GEER 2023

Greater Everglades Ecosystem Restoration

Data Synthesis, Integration, and Innovation

April 17-20, 2023 | Coral Springs, Florida

USGS science for a changing world

National Park Service

U.S. Fish & Wildlife Service, Department of the Interior

UF | IFAS University of Florida

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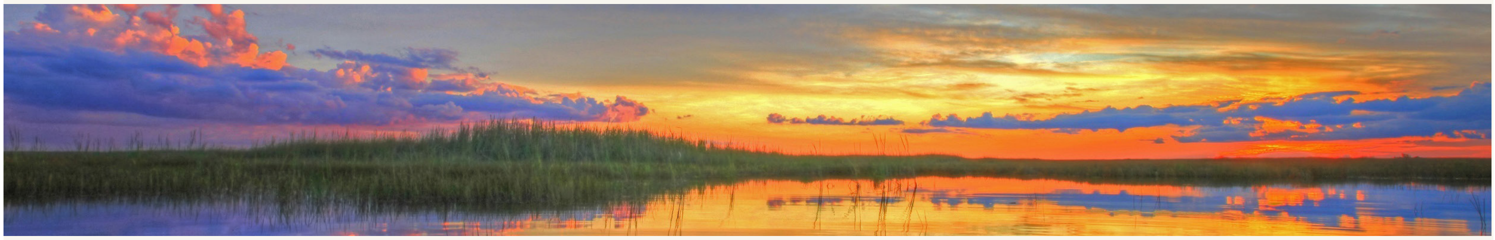

MEETING LOCATOR

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

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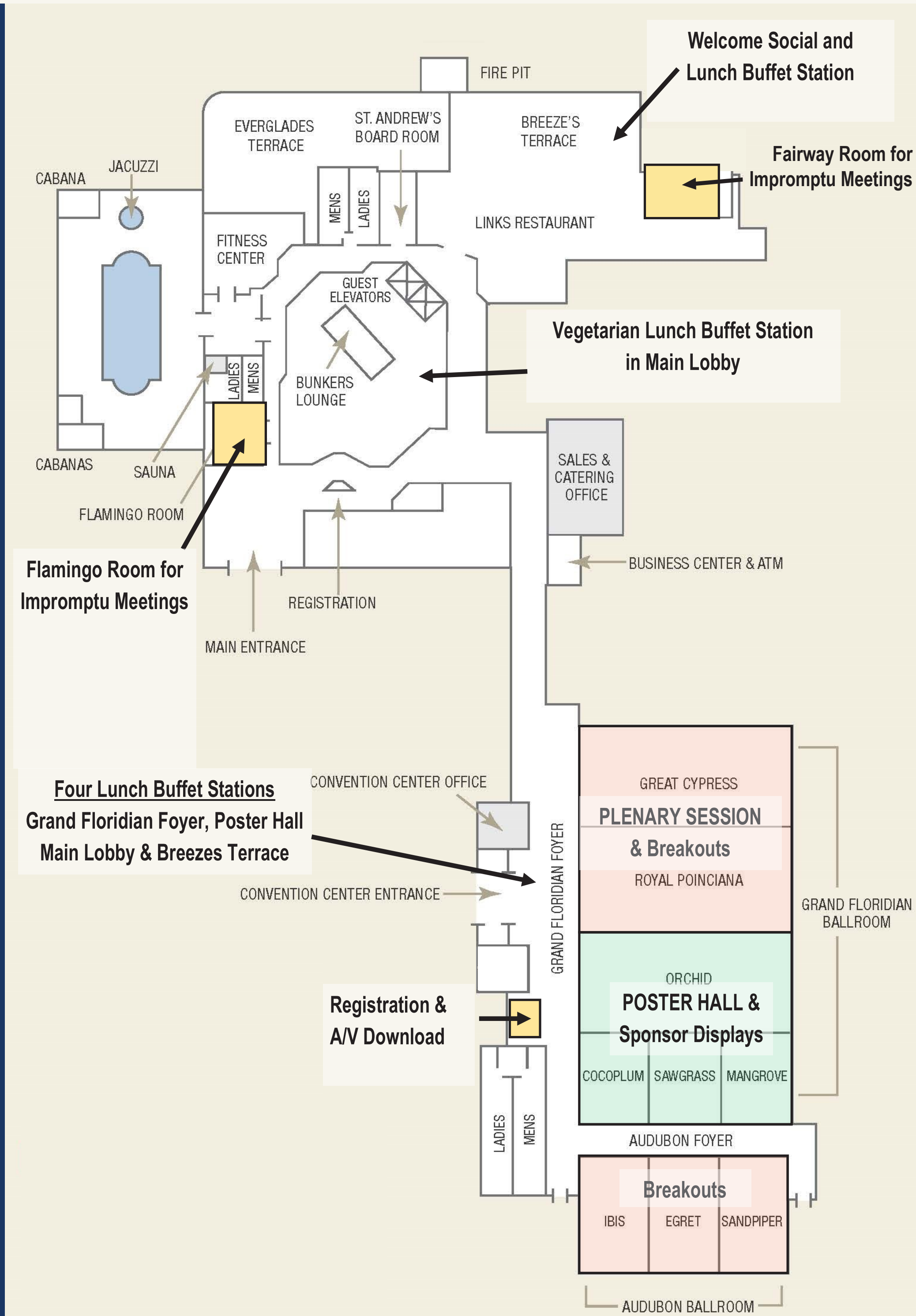

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WiFi: Marriott_CONF | Password: GEER2023

conference.ifas.ufl.edu/geer

All conference documents are available electronically on the GEER website: **conference.ifas.ufl.edu/geer**

Scan these QR codes for quick access:

Agenda (PDF)

Posters (PDF)

Abstracts (PDF)

Program (PDF)

Session Recordings & Poster PDFs

GEER 2023 sessions are being recorded. Recordings will be made posted as links on a private, password protected virtual platform by **June 2**. Registrants will be sent instructions how to log-in and view session recordings and poster PDFs.

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Name Badge

Your name badge serves as your admission to all networking functions while attending GEER 2023, so be sure to wear it throughout the conference.

Guests must be registered in order to attend networking functions and also wear their name badges for entry into functions that are included with the guest fee. The guest fee allows guests 16 years of age and older to attend the Welcome Social on Monday evening and the Poster Session Networking Receptions on Tuesday and Wednesday. Please be sure to register all guests and pay the applicable registration fee.

In honor of

MAGGY RENO HURCHALLA

(1940 – 2022)

Maggy's impact on Florida's conservation movement cannot be overstated. She's the reason developers can't fill in wetlands in Martin County, and the reason I-95 bends away from Stuart. During her 20 years as a Martin County commissioner, she helped craft development rules that made the community a leader in the state for environmental preservation. Her advocacy was fueled by a deep love for Florida's wilderness. She kayaked as often as she could, and spoke about the Everglades to anyone who would listen.

Those of us who had the honor of joining Maggy for a paddle gained a new appreciation for the magic of mangrove tunnels, and we were often treated to a recitation of poetry. She was inspiringly irreverent, and she left a mark on our community that will not be forgotten.

Maggy worked as an advocate until her final days. She sat on Friends of the Everglades Policy & Science Committee, always offering insightful context. She was an eternal optimist, and a generous heart. Maggy also served five terms as County Commissioner in Martin County, Florida, where she was a driving force behind the creation of the county's highly regarded Comprehensive Growth Management Plan, which is arguably the best in the state for its environmental protections. Her efforts are reflected today in the low-density model Martin County enjoys, unique among its neighbors in South Florida. Maggy served on numerous commissions and committees at the regional and state level including Governor Askew's Blue Ribbon Transportation Committee, the State Comprehensive Plan Committee, Governor Chiles' Growth Management Task Force, and was Chairperson of the original Treasure Coast Regional Planning Council.

Among the many awards she received for defending our natural resources are the Martin County Conservation Alliance lifetime award, the Audubon of the Everglades Conservation Award, Florida Association of Environmental Regulators-Environmentalist of the Year 1994, the Everglades Coalition "George Barley Conservationist of the Year Award" 2002, the 2003 National Wetlands Award for Volunteer Leadership, the Everglades Coalition Hall of Fame Award, and the Marjory Stoneman Douglas Defender of the Everglades Award. Her work on wetlands conservation in Florida earned her national recognition as an expert on Florida's wetlands. She continued to serve on advisory councils such as the Governor's Commission for a Sustainable South Florida even after leaving office and remained involved in the battle for Everglades restoration until her death in 2022.

Maggy led an incredible life of adventure outside of her advocacy for the Everglades, frequently traveling and kayaking the waters she worked so hard to protect. Most of all, Maggy brought people together around one very central idea, that we are all connected by water.

Looking for a special place to remember Maggy Hurchalla?

Visit Maggy's Hammock at 3854 SE Kubin Ave, Stuart, FL 34997

Continue Maggy's legacy by donating:

https://www.everglades.org/maggy-hurchalla-opportunity-fund/

Photo: Maggy Reno Hurchalla kayaks through magrove tunnels

Friends *of the* Everglades

Tribute generously shared by Friends of the Everglades

In honor of

ROBERT (ROB) EDWIN BENNETTS

(1953 – 2022)

Rob Bennetts is most well known for his contribution to understanding the ecology and conservation of the endangered Florida Snail Kite. Although he left Florida in 2003, his influence is recognized 20 years later based on his identifying and quantifying the interconnectedness between Snail Kites, apple snails, wetland plant communities, and hydrology. Protocols for monitoring Snail Kites, and ideas on how to monitor and conduct research on kites and snails, are still being applied in 2023.

Rob started working on Snail Kites in 1986, and was subsequently first author on a comprehensive report on Snail Kite nesting in the Everglades (Bennetts, Collopy, and Beissinger 1988). At that point in his career he had earned his Bachelor's degree from the University of Montana. In that 1988 report, Rob (again, with a Bachelor's degree) put in writing several hypotheses about what influenced Snail Kite foraging success and reproduction, many of which resulted in funded grants in the 1990s and 2000s that created empirical data that supported his ideas from the 1980s. He left Florida and began work on his Master's degree in 1988 at Colorado State University (thesis advisor Dr. Gary White); this is where he began his long career emphasis on quantitative aspects of wildlife movements and demography and habitat quality assessment.

Rob returned to Florida in 1991 to pursue a PhD at the University of Florida with Dr. Wiley Kitchens as his advisor. They designed and executed one of the largest projects, in terms of scale and scope, on a single species in Florida. The radio-tracking data obtained revealed novel information on the extensive movements, exploratory behavior, and survival patterns of Snail Kites, and created a new perspective on the scale at which kites successfully navigate wetlands spread out over 8,000 square miles. Rob et al. produced 22 published manuscripts on kites, three book chapters, and five manuscripts on snails, on which he was first author or co-author. Rob was generous in his sharing of data to include first-authorship for students and field staff as he mentored their careers.

As great an influence as Dr. Bennetts had on our understanding of Snail Kites in Florida, he had just as much influence, if not more so, once he left Florida to lead, as a quantitative ecologist, monitoring and adaptive management programs for the National Park Service out west. He worked at Grand Teton and Yellowstone National Parks, but in the last 10 years of his career he cherished his work on lesser known parks such as Sand Creek Massacre National Historic Site, Fort Union National Monument, Bent's Old Fort National Historic Site, and Washita Battlefield National Historic Site.

Rob' s protocols for monitoring Snail Kites, and ideas on how to monitor and conduct research on kites and snails, are still being applied in 2023.

Photo: Robert (Rob) Edwin Bennetts operating an airboat through a river of grass

GEER 2023

Greater Everglades Ecosystem Restoration

Data Synthesis, Integration, and Innovation

Welcome back to Coral Springs for GEER 2023 - the Greater Everglades Ecosystem Restoration (GEER) Science Conference and the first in-person event since GEER 2019!

Initiated by the University of Florida-IFAS and the U.S. Geological Survey and its Greater Everglades Priority Ecosystem Sciences Program, GEER has become the preeminent Everglades science conference. The GEER 2023 theme is “Data synthesis, integration, and innovation”, highlighting the importance of big data, how we compile and analyze large amounts of data, and how we use those data for innovation as we provide science in support of Everglades restoration.

High quality science remains a major pillar of effective restoration. We have again faced severe tropical storms such as Hurricane Ian, and the Everglades restoration continues to be challenged by other natural and human-caused stressors and threats. GEER showcases the science behind recent advances in restoration that helps insure that our restoration efforts 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.

Despite these challenges, there has been amazing progress in our restoration program. The U.S. Army Corps of Engineers is in the final steps of completing the Lake Okeechobee System Operating Manual – the policy that will give us the next rule book on how to operate the lake and send its water throughout the system. Progress is being made on the next steps in planning restoration, including the Western Everglades Restoration Project, to help restore, reconnect, and maintain areas in the western Everglades. Work has begun on the Biscayne Bay and Southeastern Everglades Restoration Project to restore parts Biscayne Bay’s coastal wetlands and subtidal areas. Work continues on the South Florida Water Management District’s Restoration Strategies Program to improve water quality flowing into the Everglades. Cutting edge science is being conducted on better understanding the ecology of the highly invasive Burmese python and examining ways to control that ever-expanding population, and that of other invasive animals and plants. Science is at the forefront of all of these efforts and many more, and GEER 2023 is where you will hear the latest and greatest about these research, monitoring, and modeling studies.

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. The program agenda features five concurrent sessions with 230 oral presentations, two evening poster sessions highlighting 90 posters on Tuesday and Wednesday, an opening plenary session Tuesday morning, our well-known DIG talks on Wednesday morning, and a closing keynote address by Assistant Secretary of Fish and Wildlife and Parks, Ms. Shannon Estenoz on Thursday afternoon. We encourage you to stay until the very end. You won't want to miss these presentations!

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

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 the 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 U.S. Geological Survey, the National Park Service, and the U.S. Fish and Wildlife Service; our Silver Sponsors, the Everglades Foundation, Florida International University's Institute of the Environment, the South Florida Water Management District, and the Miccosukee Tribe of Indians of Florida; and our Bronze Sponsors, Audubon of Florida, Stantec, Florida Atlantic University's Center for Environmental Studies, Eureka Water Probes, the U.S. Department of the Interior, In Situ, and the U.S. Army Corps of Engineers.

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 2023. *We're glad you could join us!*

Nicholas G. Aumen

Conference Chair

Regional Science Advisor - South Florida
U.S. Geological Survey
Loxahatchee, FL

K. Ramesh Reddy

Conference Co-Chair

Graduate Research Professor
Distance Education Coordinator
UF/IFAS Soil and Water Sciences
Gainesville, FL

ABOUT GEER

Science is the foundational element for Everglades restoration and management and GEER is the premier showcase for Everglades science.

Sessions will feature presentations by the best and brightest working in the Everglades, addressing the most pressing and complex science issues that we face now and into the future of restoration – a future that includes a changing climate, threats from invasive species, altered hydrology, development pressure, and degraded water quality. Sound science relevant to these challenges and the restoration efforts is required to provide resource managers and policy-makers with the best information possible.

High-quality science has supported new restoration projects, including:

- the ecological and hydrological effects of new CERP projects and a revised Lake Okeechobee operating schedule
- investigating invasive species such as the Burmese python and the Argentine black and white tegu, and how we can better detect and control them in the future
- providing advanced and easy-to-use scientific tools for restoration managers
- studying how to best achieve balance between restoration goals and endangered species protection
- assessing how a degraded Everglades will respond to restored sheet flow

LOOKING TO THE FUTURE

Scientists are using innovative approaches – think molecular biology, ecosystem modeling, artificial intelligence, advanced remote sensing -- to provide more data for restoration planning and decision-making. As we progress, we look for opportunities to integrate these innovative data with measurements from the ground, such as, integrating satellite-derived Lidar ground elevation data and water-level surfaces with EDEN. This example is just one that shows that how collaboration can take advantage of innovation to lead to integration, and ultimately synthesis. For GEER 2023, speakers are asked to consider where we are now, and what is possible by sharing data, collaborating, and synthesizing to build consensus and provide a vision for the future.

GEER 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.

Thank you for joining us and participating in GEER 2023's dialogue to better understand and inform Everglades restoration!

COMMITTEE RECOGNITION

Executive Committee

Becky Allenbach, U.S. Environmental Protection Agency, Atlanta, GA

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

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

Steve Davis, Everglades Foundation, Palmetto Bay, FL

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

Evelyn Gaiser, Florida International University, Miami, FL

Lawrence Glenn, South Florida Water Management District, West Palm Beach, FL

Melodie Naja, Everglades National Park, Homestead, FL

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

Lt. Col. Todd Polk, U.S. Army Corps of Engineers, West Palm 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

K. Ramesh Reddy, *Conference Co-Chair*, UF/IFAS, Gainesville, FL

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

Program Committee

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

Steve Davis, Everglades Foundation, Palmetto Bay, FL

Howie Gonzalez, U.S. Army Corps of Engineers, Jacksonville, FL

Melissa Martin, U.S. Department of Agriculture, Natural Resource Conservation Service, Washington DC

Beth Miller-Tipton, *Conference Coordinator*, UF/IFAS Office of Conferences & Institutes, Gainesville, FL

K. Ramesh Reddy, *Conference Co-Chair*, UF/IFAS Soil & Water Sciences Department, Gainesville, FL

Stephanie Romañach, U.S. Geological Survey, Gainesville, FL

Dave Rudnick, Retired, Gainesville, FL

Dan Scheidt, USEPA Region 4 Water Division, Athens, Georgia

Fred Sklar, South Florida Water Management District, West Palm Beach, FL

Joel Trexler, Florida State University, Tallahassee, FL

Matt Whiles, UF/IFAS Soil & Water Sciences Department, Gainesville, FL

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Without their generous support, this conference would not be possible.

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National Park Service

nps.gov

Since 1916, the National Park Service has been entrusted with the care of our national parks. With the help of volunteers and partners, we safeguard these special places and share their stories with more than 318 million visitors every year. But our work doesn't stop there. We are proud that tribes, local governments, nonprofit organizations, businesses, and individual citizens ask for our help in revitalizing their communities, preserving local history, celebrating local heritage, and creating close-to-home opportunities for kids and families to get outside, be active, and have fun. Approximately 20,000 strong, the uncommon men and women of the National Park Service share a common trait: a passion for caring for the nation's special places and sharing their stories. The National Park Service preserves the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations. The Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

U.S. Geological Survey

usgs.gov

USGS serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life. USGS employs the best and the brightest experts who bring a range of earth and life science disciplines to bear on problems. By integrating diverse scientific expertise, USGS is able to understand complex natural science phenomena and provide scientific products that lead to solutions. Every day the 10,000 scientists, technicians, and support staff of USGS are working for you in more than 400 locations throughout the United States. As the Nation's largest water, earth, and biological science and civilian mapping agency, USGS collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems.

