing effective coral-reef management and restoration programs.

Using geological samples (reef cores) collected throughout the Florida Keys reef tract to reconstruct the millennial-scale history of regional coral-reef development, we provide a geological perspective on the management of Florida's coral reefs with respect to processes such as carbonate production and reef accretion. We show that changes in hydrography and climate starting ~6000 years ago resulted in slowed reef growth, so much so that reef building throughout the region had ceased by ~3000 years ago. The regional shut down of reef development left Florida's reefs balanced at a delicate tipping point wherein a veneer of living coral was the only barrier preventing largescale reef erosion. Unfortunately, declines in coral populations observed in the last several decades have pushed many reefs past that critical threshold, triggering reef erosion and the structural decline of Florida's reefs.

Because reef growth in south Florida has been negligible for millennia, it is unlikely that local management efforts alone will be able to restore all of the ecological and geological functions of reefs in the region; however, management aimed at restoring a cap of living coral to Florida's reefs could help to prevent further reef erosion. Most restoration efforts to date in the western Atlantic Ocean have focused on the finely-branching coral *Acropora cervicornis*, which provides valuable habitat in the short-term, but contributes minimally to carbonate production and reef building in the long-term. We show that over the last 10,000 years, two coral taxa—*Acropora palmata* and *Orbicella* spp.—were the primary reef-building species in south Florida, accounting for ~75% of the reef structure built throughout the Florida Keys reef tract. We suggest that focusing coral restoration on reef-building taxa *A. palmata*, *Orbicella* spp., and other coral with robust, massive morphologies, will optimize the outcomes of coral-reef management by mitigating reef erosion and promoting the growth of lasting reef structure.

PRESENTER BIO: Dr. Toth is a Research Oceanographer at the U.S. Geological Survey. She uses insights from geological records to better understand and manage the modern decline of coral-reef ecosystems. By developing reconstructions of Quaternary reef development, her research aims to determine what environmental conditions promote reef growth and cause reef decline.

INVASIVE SPECIES IMPACTS IN SPACE AND TIME: SCALING UP TO ECOSYSTEM FUNCTION

Joel Trexler
Florida International University, Miami, FL, USA

Everglades aquatic communities support apex predators that define its iconic status. Wading bird abundance is greatly reduced in the modern ecosystem and they often experience years of low nesting success because of food limitation. Everglades restoration assumes that water delivery is the source of these losses and that apex predators will rebound if historical hydropatterns are recovered. The Everglades is experiencing marked invasion by non-native plants and animals, and in aquatic habitats a diversity of fishes have become established and at times reach high numbers. The impact of these invasions on proposed benefits of hydrological restoration is unclear. The objective of this presentation will be to evaluate if these invaded aquatic communities still provide historical function of high-quality prey resources for apex predators at the time and place needed to support nesting. I will use long-term data records to evaluate the impacts of invasive species on fish biomass and community dynamics at the landscape scale. I have developed statistical models that predict fish biomass and community structure as a function of hydrological conditions, parameterized with data collected before the invasions of African Jewelfish (*Hemichromis letourneuxi*), Asian Swamp Eels (*Monopterus albus*), and Spotfin Spiny Eels (*Macrognathus siamensis*). I will use these predictions to evaluate community structure since the invasions and document their impacts on community function.

African Jewelfish increased in numbers in the Shark River Slough (SRS) following a 2010 cold snap and were present at ~50% of monitoring sites by 2012; their relative abundance exceeded 15% of all fishes collected at 70% of study sites in 2014. Asian Swamp Eels and Spotfin Spiny Eels also increased in numbers over the same period in Taylor Slough (TSL) but were absent or incidental elsewhere through 2015. In 2012, the density of native fish in SRS was less than expected based on hydrology in pre-invasion models, though the density of all fish (native plus non-native) was similar to predicted, biomass was lower. In TSL, there is no evidence of decreased density of native fishes linked to the two invasive species that are now common there. The current data do not indicate that fish invasions have altered the food production system that underlies major features of the Everglades in the public's view, though community structure has been altered in irreversible ways. The density of African Jewelfish in SRS and Asian Swamp Eels in TSL dropped markedly in dry-season samples collected in 2018. Continuing research is needed to determine if this new community can be managed in a way to sustain iconic values of the Everglades and if the recent dip in non-native fish density will persist.

PRESENTER BIO: Dr. Trexler is a Professor of Biology at Florida International University who studies population and community ecology of aquatic systems. Since joining FIU in 1991, he has studied fish and macroinvertebrate ecology in the Everglades with a focus on linkages of their dynamics to hydrological management and ecosystem restoration.

RESPONSES OF MARSH ECOSYSTEMS TO COASTAL CHANGE IN THE SOUTHEASTERN FLORIDA EVERGLADES

Tiffany G. Troxler[1], *Ben Wilso*[2], *Edward Castaneda*[1], *Emily Standen*[1], *Fred Sklar*[3] *and Chris Madden*[3]
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Climate change poses an unprecedented threat to coastlines by exposing >40% of the human population to impacts of storm activity and sea level rise (SLR), but also increasingly evident impacts on coastal systems around the globe. Direct effects of climate change on coastal ecosystems are manifest in losses in wetland extent and function as rates of SLR exceed their natural capacity to adapt. South Florida provides an important example of the sensitive balance between the pressures of SLR and increasing human demand for an increasingly limited freshwater supply.

Effects of SLR on wetland productivity depend partly on local factors such as the rates and history of exposure to saltwater encroachment, and ability of species to adapt to changing inundation, salinity, and nutrient availability. Since organic matter accumulation and turnover are the primary processes controlling soil formation and accretion, wetland dynamics can control how vegetation will respond to future impacts of SLR. Long-term data in the Florida Coastal Everglades suggest an increasing effect of salinity and stage as primary drivers of productivity. Salinity patterns across the Southeastern Saline Everglades suggest a strong correlation between the variability in freshwater discharge and lower ecotone salinity illustrating how upstream water diversion can amplify the effect of SLR. Further, salinity classes describe variation in sawgrass biomass. Experimental results illustrate a potential salinity threshold for sawgrass productivity with carbon loss exacerbated by annual drydown. Taken together, these data suggest a continued trend toward significant change in coastal Everglades plant community structure and productivity that may be modulated by freshwater management. Integrated modeling, new remote sensing efforts and extended field experiments are anticipated next steps in this program of work to understand coastal landscape vegetation change with SLR and water management.

PRESENTER BIO: Dr. Troxler directs the Sea Level Solutions Center at Florida International University, a state university center that focuses on advancing knowledge, decision making and actions toward mitigating the causes and adapting to the effects of sea-level rise. She is a research scientist with expertise in coastal and wetland ecosystem science. Some of her projects include collaborative research that examines the effects of saltwater inundation on Everglades coastal wetlands, monitoring management actions associated with Everglades restoration and advancing interdisciplinary urban solutions to sea-level rise.

DECISION ANALYSIS FOR THE OPTIMAL CONTROL OF INVASIVE PLANTS

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Florida spends millions of dollars annually on the control of invasive exotics. These plants invade native ecosystems, displacing native species, altering nutrient cycling and ecosystem function, and ultimately lead to biotic homogenization. Invasive plants are managed in part by using aerial surveys to detect areas it has invaded, then sending ground crews to remove it with herbicide and mechanical treatments. The introduction of biocontrol agents has also proved promising in controlling the reproduction and spread of some species. However, conducting surveys, funding crews, and implementing biocontrol programs all have costs and tradeoffs. Unfortunately, it is often unclear what the most cost effective management strategies are, or where they should be applied spatially. This is further complicated by imperfect detection of the invasive and uncertainty in its spread.

These general problems encountered in invasive plant management make it a prime candidate for decision analysis. We present decision analysis applications to address two common problems faced by invasive plant managers. The first problem is how to maximize removal efforts within a given year for a set budget. After creating a map of occurrence probabilities (e.g. using occupancy models) or abundance predictions (e.g. using UAS surveying), and developing a map of the cost/access of management in each location, static optimization methods (e.g. linear integer programming) can be used to determine the optimal set of locations which should be treated to minimize occurrence or abundance for a fixed budget. We demonstrate an application of this approach to optimizing removal efforts of melaleuca using aerial survey data.