U.S. Fish and Wildlife Service

fws.gov

The U.S. Fish and Wildlife Service helps ensure a healthy environment for people by providing opportunities for Americans to enjoy the outdoors and our shared natural heritage. We offer a number of services to the public, companies, and local government agencies including agriculture, communication, consultation and technical assistance, duck stamps, entrance passes, fish stocking, importing and exporting, invasive and injurious species, investigational new animal drugs, species management, as well as land management and conservation assistance. With more than 560 National Wildlife Refuges, 70 national fish hatcheries, numerous regional and field offices across the country and thousands of active conservation projects, U.S. Fish and Wildlife Service employs more than 8,400+ individuals dedicated to our mission to conserve, protect and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people. We are the only federal government agency whose primary responsibility is to manage fish and wildlife resources in the public trust for people today and future generations.

continued on next page

SILVER SPONSORS

Everglades Foundation

evergladesfoundation.org

Driven by science since 1993, The Everglades Foundation works to restore and protect America's Everglades. Our renowned scientists are dedicated to unearthing the facts and conducting practical analysis to help local, state, and national leaders make well-informed decisions. By coupling sound science with policy expertise, the Foundation is positioned as one of the most influential players in the fight to preserve and restore one of the world's most unique wetlands.

Florida International University/ Institute of Environment

environment.fiu.edu

The FIU Institute of Environment represents one of the largest and most impactful environmental research programs in the world. We carry over 25 years of experience in water quality research and monitoring, water management and Everglades restoration. Our pioneering research in the Everglades contributes to science-backed solutions for some of the ecosystem's most critical threats, like sea-level rise and saltwater intrusion, biodiversity loss, pollution and contamination, and climate change.

The Miccosukee Tribe of Indians of Florida

miccosukee.com

The Miccosukee Tribe of Indians of Florida (Tribe) is a federally recognized Tribe under the Indian Reorganization Act (1934), as amended, with use and occupancy rights in over 1,000,000 acres of Tribal Lands located within the Everglades and Big Cypress. The Tribe is a named partner and key stakeholder in Everglades restoration. The Tribe's dedication to protecting the Everglades is a matter of primary cultural significance, and Everglades protection is codified in the Tribe's Constitution.

South Florida Water Management District

sfwmd.gov

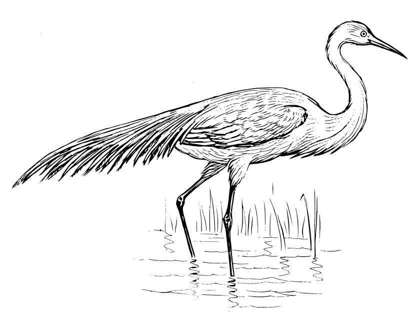
The South Florida Water Management District's mission is to manage and protect water resources of the region by balancing and improving flood control, water supply, water quality and natural systems. They are a regional governmental agency that manages the water resources in the southern half of Florida, covering 16 counties from Orlando to the Florida Keys and serving a population of 8.1 million residents. A key initiative is restoration of the Everglades – the largest environmental restoration.

BRONZE SPONSORS

Audubon Florida

fl.audubon.org

At Audubon Florida, we focus on using sound science to advocate for common sense solutions to challenges facing the Sunshine State. From clean water to clean energy, natural landscapes to special places, we are here to protect Floridians' prosperity and quality of life. Conservation is good for the environment - and our economy too. We are biologists, policy experts, educators, community members, and volunteers. Audubon Florida protects birds and the places they need, today and tomorrow.



(Bronze Sponsors continued)

Eureka Water Probes

waterprobes.com

Eureka Water Probes manufactures multiparameter water quality sondes for surface and ground water monitoring. Manta+ probes may be used for spot checking, as self-powered dataloggers, or for remote continuous real-time monitoring with cellular or satellite telemetry stations. Manta sondes are easy to use, reliable and operate in the toughest field conditions!

FAU's Florida Center for Environmental Studies & FAU's Environmental Science Program

ces.fau.edu

science.fau.edu/envirosci

FAU's Center for Environmental Studies mission is to conduct research, education, and community engagement activities related to coastal resilience, wetlands ecology, and energy sustainability, including developing community-wide strategies for adapting to social and environmental changes and best practices for coastal cities and land management in urban ecosystems.

In-Situ Inc.

in-situ.com/us

In-Situ Inc. has been creating industry-leading environmental monitoring instrumentation for over 40 years. Specializing in multiparameter water quality sondes, water level pressure transducers, dataloggers, ultrasonic flow meters, and telemetry with a focus on great design, usability, and high reliability in harsh conditions. In-Situ offers a turn-key solution for delivery of decision-quality data via easy integration with telemetry and data services with best-in-class mobile and cloud software.

Stantec Inc.

stantec.com/en

Communities are fundamental. Whether around the corner or across the globe, they provide a foundation--a sense of place and belonging. That is why at Stantec, we are always working to improve our communities. We are scientists, engineers, architects and designers, innovating together at the intersection of community, creativity, and client relationships, all while working passionately to make this a better world. Visit us at stantec.com or on social media.

U.S. Army Corps of Engineers - Jacksonville District

saj.usace.army.mil

The United States Army Corps of Engineers (USACE) Jacksonville District was established in 1884 and is the second largest civil works district in the U.S. Army Corps of Engineers, with an area of responsibility that encompasses Florida and the Caribbean. They provide quality planning, engineering, construction while leading the Corps' single largest ecosystem restoration project – the restoration of America's Everglades.

U.S. Department of the Interior, Office of Everglades Restoration Initiatives

evergladesrestoration.gov

The OERI, under the leadership of the Assistant Secretary for Fish, Wildlife and Parks, serves as the south Florida liaison for the Secretary in coordinating departmental and bureau-level Everglades restoration activities, projects, and programs. The DOI manages nearly 2.5 million acres of land and water resources in the Everglades, has regulatory responsibility for 93 listed species in the Everglades, and produces much of the science that serves as the road map for the restoration program.

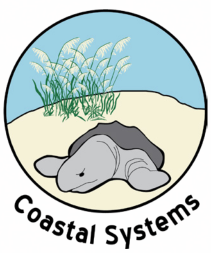
The Florida Master Naturalist Program

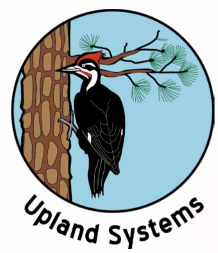
A Natural History Training Program

The Florida Master Naturalist Program (FMNP) is a UF/IFAS Extension environmental education program for adult audiences. FMNP courses are provided by Certified Instructors throughout the state of Florida at Extension offices and other environmental education organizations.

The goal of FMNP is to promote awareness, understanding, and respect of Florida's natural world. FMNP graduates share their knowledge through formal and informal training programs. FMNP consists of three tracks of courses: ***Core, Land Steward, and Restoration!***

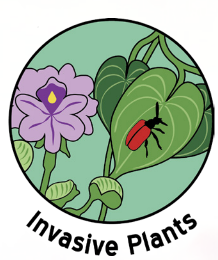
Core Courses





Land Steward Courses

Restoration Courses



FMNP Outreach Opportunities

Are you interested in becoming an FMNP instructor or guest speaker? Scan the code below to find out how!

Scan me!

https://bit.ly/3LZtj4q

Hands-on Learning

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Florida Master Naturalist Program

www.MasterNaturalist.org

CONFERENCE CHAIRS

Nicholas G. Aumen

Conference Chair

Regional Science Advisor - South Florida
U.S. Geological Survey
Loxahatchee, FL

Nick Aumen is Regional Science Advisor for the U.S. Geological Survey (Southeast Region), overseeing the Greater Everglades Priority Ecosystem Sciences program. This program, involving USGS scientists nationwide, provides high quality science in support of Everglades restoration. Nick was an aquatic ecologist for 15 years with Everglades National Park, leading an interagency team of scientists tracking restoration progress. Prior to his National Park Service position, Nick was the Research Director at the South Florida Water Management District, directing a team of 120-plus scientists conducting research in support of ecosystem restoration. Nick received his B.S. and M.S. in biology at the University of West Florida, and his Ph.D. in microbial ecology at Oregon State University. He was a faculty member in the Biology Department at the University of Mississippi, and was a tenured Associate Professor of Biology when he returned to Florida. Nick presently is an affiliate faculty member at Florida Atlantic University (Department of Geosciences), and at the University of Florida (Soil and Water Science Department). He also served five years on the national Board of Directors of the Sierra Club, a 120-yr-old environmental organization with more than 750,000 members, and served two terms as its Vice-President and one as Treasurer.

K. Ramesh Reddy

Conference Co-chair

Graduate Research Professor, Distance Education Coordinator
UF/IFAS Soil and Water Sciences
Gainesville, FL

Dr. K. Ramesh Reddy is the Director of the UF/IFAS School of Natural Resources and Environment and a Graduate Research Professor of the UF/IFAS Soil, Water, and Ecosystem Sciences Department. He holds a Ph.D. in soil science with specialization in biogeochemistry from Louisiana State University. He conducts research on coupled biogeochemical cycling of nutrients and other contaminants in wetlands and aquatic systems, as related to water quality, coupled biogeochemical cycling, ecosystem productivity, and restoration. He has worked on Florida's wetlands and aquatic systems for more than 45 years. Dr. Reddy established an interdisciplinary program on biogeochemistry of wetlands and aquatic systems, through the Wetland Biogeochemistry Laboratory (WBL) established within the SWSD. Since its establishment in 1987, the WBL has provided a home for graduate students from various disciplines, postdoctoral associates and visiting scientists. He has served on numerous advisory committees at state, national, and international levels. He has served on the National Research Council Committee on Soil Science and the Committee on Independent Scientific Review of Everglades Restoration Progress. He also served on several U.S. Environmental Protection Agency committees including the Science Advisory Board Ecological Effects Committee, Wetland Connectivity Panel, and Lake Erie Phosphorus Objective Panel.

WELCOME REMARKS

J. Scott Angle

Senior Vice President of Agriculture and Natural Resources
University of Florida
Gainesville, FL

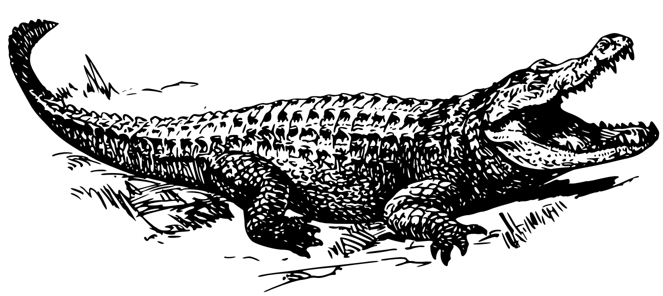
Dr. J. Scott Angle is the University of Florida's Senior Vice President for Agriculture and Natural Resources and leader of UF/IFAS. As chief executive of the agriculture and environmental sciences arm of a leading land-grant university, he champions public science as a path to improve lives and reduce human suffering. Dr. Angle leads nearly 2,300 employees who work in all 67 Florida counties. UF/IFAS encompasses the College of Agricultural and Life Sciences, the Florida Cooperative Extension Service, and the Florida Agricultural Experiment Station.

Dr. Angle previously served as the Director of the National Institute of Food and Agriculture (NIFA) from October 2018 to July 2020. Prior to that, Angle worked for 24 years as a Professor of Soil Science and Associate Director of the Maryland Agricultural Experiment Station and Maryland Cooperative Extension at the University of Maryland. His early work focused on the study of losses of nutrients from agro-ecosystems and their impact on the Chesapeake Bay. He also studied the impact of heavy metals on the food chain with the goal of protecting our food supply from these harmful elements. Later, he concentrated his research on phytoremediation, the use of plants for extraction of heavy metals from soil. In 2005, he moved to Athens, Georgia, where he served as Dean and Director of the College of Agricultural and Environmental Sciences at the University of Georgia for 10 years.

A frequently published author, Angle is a fellow in the American Society of Agronomy and the Soil Science Society of America. He is also a Fulbright Fellow, having worked at Rothamsted Research in the UK.

Angle served as President and CEO of the International Fertilizer Development Center (IFDC) from 2015 to 2018, where he oversaw a staff of more than 800 and coordinated development projects in diverse regions of the world. IFDC provides solutions to alleviate global hunger and poverty through the promotion of economic development and self-sufficiency.

Angle earned his B.S. and M.S. at the University of Maryland in Agronomy and Soil Science, respectively. He earned his Ph.D. from the University of Missouri with an emphasis on Soil Microbiology.



OPENING KEYNOTE SPEAKER

Tuesday, April 18, 2023 | 8:30am – 10:00am

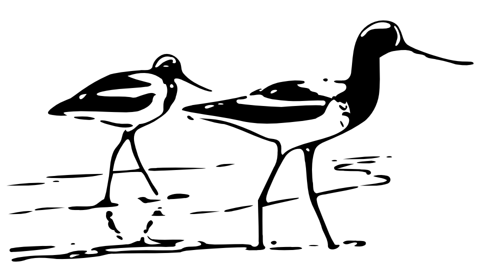
David Krabbenhoft

Senior Scientist (Emeritus)
U.S. Geological Survey, Mercury Research Lab
Madison, WI

Dr. David Krabbenhoft is a Senior Research Scientist (emeritus) with the U.S. Geological Survey (USGS) Mercury Research Lab, located in Madison, Wisconsin. Dave began working on environmental mercury sources and cycling in 1987, and since that time the topic has consumed his professional life. In 1993, Dave established the USGS's Mercury Research Laboratory (MRL), which includes a team of multi-disciplinary mercury scientists and a state-of-the-art analytical facility strictly dedicated to low-level speciation and isotope analysis of mercury in all environmental media. Since its inception, the MRL as conducted mercury research projects that span environments as far ranging as the each of the world's oceans, and freshwater systems from Alaska to Florida, California to New England, and more recently across the entire Great Lakes ecosystem.

While environmental mercury research has been his focus, the specifics of his research are wide ranging, including: atmospheric mercury sources and transport at local-to-global scales; cycling and fluxes of mercury in aquatic and terrestrial ecosystems; biogeochemical controls on the bioavailability of mercury to methylation; and, human epidemiology studies. Over his career, Dave served on a large number of national and international level committees and panels regarding mercury pollution of the environment and has given testimony to the U.S. Congress on several occasions.

In 2006, he served as the co-host for the International Conference on Mercury as a Global Pollutant, which was attended by over 1,200 researchers representing 54 countries across the globe. Since 1990, he has authored or coauthored over 190 papers on mercury in the environment. In 2015, Dave was promoted by USGS, Department of the Interior to Senior Research Scientist (ST), the highest level attainable by a scientist in the federal government system.



CLOSING KEYNOTE SPEAKER

Thursday, April 20, 2023 | 3:30pm–4:30pm

Shannon A. Estenoz

Assistant Secretary for Fish and Wildlife and Parks
U.S. Department of the Interior
Washington, DC

As Assistant Secretary for Fish and Wildlife and Parks, Shannon oversees the U.S. Fish and Wildlife Service, the National Park Service, and the Office of Everglades Restoration Initiatives. Confirmed by the United States Senate in June of 2021, Shannon is a member of the Secretary's leadership team, and an advisor to the Department and the Administration on a wide variety of regulatory, policy, restoration, and management matters that fall under her authority and responsibility. She is also a member of the Department's Infrastructure Executive Board and Climate Change Task Force. Shannon's responsibilities include a broad range of policy and regulatory domains including for example, historic preservation, park and refuge management, resource and species protection, grant administration, tribal trust, land acquisition, and the implementation of dozens of regulatory programs across the U.S. Fish and Wildlife Service and National Park Service.

Shannon's career in landscape scale conservation, restoration, public policy, and management spans 26 years including more than seven years as the U.S. Department of the Interior's Director of Everglades Restoration Initiatives and the Executive Director of the South Florida Ecosystem Restoration Task Force. In the Everglades, Shannon engaged as an advocate, a state water manager and a federal policy expert as the regulatory and policy frameworks of Everglades restoration took shape over two decades. She has served on every major stakeholder and decision-making body in the Everglades over the same period. In her role as the Director of Everglades Restoration Initiatives, Shannon was also a leader on the implementation teams for the largest Everglades restoration projects including the Central Everglades Planning Project, and the Modified Water Deliveries, Western Everglades and Tamiami Trail Next Steps projects.

Shannon's previous professional roles include Chief Operating Officer of the Everglades Foundation, Sun Coast Regional Director of the National Parks Conservation Association, Everglades Program Director of the World Wildlife Fund, Executive Director of the Environmental and Land Use Law Center, and three terms as the National Co-Chair of the Everglades Coalition. Shannon's public service includes appointments by four gubernatorial administrations since 1997 including to the Governor's Commission for a Sustainable South Florida, the Governor's Commission for the Everglades, the Governing Board of the South Florida Water Management District, and the M-CORES Task Force. Shannon also chaired the SFWMD Water Resources Advisory Commission and the Broward County Water Resources Task Force. Shannon has received numerous awards for her work in conservation including from Friends of the Everglades, Audubon of Florida, the Everglades Coalition, the Florida Wildlife Federation, the Environmental Law Institute, and the Ecological Society of America.

Shannon is a fifth generation native of Key West, Florida. She holds degrees in International Affairs and Civil Engineering from Florida State University.

"DIG" PLENARY SESSION SPEAKERS

Design, Innovation & Governance (DIG)

Wednesday, April 19, 2023 | 8:30am–10:00am

Fred Sklar

DIG Organizer

Director of the Everglades Systems Assessment Section
South Florida Water Management District
West Palm Beach, FL

Fred H. Sklar has a Masters in Oceanography and a Ph.D. in Wetland Ecology. He is currently the Director of the Everglades Systems Assessment Section of the South Florida Water Management District (SFWMD) in West Palm Beach. Dr. Sklar has published over 100 articles on the hydrology, soil, plant, and animal processes associated with both the degradation and restoration of wetland and coastal ecosystems. He is an Associate Editor for the ESA journal: Frontiers in Ecology; an executive member of the steering committee for the Florida Coastal Ecosystem LTER Program and a RECOVER Executive Committee member for the Restoration of the Everglades. Past memberships include the National Environmental Advisory Board to the Chief of the USACE; the Science and Engineering Advisory Committee for the Louisiana Water Institute of the Gulf; and scientific coordinator for the North Inlet Long-Term Ecological Research (LTER) program at the University of South Carolina.

Jeremy Conrad

"The Future Needs To Be R.A.D.ical"

Coastal Ecologist
U.S. Fish and Wildlife Service
Sanibel Island, FL

Jeremy Conrad is a coastal ecologist with the United States Fish and Wildlife Service in the branch of Inventory and Monitoring providing natural resource program support for thirty National Wildlife Refuges throughout Florida and the Caribbean. Jeremy is a native of South Florida and spent much of his free time as a youth at the beach or in the Everglades. His passion for the outdoors and conservation led him to earn a M.S. in Marine Ecology and a Ph.D. in Coastal/Estuarine Ecology focused on Everglade's watershed management and the eutrophication of estuarine ecosystems. He has worked for the USFWS for over 15 years focusing on land management for federal trust species in Florida's Everglades, Estuaries and Barrier Island systems. His experience and interest include wetland ecology with a focus on coastal wetland resiliency to large disturbance events and rising sea levels, disturbance ecology, climate change and ecological transformation, and non-native invasive species management.

Lawrence Glenn

"Rapid Data Synthesis Can be HABit Forming"

Director, Water Resources Division
South Florida Water Management District
West Palm Beach, FL

Lawrence serves as Director of the Water Resources Division of the South Florida Water Management District. Glenn manages the Water Supply, Water Quality, and Applied Sciences Bureaus at the District. He supervises the water quality monitoring conducted across the District, updating of regional water supply plans, rulemaking for Minimum Flow and Levels and Water Reservations, and scientific monitoring to evaluate ecological conditions in the District's lakes, rivers, estuaries, and Greater Everglades including Florida Bay. He is a 25-year veteran of participation in large-scale ecosystem restoration projects across the central and south Florida Landscape. He also serves as the Chairman of the South Florida Environmental Restoration Task Force Science Coordination Group and serves on the RECOVER Leadership Group.

John Stephen Kominoski

"Hurricane Trends: Is it all Doom and Gloom?"

Associate Professor
Florida International University
Miami, FL

John Kominoski is an Associate Professor in the Institute of Environment and Department of Biological Sciences at Florida International University. He is the Lead Principal Investigator of the Florida Coastal Everglades Long Term Ecological Research program, which is funded by the National Science Foundation (NSF). His research focuses on biogeochemistry and ecosystem ecology, especially on organic matter processing and the dynamic role of disturbances on spatiotemporal patterns of carbon and nutrients in coastal ecosystems. John's research spans streams, wetlands, and coastal marshes and mangroves. He has conducted research for over 10 years in the Florida Everglades. John collaborates broadly and incorporates both ecological theory and application in his research. He is co-leading an NSF-funded Research Coordination Network called "Hurricane Ecosystem Response Synthesis" that compares storm characteristics and ecosystem responses across subtropical and tropical ecosystems. John has published more than 100 peer-reviewed articles, been awarded grants that have totaled over $15 million, and advised 9 Ph.D. and M.S. students. In 2022, he was honored as a Fellow by the Association for the Sciences of Limnology and Oceanography for his advances to aquatic ecology.

continued on next page

Denise J. Reed

"How Many Eggs do you Crack to Save a Coastal Wetland?"

Professor of Research GRATIS
University of New Orleans
New Orleans, LA

Denise J. Reed is an expert in coastal marsh sustainability and the role of human activities in modifying coastal systems with over 35 years of experience studying coastal issues in the United States and abroad. She has been involved in restoration and resilience planning in coastal Louisiana for over three decades, as well as in the California Bay-Delta, San Francisco Bay and Puget Sound, and has published extensively on the effects of sea-level rise on coastal marshes. Dr. Reed has served as a Distinguished Research Professor at the University of New Orleans and spent five years as Chief Scientist at The Water Institute of the Gulf. She has served on numerous boards and panels addressing the effects of human alterations on coastal environments and the role of science in guiding restoration including the NOAA Science Advisory Board, the Chief of Engineers Environmental Advisory Board, and a number of National Academies' committees including USACE planning, Everglades restoration and the protection of sheltered shorelines. Dr. Reed received her B.S. degree in Geography from Sidney Sussex College, Cambridge and her M.A. and Ph.D. degrees from University of Cambridge, UK.

Stephanie Romañach

"Who's Afraid of Climate Change?"

Research Ecologist
U.S. Geological Survey's Wetland and Aquatic Research Center
Fort Lauderdale, FL

Stephanie Romañach is a Research Ecologist with the U.S. Geological Survey's Wetland and Aquatic Research Center. Stephanie leads Joint Ecosystem Modeling (JEM), focused on developing predictive ecological models and decision support tools that help decision makers explore potential ecological impacts from ecosystem restoration and climate change. In addition to her work on Everglades restoration and conservation planning in Florida, she also works on natural resources conservation in Africa and Asia. She earned her Ph.D. and M.A. in Ecology from the University of California at Santa Barbara, and her B.S. in Zoology from the University of Florida.

G. Lynn Wingard

"The Future is Behind Us"

Research Geologist
Florence Bascom Geoscience Center, U.S. Geological Survey
Reston, VA

Lynn Wingard has been a Research Geologist with the U.S. Geological Survey since 1991 and is Project Chief of two Everglades projects. The majority of her work over the last 25 years has been in support of Everglades Restoration. Her research focuses on analyzing estuarine sediment cores to determine changes in coastal environments over the last 100-5000 years. Lynn's combination of paleontological and modern data has provided Everglades resource managers with information on changes to freshwater flow into the estuaries, changes in habitats and species in the coastal environments, and long-term trends in sea level and climate. Her examination of centennial to millennial scale changes provides a long-term perspective on the impacts of drivers on the ecosystem. She has served on numerous scientific panels, is an associate editor of two journals, and is adjunct faculty at two universities. Lynn has served on several RECOVER Project Delivery Teams, most recently the Biscayne Bay Southeast Everglades Restoration PDT. She received her B.S. degree in geology from the College of William & Mary, Williamsburg, VA, and her M.S. and Ph.D. degrees from George Washington University, Washington, DC.

THANK YOU TO OUR DIG COACH

Jezra Kaye

"Teaching you how to SPEAK LIKE YOURSELF...NO, REALLY!"

Public speaking coach and speechwriter
Speak Up for Success
Brooklyn, New York

DIG speakers were coached by Jezra Kaye, President of Speak Up for Success. Jezra, who's based in Brooklyn, New York, is an acclaimed public speaking coach who has created and delivered hundreds of public speaking workshops and training sessions. Jezra coaches private clients from all backgrounds and industries, in person and via Skype. She is also the author or co-author of six books on business, fundraising, and public speaking.

Whatever your interest, challenge, or goal...
...if it involves public speaking, Jezra can help.
speakupforsuccess.com

SESSION ORGANIZERS & MODERATORS

Join us in thanking the following individuals for their efforts organizing and moderating sessions:

1 .... **Jill King**, SFWMD, West Palm Beach, FL

2 .... **Amanda Kahn**, SFWMD, West Palm Beach, FL

3 .... **Tyler Beck**, Florida Fish and Wildlife Conservation Commission, Tequesta, FL

4 .... **Anna Wachnicka**, SFWMD, West Palm Beach, FL

5 .... **Mike Duever**, Natural Ecosystems, Naples, FL

6 .... **Jacob Dombrowski**, SFWMD, West Palm Beach, FL

7 .... **Gina Ralph**, U.S. Army Corps of Engineers, Jacksonville, FL

8 .... **Victoria Garcia**, USFWS, Vero Beach, FL

9 .... **David Rudnick**, National Park Service & SFWMD (ret.), Gainesville, FL

10 .... **Mahadev Bhat**, Florida International University, Miami, FL

11 .... **Patrick Inglett**, UF/IFAS Soil, Water, and Ecosystem Sciences Department, Gainesville, FL

12 .... **Stacie Flood**, SFWMD, West Palm Beach, FL

13 .... **Elizabeth Boughton**, Archbold Biological Station, Venus, FL

14 .... **Shimelis Setegn**, SFWMD, West Palm Beach, FL

15 .... **Grace Kahmann**, Coastal Carolina University, Conway, SC

16 .... **Mike Jerauld**, DB Environmental, Rockledge, FL

17 .... **Evelyn Gaiser** and **Paige Kleindl**, Florida International University, Miami, FL

18 .... **Fahmida Khatun**, Restoration Sciences Branch, South Florida Natural Resources Center Division, National Park Service, and Interagency Modeling Center (IMC), Boynton Beach, FL

19 .... **Brett Poulin**, University of California Davis, Davis, CA

20 .... **Nathan Dorn**, Florida International University, Miami, FL

21 .... **Kathleen Pietro**, SFWMD, West Palm Beach, FL

22 ....**Evelyn Gaiser** and **Paige Kleindl**, Florida International University, Miami, FL

23 ....**Steve Bousquin**, SFWMD, West Palm Beach, FL

24 .... **Fred Sklar**, SFWMD, West Palm Beach, FL

25 ....**Mark Cook**, SFWMD, West Palm Beach, FL

26 ....**Richard James**, SFWMD, West Palm Beach, FL

27 ....**Cassondra Armstrong**, SFWMD, West Palm Beach, FL

28 ....**Shawn Clem**, Audubon Florida, Naples, FL

29 .... **John Stamm**, U.S. Geological Survey, Lutz, FL

30 .... **Barclay Shoemaker**, U.S. Geological Survey, Davie, FL

31 .... **Ana Carolina Coelho Maran**, SFWMD, West Palm Beach, FL

32 ....**Kristen Hart**, U.S. Geological Survey, Davie, FL

33 ....**Fahmida Khatun**, Restoration Sciences Branch, South Florida Natural Resources Center Division, National Park Service, and Interagency Modeling Center (IMC), Boynton Beach, FL

34 ....**Judson Harvey**, U.S. Geological Survey, Reston, VA

35 ....**Donatto Surratt**, Everglades National Park - National Park Service, Boynton Beach, FL

36 .... **Anna Springston**, Ardurra Group, Inc., Metairie, LA

37 ....**Kristen Hart**, U.S. Geological Survey, Davie, FL

38 ....**Sharon Ewe**, Stantec Inc., St. Petersburg, FL

39 ....**Theresa Strazisar** and **Chris Madden**, SFWMD, West Palm Beach, FL

40 ....**Matahel Ansar** and **Seyed Hajimirzaie**, SFWMD, West Palm Beach, FL

41 ......**Stephanie Johnson**, National Academies of Sciences, Engineering, and Medicine, Washington, DC

42 .... **Stephanie Romañach**, U.S. Geological Survey, Fort Lauderdale, FL

43 ....**Sharon Ewe**, Stantec Inc., St. Petersburg, FL

44 .... **Saira Haider**, U.S. Geological Survey, Fort Lauderdale, FL

45 ....**Randall Parkinson**, Florida International University, Melbourne, FL

CONCURRENT SESSION DESCRIPTIONS

The following descriptions provide an overview of each session topic, and why the subject matter is timely and how it is relevant to Everglades ecosystem restoration.

Day	8:30am - 10:00am	10:30am - 12:00pm	1:30pm - 3:00pm	3:30pm - 5:00pm
Tues., April 18	Opening Plenary	Sessions 1-5	Sessions 5-10	Sessions 11-15
Wed., April 19	DIG Plenary	Sessions 16-20	Sessions 21-25	Sessions 26-30
Thur., April 20	Sessions 31-35	Sessions 36-40	Sessions 41-45	Closing Plenary

SESSION 1

STAs 101: The Story of the Everglades Stormwater Treatment Areas

This session will provide an overview of how the Stormwater Treatment Areas (STAs) were developed, how they operate, along with the science and management that goes into ensuring phosphorus removal efficiency to achieve the mandated water quality based effluent limit. STA-5/6 will be highlighted as a case study of lessons learned in the management of these important systems. The session will also provide a history and operation of the Northern STAs that help improve water quality to Lake Okeechobee and the St. Lucie Estuary.

SESSION 2

How RECOVER Science Informs Comprehensive Everglades Restoration Project Planning

This session provides specific examples of how data collected through RECOVER's Monitoring and Assessment Plan informs CERP project planning. It is vital to utilize the best available monitoring data, scientific analyses, and predictive models to inform Performance Measures utilized in project evaluation and the most current modeling tools to address effects of uncertainties on restoration project goals. This session would be of interest to engineers, researchers, modelers, and agency managers.

SESSION 3

Environmental Factors Influencing Apple Snails and Snail Kites

Declines in native apple snails, the expansion of non-native apple snails, and changes in habitat and hydrology have contributed to shifting patterns in Everglade snail kite nesting. Understanding these patterns can aid in snail kite recovery and Everglades ecosystem restoration efforts in Florida. In this session we will examine how environmental factors affect apple snails and snail kites, and how these could explain current trends in snail kite population size and distribution.

SESSION 4

Monitoring, Forecasting and Mitigating Harmful Algal Blooms in Lake Okeechobee and Adjacent Ecosystems

Lake Okeechobee experiences annually extensive and often toxic HABs. Discharges of this HAB- and nutrient-rich water may thus adversely affect downstream ecosystem restoration efforts. The purpose of this session is to highlight the latest research into spatial and temporal HAB dynamics, bloom drivers, and newly developed forecasting models. The session topic targets agency managers, researchers, modelers, and other stakeholders with an interest in regional ecosystem operational decision-making.

SESSION 5

Six Year Post-Restoration Picayune Strand Restoration Project Monitoring Results – Is IT working?

This session will present the first meaningful post-restoration Picayune monitoring data for hydrology, plant communities, and aquatic fauna showing changes resulting from plugging Picayune canals and removing impediments to natural overland flow. We have repeatedly been asked by engineers, modelers, hydrologists, researchers, agency managers, etc. whether the restoration is working. Based on our monitoring data the answer is yes, but also no due to some influences beyond the control of the project.

SESSION 6

STA Vegetation, a Growing Body of Knowledge

An overview of the latest vegetation research in the Everglades Stormwater Treatment Areas (STAs) with a focus on vegetation resilience, phosphorus (P) removal capacity, and management implications. Past efforts have provided invaluable guidance for STA managers, though questions remain regarding the P removal capacity of vegetation communities and how to enhance their sustainability. Maintaining thriving communities remains a key goal for providing low P water to the Everglades protection area.

SESSION 7

How RECOVER Science Informs Comprehensive Everglades Restoration Project Design and Implementation

This session will provide specific examples of how data collected through RECOVER's Monitoring and Assessment Plan informs CERP project design and implementation. As CERP pivots from planning to the design, construction and operation phases, it is imperative that the latest technical data and scientific information is applied to achieve specific project restoration goals and improve system-wide performance. This session would be of interest to engineers, researchers, and agency managers.

SESSION 8

Status and Dynamics of Snail Kite and Apple Snail Populations

Long-term studies of apple snails and snail kites provide critical insight into conservation and management of these species and their responses to Everglades ecosystem restoration. This session will explore factors affecting the status, distribution, and dynamics of apple snails and snail kites, and delve into the current status and likely future of snail kites. This session will be of interest to water and habitat managers, hydrologists, researchers, planners, and agency personnel.

SESSION 9

Long-term Everglades Datasets and Processes

One distinguishing feature of the Everglades science enterprise is the number of years that science in support of restoration has been conducted, and the huge amounts of long-term data that exist. The amount of data collected here and the time period over which those data were collected may be greater than almost any other location anywhere. These talks address various aspects of these data, including TP, fish production, estuarine infauna, fire history, and vegetation patterns.

SESSION 10

Social Science Research in the Everglades Ecosystem and Implications for Restoration

Ecosystem services (ES) of the Everglades, as perceived by stakeholders, influence restoration and infrastructure development decisions. There is a growing interest in knowing how monetary values of ES such as carbon and recreation can be appropriated through payment for ES, infrastructure risk rating, and conservation finance. This session will explore if such emerging market-based programs can boost long-term restoration efforts. This will be of interest to agencies, investors, and academia.

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SESSION 11

Dissolved Organic Matter in the STAs: Composition, Transformation and Role in P Transport and Fate

Dissolved organic matter includes a significant portion of the P loads to the Everglades system. Despite this fact, the properties, origins, and fate of this P source remains uncertain. This session is devoted to recent studies directed at better identifying the sources and types of dissolved organic matter and P compounds, as well as the key biotic and abiotic processes affecting their transformation and fate in the watersheds of the Stormwater Treatment Area wetlands.

SESSION 12

Leveraging Next Generation Remote Sensing to Monitor Cyanobacteria Blooms- from Drones to Satellites

South Florida has a history of experiencing potentially toxic harmful algal blooms (HABs). This session will bring together a panel of government and academic groups expert in developing HAB-specific tools to monitor large regional areas using multi- and hyperspectral imagery at multiple scales. This discussion will empower aquatic resource managers to evaluate HAB imagery products for their applicability for monitoring efforts, model development or as inputs for machine-learning applications.

SESSION 13

Development and Assessment of Payment for Water Service Programs on Ranchlands in the Northern Everglades

The session will present lessons learned over 11 years since the Northern Everglades Payment-for-Environmental (NEPES) program began. The introduction will summarize NEPES, a form of Dispersed Water Management (DWM). Presentations will address: 1) Program history; 2) Project performance; 3) Co-benefits and trade-offs; 4) Programmatic perspective; and 5) A rancher perspective on DWM. Of broad interest, this session will increase knowledge on the effectiveness of ranchland DWM projects.

SESSION 14

Hydrological and Hydrodynamic Modeling for Environmental Management in the Everglades and Estuaries

This proposed session introduces an integrated modeling system applied in the everglades, estuaries, and coastal ecosystems. It focuses on the use of models as decision support tool to implement alternative management strategies for water resources allocation, flood and environmental pollution control, re-evaluation of MFL and development of BMAP & TMDL, and Everglades and estuary ecosystem restoration. This session will interest scientists, modelers, hydrologists, engineers, and decision makers.This session will interest scientists, modelers, hydrologists, engineers, and decision makers.