This approach has limitations, however, in that it is based on a static pattern of occurrence, and does not account for the effects of different types of management. The second problem is how to spatially allocate a limited budget to minimize occurrence or abundance of the invasive in the landscape over time. A decision analysis approach for this problem quantifies the links among different management actions with dynamic models of invasive plant survival and spread. It then uses this information to determine efficient strategies to control the invasive over time. We discuss the relative utility of both approaches, and when one approach is more appropriate than another. We demonstrate these approaches with an application to melaleuca in Loxahatchee National Wildlife Refuge. We note that both approaches demonstrated here can be easily transferred and applied to control efforts for other invasive plants and vertebrates of concern.

PRESENTER BIO: Bradley Udell is a PhD student at the University of Florida studying the optimal control of invasive species. His work combines statistical estimation, process-based modeling, and decision analytic approaches to solve pressing conservation management problems; which are guided by perspectives in theoretical, applied, and landscape ecology.

THE MICROBIAL COMMUNITIES OF LEAVES AND ROOTS ASSOCIATED WITH TURTLE GRASS AND MANATEE GRASS DIFFER FROM SEAWATER AND SEDIMENT COMMUNITIES, BUT ARE SIMILAR BETWEEN SPECIES

***Kelly Ugarelli**, Peeter Laas and Ulrich Stingl*
University of Florida, UF/IFAS Fort Lauderdale REC, Davie, FL USA

Seagrasses are valuable members of coastal systems, and provide several important ecosystem services, such as improvement of water quality, shoreline protection, and serving as shelter, food and nursery to many species, including commercially important fish. Not only are seagrasses a major carbon sink, but they also supply copious amounts of oxygen to the ocean. Seagrasses have declined worldwide due to many factors including climate change, direct and indirect human activities, diseases and increased sulfide concentrations in the coastal porewaters. A symbiotic relationship between seagrasses and their microbiome has been shown by several studies. For example, the sulfur, nitrogen and carbon cycles are important biochemical pathways that seem to be linked between the plant and its microbiome. The microbiome seemingly contributes to the health of seagrasses, for example by oxidizing phyto-toxic sulfide into non-toxic sulfate, or by shielding seagrasses from pathogens. In Florida, two of the most abundant seagrasses include *Thalassia testudinum* (turtle grass) and *Syringodium filliforme* (manatee grass); however, limited data on the composition of their microbiome is available. In this study, the microbial composition of the phyllosphere and rhizosphere of turtle grass and manatee grass were compared to water and sediment controls using amplicon sequencing of the 16S rRNA gene.

The microbial communities of the different sample-types differ from one another, but are similar between the two species of seagrasses. Although some of the taxa were present in most of the samples, the relative abundance of the taxa differed from species to species as well as from sample-type to sample-type. Some of the most abundant organisms found in the communities of these seagrasses are involved in important biogeochemical cycles that can benefit their seagrass host, including carbon, nitrogen and sulfur cycles. When comparing our results with other studies, there is strong evidence that a core microbiome exists for seagrasses.

PRESENTER BIO: Kelly Ugarelli is a PhD student in the Microbiology and Cell Science department at the University of Florida under the supervision or Dr. Ulrich Stingl. Her research consists of studying the microbial communities associated with seagrasses.

WILDLIFE USE OF TEMPORALLY INUNDATED TREE ISLANDS IN WCA-3A

***Craig van der Heiden**, and Daniel Hagood*
Miccosukee Tribe of Indians, Miami, FL, USA

Tree islands occupy a small but distinctive part of the Everglades landscape. As biodiversity hotspots they support numerous plant species, provide habitat and wet-season refuges for animal species and are crucial nesting habitat for a variety of reptiles and birds. In the central Everglades, tree islands have been dramatically altered over the last century. The principle causes of damage to island vegetation and soils are dry downs, fires, and prolonged flooding. Because of the importance in the Everglades landscape, tree islands have been selected as one of the performance measures, or indicators, of the success of the Comprehensive Everglades Restoration Plan. Our multi-year study examines the effect of severe high-water levels, resulting from above normal summer rainfall and Hurricane Irma, on wildlife use of tree islands. We surveyed vegetation and monitored wildlife on tree islands with different elevations and hydrological inundation. Preliminary results identify negative impacts on faunal presence with prolonged hydroperiod. Species richness increases along a longitudinal gradient.

PRESENTER BIO: Craig van der Heiden is a conservation biologist, directing the Fish and Wildlife Department for the Miccosukee Tribe of Indians. His research interests focus on animal use of habitat, endangered species management, and restoration ecology.

INFLUENCE OF VEGETATION ON ORGANIC PHOSPHORUS FORMS IN WETLAND SOILS

***Lilit Vardanyan*[1]**, *K. Ramesh Reddy*[1], *and Sue Newman*[2]
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Treatment wetlands sequester inorganic and organic forms of phosphorus (P), the bioavailability of which regulates the potential flux of P from soil to the overlying water column. Therefore, understanding the chemical nature of the forms of inorganic and organic P is critical in developing management strategies to maintain desired effluent P concentrations and for the long-term sustainability of these systems.

Detrital flocculent material (floc), recently accreted soils (RAS), and native peat soil were sampled at inflow, midflow, and outflow sites of two contrasting flow-ways (FW) within stormwater treatment areas (STAs) in Florida. These STAs were designed to remove P from agricultural runoff prior to discharge into the Everglades Protection Area. The quality of organic P accreted in these wetlands is influenced by the type of vegetation and nutrient status. In this study we hypothesized that emergent aquatic vegetation (EAV) dominated FWs produce more stable organic P than the submersed aquatic vegetation (SAV) dominated FWs.
We used conventional P sequential fractionation analyses and solution ^{31}P Nuclear Magnetic Resonance Spectroscopy (NMR) to speciate P forms in floc and soils. ^{31}P NMR identified most of the major P forms, such as orthophosphates, phosphomonoesters, phosphodiesters and pyrophosphates. Organic P concentrations (monoesters+diesters) ranged between 613 to 429 mg P kg^{-1} in floc and RAS samples in the EAV FW, constituting between 28 and 42% of the total P. In the SAV FW, organic P concentrations were 135 and 248 mg P kg^{-1}, comprising 25-43% of total P. In both FWs, the proportion of organic P generally increased with distance from inflow. For native peat soil samples the organic P concentration ranged between 103-169 and 120-264 mg P kg^{-1} in EAV and SAV respectively, with the highest concentration in outflow sites.

The total P extracted by NaOH-EDTA and total organic P determined by solution ^{31}P NMR were positively correlated with the microbial biomass P (MBP) in the EAV FW ($P<0.05$). Similarly, orthophosphate monoesters and diesters were positively strongly correlated with the acid and alkali extractable P in the EAV FW ($P<0.001$). By contrast, with the exception of a correlation between diesters and MBP ($P<0.005$), there were no other correlations between P pools in the SAV FW. The ratio of monoesters/diesters increased with sediment depth in both FW's, with highest diester concentrations in the surface layers. By contrast, the total P concentration decreased with depth, with the lowest concentrations measured in native peat soil samples.

Although most soil P is stored as orthophosphate monoesters, soil organic P inputs are dominated by diesters, implying that plants and microorganisms highly control the composition of P forms. This supports the significant difference in organic P form distributions and the concentration in EAV and SAV FW, which is explained by the effect of dominant vegetation type. Overall, P loading increased the concentration of P stored as inorganic P in SAV systems and as organic P in EAV systems.

<u>PRESENTER BIO</u>: Dr. Lilit Vardanyan is a postdoctoral Research Associate with more than 15 years of experience in biogeochemistry of water and plants of lakes, rivers and the wetlands from different part of the world. She has worked on many different projects related to the wetland and lake restoration.

INCREASES IN MACROALGAE AND WATER QUALITY TRENDS ASSOCIATED TO SEAGRASS LOSS IN NORTH BISCAYNE BAY

Galia Varona[1], *Christian Avila*[1], *Ligia Collado-Vides*[2], *Bowen Murley*[2] *and Omar Abdelrahman*[1]
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An increase in macroalgae abundance has been observed in the northern areas of Biscayne Bay following seagrass die-off events. Sampling conducted by Miami-Dade Division of Environmental Resources Management (DERM) and the United States Geological Survey (USGS) in this area prior to 2018 documented green rhizophytic macroalgae (GCR) coverage below 25% and a seagrass community dominated by *Syringodium filiforme*. Between 2017 and 2018, a shift in the Submerged Aquatic Vegetation (SAV) composition to a community dominated by GCR became apparent. In 2018, SAV data collected by DERM at 236 stations in areas previously dominated by seagrass showed average green algae coverage of 37.2% between Rickenbacker Causeway and the 96th Street (Broad Causeway), in North Biscayne Bay. The main component of the Green Algae morpho-functional group was the genus *Halimeda*, found above 25% coverage throughout approximately 21 km^2 of the sampled area (43.5km^2) with higher density values along the shoreline. In this area, water quality characteristics are affected by the discharges of the Miami River and five other canals. From 2010 to the present, water quality parameters have declined, Total Phosphorus and Ammonia Nitrogen have trended higher, along with increases in Chlorophyll-a, Total Suspended Solids, and Light Attenuation.

Laboratory experiments were conducted from August 2nd to October 25th, 2018 to estimate growth rate as a function of light availability (low, mid, and high) in *Halimeda discoidea*, the dominant specie within this genera in North Biscayne Bay. Morphometric analysis conducted on individual plants reveal that the number of segments and dry weight have a strong linear relationship (R^2= 0.7897), therefore the number of segments can be used as proxy for growth estimation. Survival and subsequent plant growth occurred at low light and mid-level light treatments, respectively. Organic and inorganic content of *H. discoidea* was also estimated using the Loss by Ignition method. The contribution of this species to the production of sand is similar to other species found in the Caribbean playing an important role in the accumulation of $CaCO_3$ in the soils. Calcareous rhizophytic species, as pioneer species, help create conditions for the colonization of seagrasses. Survival in low-light conditions appears to provide a competitive advantage for *H. discoidea* in North Biscayne Bay where light has been reduced by increases in Chlorophyll-*a* and suspended sediments and it is possible that the presence of this specie might be a first step of a succession towards a possible recovery of seagrasses in the area.

PRESENTER BIO: Galia Varona is the current field operations manager for the Submerged Aquatic Vegetation projects in the Restoration and Enhancement Section at DERM. She has a degree in Biology with postgraduate studies in Marine Ecology and Aquaculture and has worked as Biologist at Miami-Dade County, DERM since 2006.

NON-INVASIVE INVESTIGATION OF THE INTERNAL STRUCTURE OF TREE TRUNKS USING HIGH-RESOLUTION GROUND PENETRATING RADAR (GPR) MEASUREMENTS

Mackenzie Vecchio*, Michael Rebar and Xavier Comas*
Florida Atlantic University, Davie, Florida, USA

Tree anatomy is a critical aspect for properly understanding the patterns of transpiration and soil moisture distribution in trees. Moisture content distribution along the tree trunk can provide valuable information about the health of the tree and help detecting the presence of rotting or dry cavities. At the same time, internal anatomy dictates sap flow dynamics in trees which can provide critical information on water use and function under different environmental conditions. Despite this importance, current methods exploring the internal structure of trees are limited to traditional invasive methods, and only a handful of studies have used non-invasive geophysical methods like electrical resistivity or ground-penetrating radar (GPR) to explore various aspects of the tree anatomy. In this study we use a unique array of high-frequency GPR antennas (1,200 MHz) deployed in high-resolution transmission mode, to estimate changes in electromagnetic (EM) wave velocity, and use petrophysical models (like the complex refractive index model, CRIM) to infer moisture content variability within the tree trunk of several trees including softwood and a hardwood species. This study shows the potential of the method to non-invasively investigate the spatial distribution of moisture content in a variety of trees (both as one-dimensional profiles and tomographic images), as well as its temporal distribution when expanding surveys in time-lapse mode.

PRESENTER BIO: Mackenzie Vecchio is a PhD geosciences student at FAU developing quantitative techniques for applications in ecohydrology. She is a geologist who is interested in the wellbeing of plants.

BASS IN THE COAST: PATTERNS OF SEASONAL HABITAT USE BY FLORIDA LARGEMOUTH BASS IN THE UPPER SHARK RIVER, EVERGLADES NATIONAL PARK

Natasha M. Viadero*, Cody W. Eggenberger, Jordan A. Massie, Rolando O. Santos, Jennifer S. Rehage*
Florida International University, Miami, FL, USA

Recreational angling for species such as Florida Largemouth Bass (*Micropterus salmoides floridanus*) significantly contributes to Florida's economy, especially throughout the Everglades. The resilience of these recreational fisheries relies on healthy fish populations and on maintaining favorable environmental conditions in the ecosystems that support them. However, our understanding of how biotic and abiotic factors interact to produce these conditions remains limited. Previous work has shown that bass move out of headwater marshes into deeper perennial habitats in the main channels of the Shark River as upstream marshes dry down seasonally, but the precise timing and drivers of these movements and extent of the habitat use in the estuary remain poorly understood. In this study, we used acoustic telemetry to track the drivers, timing, and extent of habitat shifts from marshes to mangrove habitats for bass in relation to seasonal stage fluctuations. We correlated these movements with data on water levels, flow, and recession rates across multiple years with varying hydrological conditions. An increased understanding of how bass utilize and move between different habitats can help inform water management decisions and ongoing restoration efforts in the Everglades, and the link between these and socio-economic valuable recreational fisheries.

PRESENTER BIO: Natasha Viadero has been working in the Rehage Coastal Fisheries Ecology Lab at Florida International University for over 2 years. She is responsible for managing and conducting seasonal sampling and maintaining the acoustic array in Shark River, Everglades National Park during her time with the lab. She also aids in field and lab work for several current research projects in the Rehage lab.

QUANTIFYING INTRASPECIFIC VARIATION OF RED MANGROVE LEAF TRAITS IN THE SOUTHEAST SALINE EVERGLADES

Rosario Vidales[1, 2], *Michael S. Ross*[1, 2], *Leonard J. Scinto*[1, 2]
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[2]Southeast Environmental Research Center, Florida International University, Miami FL USA

We present a study of intraspecific variation in *Rhizophora mangle* (red mangrove) leaf functional traits along the soil nutrient (C, N, P) and water salinity gradients of the Southeast Saline Everglades (SESE). Individuals sampled include scrub mangrove and shrubs or trees within tree islands. Focal traits are leaf dimensions, stomatal size and density, leaf nutrient content (C, N, P), and leaf $\delta^{13}C$. Preliminary analysis of *R. mangle* leaves showed that leaf $\delta^{13}C$ ratio decreased with increased soil total phosphorus ($p<0.05$, R^2= 37%) and increased with leaf N:P ($p<0.05$, R^2= 32%), suggesting the influence of P-limitation. However, no significant trend between $\delta^{13}C$ discrimination and pore water salinity was observed ($p=0.07$, R^2= 5.9%). The lack of correlation between pore water salinity and *R. mangle* stress (proxy by $\delta^{13}C$) may be a result of high levels of intraspecific variation among adult trees within stands, a topic that has not yet been explored. To fill that gap, I examine here the effect of pore water salinity and soil nutrient concentration on intraspecific variation of functional leaf traits.
The Southeast Saline Everglades (SESE) captures gradients of variable water salinity and soil nutrients at several scales, making it an excellent candidate for study of intraspecific plant variation. A study of *Rhizophora mangle* populations along these gradients may contribute to a broader understanding of how phenotypic plasticity allows this ubiquitous species to navigate multiple stressors, and will improve prediction of the ecological repercussions of changing environments. My overarching research question is whether there is significant intraspecific variation of leaf traits in populations of *R. mangle* within the Southeast Saline Everglades, and what this may imply for the future of Everglades restoration. More specifically:

- Do salinity concentrations affect intraspecific variation in leaf traits such as length, width, dry weight, stomatal size, or stomatal density?
- Is there a greater amount of intraspecific variation at the freshwater end of the study gradient compared to the saline end?

We may expect to find limiting similarity in freshwater areas that support many other species and competitors for water and nutrients in the vadose zone. As a result of strong environmental filtering, we expect a decrease in intraspecific variation toward the saline end of the gradient.

PRESENTER BIO: Rosario Vidales is a Master's student of the Department of Earth & Environment at Florida International University. She has worked within the Everglades for the past four years, assisting in vegetation monitoring studies of various ecosystems including mangrove scrub, tree islands, ridge and slough, and wet prairies.