SESSION 15

Multiple Invasive Species in the Everglades

Although Burmese pythons are the focus of a lot of invasive species research, other significant animal invaders threaten the Everglades. These include the invasive apple snail, peacock eel, New Guinea flatworm, and Argentine black and white tegu. These talks highlight important, management-relevant research including their diet, impact on soil microbial communities, population trends, and effects on native species.

SESSION 16

Legacy Phosphorus in the STAs: Challenges at the Frontier of Treatment Wetland Performance

Like elite athletes, the Everglades Stormwater Treatment Areas (STAs) Everglades are highly tuned treatment wetlands, pushing the limits of phosphorus (P) removal. At the ultra-low concentrations required by regulatory targets, STA performance becomes sensitive to factors obscured in higher-P systems. Lab, mesocosm, full-scale and model experiments reveal that legacy P in the underlying soil, when accessed by plants, creates an “internal P load” that hampers maximum achievable STA performance.

SESSION 17

(Part 1 of 2) Student Stewards of the Everglades: Contributions to Federally Funded Research and Collaborations

The substantial involvement of students in Everglades research is federally supported through the South Florida Caribbean Cooperative Ecosystem Studies Unit (SFC-CESU), which provides researchers opportunities to make and communicate scientific advances and promote institution and federal agency collaboration. This session focuses on student contributions to SFC-CESU projects and highlights student engagement opportunities in science-based Everglades management and across institution synthesis.

SESSION 18

Role of Modeling toward the Biscayne Bay and Southeastern Everglades Ecosystem Restoration Efforts

This session will showcase the implementation of a suite of modeling tools to find effective solutions toward Biscayne Bay and Southeastern Everglades Ecosystem Restoration. Historically, natural freshwater produced a distinctive salinity gradient to nurture the diverse habitats, but the current water management system poses environmental challenges. Modeling can suggest ways to restore the ecosystem. This session will benefit engineers, modelers, hydrologists, researchers, and agency managers.

SESSION 19

Multidisciplinary Science to Understand and Forecast Mercury Cycling in the Everglades Ecosystem

Restoration actions and climate drivers are simultaneously altering the hydrology of the Florida Everglades ecosystem, and consequently influencing the biogeochemical cycling of major (e.g., carbon, sulfur) and trace elements (e.g., mercury). This session will present a set of multidisciplinary studies that highlight the state-of-the-science of mercury research in freshwater and coastal portions of the Florida Everglades, highlighting both "lessons learned" and current science needs.

SESSION 20

(Part 1of 2) Updating our Knowledge of Trophic Interactions and Prey Production in the Everglades

Producing prey for large predators like wading birds, alligators and gamefish is a function of the Everglades that is important for restoration scientists to be able to both understand and evaluate in spatiotemporal, historical and restoration contexts. New research on both predators and their prey populations are providing important insights into hydrology-prey-predator relationships across the landscape that could have large implications for restoration scientists, managers, and planners.

SESSION 21

Innovative Research in the Everglades STAs to Understand Internal Wetland Processes

Understanding the transformation and impact of organic and particulate materials within STAs is intrinsic to achieving and sustaining the legally mandated nutrient removal performance in these created systems. This session will present some of the latest research in the fate and turnover of organic material and the influence of fish, sediment, and microbial activity on water quality.

SESSION 22

(Part 2 of 2) Student Stewards of the Everglades: Contributions to Federally Funded Research and Collaborations

The substantial involvement of students in Everglades research is federally supported through the South Florida Caribbean Cooperative Ecosystem Studies Unit (SFC-CESU), which provides researchers opportunities to make and communicate scientific advances and promote institution and federal agency collaboration. This session focuses on student contributions to SFC-CESU projects and highlights student engagement opportunities in science-based Everglades management and across institution synthesis.

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SESSION 23

Kissimmee River Restoration: Progress and Challenges

This session will provide an update on the status of the Kissimmee River Restoration Project which completed construction in 2021 but awaits a new regulation schedule to reestablish the pre-channelization flow regime to the river. The session will emphasize monitoring results for hydrology, geomorphology, dissolved oxygen and floodplain vegetation, all of which are being monitored as indicators of the status and success of the restoration project.

SESSION 24

Decompartmentalization Physical Model

The Decompartmentalization Physical Model (DPM) is an adaptive management (AM) experiment assessing benefits of sheet flow and canal filling. DPM also includes experimental herbicide applications and other active marsh improvement efforts. Talks highlight how to best scale-up flow, optimize flow and loads, and reduce harmful canal flow impacts relevant to (and within) the CEPP-S footprint.

SESSION 25

(Part 2 of 2) Updating Our Knowledge of Trophic Interactions and Prey Production in the Everglades

This is a continuation of a two-part session on trophic interactions and prey production. Producing prey for large predators like wading birds, alligators and gamefish is a function of the Everglades that is important for restoration scientists to be able to both understand and evaluate in spatiotemporal, historical and restoration contexts. New research on both predators and their prey populations are providing important insights into hydrology-prey-predator relationships across the landscape that could have large implications for restoration scientists, managers, and planners.

SESSION 26

Integrating Stormwater Treatment Area Research with Simulation Models

Simulation models have been applied to the Everglades Stormwater Treatment areas for decades to support management decisions on sizing and operations. Until recently, these models were relatively simple, evaluating few interactions among the water column, plants and soils. The Restoration Strategies Science Plan (RSSP), a framework to coordinate research on phosphorus cycling in the Everglades Stormwater Treatment Areas, has provided a tremendous amount of information that allows the development and parameterization of more realistic models. This session will present the value of the very simple and relatively complex models and how they can be used to support Restoration Strategies.

SESSION 27

Novel Approaches to CyanoHAB Monitoring in Turbid Inland Waters

Harmful algal blooms have become increasingly prevalent in South Florida ecosystems. Much effort has been put into monitoring and assessment of these blooms and pushing current technologies to meet these needs. This session will discuss several technologies, from satellites to sondes, that have proven useful but not full proof in their ability to collect accurate and timely data. Target audience includes water managers, water quality samplers, harmful algal bloom scientists.

SESSION 28

Combating the Shrubification of Florida’s Freshwater Wetlands

Expansion of Carolina willow and other native shrubs in Florida’s herbaceous wetlands is increasingly creating management challenges throughout state and resulting in altered wetland function and loss of critical wildlife habitat. Advances in our understanding of willow ecology and development of effective removal and control strategies is allowing some land managers to combat succession by restoring and maintaining herbaceous habitats.

SESSION 29

High-resolution Models and Datasets for Historical and Projected Climate of Southern Florida

The climate setting of Florida is unique in that it is surrounded by oceans and has large areas with surface water, such as the Everglades. Small-scale weather processes such as sea breezes and convection play an important role in controlling rainfall. Models need to be developed that are specific to the scale of processes in Florida. This session provides a forum to discuss the needs for high-resolution climate/ocean models and datasets specifically for southern Florida and the Everglades.

SESSION 30

Water, Energy, and Biogeochemical Cycling in the Everglades – From Fluxes to Disturbances, Synthesis and Innovations

Water, solar energy, and biogeochemical (WEB) cycles have shaped the ecology of the Everglades for millennia. However, these critical cycles are increasingly being impacted by climate change, land use change, and accelerated sea-level rise. This session calls for abstracts that investigate historic, current, and future changes in WEB cycles, including disturbances, innovative approaches, and synthesis. Abstracts could include application of machine learning to map greenhouse gas and evapotranspiration exchanges, soil carbon accumulation and loss, as well as synthesis of multiple sources of data. Through a broad range of submissions, we hope to identify research priorities and emerging issues while promoting collaborative science between the private sector, government agencies and academia.

SESSION 31

(Part 1 of 2) Building Resiliency on Flood Protection in South Florida Region

The session is designed to bring together modelers, engineers, policy makers, planners and partners actively involved in or affected by all aspects of building resiliency in flood protection level of service in planning for future sea level rise, extreme rainfall condition, landuse change, etc. Participants will interact in an interdisciplinary setting to summarize and review best-in-class approach in modeling, planning, management activities and science in building resiliency in Flood Protection level of service. The Flood Protection Level of Service Program of the South Florida Water Management District allows the agency to evaluate the effectiveness of its flood control assets including canals, structures and pump stations to determine their ability to meet and continue to meet the flood protection needs of the region. With an ageing system with many assets approaching end of design life, it is critical to implement this program to inform decisions on flood control infrastructure needs of the region and achieve resiliency for flood protection level of service.

SESSION 32

(Part 1 of 2) Python Science in the Greater Everglades

This two-part session will kick off with a summary of the new Burmese python Science Synthesis, a peer-reviewed summary of python scientific publications through August 2022. The remaining presentations will showcase active python projects throughout the Greater Everglades, to update the audience on the scope and scale of current work on this damaging invader. Managers, scientists, graduate students, and other researchers will be interested in this session.

SESSION 33

Modeling Efforts to Address Challenges in Greater Everglades Ecosystem

The ecosystem restoration challenges in Greater Everglades are multi-faced (such as sea-level rise, conveyance issues, need for operational optimization, water quality etc.) This session will showcase the application of a suite of modeling tools to propose solutions to issues in Northern Everglades (Kissimmee River, Lake Okeechobee areas), Western and Southern Everglades (Florida Bay and Biscayne Bay areas). This session will benefit engineers, modelers, hydrologists, researchers, and agency managers.

continued on next page

SESSION 34

Getting the Water Right – Revisited

This session discusses an evolving challenge of Everglades restoration - as levees are breached and basins reconnected the wetland vegetation becomes the dominant roughness factor controlling water depth in a "free-flowing" Everglades. New research aimed at anticipating outcomes of high-flow restoration is presented, with the goal to help agencies and managers anticipate future changes in water storage, flood conveyance, restoration of deepwater sloughs, and overall ecological health.

SESSION 35

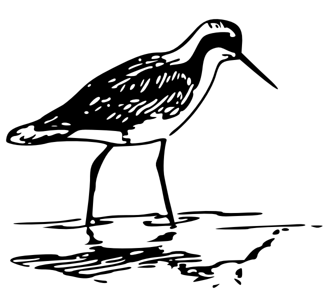
Water Quality Implication for Restoration

The session reviews water quality restoration and explores ecosystem responses we are observing through Everglades restoration. With only a few years remaining before completion of the State-led Restorations Strategies project, it is appropriate to review the capacity of the water management system to improve water quality for southern Everglades. The session is broad, ranging from regional perspectives to location specific analyses concerning water quality improvements and ecosystem response.

SESSION 36

(Part 2 of 2) Building Resiliency on Flood Protection in South Florida Region

This is a continuation of a two-part session Building resiliency for flood protection using high quality integrated modeling tools and pragmatic in its implementation through collaborative with partners and stakeholders with responsibility for the secondary and tertiary flood control systems in the search for the best course of action to mitigate identified deficiencies in flood protection.



SESSION 37

(Part 2 of 2) Python Science in the Greater Everglades

This is a continuation of a two-part session that kicks off with a summary of the new Burmese python Science Synthesis, a peer-reviewed summary of python scientific publications through August 2022. Remaining presentations showcase active python projects throughout the Greater Everglades, to update the audience on the scope and scale of current work on this damaging invader. Managers, scientists, graduate students, and other researchers will be interested in this session.

SESSION 38

Resiliency and Recovery of Tree Islands: Successes from Restoration and Mitigation Efforts

Tree islands have been affected by hydrology and other factors. However, measures such as levee degradation/canal backfilling, restoration of wildlife habitat, control/elimination of invasive species and adaptive management have helped improve tree island resiliency and persistence. Tree island recovery and conservation is critical given hydrologic management and sea-level rise in South Florida. This session will be of interest to Everglades ecologists, hydrologists, and restoration managers.

SESSION 39

Florida Bay Connections: Cross-boundary Integration and Synthesis in the Southern Everglades

In the Everglades, multiple connections across systems and boundaries exist, such as geographic regions, spatio-temporal scales, trophic levels, hydrologic linkages, and the human-nature interface. Studies advancing our understanding of Everglades complexity through integration and synthesis of these connections are important to support CERP with uncertainty in future conditions. This session highlights innovative research on connections within the Everglades southern estuaries and Florida Bay.

SESSION 40

Role of Computational Fluid Dynamics (CFD) in Everglades Restoration

The purpose of this session is to highlight the key role that Computational Fluid Dynamics (CFD) plays in Everglades Restoration. CFD is the science of predicting fluid flow, heat and mass transfer, chemical reactions, and related phenomena by solving a set of numerical governing mathematical equations including conservation of mass, conservation of momentum, and conservation of energy. At SFWMD, CFD has been used to support the hydraulic design and assess performance of project features in several Everglades Restoration projects including C43 Reservoir, L-8 FEB, A-1 FEB, S333 Expansion, S332B and C replacement, S356 pump station, and STAs.

SESSION 41

National Academies' 2022 Review of Everglades Restoration Progress

This session discusses the findings of the congressionally mandated National Academies' 2022 biennial review of Everglades restoration progress]. Committee members will present their evaluation of recent restoration progress, including in depth analysis of stormwater treatment areas and their linkage to CERP progress, restoration in the context of climate change, and science to support decision making. The committee's findings should be of interest to researchers, managers, and modelers.

SESSION 42

Cape Sable Seaside Sparrow Science

The goal of this session is to provide a forum for managers and scientists to learn about recent science on the endangered Cape Sable seaside sparrow. The session will feature new science on sparrow population trends, genetics, vegetation dynamics within sparrow habitat, and impacts of mercury on sparrow breeding.

SESSION 43

Restoring Biscayne Bay: Stepping Back from the Tipping Point?

The ecological health of Biscayne Bay is integral to the economy and vitality of Florida. The Bay has been degraded for many decades, but concerted efforts are now being led by local, state and federal government agencies, universities, businesses and community advocacy groups, to implement monitoring, restoration and management solutions. The science, restoration, socio-economics and policy will be of interest to restoration/ecosystem ecologists, modelers, economists, and land managers.

SESSION 44

Innovative Developments, Applications, and Next Steps: The Everglades Depth Estimation Network (EDEN)

This session brings together scientists, data users, water managers, and researchers that use the Everglades Depth Estimation Network (EDEN) as a support tool, information repository, and ecosystem indicator. Presentations will showcase features and innovative applications of EDEN, and we'll end with a discussion and brainstorming session to guide and develop future advances in EDEN.

SESSION 45

South Florida Coastal Wetland Responses to Climate Change and Hydrologic Restoration

The response of South Florida coastal wetlands to climate change and hydrologic restoration is uncertain. This session will describe ongoing investigations designed to fill knowledge gaps that have historically limited our capacity to forecast South Florida coastal wetland resiliency. Discussion topics include (1) ecology, (2) geochemistry, (3) hydrogeology, (4) sediment accumulation and accretion, and (5) tropical cyclones.

AGENDA-AT-A-GLANCE

Monday, April 17, 2023	
4:00pm–7:00pm	Main Conference Registration Officially Opens
4:00pm–6:00pm	Exhibiting Sponsors Move-in Displays and Session One Poster Presenters Set up Posters
5:00pm–7:00pm	Welcome Networking Social
10:00am–5:30pm	Impromptu Meetings: Take advantage of having multiple colleagues in one location to hold a private meeting. Two rooms are available on a first-come, first-served basis throughout GEER. A sign-up sheet is posted on the MESSAGE BOARD in the pre-function area.
Tuesday, April 18, 2023	
7:30am–8:30am	Early Morning Refreshments in Poster & Sponsor Display Area
8:30am–10:00am	Opening Plenary
10:30am–5:00pm	Concurrent Sessions
12:00pm–1:30pm	Lunch Buffet Provided
5:00pm–7:30pm	Poster Session One and Networking Reception
Wednesday, April 19, 2023	
7:30am–8:30am	Early Morning Refreshments in Poster & Sponsor Display Area
8:30am–10:00am	Design Innovation and Governance (DIG) Plenary
10:30am–5:00pm	Concurrent Sessions
12:00pm–1:30pm	Lunch Buffet Provided [Session One Posters Removed; Session Two Posters Installed]
5:00pm–7:30pm	Poster Session Two and Networking Reception
Thursday, April 20, 2023	
7:30am–8:30am	Early Morning Refreshments in Poster & Sponsor Display Area
8:30am–10:00am	Concurrent Sessions
10:30am–12:00pm	Concurrent Sessions
12:00pm–1:30pm	Lunch Buffet Provided
1:30pm–3:00pm	Concurrent Sessions
3:30pm–4:30pm	Closing Plenary
4:30pm–5:30pm	Exhibitors & Session Two Poster Presenters Remove Displays – GEER Concludes

DETAILED AGENDA

Monday, April 17, 2023	
4:00pm-6:00pm	**Conference Registration Opens** Session One poster presenters and exhibitimg sponsors set up displays. Tuesday speakers turn in presentation PowerPoint files.
5:00pm-7:00pm	**Informal Early Bird Networking Social on the Terrace**
Tuesday, April 18, 2022	
7:30am-5:00pm	**Conference Registration Open**
7:30am-8:30am	**Morning Refreshments in Poster Hall**
8:30am-10:00am	**Opening Plenary Session** **Welcome Remarks** **Dr. Nick Aumen**, Conference Chair, and Regional Science Advisor – South Florida U.S. Geological Survey Southeast Region, Loxahatchee, FL **Dr. K. Ramesh Reddy**, Conference Co-Chair, Director, UF/IFAS School of Natural Resources and Environment; and Graduate Research Professor UF/IFAS Soil, Water, and Ecosystem Sciences Department, Gainesville, FL **Dr. Scott Angle**, Senior Vice President of Agriculture and Natural Resources, University of Florida, Gainesville, FL **Keynote Speaker** **Dr. David P. Krabbenhoft**, Senior Scientist (Emeritus) U.S. Geological Survey Mercury Research Lab, Madison, WI **Keynote Presentation** "Long-term Data Synthesis, Integration, and Methodological Innovations: Toward Harmonized Conceptual Models to Inform Natural Resource Management"
10:00am-10:30am	**AM Refreshments & Networking Break in Poster Hall**

PRESENTATION NOTES

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Tuesday, April 18, 2022 (continued)