KEY BIOGEOCHEMICAL FACTORS AND PROCESSES INFLUENCING WATER QUALITY IN THE EVERGLADES STORMWATER TREATMENT AREAS

Odi Villapando
South Florida Water Management District, West Palm Beach, FL, USA

The Everglades Stormwater Treatment Areas (STAs) are large constructed wetlands that were built south of Lake Okeechobee to reduce TP concentrations in surface water runoff prior to discharge into the Everglades Protection Area. The five STAs combined, have effectively reduced total phosphorus (TP) concentrations in the surface water, to as low as 20 µg L^{-1} and reduced TP loads, by as much as 86 percent in the recent years. However, the mandates to achieve lower TP concentrations at the outflow structures emphasize the need for a better understanding of the factors and mechanisms that might limit the STAs to achieve and sustain the current long-term Water Quality Based Effluent Limit of 13 µg L^{-1}.

Phosphorus cycling and reduction in the STAs are a function of various physical, chemical, and biological processes operating at different regions of the flow-way. The concentration of P observed at the outflow structure is a net result of all these processes. This presentation will provide a synthesis of the results gathered to date from the different components of the P Flux study in an attempt to identify important biogeochemical factors and processes affecting STA performance, particularly those that are key performance drivers at the lower reaches of the treatment trains. Potential management strategies based on information gained from different studies will be discussed.

PRESENTER BIO: Dr. Villapando is currently a Lead Environmental Scientist for the South Florida Water Management District with over 20 years of experience managing a variety of water quality improvement/restoration projects in support of the Lake Okeechobee and Everglades Restoration programs.

USING MULTI-CRITERIA ANALYSIS TO FACILITATE EVERGLADES RESTORATION DECISION-MAKING

Chloe' Vorseth[1], *G. Andrew Stainback*[2], *and Mahadev Bhat*[1]
[1]Florida International University, Miami, FL, USA
[2]The Everglades Foundation, Palmetto Bay, FL, USA

Restoration of the Greater Everglades Ecosystem (GEE) is a notoriously complex endeavor. Due to its close proximity and connection to human systems, each restoration decision is accompanied by a lengthy set of trade-offs to both human and natural systems. As a result of this complexity, decision-making in Everglades restoration has been plagued by delays and stalemates, often resulting in inaction and further ecosystem degradation.

The Analytical Hierarchy Process (AHP), a form of Multi-Criteria Analysis, has been utilized in a number of ecosystems around the world to assess trade-offs involved in ecosystem management decisions. We discuss an ongoing project using the Analytical Hierarchy Process (AHP) with experts and stakeholders involved in GEE restoration to prioritize specific outcomes of GEE restoration, provide a ranking of GEE restoration alternatives, and to understand potential motivations behind stakeholder decision-making. Because AHP is a deliberative process, stakeholders are forced to make trade-offs between restoration outcomes through discussion and agreement, thus producing rankings of GEE restoration scenarios with input from all represented stakeholder groups.

In conjunction with hydrological, ecological, and economic information, AHP has the potential to aid in the state and federal GEE restoration decision-making process by indicating factors considered of greatest importance to diverse stakeholder groups and relevant expert groups. With a clear understanding of specific goals and priorities of GEE restoration that consider all affected parties, it is hoped that state and federal policy makers can make better GEE restoration policy decisions.

PRESENTER BIO: Chloe' Vorseth is earning her master's degree at Florida International University in Environmental Studies, specializing in Everglades policy. She is also a recipient of the FIU ForEverglades scholarship at The Everglades Foundation in Palmetto Bay, Florida. Prior to her work in Miami, she received her bachelor's degree from the University of Kentucky.

SPATIOTEMPORAL SHIFTS IN PHYTOPLANKTON BIOMASS IN ST. LUCIE RIVER ESTUARY (FL, USA)

Anna Wachnicka *and Alexandra Serna*
South Florida Water Management District, West Palm Beach, FL, USA

Phytoplankton have a critical role in primary production, nutrient cycling and food web dynamics in estuarine systems. Spatiotemporal changes in their biomass reflect the complex and highly dynamic nature of these systems, where marine waters are influenced by connectivity to land. In subtropical estuaries, where seasonal climatic variability is not strong enough to override local influences, phytoplankton respond more strongly to local influences such as nutrient delivery from terrestrial freshwater flows and connectivity to highly developed watersheds rather than regional climate forcing.

We used time series of chl *a* (phytoplankton biomass proxy) to show the diverse character of phytoplankton variability observed within St. Lucie River Estuary. Time series analysis revealed that there was a downward trend in chl *a* concentration, which was especially pronounced in the dry season data, in central part of the estuary. Analysis of variance revealed that North Fork had on average the highest chl *a* concentration within the estuary. Regression analysis showed that different water quality variables influenced chl *a* concentrations in different seasons.

PRESENTER BIO**:** Dr. Wachnicka is a research geoscientist with over 17 years of experience conducting ecological and paleoecological studies in estuarine and coastal wetland ecosystems of South Florida in support of the Everglades restoration.

A DAILY CAPTURE PROBABILITY MODEL FOR MANAGEMENT OF AN INVASIVE REPTILE

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[2]University of Florida, Fort Lauderdale, FL USA

The Argentinian black and white tegu (*Salvator merianae*) is a large introduced lizard species in Florida that is a major threat to native species due to a high reproductive rate and a generalist carnivorous diet. To mitigate this threat, research and management agencies have been conducting trapping efforts to remove tegus. The goal of this trapping is to reduce the population size and reduce the spread of tegus in southern Florida. To understand the effectiveness of various trapping techniques (e.g. trap type, bait, etc.) and conditions (e.g. sites, time of year, etc.), it is important to have a useful metric of trap effectiveness. Catch per unit effort (CPUE) is one such measure, however, it is difficult to model the effects of different techniques and conditions on CPUE.

To assist managers in evaluating trapping success, we have developed a Bayesian model to estimate capture probability directly from trapping data when standard live traps are checked daily. The model is a logistic exposure model similar to nest survival models that assumes one animal capture is possible each trap night. The data is then fit to Bayesian logistic regression to estimate the daily capture probability as a function of any combination of covariates. Results will be presented from 4 years of trapping, 2014-2017.

Using this model to determine the daily capture probability can support the decision-making process for managers seeking to control tegus efficiently. The information generated from this model will directly benefit managers by helping to guide decisions about the trap type, trap location, timing, and effort that is most efficient. In addition, the time series that we have collected can be used to determine the trend in capture rates over time, which can provide information about trend in tegu abundance at sites and by age class. Capture rate data such as this are also a critical piece to estimating overall tegu abundance as a function of the number removed. This will provide information managers need to evaluate the effectiveness of trapping efforts and make decisions about the next iteration of trapping effort in an adaptive management framework.

PRESENTER BIO: Dr. Waddle is a research ecologist with over 20 years of experience researching amphibians and reptiles in the Everglades. He has worked on projects using amphibians as indicators of restoration success in wetlands and is also interested in applying quantitative population models to questions about the management of invasive species.

SEASONAL ABUNDANCE AND SPATIAL DISTRIBUTION OF BLACKTIP SHARKS (*CARCHARHINUS LIMBATUS*) IN SOUTHEAST FLORIDA

***Jordan M. Waldron**, and Stephen M. Kajiura*
Florida Atlantic University, Boca Raton, FL, USA

Southeast Florida's marine ecosystem experiences a seasonal influx of upper trophic level predators each winter due to the large-scale annual migration of blacktip sharks (*Carcharhinus limbatus*). Blacktip sharks occupy shallow, coastal habitats and are distributed from Georgia to North Carolina during the late spring and summer, migrate south during the fall to overwinter in Florida, and then migrate north in late winter and early spring. As they migrate, blacktip sharks form dense aggregations along Florida's coastline. Although these large shark aggregations attract significant public interest, surprisingly little empirical data have been collected on the sharks' abundance, spatial distribution, and the factors driving their migration. Manned aerial surveys of coastal waters were conducted from Boca Raton, FL to Jupiter, FL (2011-2014), and Miami, FL to Jupiter, FL (2015-2018). A high definition video camera mounted out the open window of the plane recorded the transect to a distance approximately 200m seaward of the beach. These videos were analyzed to determine blacktip shark abundance, and shark densities within inlet-bound sections of the coastline. Water temperature was also recorded to determine correlations with shark abundance. Results indicate that the highest shark densities, exceeding 2,000 sharks km^{-2}, were in the northern-most sections of the transect (Palm Beach County) in February and March, when water temperature was at its lowest. Peak shark abundance was significantly inversely correlated with water temperature. This strong correlation between water temperature and shark abundance suggests that warming oceans might shift the southern terminus of the migration towards higher latitudes, causing ecological imbalances along the United States Eastern seaboard.

RECONSTRUCTING SIX DECADES OF SALINITY STRUCTURE IN THE LOXAHATCHEE RIVER USING ARTIFICIAL NEURAL NETWORKS

Yongshan Wan
USEPA National Health and Environmental Effects Research Laboratory

Understanding saltwater intrusion into freshwater coastal wetlands requires long-term historical salinity data, which are often not available in most tidal river systems. This study developed an artificial neural network (ANN) modelling tool to elucidate the relationship between saltwater intrusion and mangrove encroachment into the freshwater floodplain of the Loxahatchee River. Three ANN models simulated river salinity at three key locations on a daily time step over a period of six decades (1948–2011) using freshwater inflow, rainfall and tide as inputs. With 8 years of measured data for training and testing, the ANN model demonstrated comparable or superior model performance for salinity simulation to its hydrodynamic counterpart. Modeled historical salinity indicated that the intensity of saltwater intrusion clearly correlated with watershed hydrology, which, in turn, was linked to historical watershed alterations and regional rainfall variability. The results established the ecohydrological controls over vegetation shift in the floodplain of the Loxahatchee River, supporting the ongoing ecosystem restoration program with the aim to achieve incremental freshwater flow targets to protect and restore the floodplain ecosystem.

<ins>PRESENTER BIO</ins>: Dr. Wan is a branch chief at the USEPA National Health and Environmental Effects Research Laboratory, Gulf Ecology Division. He has extensive experience in hydrology, water quality, and ecosystem restoration, especially with estuaries and wetlands of the Everglades.

REGIONAL SEA LEVEL RISE PROJECTIONS

Jayantha Obeysekera[1] *and* ***Shimon Wdowinski***[2]
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[2]Florida International University (FIU), Department of Earth and Environment, Miami, FL, USA

The Sea Level Rise (SLR) around the globe is already impacting both short- and long-range planning of water resources projects in coastal environments. In South Florida, the protection of investments in Everglades Restoration and the coastal infrastructure is important. It will require consideration of climate change in general, and in particular, the regional and local projections of sea level rise. While data from tide gauges and satellite altimetry provide valuable information on historical rates of regional sea level rise, recent work clearly indicates that these rates are dynamic and likely to change in the future due to a variety of factors at both global and regional scales. Significant acceleration of global sea level rise cannot be excluded from consideration in future planning of Everglades Restoration and coastal infrastructure projects. Projections of regional sea level need to consider modifications to the global mean sea level due to both regional and local factors. They include vertical land movement, dynamic effects of ocean circulation and wind patterns, and the changes in gravitational effects of melting ice from glaciers, Greenland and Antarctica. In addition, planning of water resources projects needs to embrace uncertainties in projections. Numerous entities have attempted to project regional sea level change, and the recent efforts have included probabilistic approaches. This presentation will include the recent evolution of global SLR scenarios, the regionalization of global scenarios, and some efforts to project extreme sea levels.

PRESENTER BIO: Dr. Shimon Wdowinski is an Associate Professor for Geophysics at the Department of Earth and Environment, Florida International University. He has used space geodetic and remote sensing technologies for studying wetland hydrology and vegetation structure from space.

SPACE-BASED HYDROLOGICAL MONITORING OF THE ENTIRE EVERGLADES USING SENTINEL-1 OBSERVATIONS

Shimon Wdowinski*, Heming Liao, and Paul (Boya) Zhang*
Florida International University, FL, USA

A key element in the Everglades conservation, management, and restoration involves monitoring its hydrologic system, as the entire ecosystem depends on its water supply. Hydrologic monitoring of the Everglades is mainly conducted by stage (water level) stations, which provide good temporal resolution, but suffer from poor spatial resolution, as stage stations are typically distributed several, or even tens of kilometers, from one another. Furthermore, due to logistical constraints many of the stage stations are located near hydrological structures and often do not represent water level conditions in interior sections.

The space-based Synthetic Aperture Radar (SAR) technology provides the needed high spatial resolution hydrological observations. SAR measurements includes two independent observables, amplitude and phase, both are sensitive to hydrological conditions of wetlands. Amplitude observations measure the intensity of the backscattered radar signal, which is sensitive to the vegetation cover and water inundation level. Phase observations measure the phase fraction of the range between the satellite and the surface and were successfully used to measure water level changes between two SAR acquisitions of the same area from roughly the same location in space. In this study we use observations acquired by the Sentinel-1 satellite constellation, which is operated by the European Space Agency (ESA), and provides high spatial resolution (~10 m pixel dimension), wide coverage observations (250 km wide swath) with 6/12 day repeat orbit. This wide coverage and frequent observations of the Sentinel-1 satellite constellation enable us to monitor annual and seasonal changes of the entire Everglades. Preliminary results reveal many interesting hydrological features, including (1) flow discontinuities due to levies and roads, (2) patterns of tidal flow in the coastal Everglades, (3) seasonal changes in the extent of tidal inundation into the freshwater wetlands, (4) water level changes due to hydrological structure operations, and (5) mapping the flooding extend induced by the 2017 Hurricane Irma. The new Sentinel-1 observations have the potential for serving as reliable monitoring tool of surface flow changes, including mapping flood pulse induced by extreme weather events, in the entire Everglades wetlands.

PRESENTER BIO: Dr. Shimon Wdowinski is an Associate Professor for Geophysics at the Department of Earth and Environment, Florida International University. He has used space geodetic and remote sensing technologies for studying wetland hydrology and vegetation structure from space.

URBAN LAND USE, MOVEMENTS, AND SEASONALITY OF WHITE IBISES (*EUDOCIMUS ALBUS*) IN SOUTH FLORIDA

***Catharine N. Welch*[1, 2]**, *Anje Kidd*[3], *Maureen Murray*[4], *Shannon E. Curry*[1, 2,] *and Sonia M. Hernandez*[1, 2]
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The Greater Everglades Ecosystem has suffered from human development and its biodiversity is threatened not only by its resultant habitat loss and altered hydrology. The White Ibis (*Eudocimus albus*) is one of the many species heavily dependent on the Everglades' specific hydrology for optimum foraging success. Within the last two decades, ibises, potentially displaced by poor conditions in the remaining Everglades wetlands, have been increasingly observed in urban areas of South Florida foraging on lawns, golf courses and landfills, and hand-fed in urban parks.

Many studies have explored the trade-offs that urban wildlife face when they take advantage of readily available, novel anthropogenic food resources. As its shift from a wetland specialist to an urban generalist is fairly recent, the White Ibis is a great model species to study the effects of urban adaptation, especially as the Everglades struggle to regain natural water flow. The UGA White Ibis Project has been studying the effects of this recent urbanization since 2009, hypothesizing that ibises are spending more time in urban areas than in natural areas, showing higher site fidelity to urban areas where food and handouts are abundant, and questioning the effects of this shift on their health (i.e. body condition, ectoparasite burdens, stress, immunity, and pathogen prevalence) where they consume largely carbohydrate-rich and protein-poor diets.

Beginning in 2013, we captured and outfitted adult ibises with VHF transmitters in urban Palm Beach County. From 2015 to 2017, we captured ibises both within the urban landscape and in natural wetlands, this time with GPS-GSM technology. We also used stable isotope analysis to understand their diets. Our results suggest that ibises in urban areas show higher site fidelity throughout the non-breeding season and are heavily provisioned with anthropogenic food, which appears to offer a trade-off by providing low-quality, but easily accessible calories that may not support high mass but may increase time available for behaviors, such as preening, that decrease ectoparasites. Furthermore, urban ibises have longer non-breeding seasons, shorter breeding seasons, and are more likely to skip the search-and-dispersal seasons, which is a typical, nomadic behavior of ibises. These seasonality differences combined with smaller overall ranges suggest our urban birds are much more sedentary and exposed to novel stressors, pathogens, and food items more often than more natural ibises. Understanding the trade-offs ibis face is important for future conservation and management of birds in human-modified habitats.