Concurrent Sessions [10:30am-12noon]

	Great Cypress	Royal Poinciana	Ibis	Egret	Sandpiper
	Session 1	**Session 2**	**Session 3**	**Session 4**	**Session 5**
Session Title	**STAs 101-The Story of the Everglades Stormwater Treatment Areas**	**How RECOVER Science Informs Comprehensive Everglades Restoration Project Planning**	**Environmental Factors Influencing Apple Snails and Snail Kites**	**Monitoring, Forecasting and Mitigation of Harmful Algal Blooms in Lake Okeechobee and Adjacent Ecosystems**	**Six Year Post-Restoration Picayune Strand Restoration Project Monitoring Results – Is it Working?**
Moderator	**Jill King** South Florida Water Management District	**Amanda Kahn** South Florida Water Management District	**Tyler Beck** Florida Fish and Wildlife Conservation Commission	**Anna Wachnicka** South Florida Water Management District	**Mike Duever** Natural Ecosystems
	Introduction & Overview	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**
10:35am	**Jill King** STAs 101: The Story of the Everglades Stormwater Treatment Areas	**Amanda Kahn** How Adaptive Assessment and Monitoring Informs CERP Planning & Implementation (and More!)	**Nathan Barrus** Interactive Effects of Juvenile Snail Predators and Individual Growth Limit *Pomacea paludosa* Populations	**Anna Wachnicka** 2.5 Years of Expanded HAB Monitoring on Lake Okeechobee - What Did We Learn?	**Mike Duever** Hydrologic Restoration in the Picayune Strand Restoration Project and Adjacent Fakahatchee Strand Preserve State Park
10:50am	**Eric Crawford** Ecosystem Management in Vegetation Based Stormwater Treatment Areas	**Nicole Niemeyer** Biscayne Bay and Southeastern Everglades Ecosystem Restoration (BBSEER) Project	**Caroline Poli** An Invasive Prey Provides Long-lasting Silver Spoon Effects for an Endangered Predator	**Jordon Beckler** The HALO Project: Monitoring Sediment Biogeochemical Dynamics to Inform Lake Okeechobee HAB and Nutrient Mitigation	**Sheryl Van Der Heiden** Initial Recovery of Groundcover Plant Communities as the Picayune Strand Restoration Project Progresses
11:05am	**Sarah Bornhoeft** *The Science Plan for the Everglades Stormwater Treatment Areas*: A Strategy for Improving Performance	**Joan Browder** Monitoring, Development, and Application of Performance Measures for Nearshore Southwestern Biscayne Bay	**Meghan Beatty** Source-Sink Dynamics of Snail Kites During the Invasion of a Novel Prey Species	**Richard Stumpf** Cyanobacteria Blooms in Lake Okeechobee	**Maureen Bonness** After Bulldozer Dust Settles: Woody Vegetation Recovery on Picayune Construction Footprints
11:20am	**Tarana Solaiman** Dryout in STAs: An STA-5/6 Case Study	**Fred Sklar** Adaptive Foundational Resilience (AFR): A Performance Measure to Assess the Ability of Native, Endemic Vegetation to Adapt to Sea Level Rise in Southeastern Florida	**Alyssa Jordan** Snail Kite and Wading Bird Response to Torpedograss and Cattail Management on Lake Okeechobee	**Hidetoshi Urakawa** Harmful Algal Bloom Prediction Using Hydrogen Peroxide Monitoring	**David Ceilley** Aquatic Macroinvertebrate Communities of Reference, Restored and Unrestored Wetlands: Picayune Strand Restoration Project
11:35am	**Susan Mason** The Northern STAs – Helping Improve Water Quality in Lake O and the St. Lucie River	**Caitlin Hackett** Predicting Landscape Scale Vegetation Change	**Brian Jeffery** Hydrologic Thresholds and Nest Survival of the Snail Kite	**Kaytee Pokrzywinski** Assessment of a Peroxide-Based Algaecide Product for Potential Control of Cyanobacteria in Lake Okeechobee: A Mesocosm Study	**Discussion**
11:50am	**Discussion**	**Discussion**	**Discussion**	**Discussion**	
12:00pm-1:30pm	**Group Lunch Buffet**				

PRESENTATION NOTES

Session No.	Speaker Name / Notes

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Tuesday, April 18, 2022 (continued)					
Concurrent Sessions [1:30pm-3:00pm]					
	Great Cypress	Royal Poinciana	Ibis	Egret	Sandpiper
	Session 6	Session 7	Session 8	Session 9	Session 10
Session Title	**STA Vegetation, a Growing Body of Knowledge**	**How RECOVER Science Informs Comprehensive Everglades Restoration Project Design and Implementation**	**Status and Dynamics of Snail Kite and Apple Snail Populations**	**Long-term Everglades Datasets and Processes**	**Social Science Research in the Everglades Ecosystem and Implications for Restoration**
Moderator	**Jake Dombrowski** South Florida Water Management District	**Gina Paduano Ralph** U.S. Army Corps of Engineers	**Victoria Garcia** U.S. Fish and Wildlife Service	**David Rudnick** National Park Service - and - SFWMD (ret.)	**Mahadev Bhat** Florida International University
	Introduction & Overview	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**
1:35pm	**Camille Herteux** Submerged Aquatic Vegetation Coverage in the STAs- Twenty Years of Survey Data	**Phyllis Klarmann** Integration of Monitoring to Support the Indian River Lagoon-South and C-43 Reservoir CERP Projects	**Josh Cullen** Population Viability of the Everglade Snail Kite Under Future Climate Change Scenarios	**Evelyn Gaiser** Long Term Dynamics of Phosphorus Pulses and their Legacies in the Florida Coastal Everglades	**Melissa Bernardo** Actually-Existing Resilience: Mobilizing Co-Production for Problem Identification in South Florida Environmental Governance
1:50pm	**Luke Evans** Biomass Density Effects on P Cycling in the Treatment Wetland Water Column	**Jenna May** Central Everglades Planning Project - North: How to Engineer the Building of Vegetated Hammock	**Kathryn Smith** Species Status Assessment Report for the Everglade Snail Kite (*Rostrhamus sociabilis plumbeus)*	**John Gatto** Testing for Changes in Long Term Marsh Fish Production Over 26 Years	**Chloe' Vorseth** Tight Lines and Survey Designs: Estimating the Recreational Economic Value of Lake Okeechobee
2:05pm	**Matt Powers** Phosphorus Retention of STA Ecotopes	**Danette Goss** How the Decomp Physical Model Informs Central Everglades Planning Project Adaptive Management	**Kenneth Meyer** The Precarious Status and Future of the U. S. Population of Snail Kites	**Grace McLeod** Fire History and Climate Drive Patterns in Post-Fire Recovery	**Erik Stabenau** Marsh Transformation Index to Inform Coastal Restoration Planning
2:20pm	**Orlando Diaz** Evaluation of Water Depth and Inundation Duration on *Typha domingensis* Sustainability: Test Cell Study	**Gina Paduano Ralph** Use of Regional Sediment Management to Increase Coastal Wetland Resilience to Sea Level Rise	**Phil Darby** Hydrology and Temperature Influences on *Pomacea paludosa* Demography	**Michael Ross** Dynamics of Vegetation Composition and Diversity during Coastal Transgression in the C111 Watershed since 1995	**Mahadev Bhat** Valuing Ecosystem Services of Everglades Restoration: Regional and National Policy Implications
2:35pm	**M. Zaki Moustafa** Maintaining Controllability In Treatment Wetlands While Achieving Sustainability	**Carlos Coronado** Everglades Mangrove Migration Assessment: A Resiliency Pilot Study	**Phil Darby** In Memory of Rob Bennetts: A Retrospective on Snail Kite and Apple Snail Studies, 1985 to the Present	**Christopher Searcy** Distribution, Abundance, and Community Composition of Amphibians in the Everglades Ecosystem.	**Luke Boutwell** Carbon Sequestration in the Everglades
2:50pm	**Discussion**	**Discussion**	**Discussion**	**Discussion**	**Discussion**
3:00pm-3:30pm	**PM Refreshments & Networking Break in Poster Hall**				

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Tuesday, April 18, 2022 (continued)					
Concurrent Sessions [3:30pm-5:00pm]					
	Great Cypress	Royal Poinciana	Ibis	Egret	Sandpiper
	Session 11	Session 12	Session 13	Session 14	Session 15
Session Title	**Dissolved Organic Matter in the STAs: Composition, Transformation and Role in P Transport and Fate**	**Leveraging Next Generation Remote Sensing to Monitor Cyanobacteria Blooms-from Drones to Satellites**	**Development and Assessment of Payment for Water Service Programs on Ranchlands in the Northern Everglades**	**Hydrological and Hydrodynamic Modeling for Environmental Management in the Everglades and Estuaries**	**Multiple Invasive Species in the Everglades**
Moderator	**Patrick W. Inglett** UF/IFAS Soil, Water & Ecosystem Sciences Dept.	**Stacie Flood** South Florida Water Management District	**Elizabeth Boughton** Archbold Biological Station	**Shimelis Setegn** South Florida Water Management District	**Grace Kahmann** Coastal Carolina University
	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
3:35pm	**Caroline Buchanan** Phosphorus Speciation in Waters Entering and Leaving Everglades Stormwater Treatment Areas as Determined by 31P NMR, XAS and EMPA	**Zhiqiang Chen** Advances in Remote Sensing of CyanoHABs in South Florida Estuaries: Satellite Sensors, Constellations, and Artificial Intelligence	**Benita Whalen** Development of Payment for Water Services in the Northern Everglades	**Yogesh Khare** Quantifying Impacts of Anthropogenic Agricultural Nutrient Accumulations on Phosphorus Loads in a Lake Okeechobee Sub-Watershed	**Yuxi Guo** Wetland Soil Microbial Responses to Land Intensification and an Invasive Macroinvertebrate
3:50pm	**Praveen Subedi** Bioavailability of Dissolved Organic Phosphorus Varies with Inflow Source and Vegetation Type in the Everglades Stormwater Treatment Areas	**Megan Coffer** Eyes in the Sky Monitor Cyanobacterial Blooms in Florida Waters	**Amartya Saha** Estimating Water and Nutrient Retention of Payment for Water Services Projects on South Florida Ranchlands	**Haimanote Bayabil** Developing Efficient Evapotranspiration Modeling Approaches for Sustainable Agricultural Water Management	**Grace Kahmann** Population Trends and Trophic Ecology of Invasive Peacock Eels *(Macrognathus siamensis)* in the Florida Everglades
4:05pm	**Elise Morrison** Characterizing Biomarkers of Litter and Floc Decomposition: Results from a DOM Leaching Experiment	**Michelle Tomlinson** Monitoring Inland Lakes for CyanoHABs Through the Use of Satellite Remote Sensing	**Elizabeth Boughton** Trade-offs and Synergies in a Payment-for-Ecosystem Services Program on Ranchlands in the Everglades Headwaters	**Detong Sun** Freshwater Management Strategies for Potential Algal Bloom in the St. Lucie Estuary, Perspective from a Simple Box Model Theory	**Lawrence Lopez** The Impact of the New Guinea Flatworm: Apparent Local Tree Snail Extinctions in Conservation Lands
4:20pm	**Jacob Gaddy** Amino Acids as Biomarkers of Organic Matter Decay and Source in Treatment Wetland Litter and Floc	**Natalie Hall** Monitoring of Harmful Algal Blooms (HABs) using Hyperspectral Remote Sensing	**Jonathan Madden** Dispersed Water Management – A Programmatic Perspective	**Fitsum Teshome** Evaluating field scale hydrologic and crop simulation models in South Florida	**Jiangxiao Qiu** Invasive Snails Alter Multiple Ecosystem Functions and Services in Subtropical Wetlands
4:35pm	**Todd Osborne** An Overview of the Role of Photolysis in Dissolved Organic Matter Cycling in Stormwater Treatment Areas	**Andrew Kamerosky** Remote Sensing of HABs in the Indian River Lagoon, Florida: UAS Hyperspectral to Satellite Multispectral	**Wes Carlton** The Role of Dispersed Water Management in the Northern Everglades – A Rancher Perspective	**Shimelis Setegn** Modeling Freshwater Inflows in the Loxahatchee River and Estuary Watershed	**Joel Trexler** Illustrating Impacts of the Boom-and-Bust Dynamics of African Jewelfish in the Shark River Slough
4:50pm	Discussion	Discussion	Discussion	Discussion	Discussion
5:00pm-7:30pm	Poster Session One and Networking Reception				

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Wednesday, April 19, 2022	
7:30am-5:00pm	**Conference Registration Open**
7:30am-8:30am	**Morning Refreshments in Poster Hall**
8:30am-10:00am	**DIG Plenary Session** **Design, Innovation, and Governance (DIG): Solutions for Everglades Restoration** Six Ted-style presentations will offer a unique blend of the art of communication with a passion for science on Everglades science and restoration topics. **Welcome Remarks** **Dr. Nick Aumen**, Conference Chair, and Regional Science Advisor – South Florida, U.S. Geological Survey, Davie, FL **DIG Session Organizer and Moderator** **Dr. Fred Sklar**, Director and Section Administrator, Everglades Systems Assessment Section South Florida Water Management District, West Palm Beach, FL **DIG Presentations** "Rapid Data Synthesis Can be HABit Forming" **Mr. Lawrence Glenn**, South Florida Water Management District, West Palm Beach, FL "The Future is Behind Us" **Dr. G. Lynn Wingard**, U.S. Geological Survey, Reston, VA "The Future Needs To Be R.A.D.ical" **Dr. Jeremy Conrad**, U.S. Fish and Wildlife Service, Sanibel Island, FL "How Many Eggs do you Crack to Save a Coastal Wetland?" **Dr. Denise Reed**, University of New Orleans, New Orleans, LA "Hurricane Trends: Is it all Doom and Gloom?" **Dr. John Kominoski**, Florida International University, Miami, FL "Who's Afraid of Climate Change?" **Dr. Stephanie Romañach**, U.S. Geological Survey, Gainesville, FL
10:00am-10:30am	**AM Refreshments & Networking Break in Poster Hall & Removal of Session One Posters**

PRESENTATION NOTES

PRESENTATION NOTES

Session No.	Speaker Name / Notes

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Wednesday, April 19, 2022 (continued)					
Concurrent Sessions [10:30am-12:00pm]					
	Great Cypress	Royal Poinciana	Ibis	Egret	Sandpiper
	Session 16	Session 17	Session 18	Session 19	Session 20
Session Title	**Legacy Phosphorus in the STAs: Challenges at the Frontier of Treatment Wetland Performance**	**Student Stewards of the Everglades: Contributions to Federally Funded Research and Collaborations (Part 1 of 2)**	**Role of Modeling toward the Biscayne Bay and Southeastern Everglades Ecosystem Restoration Efforts**	**Multidisciplinary Science to Understand and Forecast Mercury Cycling in the Everglades Ecosystem**	**Updating our Knowledge of Trophic Interactions and Prey Production in the Everglades (Part 1 of 2)**
Moderator	**Mike Jerauld** DB Environmental	**Paige Kleindl** Florida International University	**Fahmida Khatun** National Park Service, Department of the Interior	**Brett Poulin** University of California - Davis	**Nathan Dorn** Florida International University
	Introduction & Overview	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**
10:35am	**Jacob Dombrowski** Internal and External Loading Effects on Water Column P in Treatment Wetlands for Everglades Restoration	**Paige Kleindl** The Role of Benthic Periphyton Mats in Regulating Macrophyte Communities in a Marl Prairie Wetland	**Sarah Bellmund** CERP: BBCW to BBSEER, Modeling World to Real World and Back	**David Krabbenhoft** Everglades Mercury Science: Toward an Internally Consistent Paradigm	**David Essian** Summarizing Prey Use and Selectivity by Wading Birds in Four Major Wetland Types in the Everglades
10:50am	**Jessica Vaccare** Rooted Vegetation Mobilizes Phosphorus from Muck Soils: Results from Mesocosm Studies	**Brittany Mason** Predicting Dispersal Paths of the Invasive Argentine Black and White Tegu Using Circuit Theory	**Maliha Ahmed** Development of Tidal Boundary Condition for Regional Model (RSMGL) in Support of BBSEER Project	**Matthew Varonka** Sources and Temporal Trends of Sulfate in the Freshwater Everglades	**Mark Cook** What Triggers Irruptive Wading Bird Breeding Events? New Insights from Landscape-scale Foraging Patterns
11:05am	**Kevin Grace** Soil Management Opportunities to Curtail Plant Cycling of Excess Soil P for Water Quality Improvement	**Veronica Restrepo** Quantifying Post-Hurricane Regeneration of Mangrove Species Along Phosphorus Fertility Gradients in the Florida Coastal Everglades	**Walter Wilcox** Statistical Emulation of the Biscayne Bay Simulation Model	**Benjamin Peterson** Microbial and Biogeochemical Controls on Mercury Methylation in the Everglades	**Alexander Blochel** Connectivity Between Submerged Aquatic Vegetation Structures and Prey Base Fish Communities within the Coastal Mangrove Zone
11:20am	**Mike Jerauld** Connections Between Plant-Available Legacy Soil P, Internal Loading and Treatment Performance in Full-Scale STAs	**Himadri Biswas** Spatial Distribution Pattern of *Rhizophora mangle* in Southeast Saline Everglades	**Jaime Graulau-Santiago** Application of BBSM Model for Nearshore Salinities in Support of the BBSEER Project	**Bryce Cook** Laboratory Assessment of Sea-Level Rise Effects on Mercury Methylation in Coastal Everglades Wetlands	**Jennifer Rehage** Temperature and Flooding Duration Mediate the Structure of a Marsh Prey Subsidy in the Coastal Everglades
11:35am	**John Juston** Integration of Internal Loading Rates from Legacy Soil P Improves STA Numerical Simulation	**Paisley Samuel** Effects of Cyanobacteria Harmful Algal Blooms on Microbial Communities Within Lake Okeechobee, FL, USA	**Khandker Ishtiaq** BISECT Calibration to Develop Salinity Performance Measures and Integration with RSM-GL to Support Evaluation of BBSEER Alternatives	**Sarah Janssen** Decadal Trends of Mercury Cycling and Bioaccumulation within Everglades National Park	**Sergio Balaguera-Reina** Linking American Alligators with Marsh Productivity, an Empirical Framework
11:50am	**Discussion**	**Discussion**	**Discussion**	**Discussion**	**Discussion**
12:00pm-1:30pm	**Lunch Buffet & Installation of Session Two Posters**				

PRESENTATION NOTES

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Wednesday, April 19, 2022 (continued)					
Concurrent Sessions [1:30pm-3:00pm]					
	Great Cypress	Royal Poinciana	Ibis	Egret	Sandpiper
	Session 21	**Session 22**	**Session 23**	**Session 24**	**Session 25**
Session Title	**Innovative Research in the Everglades STAs to Understand Internal Wetland Processes**	**Student Stewards of the Everglades: Contributions to Federally Funded Research and Collaborations (Part 2 of 2)**	**Kissimmee River Restoration: Progress and Challenges**	**Decompartmentalization Physical Model**	**Updating our Knowledge of Trophic Interactions and Prey Production in the Everglades. (Part 2 of 2)**
Moderator	**Kathleen Pietro** South Florida Water Management District	**Paige Kleindl** Florida International University	**Steve Bousquin** South Florida Water Management District	**Fred Sklar** South Florida Water Management District	**Mark Cook** South Florida Water Management District
	Introduction & Overview	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**
1:35pm	**Patrick Inglett** Soil Accretion in the STAs: Relationships with Vegetation/Water Quality and its Role in Benthic P Stability	**Jessika Reyes** Landward Creek Expansion in the Southern Everglades and Distribution of Halophytic Communities	**Steve Bousquin** Kissimmee River Restoration: Progress and Challenges	**Lisa Jackson** Litter Decomposition along a Restored Flow Gradient	**Michelle Peterson** Modeling Trophic Linkages: Dry Season Prey Concentrations of Aquatic Fauna and Wading Bird Nesting
1:50pm	**Joao Henrique Fernandes Amaral** Organic Carbon and Nutrient Turnover in Treatment Wetlands: Insights from a Multiple Biogeochemical Approach	**Nicole Stickland** Evaluating the Effects of Habitat Stratification on Sampling Bias for Estimations of Aquatic Animal Populations	**David Anderson** Challenges to Hydrologic Restoration of the Kissimmee River During a Twenty-Year Interim Period	**Sue Newman** Prescribing Flow-Preliminary Results from an In-Situ Flume within the Everglades	**Jordan Massie** Getting the Timing Right: Matches and Mismatches for Consumers and Prey Subsidies in the Everglades
2:05pm	**Mark Barton** Faunal Effects on Phosphorus Dynamics in the Everglades STAs: Part 1 (Mechanisms)	**Ximena Mesa** Environmental Heterogeneity and Spatial Patterns of Woody Vegetation in the Greater Everglades	**Brent Anderson** Assessment of River Channel Changes Following the Reintroduction of Flow to the Kissimmee River	**Colin Saunders** Model-based Design Recommendations to Reduce Canal Flow in the Blue Shanty Flowway	**Marco Fernandez** Flowing Water Effects on Aquatic Animal Communities: Insights from the Decompartmentalization Physical Model
2:20pm	**Janelle Goeke** Faunal Effects on Phosphorus Dynamics in the Everglades STAs: Part 2 (Surveys and Scaling)	**Carlos Pulido** Assessing Plant Taxonomic and Functional Diversity along Hydrologic Gradients: An Integrated Field and Remote Sensing Approach	**Darryl Marois** Evaluation of Dissolved Oxygen Trends and Potential Drivers of Hypoxia Within the Kissimmee River Restoration Area	**Liqiong Zhang** Vegetative Flow Simulation in Water Conservation Area-3A and Flow Uniformity Evaluation	**Jerry Lorenz** Degradation of Roseate Spoonbill Foraging Quality by Introduced Mayan Cichlids has been Exacerbated by SLR
2:35pm	**Kathleen Pietro** What Can the Trends in Periphyton Enzyme Activity within the STAs Tell Us?	**Kenny Anderson** Peat and Marl Dissolved Organic Matter Vary Among Wetlands with Nutrient Enrichment and Restored Hydrology	**Lawrence Spencer** Mapping Kissimmee River Floodplain Vegetation: A New Approach Using Machine Learning Algorithms	**Christa Zweig** Flow Restoration in a Complex Landscape	**Nathan Dorn** A Novel Invasive Predator Threatening Aquatic Prey Production in the Everglades
2:50pm	**Discussion**	**Discussion**	**Discussion**	**Discussion**	**Discussion**
3:00pm-3:30pm	**PM Refreshments & Networking Break in Poster Hall**				

PRESENTATION NOTES

Session No.	Speaker Name / Notes

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Wednesday, April 19, 2022 (continued)					
Concurrent Sessions [3:30pm-5:00pm]					
	Great Cypress	Royal Poinciana	Ibis	Egret	Sandpiper
	Session 26	Session 27	Session 28	Session 29	Session 30
Session Title	**Integrating Stormwater Treatment Area Research with Simulation Models**	**Novel Approaches to CyanoHAB Monitoring in Turbid Inland Waters**	**Combating the Shrubification of Florida's Freshwater Wetlands**	**High-resolution Models and Datasets for Historical and Projected Climate of Southern Florida**	**Water, Energy, and Biogeochemical Cycling in the Everglades – From Fluxes to Disturbances, Synthesis and Innovations**
Moderator	**Richard James** South Florida Water Management District	**Cassondra Armstrong** South Florida Water Management District	**Shawn Clem** Audubon Florida	**John Stamm** U.S. Geological Survey	**W. Barclay Shoemaker** U.S. Geological Survey
	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
3:35pm	**Richard James** Using Water Quality Models to Support Design and Management of Stormwater Treatment Areas	**Danielle Taylor** Considerations for Using Drone Technology for Estuarine Harmful Algal Bloom (HAB) Monitoring	**Shawn Clem** Challenges and Successes Restoring Marsh and Wet Prairie Habitat at Audubon's Corkscrew Swamp Sanctuary	**Thomas Frazer** Research Directions of the Florida Flood Hub for Applied Research and Innovation	**Michael Osland** Sea-level Rise Thresholds for Wetland Loss and Transformation: When Could Tipping Points Be Crossed?
3:50pm	**Silong Lu** The Effect of Vertical Groundwater Seepage on Outflow TP Concentrations in Everglades Stormwater Treatment Areas	**Greg Toolan** What Role Can UAS Play in the Effort to Detect, Monitor, and Prevent Harmful Algal Blooms: Integrating UAS into the South Florida Water Management District's Current Program	**Jacob Zetzer** Quantifying Vegetation and Wildlife Response to Mechanical Removal of Native Wetland Shrubs	**Ana Carolina Coelho Maran** Incorporating Future Rainfall Estimates Into the Water and Climate Resilience Adaptation Planning	**Laura Feher** A Regional Synthesis of Soil Elevation Change in the Coastal Wetlands of the Greater Everglades
4:05pm	**Christopher Buzzelli** Modeling Phosphorus Biogeochemistry in Emergent and Submerged Habitats of the Everglades Stormwater Treatment Areas	**Regina Hanlon** Drone-based Water Sampling and Characterization of Three Freshwater Harmful Algal Blooms in the United States	**Jean McCollom** Vegetation Response to Mechanically and Chemically Treating Willows Invading Marshes in Southwest Florida's Corkscrew Watershed	**Jason Bellino** High-Resolution Weather Reanalysis and Projected Changes in Extreme Rainfall Events in South Florida	**Barclay Shoemaker** Carbon Cycling Research with Digital Imagery in Greater Everglades Forested Wetlands
4:20pm	**Steven Bartell** Adapting an Aquatic Food-Web/Ecosystem Model to Simulate P Dynamics in Stormwater Treatment Area 2	**Thomas Behlmer** Surveying Estuarine Responses to Freshwater Inflows: An Algal Bloom Monitoring Tool in the Northern Estuaries	**Kimberli Ponzio** Using Herbicides to Control *Salix caroliniana* and Restore Marshes in the St. Johns River Floodplain	**Ben Kirtman** High-Resolution, Global Ocean-Atmosphere Models of Historical and Projected Climate	**Caiyun Zhang** Applying Machine Learning to Map Greenhouse Gases and ET in the Everglades Wetlands
4:35pm	Discussion	**Cassondra Armstrong** Linking Technologies to Maximize Detection and Measurement of Harmful Algal Blooms	**Penny Cople** Incorporating Land Management Strategies in the Mitigation Bank Regulatory Framework for Management of *Salix caroliniana*	**Christopher Madden** High-resolution Models and Datasets for Historical and Projected Climate of Southern Florida	**Sparkle Malone** Mangrove Forests Are an Unlikely Source of CH_4 to the Atmosphere in the Subtropical Florida Everglades
4:50pm		Discussion	Discussion	Discussion	Discussion
5:00pm-7:00pm	Poster Session Two and Networking Reception				

PRESENTATION NOTES

Session No.	Speaker Name / Notes

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Thursday, April 20, 2023					
7:30am-5:00pm	**Conference Registration Open**				
7:30am-8:30am	**Morning Refreshments in Poster Hall**				
	Concurrent Sessions [8:30am-10:00am]				
	Great Cypress	**Royal Poinciana**	**Ibis**	**Egret**	**Sandpiper**
	Session 31	**Session 32**	**Session 33**	**Session 34**	**Session 35**
Session Title	**Building Resiliency in Flood Protection in South Florida Region (Part 1 of 2)**	**Python Science in the Greater Everglades (Part 1 of 2)**	**Modeling Efforts to Address Challenges in Greater Everglades Ecosystem**	**Getting the Water Right - Revisited**	**Water Quality Implication for Restoration**
Moderator	**Ana Carolina Coelho Maran** South Florida Water Management District	**Kristen Hart** U.S. Geological Survey	**Fahmida Khatun** National Park Service, Department of the Interior	**Jud Harvey** U.S. Geological Survey	**Donatto Surratt** Everglades National Park
	Introduction & Overview	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**
8:35am	**Akintunde Owosina** C-8 and C-9 Watersheds Flood Protection Level of Service - Adaptation and Mitigation Planning Study	**Jacquelyn Guzy** Burmese Pythons in Florida: A Synthesis of Biology, Impacts, and Management Tools	**Shimelis Dessu** Conceptual Modeling Framework to Link Water Management, Sea-level Rise, and Salinity in Central Florida Bay	**Jay Choi** Biophysically-based Simulations of Sheet Flow at the Decomp Physical Model (DPM) to Assess Restoration Challenges	**Jose Otero** Update on the Implementation of Restoration Strategies
8:50am	**Matahel Ansar** Application of Storm Surge Models to Resiliency Studies in South Florida	**Andrea Currylow** Invasive Python Size Descriptions and Reproductive Phenology in Florida	**Angela Montoya** Improvements for the Biscayne Aquifer Model of Urban Miami-Dade County, Including Effects due to Biscayne Bay Southern Everglades Ecosystem Restoration (BBSEER)	**Clay Brown** Natural System Model Enhancements in Support of a Restored Everglades Landscape	**Paul Julian** Unintended Consequences of Hydrologic Restoration, Water Quality Considerations for Picayune Strand Restoration Project
9:05am	**Stephanie Long-Marquez** C2, C3W, C4, C5, and C6 Watersheds Flood Protection Level of Service for Current and Future SLR Conditions	**Christina Romagosa** Prey Species Composition, Richness, and Diversity of Burmese Python Diet in Florida	**Lichun Zhang** HEC-RAS 2D Analysis for Impacts of L-28S Culverts in WERP Region 4	**Matt Cohen** Insights on Pattern and Hydrological Process in the Ridge-Slough Landscape	**Dilip Shinde** Water Quality Dynamics at S12A Discharge Structure on the Western Edge of Everglades National Park
9:20am	**Rajendra Sishodia** Broward County Hydrological Modeling Efforts: Planning for Resilience	**Kristen Hart** Python Survival and Activity Patterns	**Jenifer Barnes** Optimization Modeling for the Lake Okeechobee System Operating Manual (LOSOM)	**Jing Yuan** Remote Sensing of Vegetation Biomass to Predict Changing Flow Resistance for Improved Hydrological Modeling	**Yuheng Qiu** Characterization of Canal and Marsh Chemical Composition within the Everglades Basin
9:35am	**Katharine Mach** Fine-scale, Interactive Collaborative Flood Modeling for Inclusive and Time-Efficient Climate Adaptation	**Amy Yackel Adams** Evaluating the Use of Removal and Abundance Models to Inform Invasive Burmese Python Management	**Jie Zeng** Application of 2D HEC-RAS Model to Kissimmee River Restoration Project	**Wasantha Lal** How Flow Resistance Modeling Can Improve Water Management	**Andrea Nocentini** Rehydration Drives Landscape-Scale Shifts in Wetland Vegetation Relative to Patch-Scale Effects of Chemistry and Fire
9:50am	**Discussion**	**Discussion**	**Discussion**	**Discussion**	**Discussion**
10:00am-10:30am	**AM Refreshments & Networking Break in Poster Hall**				

PRESENTATION NOTES

Session No.	Speaker Name / Notes

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Thursday, April 20, 2023 (continued)					
Concurrent Sessions [10:30am-12:00pm]					
	Great Cypress	Royal Poinciana	Ibis	Egret	Sandpiper
	Session 36	Session 37	Session 38	Session 39	Session 40
Session Title	**Building Resiliency on Flood Protection in South Florida Region (Part 2 of 2)**	**Python Science in the Greater Everglades (Part 2 of 2)**	**Resiliency and Recovery of Tree Islands: Successes from Restoration and Mitigation Efforts**	**Florida Bay Connections: Cross-boundary Integration and Synthesis in the Southern Everglades**	**Role of Computational Fluid Dynamics (CFD) in Everglades Restoration**
Moderator	**Ann Springston** Ardurra Group, Inc.	**Kristen Hart** U.S. Geological Survey	**Sharon Ewe** Stantec, Inc.	**Theresa Strazisar** South Florida Water Management District	**Seyed Hajimirzaie** South Florida Water Management District
	Introduction & Overview	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**
10:35am	**David Colangelo** South Florida Water Management District Sea Level Rise And Flood Resiliency Plan, 2023	**Maggie Hunter** Molecular Investigation of the Invasive Burmese Python in the Greater Everglades Ecosystem	**Susanna Stofella** Flooding and Planting Density Shape Forests in an Experimental Everglades Landscape: Lessons for Forest Restoration	**Courtney Moore** Coastal Community Transitions Across a Salinizing Coastal Freshwater Short-Hydroperiod Wetland in the Southeastern Everglades: Implications for Ecosystem Structure and Function	**George Constantinescu** Numerical Simulations of Pump Intake Flows: Toward a Numerically-Based Design of Pump Intakes
10:50am	**Carol Ballard** Flood Protection Level of Service Assessment for C-111, Model-Land, and L-31NS Watersheds in MD County	**Jacob Orgorek** Mercury in Everglades Pythons	**Kristin Vaughan** Two Decades of Change In WCA-3 Tree Islands: Effects of Hydrology and Natural Disturbance	**Julian Alwakeel** Determining Groundwater Input, Sources and Amounts into Everglades Estuarine Lakes	**Kelin Hu** Hydrodynamic and Water Quality Modeling in Biscayne Bay
11:05am	**Nicole Iadevaia** Moving Water to Restore Rivers Wetlands and Estuaries in Southwest Florida and the Caloosahatchee Basin	**Jeremy Dixon** Python Research and Management to Protect Endangered Species in the Florida Keys	**Elli Danielson** *Lygodium microphyllum* Populations and Control In WCA-3	**Rolando Santos** Shift in Trophic Niche Characteristics of Common Snook and Atlantic Tarpon in Everglades Coastal Lakes	**Benjamin Israel Devadason** CFD Modeling – The Greater Everglades Pump Station Designer's Best Friend
11:20am	**Francisco Pena Guerra** Understanding the Impacts of Future Extreme Rainfall and Compound Flooding in Broward and North Miami	**Ian Bartoszek** Utilization of Scout Snakes as a Primary Tool for Burmese Python Removal in Southwestern Florida	**Marcel Bozas** Mammalian Distributions and Spatiotemporal Use of Everglades Tree Islands	**John Carroll** Impacts of Submarine Groundwater Discharge on Seagrass in Florida Bay	**Zubayed Rakib** Application of CFD to Restoration Hydraulics in Everglades Restoration Project
11:35am	**Katherine Loesser** Spatiotemporal Comparisons of Hydrologic Model Outputs to Inform Water Operations in the Everglades	**Mark Sandfoss** Big Cypress National Preserve Scout Snake Program, Where We've Been and Where We're Going	**Marsha Ward** Wildlife Utilization of Tree Islands in Everglades and Francis S. Taylor Wildlife Management Area	**Mingshun Jiang** Development of a Physical-Biogeochemical Model for Predicting HABs and Water Quality in Greater Florida Bay	**Seyed Hajimirzaie** Applications of CFD Model for Refined Spreader Canal Hydraulics in STA 3/4
11:50am	**Discussion**	**Discussion**	**Discussion**	**Discussion**	**Discussion**
12:00pm-1:30pm	**Lunch Buffet**				