<u>PRESENTER BIO</u>: Catharine grew up in South Florida and has been working on the White Ibis project since 2009, completing her MS in 2016 UGA. She is currently a research technician working on a project studying the epidemiology of Newcastle disease virus in Kenya's songbirds and their interaction with backyard chickens.

A SPATIAL COMPARISON APPROACH FOR MULTIPLE INDICATOR SPECIES UNDER EVERGLADES RESTORATION

Ruscena Wiederholt*, Rajendra Paudel, Stephen Davis, Melodie Naja, Thomas Van Lent, Yogesh Khare*

Everglades Foundation, Palmetto Bay, FL, USA

The greater Everglades region in Florida, USA, is an area of freshwater wetlands that has been highly altered, reduced to 50% of its original area. The Everglades ecosystem is threatened by a variety of factors including drainage, development, invasive species, climate change, pollution, and changes in regional hydrology. Spatial landscape analysis can help guide a complex restoration process involving billions of dollars, and multiple groups of stakeholders.

To guide Everglades management efforts, we evaluated ecological performance of different hydrologic restoration scenarios using a novel technique, the structural similarity index, which quantitatively compares similarity between pairs of gridded maps in terms of mean, variance, and covariance. Using the structural similarity index, we evaluated performance of apple snails, American alligators, great egrets, and long- and short-hydroperiod vegetation types under multiple restoration scenarios that varied in operations, amounts of water storage, removal of levees and canals (decompartmentalization), and seepage control barriers. We then compared indicator response under each restoration scenario to a target scenario that simulated the natural system.

Our results demonstrated that decompartmentalization benefits these indicator species. In general, scenarios with larger amounts of water storage were also closer to the target scenario. This spatial comparison technique that the structural similarity index provides is a useful tool for evaluating restoration efforts at multiple spatial scales, including both whole-system as well as compartment-scales. This approach provides a reliable means of scenario comparison, accounting for both the local magnitude and spatial structure of the underlying data. The results can be used to inform management and restoration efforts, and to guide policy for the greater Everglades area.

PRESENTER BIO: Dr. Wiederholt is a quantitative ecologist at the non-profit organization Everglades Foundation. Her area of expertise is in developing quantitative tools and methods to understand the causes and consequences of species decline, and to inform conservation strategies and decision-making at the species-to-landscape scale.

REGIONAL MODELING OF LANDSCAPE DYNAMICS FOR RESTORATION PLANNING

Walter M. Wilcox, *Wasantha A. M. Lal, M. Clay Brown, Colin Saunders, Christa Zweig and Sue Newman*
South Florida Water Management District, West Palm Beach, FL, USA

Restoration of America's Everglades greatly depends on achieving hydrologic regimes capable of supporting the Everglades' unique ridge and slough landscape comprised of densely vegetated marshes and tree islands comingled with connected open water sloughs. Significantly improved knowledge of overland flow dynamics considering the effects of vegetation resistance, microtopography and flow dynamics have evolved in recent years through ongoing research and field studies including efforts by the Comprehensive Everglades Restoration Plan (CERP) Decomp Physical Model project and the South Florida Water Management District's Restoration Strategies Science Plan. To further anticipate restoration project planning, regional hydrologic models that are utilized in CERP, such as the Regional Simulation Model (RSM) and the Natural System Regional Simulation Model (NSRSM) are being updated to provide an improved representation of the Everglades microtopography and overland flow dynamics moving beyond the traditional average topography and Manning's flow assumptions historically utilized.

The sensitivity of models at the regional scale to improved algorithms and modeling techniques can be demonstrated using the NSRSM. Improved representation of flow dynamics and relative depth regimes within ridge and slough topography can be observed when explicit stage-volume relationships are coupled with power-law functions and fully dynamic equations for overland flow simulation, departing from historical simplifications used in regional models that traditionally assumed diffusive flow. Additionally, exploration of regional-scale evaluation metrics and the use of anisotropic resistance formulations are proposed as possible measures of future CERP successes. These metrics attempt to bridge the scale issues inherent when trying to resolve hydraulic field-scale understanding of flow and floc transport mechanisms with large scale, hydrologic simulation of regional water movement.

<u>PRESENTER BIO</u>: Walter M. Wilcox, P.E. leads the Modeling Section of the Hydrology & Hydraulics Bureau at the South Florida Water Management District. Mr. Wilcox has two decades of experience in Everglades modeling and has helped to achieve authorization of over 10 billion dollars in Everglades Restoration projects.

INUNDATION OF THE SOUTH FLORIDA COAST ~1000 BCE: INFORMATION FOR 2100 CE

G. Lynn Wingard[1], *Miriam C. Jones*[1], *Bethany L. Stackhouse*[1], *Marci E. Marot*[2], *Sarah E. Bergstresser*[1], *Andre Daniels*[3], *Kristen Hoefke*[1], *Katherine Keller*[4]

[1]Florence Bascom Geoscience Center, U.S. Geological Survey, Reston, VA, USA
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[3]Wetland and Aquatic Research Center, U.S. Geological Survey, Fort Lauderdale, FL, USA
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Analyses of sediment cores from four islands in Florida Bay, coupled with recent field observations and satellite imagery following Hurricane Irma, provide insight into the role of sea level and climate in shaping the southern coastline of Florida over the last 4,500 years. In 2014, cores were collected from Russell Key, Bob Allen Key, Buttonwood Key #7, and Jim Foot Key. Five cores were analyzed for sediment characteristics, radiometric dating, bulk density, stable isotopes of carbon and nitrogen, mollusks, and pollen to determine the timing and nature of shifts in the environment. We developed Bayesian age-depth models for each core using six to eleven carbon-14 dates per core, and we calculated sediment accumulation rates at every centimeter.

Based on our analyses, the southern coast of Florida extended into what is now Florida Bay until at least 4,000 years before present (ybp). Depending on location, the transition from freshwater to mangrove coastal forests began ~4,000 to 3,600 ybp, followed by a transition to an estuarine environment between ~3,400 and 2,700 ypb at all sites except Bob Allen. This flooding represents the beginning of modern-day Florida Bay and occurred despite the relatively low rate of sea-level rise we calculate for this time (~0.67 to 1.6 mm/yr for 4,200 to 2,800 ybp). Furthermore, we estimate that this transition from terrestrial to estuarine environments occurred at each site within ~200 years. Other studies (Haug et al., 2001; Moy et al., 2002; Rein, 2007; Conroy et al. 2008) indicate this transition occurred during a period of increased storminess in south Florida that could explain the coastal submergence through overstepping of the margin. Following the period of submergence, the islands began to emerge ~2,500 to 500 ybp.

The recent passage of Hurricane Irma in September 2017 provided an opportunity to observe how storms impact the coast and contribute to overstepping of coastal margins. Analysis of satellite imagery showed a loss of vegetated cover on the islands ranging from 9.3% on the western-most island closest to the eye of the storm (Jim Foot) to 1.9% on the eastern-most (Russell). Jim Foot Key suffered a loss of 32-42% of the width of the berm on the east side of the island. Because the centers of the islands lie below mean sea level, the mangrove berms stabilize the island perimeter. Prior to Hurricane Irma, the perimeter of Jim Foot and the largest lagoon on Russell had already been breached and regularly exchange water with Florida Bay. Given the current rate of sea-level rise (2.4 to 3.7 mm/yr), our estimations of sediment accretion rates from the berms over the last 100 years (1.4 to 4.6 mm/yr), and uncertainty surrounding future tropical storm intensity, the islands in Florida Bay could be submerged again in the next 100 years. Understanding the role of sea level and climate in shaping the south Florida coastline over the last 5,000 years provides important information for resource managers and urban planners responsible for developing plans to mitigate the impacts of future changes.

<ins>PRESENTER BIO</ins>: Dr. Wingard is a research geologist with more than 20 years of experience leading projects that apply paleoecologic analyses to understand the past coastal and marine ecosystems of south Florida in support of Everglades restoration. As part of this effort she has served on numerous science advisory teams.

INVASIVE NON-NATIVE SPECIES MAY CONFOUND BIO-INDICATOR EVALUATIONS IN THE PICAYUNE STRAND RESTORATION PROJECT AREA

***Kathy Worley**, Jeffrey Schmid, Melinda Schuman, Ian Bartoszek, Vanessa Booher, and Leif Johnson*
Conservancy of Southwest Florida, Naples, FL, USA

Historically, lands that now encompass Picayune Strand State Forest (PSSF) were well hydrated and seasonally flooded. A development project in the 1950's left this region fractured by roads and canals that drained water off the land, altering the hydrology. The State of Florida purchased the land and initiated the Picayune Strand Restoration Project (PSRP) to restore parts of PSSF and adjacent Fakahatchee Strand Preserve State Park (FSPSP). The restoration plan included installation of pump stations, spreader channels and, more importantly, plugging the canals and degrading the roads. Today two of the canals are plugged and the majority of roads removed. The remaining two westernmost canals remain unplugged until the southeastern flood preventative measures are completed. It was anticipated that restoration would result in the return PSSF to a more naturalized state, thereby improving habitat for native species. Ecological change is being used as one of the primary measures of restoration success. Multiple wildlife assessments were conducted pre-restoration, including "Baseline" (2005 – 2007) and "Interim" (2009 – 2011) studies, followed by a "Year 1 Post-restoration" (2016 – 2017) study. Predominance of non-native anuran and fish species was documented in the latter study and these results may have a confounding effect on documenting post-restoration progress overtime.

Coincident with restoration progress, a compounding effect on the ecosystem at large was occurring, not only within PSSF, but in the adjacent reference areas within FSPSP and the Florida Panther National Wildlife Refuge (FPNWR). Analyses of time-scale changes within anuran and fish communities pre and post-restoration and amongst reference and restoration areas, indicated that the invasion of exotic anuran and fish species into the study areas confounded results, given the noise generated by the exotics. The abundance of the exotic *Osteopilus septentrionalis* increased within the reference areas overtime, while abundances of natives *Hyla cinerea* and *Hyla squirella* were greatly diminished. This shift in species dominance suggests that *Osteopilus septentrionalis* may be being outcompeting native treefrogs, not only in the restoration area, but in the reference areas as well. This increase in *Osteopilus septentrionalis* abundance is likely independent of the restoration.

The first records of non-native *Hemichromis letourneuxi* were documented in FSPSP in 2012 and in PSSF during the "Year 1 Post-restoration" study. There was little, if any, differentiation in fish composition between the sampling years of the "Baseline" and "Interim" projects but highly significant differences between these years and that of the post-restoration project. *Hemichromis letourneuxi* was only collected during the "Year 1 Post-restoration" study and therefore contributed to the between year differences. The dominance of *Hemichromis letourneuxi* in the reference areas suggests their introduction was not related to the hydrologic restoration activities, rather a range expansion likely via the network of stormwater canals surrounding the study area or some other means of dispersal.

As ecosystems floral and faunal components shift as a result of climate change, there is a high probability that exotic species may expand their range as well. If this occurs, in the future, success criteria may need to be reexamined and targets adjusted to account for possible changes not tied to restoration.

<u>PRESENTER BIO</u>: Worley is the Director of Science with more than 30 years of experience in wetland ecology and has been involved in Western Everglades Restoration since the early 90's.

APPLICATION OF COMPUTATIONAL FLUID DYNAMICS IN THE HYDRAULIC DESIGN OF AN EVERGLADES RESTORATION PROJECT: S333N SPILLWAY

Jie Zeng[1], *Matahel Ansar*[1], *Zubayed Rakib*[2]
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As part of the initial phases of the Central Everglades Planning Project (CEPP), design and construction of a new S333N Spillway, and refurbishment of existing S333 Spillway were proposed to improve the hydraulic performance of the existing structure under various operational conditions.

This paper presents the application of Computational Fluid Dynamics (CFD) to the hydraulic design of the new S333N Spillway and refurbishment of existing S333 Spillway along with associated appurtenances and modifications to the connection canals L-67 and L-29. In this study, CFD was first used for conceptual design and scenarios evaluation based on detailed 3D flow fields, pressures and water surface elevations obtained from simulation, which are essential for assessing the performance of water control structures under various operational scenarios. CFD was further applied to optimize the hydraulic design and total engineering cost, such as proposing a flow split island to avoid the interference of flow jets from spillways S333 and S333N, flow deflectors at the end of both spillway stilling basins to control local scour and reduce the total cost of riprap and bank erosion protection.

In contrast with traditional laboratory experiment, which is reliable, but expensive and time consuming, this study exemplifies how CFD can iteratively be used to design and optimize water control and conveyance structures and predict their behavior under various operational conditions in a cost-effective manner.

PRESENTER BIO: Dr. Zeng is a Principal Engineer in the Applied Hydraulics Section at the South Florida Water Management District. Dr. Zeng has about 12 years of experience with various water resources projects including numerical modeling and field-based flow measurements.

SPACE-BASED MONITORING OF TEMPORAL WATER LEVEL VARIATIONS IN THE SOUTH FLORIDA EVERGLADES ECOSYSTEM USING SENTINEL-1 SAR OBSERVATIONS

***Boya Zhang**, and Shimon Wdowinski*
Florida International University, FL, USA

The Greater Everglades contains a variety of habitats, including freshwater marshes, hardwood hammocks, pinelands, cypress swamps and mangroves. Seasonal water availability patterns in these habitats, also known as hydroperiods, play an important role in influencing the Greater Everglades ecosystem. For example, hydroperiods determine the growth and density of sawgrass, which further influence the habitat for other species. Therefore, monitoring large regional water level is important for Everglades ecosystem management. Currently, the Everglades' hydrological conditions are monitored by a network of 316 stage stations located within distances of 5-10 km from one another. In order to obtain a continuous measure of water level conditions throughout the Everglades, the point water level observations are interpolated and provide as daily water level surfaces (https://sofia.usgs.gov/eden/csss/). Because of the 5-10 km sampling distances, the interpolated water level maps provide a good measure of long wavelength water level surfaces (> 5 km), but not of short and intermediate wavelength surfaces.

In this study, we provide water level monitoring solution at a variety of wavelengths (> 50 m) by using spaceborne Synthetic Aperture Radar (SAR) observation. We use Sentienl-1 constellation which consists of two satellites, launched by European Space Agency (ESA). The satellites' observation swath is 250km wide with pixel spacing of 10 meters, which allow water level monitoring with both wide scale coverage and high spatial resolution. Our analysis of the SAR data indicates strong sensitivity of SAR intensity values to water level conditions. The sensitivity depends on vegetation type as well as on wind, vegetation density and seasonality. Using a linear regression analysis of SAR observation in the vicinity of water gauges, we constructed a linear model for estimating temporal water levels based on SAR backscattering. Preliminary results indicate that backscattering intensity has a strong positive linear relationship with water level in both forest and most herbaceous vegetation due to double bounce scattering of the SAR signal. However, for herbaceous vegetation, at high water level conditions most likely close to the vegetation height, backscattering gradually decreases because of specular reflection. Our preliminary regression model reveals that the accuracy for water level estimation is around 5cm, which is roughly 8% of the annual water level variations. We also applied the SAR data and linear regression model to detect the flooding extent following the 2017 Irma Hurricane. The results of this analysis indicate that the majority of Everglades were flooded by more than 10 cm right after the passage of the Hurricane. Our results demonstrate that the short and intermediate wavelength signals obtained from SAR observations fills the information gap, where gauge density is low. Consequently, our results can be very useful for improving constraint of hydrological models, and investigating relationship between habitat plant density, species diversity with water level.

PRESENTER BIO: Boya Zhang is currently a PhD student in Florida International University under the supervision of Dr. Shimon Wdowinski. His interest is on mapping the flooding extent in South Florida by SAR and InSAR observations. His research on mapping flooding extent induced by Hurricane Irma is published on The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLII-3.