PRESENTATION NOTES

Session No.	Speaker Name / Notes

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Thursday, April 20, 2023 (continued)					
Concurrent Sessions [1:30pm-3:00pm]					
	Great Cypress	Royal Poinciana	Ibis	Egret	Sandpiper
	Session 41	Session 42	Session 43	Session 44	Session 45
Session Title	National Academies' 2022 Review of Everglades Restoration Progress	Cape Sable Seaside Sparrow Science	Restoring Biscayne Bay: Stepping Back from the Tipping Point?	Innovative Developments, Applications, and Next Steps: The Everglades Depth Estimation Network (EDEN)	South Florida Coastal Wetland Response to Accelerating Sea-level Rise and Hydrologic Restoration
Moderator	**Stephanie Johnson** National Academies	**Stephanie Romañach** U.S. Geological Survey	**Sharon Ewe** Stantec, Inc.	**Saira Haider** U.S. Geological Survey	**Randall W. Parkinson** Florida International University
	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
1:35pm	**Philip Dixon** Restoration Progress	**Tylan Dean** What Have We Learned About the CSSS in the Last 30 Years of Study?	**Valentina Caccia** Spatial Distribution and Temporal Variability of Physical Parameters in Biscayne Bay	**Eric Swain** Refinements and Advancements: 17 Years of the Everglades Depth Estimation Network (EDEN)	**Joseph Smoak** Past and Present Accretion, Accumulation, and Elevation as Key to the Future of Mangrove Ecosystems in Southwestern Florida
1:50pm	**Alan Steinman** Stormwater Treatment Area Water Quality and Comprehensive Everglades Restoration Plan Progress	**Marisa Takada Martinez** Population Trends of the Cape Sable Seaside Sparrow Over Decades of Monitoring in the Everglades	**Venetia Brigg-Gonzalez** American Crocodiles in Biscayne Bay	**Dong Yoon Lee** Assessing Challenges and the Potential for Wetland Restoration Using a Datalogger Network	**Tiffany Troxler** Investigating Adaptive Capacity of Salinizing Coastal Wetlands in Natural and Urban Environments
2:05pm	**Denise Reed** Restoration in the Context of Climate Change	**Jay Sah** Long-Term Vegetation Dynamics in Cape Sable Seaside Sparrow Habitat: Lessons Learned and Implications for Everglades Restoration	**Bahram Charkian** Restoration Benefits Observed from the Biscayne Bay Coastal Wetlands Project	**Jeffrey Sommer** System-Wide Shifts in Standing Stock Compositions Respond to System-Wide Drying Patterns	**Kevin Montenegro** Increasing Marine Hydrologic Connectivity Influences Physical and Biogeochemical Processes in Coastal Mangrove Soils
2:20pm	**Denice Wardrop** Science Plan to Support Restoration of the South Florida Ecosystem	**Caitlin Beaver** Genetic Analysis of Federally Endangered Cape Sable Seaside Sparrow Subpopulations in the Greater Everglades, USA	**Todd Crowl** Back to The Future: What Do We Need to Avoid the Tipping Point	**Jelena Vukomanovic and Katherine E. Jones** Using Water Surfaces and Fuel Types to Automate Daily Fire Risk Maps in South Florida	**Rene' Price** Hydraulic Conductivity of Everglades Peats
2:35pm	**Discussion**	**Alan Mock** Wet-Season Hydrology Predicts Mercury Concentrations with Effects on Breeding Success of Cape Sable Seaside Sparrow	**Irela Bague** A Collaborative Approach to Recovery Efforts in Biscayne Bay: The Role of Leadership and Governance in Guiding Policy	Discussion on Future Directions of the Everglades Depth Estimation Network (EDEN)	**Kara Radabaugh** Mangrove Mortality and Resilience Following Hurricane Ian in Southwest Florida
2:50pm		**Discussion**	**Discussion**	**Discussion**	**Discussion**
3:00pm-3:30pm	PM Refreshments & Networking Break in Poster Hall				

Thursday, April 20, 2023 (continued)	
3:30pm-4:30pm	**Closing Plenary** **Moderator** **Dr. Nick Aumen**, Conference Chair, and Regional Science Advisor – South Florida, U.S. Geological Survey, Davie, FL **Keynote Speaker** **Shannon A. Estenoz**, Assistant Secretary for Fish and Wildlife and Parks, U.S. Department of the Interior, Washington, DC **Keynote Presentation** "Scientists Listening to Managers, and Managers Listening to Scientists – Improving the Dialogue"
4:30pm-5:30pm	**Exhibitors and Poster Session Two Presenters Remove Displays – Conference Concludes**

PRESENTATION NOTES

Session No.	Speaker Name / Notes

POSTER DISPLAY INFORMATION

Poster presentations play a key role in the exchange of information. Considerable time is dedicated to viewing them, giving scientists, policy makers, planners, practitioners, and managers valuable opportunities to interact and share details of their work, successes and lessons learned.

Posters are divided into two sessions. Consult the poster directory to confirm the session assignment for individual poster presentations.

The agenda allows for ample time to view posters, network, and have discussions. Please take time to explore posters, review displays and visit with posters presenters during the early morning, mid-day and afternoon and especially during the poster session.

Poster Session One

Scan to view Session One Posters in numerical order:

Poster Installation:	Monday, April 17, 4:00pm–7:00pm *(You may also set up Tuesday morning.)*
Formal Poster Session:	Tuesday, April 18, 5:00pm–7:30pm
5:30pm–6:15pm	Presenters at Odd Numbered Boards* to stand by their posters.
6:15pm–6:30pm	Prize Drawing *(Must be present to win.)*
6:30pm–7:15pm	Presenters at Even Numbered Boards* are asked to stand at their posters.
Poster Removal:	Wednesday, April 19, 10:00am–10:30am *(During mid-morning break.)*

Poster Session Two

Scan to view Session Two Posters in numerical order:

Poster Installation:	Wednesday, April 19, 12:00pm–1:30pm *(During lunch only; not before then.)*
Formal Poster Session:	Wednesday, April 19, 5:00pm–7:30pm
5:30pm–6:15pm	Presenters at Odd Numbered Boards* to stand by their posters.
6:15pm–6:30pm	Prize Drawing *(Must be present to win.)*
6:30pm–7:15pm	Presenters at Even Numbered Boards* are asked to stand at their posters.
Poster Removal:	Thursday, April 20, 4:30pm–5:00pm *(Immediately following closing keynote.)*

*As a courtesy to the presenter before/after you, please only stand at your poster during the assigned session. Posters are divided into two sessions. Consult the poster directory to confirm your session assignment.

Poster display boards will be dismantled by the vendor Thursday evening after the closing address. Organizers are not responsible for lost posters discarded by the board vendor. Thank you.

POSTER DIRECTORY

(In alphabetical order by presenter last name)

Poster #	First Name	Last Name	Affiliation	City	ST	Abstract Title	Poster Session
13	James	Beerens	South Florida Water Management District	West Palm Beach	FL	Supporting Ecological Functions in South Florida with the Minimum Flows and Levels Program	**One**
9	Kathleen	Boston	U.S. Geological Survey	Reston	VA	Monitoring Coastal Change on Jim Foot Key in Everglades National Park, FL with SAR Technology	**Two**
34	Laura	Brandt	USFWS	Davie	FL	Trends in American Alligator Pods in Arthur R. Marshall Loxahatchee National Wildlife Refuge 1998-2021	**One**
40	Mary	Brown	U.S. Geological Survey	Gainesville	FL	Fish Slam: Ten Years of Collaborative Non-native Fish Monitoring	**One**
31	Edward	Castaneda	Florida International University	Miami	FL	Hurricane Impacts on Structural Development and Carbon Dynamics in Riverine Mangroves of the Florida Everglades	**Two**
30	Stephanie	Castellano	University of Florida	Gainesville	FL	Incorporating Sea Level Rise into Everglades Restoration Planning	**One**
42	Nicholas	Castillo	Florida International University	Miami	FL	Drugs in our Flats: Exposure of South Florida Bonefish to Pharmaceuticals	**One**
19	Katherine	Castrillon	Florida International University	Miami	FL	Rehydrating an Urban Forested Watershed: Tree Response to Flow During the First Decade	**One**
43	Sean	Charles	East Carolina University	Wanchese	NC	Everglades as Resting Grounds for Passive and Active Data Fusion: Improvements to Global Budgets and Regional Processes	**One**
15	Chang Jae	Choi	University of Florida, FLREC	Davie	FL	Comparative Genomics of Pathogenic and Non-Pathogenic Strains of *Labyrinthula sp.*	**One**
23	Tasso	Cocoves	U.S. Army Corps of Engineers	Jacksonville	FL	Informing Everglades Restoration: From Monitoring and Assessment to Evaluation Tools	**One**
18	Jenna	Cole	University of Florida	Davie	FL	Factors Influencing Body Condition of Argentine Black and White Tegus *(Salvator merianae)* in Southern Florida	**Two**
11	Timothy	Collins	Florida International University	Miami	FL	The Diversity and Distribution of Non-Native Flatworms and a Ribbon Worm in South Florida	**Two**
28	Xavier	Comas	Florida Atlantic University	Boca Raton	FL	Drone-based Ground-penetrating Radar Measurements to Characterize Carbon Dynamics of Peat Soils in the Everglades	**Two**
12	Raelene	Crandall	University of Florida	Gainesville	FL	Fire and Flooding Interact to Affect Survival of *Croton linearis*, a Rare Pine Rockland Plant	**Two**
45	Laura	D'Acunto	U.S. Geological Survey	Gainesville	FL	The Impact of Uncertainty on Model Outcomes Used for Everglades Restoration Planning	**One**
10	Wesley	Daniel	U.S. Geological Survey	Gainesville	FL	What the Early Detection and Rapid Response Information System Means to the Everglades and Florida	**Two**
16	Stephen	Davis	The Everglades Foundation	Palmetto Bay	FL	The Everglades Handbook: Understanding the Ecosystem – its 40-year Evolution	**One**

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Poster #	First Name	Last Name	Affiliation	City	ST	Abstract Title	Poster Session
4	Maite	De Maria	U.S. Geological Survey	Gainesville	FL	Transcriptomics Analysis of Glyphosate and Perfluorooctanesulfonic Acid Effects (PFOS) on the Immune System of Florida Manatees	**One**
22	Donald	DeAngelis	U.S. Geological Survey	Davie	FL	Experiment and Mathematical Model of Control of Water Hyacinth	**One**
33	Jessica	Dell	U.S. Army Corps of Engineers	Jacksonville	FL	Biscayne Bay and Southeastern Everglades Ecosystem Restoration: Performance Measure Target-Setting Informed by Sea Level Rise	**Two**
35	Mat	Denton	U.S. Geological Survey	Gainesville	FL	Isotopic Analysis of American Alligators *(Alligator mississippiensis)* Reveals Notable Intraspecific Niche Plasticity Throughout the Everglades	**One**
41	Cody	Eggenberger	Florida International University	Miami	FL	Movement Patterns and Habitat Selection of Common Snook and Atlantic Tarpon in the Coastal Everglades	**One**
41	Marissa	Figueroa	Florida International University/ Rookery Bay NERR	Naples	FL	Investigating the Influence of Rehydration on Soil Carbon Flux in Rookery Bay NERR Mangrove Forest	**Two**
48	Nicholas	Gonzalez	Miccosukee Tribe of Indians of Florida	Miami	FL	Using Trail Cameras to Estimate Relative Abundance Indices of Wildlife Across Miccosukee Tribal Lands	**Two**
47	Saira	Haider	U.S. Geological Survey	Davie	FL	Lessons Learned: Increasing Inclusivity with the Everglades Tree Island Indicator (ETrii)	**One**
9	Taylor	Hancock	University of South Florida/Florida Gulf Coast University	Fort Myers	FL	Elevated Hydrogen Peroxide Forecasts Cyanobacterial Blooms: A Gene Expression Connection	**One**
37	Dennis	Hanisak	FAU Harbor Branch	Fort Pierce	FL	Addressing the Emerging Environmental Issue of Coastal Acidification in Florida's Estuaries: The Indian River Lagoon Observatory Network of Environmental Sensors (IRLON)	**Two**
15	Madison	Harman	University of Florida	Gainesville	FL	Diet Composition of Invasive Argentine Giant Tegus *(Salvator merianae)* in Miami-Dade and Charlotte Counties, FL	**Two**
35	Young Gu	Her	University of Florida	Homestead	FL	Impacts of Climate Change and Sea Level Rise on Southeast Florida's Groundwater Resources	**Two**
17	Myranda	Hernandez	SOFTEL- Florida International University	miami	FL	Distribution of C_3 and C_4 Plants Along Hydrological Gradient in the Everglades, Florida	**One**
30	Samantha	Hormiga	Florida International University	Miami	FL	Coastal Carbon Flux: Periphyton Contributions and Diatom Indicators	**Two**
38	Hunter	Howell	University of Miami	Coral Gables	FL	The Ecology of the Greater Siren and the Two-Toed Amphiuma in the Everglades	**One**
29	Md Rajeun	Islam	Florida Atlantic University	Boca Raton	FL	Laboratory-based Airborne Ground-Penetrating Radar Measurements to Identify Hot Spots for Gas Accumulation in the Everglades	**Two**
42	Richard	James	South Florida Water Management District	West Palm Beach	FL	The Restoration Strategies Science Plan	**Two**
5	Peter	Kalla	United States Environmental Protection Agency	Athens	GA	Interacting Contaminants Can Influence Mercury Bioaccumulation in the Everglades Marsh	**One**

Poster #	First Name	Last Name	Affiliation	City	ST	Abstract Title	Poster Session
10	Andrew	Kamerosky	Applied Ecology Inc	Melbourne	FL	Remote Sensing of HABs in the Indian River Lagoon, FL: UAS Hyperspectral to Satellite Multispectral	**One**
31	Thomas	Kelly	Miccosukee Fish & Wildlife	Fort Lauderdale	FL	Passive Acoustic Monitoring of Vespertilionid and Molossid Bats on Miccosukee Tribal Lands	**One**
3	Samuel	Kent	Florida International University	Miami	FL	Horticultural Nurseries-based Pollution Dynamics and Apportionment in Canals of South Miami Dade, Florida	**One**
1	Marguerite	Koch	Florida Atlantic University	Boca Raton	FL	Linkages Between Seagrass Tissue O_2 Dynamics and Ecosystem Oxidation and Feedbacks are Revealed using Microsensors In Situ	**Two**
24	Kurt	Kowalski	U.S. Geological Survey	Ann Arbor	MI	Collaborations and Landscape-scale Adaptive Management of Invasive *Phragmites australis*: Insights from the Great Lakes	**Two**
6	Michael	Kratz	Florida Gulf Coast University	Fort Myers	FL	QT-AMP: Sequencing PCR Amplicons from Quanti-Tray Wells to Analyze Enterococci Communities	**One**
14	Savannah	Lacy	U.S. Army Corps of Engineers Jacksonville District	Jacksonville	FL	How Operational Flexibility Replenished Submerged Aquatic Vegetation on Lake Okeechobee in 2019	**One**
38	Lukas	Lamb-Wotton	Florida International University	Miami	FL	Assessing Vulnerability of Everglades Coastal Peat Marsh: A Framework for Local-to-Regional Scale Evaluation	**Two**
21	Jacob	Larsson	Florida Fish and Wildlife Conservation Commission	Sunrise	FL	Woody Vegetation Mechanical Treatment: Restoring the Sawgrass Marsh	**Two**
13	Shelby	LeClare	University of Florida	Gainesville	FL	Effects of the Invasive Burmese Python on the Everglades Food Web	**Two**
7	Dakota	Lewis	University of Florida	Gainesville	FL	Freshwater Discharge Disrupts Linkages Between the Environment and Estuarine Fish Community	**Two**
22	Yuanming	Lu	University of Florida	Gainesville	FL	Micro-Scale Spatial Patterns of Plant Invasion Dynamics and Its Controlling Efficiency	**Two**
23	Michael	Manna	South Florida Water Management District	West Palm Beach	FL	Reconnecting Everglades Vegetation Communities and Determining Effective Maintenance Control of Cattail	**Two**
19	Brittany	Mason	University of Florida	Davie	FL	Factors Influencing Movement Patterns of the Invasive Argentine Black and White Tegu *(Salvator merianae)*	**Two**
16	Kelly	McCaffrey	University of Florida	Davie	FL	Body Condition Index Validation in the Argentine Black and White Tegu *(Salvator merianae)*	**Two**
7	Christopher	McVoy	South Florida Engineering & Consulting	Lake Worth,	FL	Temperature and Dissolved Oxygen Profiles in an Everglades Slough	**One**
37	Alex	Meinders	Audubon Florida	Naples	FL	Spatial and Temporal Trends in Mammal Communities in an Ecologically Important Western Everglades Sanctuary	**One**
39	Tyler	Michels	Miccosukee Tribe of Indians of Florida	Miami	FL	Investigating Breeding Status and Distribution of Eastern Black Rail *(Laterallus jamaicensis)* on Miccosukee Tribal Lands	**One**

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Poster #	First Name	Last Name	Affiliation	City	ST	Abstract Title	Poster Session
11	Melissa	Nasuti	U.S. Army Corps of Engineers	Jacksonville	FL	2020 Combined Operational Plan Biennial Report: Connecting the Dots Between Operations, Monitoring, and Future Planning	**One**
18	Samuel	Neely	Florida International University	Miami	FL	Establishing Modern Peat Analogs to Decipher Mangrove Sub-habitats from Historical Peats	**One**
21	Danielle	Ogurcak	Florida International University	Miami	FL	Mangrove Forest Recovery in Rookery Bay National Estuarine Research Reserve Five Years following Hurricane Irma	**Two**
8	Ikechukwu	Onwuka	Florida International University	Miami	FL	Particulate and Phosphorus Dynamics in the Water Column and Sediments of Greater Everglades Ecosystem Canals	**One**
2	William	Orem	U.S. Geological Survey	Reston	VA	Lignin Phenols as Markers of Seagrass History in Florida Bay Sediments	**Two**
43	Melinda	Paduani	Florida International University	Miami	FL	Microplastic Sequestration by Mangroves in the L-31E Flow-way of Biscayne Bay	**Two**
36	Rajendra	Paudel	South Florida Natural Resources Center	Homestead	FL	Everglades Hydrologic Response to Future Climate Change	**Two**
14	Adam	Pérez	Cherokee Nation System Solutions contractor in support of the U. S. Geological Survey	Gainesville	FL	Development of an Environmental DNA CRISPR Biosensor for the Detection of Invasive Burmese Pythons in the Greater Everglades	**Two**
24	Matthew	Petkewich	U.S. Geological Survey	Columbia	SC	Real-Time Monitoring Index to Identify Changing Salinity Conditions Related to Coastal Environment Disturbance Events	**One**
3	Jennifer	Rehage	Florida International University	Miami	FL	Seagrass Seascape State, Stability, and Function in Relation to Water Quality in Biscayne Bay	**Two**
4	Laura	Reynolds	Conservation Concepts / Florida International University	Tallahassee	FL	Increased Phosphorous Availability Impacts Seagrasses in Biscayne Bay, Implications for Water Quality Management and Biscayne Bay Southeast Everglades Restoration (BBSEER) Project	**Two**
32	Amanda	Richey	Florida International University	Miami	FL	Hydrologic Effects on Net Ecosystem Exchange of CO_2 in the Southeastern Saline Everglades	**Two**
5	Jonathan	Rodemann	Florida International University	Miami	FL	Multi-scale Habitat Selection of Spotted Seatrout in an Area of Seagrass Recovery	**Two**
34	Stephanie	Romañach	U.S. Geological Survey	Gainesville	FL	Sea Level Rise Impacts on Priority Habitats and Species	**Two**
39	Deusdedith	Rugemalila	Florida International University	Miami	FL	Local and Spatial Variability in Vegetation Species Composition in Relation to Environmental Heterogeneity in the Everglades Ecosystem	**Two**
8	Darren	Rumbold	Florida Gulf Coast University	Fort Myers	FL	A Bayesian Network as a Decision Support Tool for Managing the Caloosahatchee River Estuary	**Two**
17	Daniel	Russell	University of Florida, Croc Docs	Davie	FL	Diet Analysis of Invasive Argentine Black and White Tegus *(Salvator merianae)* in Southern Florida	**Two**