MODELING SAWGRASS ABOVEGROUND BIOMASS IN THE COASTAL EVERGLADES

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Large-scale biomass quantification of sawgrass (*Cladium jamaicense*) marsh is critical to understand the carbon and energy cycle in the Florida Everglades. There is also a need to monitor biomass changes in the coastal Everglades due to continuing sea level rise. Previous research in biomass estimation of coastal marshes has focused on pixel-based parametric modeling methods. In this study, an object-based ensemble analysis approach was developed to map sawgrass biomass at multiple scales using Landsat data. Four machine learning regression algorithms including Support Vector Machine (SVM), Random Forest (RF), k-Nearest Neighbor (k-NN), and Artificial Neural Network (ANN) were evaluated and compared to the commonly used Multiple Linear Regression (MLR) method for both live and total sawgrass biomass estimation. A weighted combining scheme was developed to integrate predictions from comparable models for ensemble analysis. Nonparametric machine learning models had better performance than the parametric approach. ANN and SVM produced similar results in live biomass estimation with the correlation coefficient (r) larger than 0.9, while ANN achieved the best result for the total biomass estimation (r=0.94). Sawgrass biomass maps were produced for two harvest seasons in 2014 and 2016 at three detail levels, which successfully revealed the spatial and temporal (seasonal and interannual) sawgrass biomass variations. Ensemble analysis of the ANN and SVM predictions of live sawgrass biomass not only made the estimation more reliable, but also generated an uncertainty map to identify the regions with a robust biomass prediction, as well as challenging areas for biomass quantification. It is concluded that the object-based ensemble analysis is a promising alternative to the commonly used pixel-based biomass modeling techniques.

<u>PRESENTER BIO</u>: Dr. Zhang is Associate Professor at Florida Atlantic University. Her research focuses on vegetation mapping, remote sensing modeling, and coastal wetland vulnerability analysis.

LONG-TERM PERFORMANCE EVALUATION OF LARGE-SCALE CONSTRUCTED WETLANDS BASED ON WATER AND TOTAL PHOSPHORUS BUDGETS

***Hongying Zhao**, and Tracey Piccone*
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The Everglades Stormwater Treatment Areas (STAs) are large-scale freshwater wetlands constructed to reduce phosphorus (P) concentrations in runoff to support restoration of the Everglades. P reduction and storage in STAs occurs through settling, plant growth and accumulation of dead plant material in a layer of peat. This study evaluated the performance of the treatment cells and flow-ways in STA-2 and STA-3/4, two of the best performing Everglades STAs, through water and TP budget analyses.

Water budgets are comprised of structure flows (inflows and outflows), seepage, rainfall, evapotranspiration (ET), and change in storage. The TP budgets are comprised of TP mass loads associated with structures (inflows and outflows), rainfall, and seepage. STA performance was evaluated by comparing annual and long-term average annual flow-way and treatment cell TP load and TP flow-weighted mean (FWM) concentration reduction, and percent TP load retention and percent TP FWM concentration reduction. This study also summarized flow-way and treatment cell hydraulic residence times (HRT), hydraulic loading rates (HLR), and phosphorus loading rates (PLR). The budgets evaluated 16 years of data for STA-2 and 12 years of data for STA-3/4.

Over the period of observed operations, these flow-ways were loaded with average annual PLRs ranging between 0.64 –1.57 g m^{-2} yr^{-1} and average annual HLRs ranging between 2.2 – 4.0 cm d^{-1}. The three flow-ways in STA-2 achieved a TP load retention of 83%, 76%, and 79% and TP FWM concentration reduction of 85%, 75%, and 81%. The three flow-ways in STA-3/4 achieved a TP load retention of 76%, 69%, and 79% and TP FWM concentration reduction of 81%, 71%, and 77%. This evaluation confirmed that these large-scale treatment flow-ways effectively reduced P under a variety of hydrologic and phosphorus loading conditions.

PRESENTER BIO: Dr. Zhao is a Lead Engineer in the Water Quality Treatment Technologies Section at the South Florida Water Management District. She has extensive experience in Stormwater Treatment Area performance evaluation, hydrology and hydraulic modeling, stormwater management system designing and permitting, and basin management.

NATURAL HAZARDS AND SEAGRASS FAUNAL COMMUNITIES: IDENTIFYING EXTREME NATURAL AND ANTHROPOGENIC EVENTS FROM NATURAL VARIABILITY

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Natural variability, an inherent feature of ecological systems, occurs over seasonal, annual, decadal or longer time scales which are punctuated by episodic natural hazard events. Anthropogenic alteration of ecosystems can further increase this variability or cause permanent community regime shifts. As practitioners of Everglades restoration, our job is to distinguish natural and anthropogenic ecosystem variability to assess restoration effects. We will discuss impact of natural hazards on seagrass faunal communities in Biscayne and Florida bays. Including prior monitoring efforts, the Integrated Biscayne Bay Ecological Assessment and Monitoring (IBBEAM) epifaunal component consists of 12 yr of samples collected using a 1 m^2 throw trap along the southwestern Biscayne Bay shoreline. We investigated temporal epifuanal community structure relative to disturbance events by means of univariate and multivariate community analyses. Hurricane Irma (Wet Season 2017) significantly reduced salinity conditions and epifaunal biomass but increased species diversity, richness, evenness, and rarefaction. These results were driven by drastic reductions of the numerically dominate *Atherinomorus stipes* and rainwater killifish *Lucania parva*. Subsequent analysis of standardized abundance time series representing clusters of species identified as influential to temporal variation in the total community revealed significant impacts of Hurricane Irma, hypersaline events (droughts), a microalgal bloom, an extreme cold front, and a *Sargassum* bloom. The increase in hardhead silverside *A. stipes* abundance shortly after the 2013 Wet Season microalgal bloom was especially dramatic. A positive bloom effect was also evidenced by ~1.5x greater biomass (g) and ~1.5x the number of collected epifauna specimens. A parallel multivariate analysis of seagrass faunal communities collected from May 2017 to Jan. 2018 by otter trawl in Florida Bay under the Juvenile Sportfish Monitoring and Assessment program was conducted. This analysis identified a significant regime shift in community composition that coincided with the passage of Hurricane Irma. Species identified as influential were clustered; time series of the standardized abundances of these clusters changed in response to Hurricane Irma. Most notably, previously highly abundant mojarras (*Eucinostomus* spp.) and *L. parva* were replaced by bay anchovy *Anchoa mitchilli*, which ultimately was the numerically dominant species of this time period. This shift is reminiscent of those observed in Florida Bay between the 1980s and 1990s and suggests a transition from benthic-oriented to water column-dominated productivity. It is not yet known if these communities have recovered to a prior state or remain altered. Observed impacts of these disturbances and the resiliency of Biscayne and Florida Bays, where evident, will be discussed.

<u>PRESENTER BIO</u>: Dr. Zink is a Postdoctoral Associate working in close collaboration with NOAA, NPS, and University of Miami colleagues with 8 yr of experience working in South Florida ecosystems and Everglades restoration and 13 yr of experience planning, designing, and implementing field, manipulative laboratory and field, review, and ecological modeling studies.

SPF: CHOOSING THE RIGHT LEVEL FOR ECOSYSTEM HEALTH

Christa L. Zweig, *Sue Newman, and Colin J. Saunders*
South Florida Water Management District, West Palm Beach, FL, USA

Three key elements to the state of the Everglades ridge and slough landscape (RSL) are Sediment, Plants, and Flow—sediment grows plants and plants create sediment that is differentially distributed by flow to create a patterned system. Everglades flow restoration goals include landscape level sheetflow of 2-5 cm/sec. This has been a very general statement not accounting for spatial and temporal heterogeneity, but the Decomp Physical Model (DPM), the second largest adaptive management project in the country, provides data that allows us to move from generalities to realities.

From the DPM, we know that 2-5 cm/sec flow speed causes the clearing of submerged aquatic vegetation and periphyton in sloughs, likely through several mechanisms, and that these flow speeds couldn't be consistent over time and space as that would result in a sediment-starved system (too much flow = no vegetation = no sediment). Instead, smaller-scale data from the DPM direct us to a more detailed understanding of the co-existence of flow and vegetation in the RSL, through seasonal cycles, climate cycles (El Niño, La Niña, NAO), and spatial position. We developed a spatial model incorporating different scenarios of interactions between sediment, plants, and flow to provide recommendations for the best use of different flow regimes and active adaptive management—restoring the historical spatial arrangement of ridges and sloughs—in Everglades restoration.

PRESENTER BIO: Dr. Zweig is a Senior Scientist with the South Florida Water Management District and has 17 years of experience in the Everglades wetland system. Her experience is in wetland plant communities and the environmental gradients that affect them.

Notes

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