Poster #	First Name	Last Name	Affiliation	City	ST	Abstract Title	Poster Session
28	Owen	Schneider	University of Florida	Gainesville	FL	Two Decades of Restoration Shape Rare Plant Communities Along an Elevational Gradient in South Florida	**One**
12	Jorge Rodrigo	Sedeno	U.S. Army Corps of Engineers	Jacksonville	FL	Setting the Foundations for a CERP Science Module in the Southwestern Margins of the Everglades	**One**
32	Julia	Silva Seixas	University of Georgia	Athens	GA	From the Everglades to the Cities: Trade-offs to Urban Nesting in White Ibises *(Eudocimus albus)*	**One**
20	Dylan	Sinnickson	Florida International University	Miami	FL	Modeling Slough Crayfish Populations in Response to Hydrologic Variability	**One**
44	Daniel	Slone	U.S. Geological Survey	Gainesville	FL	How Many Are Really Down There? Evaluating Electrofishing Catchability Rates for Biosurveillance of Non-native Freshwater Fishes	**One**
20	Samantha	Smith	University of Florida	Davie	FL	Using Camera Traps to Estimate Occupancy of Invasive Tegus *(Salvator merianae)* in South Florida	**Two**
46	Bethany	Stackhouse	U.S. Geological Survey	Reston	VA	Resiliency of Mangroves and Coastlines in a Changing Climate	**Two**
6	Uli	Stingl	University of Florida	Davie	FL	Endophytic Fungi Can Inhibit the Growth of the Causative Agent of Seagrass-Wasting Disease, *Labyrinthula sp.*	**Two**
25	Eric	Swain	U.S. Geological Survey	Davie	FL	Programmatically Estimating Volumetric Flow in the Everglades Depth Estimation Network (EDEN)	**Two**
33	Christina	Tilley	Florida International University	North Miami	FL	Discerning the Relationships Between Water Levels, Crayfish Populations, and White Ibis in the Western Everglades	**One**
1	Mohsen	Tootoonchi	University of Florida	Belle Glade	FL	Impact of Floating Aquatic Vegetation in Drainage Canals and Farm Phosphorus Discharges	**One**
27	Umida	Turamuratova	Florida Atlantic University	Boca Raton	FL	Exploring The Effects of Water-Table Elevation Changes In Peat Soils Across A Salinity Gradient	**Two**
29	Stephanie	Verhulst	U.S. Army Corps of Engineers	Jacksonville	FL	Updating Methods to Estimate Florida Bay Salinity for the RECOVER Southern Coastal Systems	**One**
44	Rosario	Vidales	Florida International University	Miami	FL	Leaf Functional Trait Variation in Red Mangroves of Neighboring Coastal Environments	**Two**
36	Mariaguadalupe	Vilchez	University of Florida	Gainesville	FL	A Chomp and a Slither: The Implications of the Invasive Burmese Python on American Alligator	**One**
2	Youchao	Wang	South Florida Water Management District	West Palm Beach	FL	Everglades Agricultural Area Phosphorus Source Control Program Basin Monitoring and Performance Assessment	**One**
27	Lynn	Wingard	U.S. Geological Survey	Reston	VA	Linking Modern and Sediment Core Data to Identify Potential Indicator Species for Restoration Performance Measures	**One**
40	Nathanial	Winn	Florida Atlantic University	Boca Raton	FL	Internal Oxygen Dynamics and Rhizosphere Oxidation in Tropical Seagrass, *Thalassia testudinum*	**Two**
21	Simeon	Yurek	U.S. Geological Survey, Wetland and Aquatic Research Center	Gainesville	FL	Optimal Foraging Models of Wading Birds in Seasonally-pulsed Everglades Wetlands	**One**

ABSTRACT COMPILATION

(In alphabetical order by presenter last name)

DEVELOPMENT OF TIDAL BOUNDARY CONDITION FOR REGIONAL MODEL (RSMGL) IN SUPPORT OF BBSEER PROJECT

Maliha N. Ahmed, *Alaa Ali, Walter Wilcox, and Brion Lehar*
South Florida Water Management District, West Palm Beach, FL, USA

Tidal timeseries are essential component of the Regional Simulation Model Glades-LECSA (RSMGL) to establish the coastal overland and groundwater head boundary. This aspect of modeling is significant for the Biscayne Bay and Southeastern Everglades Ecosystem Restoration (BBSEER) project which emphasizes on restoration of the coastal wetlands and subtidal areas of the Biscayne Bay and freshwater wetlands in Southern Glades and Model Lands. Although ideal for modeling, the long-term spatially distributed historical water level data along the coast of South Florida are sparse. Therefore, the daily tidal timeseries at 26 tidal stations in the RSMGL boundary for the 1965-2016 period of simulation were established by modeling the observed water levels to represent sea level conditions as a combination of harmonic signals and predictable residuals comprising non-harmonic constituents of tide. The modeled tidal boundary condition timeseries represents a consistent sea level at a given time and sea level change, without a sea level rise trend. The best available hourly observed water level and tidal prediction data for NOAA primary and secondary control tide stations and ENP stations were obtained. Initially, 4 reference stations including 2 NOAA primary stations and 2 ENP stations were selected based on availability of long-term historical data. The observed data were pre-processed to construct continuous timeseries and converted to weekly and trended based on the 1992-centered tidal epoch. Decomposition was conducted on both the observed and corresponding predicted timeseries to obtain the intrinsic components from which the highest-frequency components were filtered out to reduce noise. Both datasets were used to train an autoregressive model to simulate the tidal timeseries. The simulated timeseries was then converted to daily timeseries and was adjusted by adding back the high-frequency intrinsic components to include the effects of shallow-water hydrodynamics. The final timeseries was constructed by applying the recommended offset to account for sea level change relative to 1992. For spatial propagation of the tidal boundary condition to the rest of the stations, correlation analysis was performed among the reference stations and the additional stations. For each of the additional stations, simulated tidal timeseries of the highest correlated reference station was selected and used to calculate the simulated data for that station. The new simulated timeseries was adjusted using the same method as above and appropriate offset was applied to prepare the final tidal timeseries. The results of this effort provide increased number of tidal stations, more frequent and spatially distributed in the coastal boundary, essentially capturing regional-scale variability in tidal levels. In addition, this modeling approach ensures the existing timeseries data can be transformed and used to represent tidal condition of any future scenario with sea level change.

STATISTICAL EMULATION OF THE BISCAYNE BAY SIMULATION MODEL

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The Comprehensive Everglades Restoration Plan aims to improve the quantity, quality, timing, and distribution of freshwater flow through central Florida to the southern coasts and to restore nearshore estuarine conditions in Biscayne Bay. The Biscayne Bay Simulation Model (BBSM) is used to evaluate the effects of proposed changes to freshwater flow on salinity in the bay. Due to the run time of one BBSM scenario is lengthy and such an evaluation to reach an optimal management strategy can take months. Of interest is to develop statistical model that can accurately emulate the BBSM performance in a fraction of its run time hence facilitating a meaningful system optimization for a faster more accurate optimal flow regime. I this study a time series recursive Artificial Neural Network (ANN) model is developed to simulate salinity time series at the BBSM 3 zone 2404 cell grid on a sub-daily time scale using inflow time and tidal time series. A tidal boundary analysis was performed to help fill missing gaps, followed with a comprehensive principal component analysis to assess the multivariate structure, and provide a more plausible multivariate representation of the BBSM model. An autoregressive ANN with exogenous variable was used to simulate salinity at 2404 grid cells on 6 hourly time scale. Results show that emulated salinity is substantially matching that produced by BBSM. Such an output can then be processed to calculate metrics to assess the performance of the Biscayne Bay & Southeastern Everglades Restoration (BBSEER) project alternatives relative to each other and to the baseline/no action to identify the extent by which proposed restoration measure will improve conditions in the nearshore saline environment.

DETERMINING GROUNDWATER INPUT, SOURCES AND AMOUNTS INTO EVERGLADES ESTUARINE LAKES

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[2]Institute of Water and Environment, Florida International University, Miami, FL, USA

Groundwater discharge may contribute water and chemical constituents at concentrations equal to or higher than surface water inflows. Diversion of water from the historical Greater Everglades watershed led to a decrease in freshwater inflow into Everglades National Park estuarine lakes in the Alligator Creek and McCormick Creek systems. Increases in both salinity and phosphorus have been observed in the estuarine lakes coincident with upstream water diversion activities. Saltwater intrusion is known to occur in the aquifer beneath the Everglades National Park southern estuarine lakes. Preliminary mixing model findings may suggest that freshwater flow into the McCormick Creek system is delivered from the direction of the Taylor Slough Bridge and the L31W canal. Alligator Creek system water appears to be most similar to Florida Bay water. Previously unknown groundwater discharge to the southern estuarine lake systems in Everglades National Park was quantified as part of this study. Water budgets were computed monthly, annually, and seasonally including seven years of data from 2014 to 2020. Preliminary estimates indicate that groundwater discharge to the estuarine lakes contributes between 0.65 m yr^{-1} to 2.25 m yr^{-1}. Estuarine lake water levels are affected by greater groundwater influence eastward, with the greatest groundwater influence at Seven Palm Lake in the McCormick Creek system and the lowest influence at West Lake in the Alligator Creek System. Larger amounts of fresher groundwater inflows were observed in the estuarine lake closest to active freshwater rehydration efforts. Groundwater discharge volumes were explored to describe how these relate to other water budget parameters, seasonality, and water deliveries into Everglades National Park. This investigation provides important information regarding the effects of Everglades Restoration efforts on water quality in the southern coastal regions of Everglades National Park.

ORGANIC CARBON AND NUTRIENT TURNOVER IN TREATMENT WETLANDS: INSIGHTS FROM A MULTIPLE BIOGEOCHEMICAL APPROACH

***Joao Henrique Fernandes Amaral**[1,2]; Jacob Gaddy[2]; Thomas S. Bianchi[2]; Todd Osborne[3]; Susan Newman[4]; Jacob Dombrowski[4] and Elise Morrison[1]*

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The Everglades Stormwater Treatment Areas (STAs) are wetlands constructed to reduce total phosphorus (TP) concentrations from runoff before discharge to the Everglades Protection area. A major component of TP discharged to and transported through the STAs is dissolved organic matter (DOM). DOM plays an important role in the phosphorus (P) and nitrogen (N) cycle, but the examination of their interactions in treatment wetlands has been limited. A leaching decomposition experiment was conducted with three decay phases; fresh (Day 0; D0), intermediate (Day 20; D20), and late (Day 40; D40), using litter and floc material from an area of submerged aquatic vegetation (SAV- *Chara* spp.*)* and emergent aquatic vegetation (EAV- *Typha domingensis)* inside STA-3/4 upstream of the outflow structures. This experiment was coupled with water sampling along the flow path within the same STA. The goal was to assess organic carbon (C) and nutrient (P, N) turnover within the STAs, using a multiple biogeochemical approach: parallel factor analysis components (PARAFAC) coupled with amino acid and bulk elemental analyses (total and dissolved C, N, P). PARAFAC results suggest that DOM was predominantly humic (4 out of 5 components, C1-C5). A humic terrestrial/vascular plant component (C1) was dominant (29%) at all transect stations. Results from the leaching experiment showed that litter from EAV (*T. domingensis*) is the primary source of C1 in STAs in the early stages of leaching (D0 and D20). The contribution of components derived from microbial (C5) and photochemically (C2) sources increased along the flow path, suggesting that photochemistry and microbial degradation are linked to the decay of SAV and EAV-derived DOM in the STAs. The microbial humic-like component (C3), leached at times D0 and D20 from *Typha* litter substrate, and consistently decreased over the leaching incubation in *Typha* floc treatments at all decay phases; this suggests C3 may be conducive to degradation of the floc layer. Component 3 was also inversely correlated with the humic photoproduct component (C4), further suggesting that C4 is produced through C3 degradation. The *Chara* litter treatment showed increases of the labile proteinaceous component (C5), associated with the amino acid, tryptophan, in the DOM pool at times DO (from 7 % to 50%) and D20 (16%). Increases in C5 were also observed for *T. domingensis* litter (7% to-14%) at time D0. An increase in C5 was observed along the transect and is likely associated with decay from fresh litter material from EAV and SAV. This is supported by the extensive leaching observed on day 0 for DOC (30 X greater than D20 for SAV, and 17 X for EAV) and total dissolved nitrogen (TDN,18X greater than D20 for SAV, and similar for EAV), from SAV and EAV litter. These results highlight the temporal and spatial variability of organic matter cycling in STAs, which occur across decay gradients driven by photochemical and biological (e.g., microbial) processes.

ASSESSMENT OF RIVER CHANNEL CHANGES FOLLOWING THE REINTRODUCTION OF FLOW TO THE KISSIMMEE RIVER

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Alterations in hydrologic patterns and flow rates can impact river channel morphology and stability. The Kissimmee River Restoration Project (KRRP) reestablished flow to the river channel following completion of the first phase of construction (C-38 canal backfilling) in 2001. Flow was primarily from the Headwaters Lakes and was regulated with an interim regulation schedule that was not designed to provide the flows necessary to restore the Kissimmee River. The resulting interim hydrologic regime had a wider range of flows and faster rates of change than occurred pre-channelization. Such changes in the hydrologic regime have the potential to affect characteristics of river channel geomorphology including stability. Permanent transects (n=13) perpendicular to the river channel were established in 2007 to evaluate changes in river channel geomorphology. The resulting cross-sections were surveyed at approximately annual intervals. These transects were located in both straight and curved sections of the river and included remnants of the natural river channel and newly excavated or "recarved" channels that were designed with characteristics similar to remnant channels. Graphs of the position of channel cross-sections on transects indicated that the channel was migrating at most transects in a remnant channel (Montsdeoca Run) and a recarved channel (Fulford Run) in the Phase I area. Over the 15-year period, cross-sectional area increased by an average of 43 m2 (SE=20) in Montsdeoca and 11 m2 (SE=1.3) in Fulford; these relatively small changes may have been partly due to monitoring at these sites beginning 6 years after flow was reestablished, potentially after more pronounced changes had occurred. For comparison, an average increase in cross-sectional area of 72 m2 (SE=13) was measured for 4 transects in 2 remnant channels (Caracara Run and Chandler Run) in the Phase II/III section of the restoration project where flow was reestablished in 2017. The relatively larger changes occurred primarily in the initial years, as data were captured immediately following reintroduction of flow to the channels. In a separate sub-study, in 2014 a permanent transect was established to measure changes where a meander bend had been cut off to form an oxbow. The cross-sectional area of the resulting channel increased from 8 m2 to 226 m2 in the first 14 months and afterwards averaged 256 m2 (SE=11); suggesting that the new channel is stabilizing. These preliminary results suggest that geomorphic responses to changes in flow in the Kissimmee River can be rapid and may already be stabilizing for some characteristics (cross-sectional area) and on-going for others (channel migration). Continued monitoring is needed to evaluate changes following implementation of the Headwaters Revitalization Schedule (HRS), currently projected for 2026. HRS is intended to provide a flow regime that more closely approximates that of the pre-channelization river.

CHALLENGES TO HYDROLOGIC RESTORATION OF THE KISSIMMEE RIVER DURING A TWENTY-YEAR INTERIM PERIOD

David H. Anderson

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The Kissimmee River Restoration Project (KRRP) began an Interim Period after completion of the first phase of construction in 2001 and reintroduction of flow to portions of the river channel and floodplain. During this Interim Period, flows to the river from the Headwaters Lakes were regulated with a temporarily-modified regulation schedule that was not designed to provide flows sufficient for full restoration of the river and floodplain. As a result, to date we have seen only modest improvements in hydrologic conditions, falling far short of ultimate project targets. Now that construction was completed in 2021, the regulation schedule will be changed in the near future to better meet project objectives. This paper will use several examples to describe current and future challenges for reestablishment of pre-regulation hydrology for KRRP. A key hydrologic objective of KRRP is to reestablish historic patterns of floodplain inundation with hydroperiod duration, seasonality, and frequency comparable to those in the pre-channelization Reference Period. During the Reference Period, the floodplain was dominated by a broadleaf marsh community (BLM), and a literature review indicated that BLM requires long hydroperiods of at least 1 foot of depth for at least 210 days; the frequency of these events was estimated by analysis of Reference Period hydrology at sites known to have had BLM communities, which showed that such hydroperiods occurred in 59% of years, while during the Interim Period, the longest hydroperiod measured at sites that had formerly been BLM was only 169 days, far short of the 210-day target in 59% of years derived from the Reference Period data. The inability to meet hydroperiod targets during the Interim Period is likely related to insufficient storage in the Headwater Lakes for restoration under the current Interim Schedule. Another hydrologic objective is to reestablish slow rates of stage ascension and recession in the floodplain. Rates of change in the Interim Period have been much more rapid than occurred during the Reference Period. This is also likely related in part to the lack of storage in the Headwater Lakes, because at higher lake stages, rising stage can trigger rapid and large increases in discharge for flood control; such rapid changes in flow have been implicated in declines in dissolved oxygen among other problems. A new regulation schedule, named the Headwaters Revitalization Schedule (HRS), is being developed for the Headwater Lakes to address these and other hydrologic issues. HRS will allow additional storage and will include discharge specifications that will improve hydroperiod characteristics. When HRS is fully implemented following a five-year period of phased implementation, hydrologic monitoring and evaluation will be continued to determine if the schedule successfully reestablishes key hydrologic characteristics or if adaptive modifications are needed.

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PEAT AND MARL DISSOLVED ORGANIC MATTER VARY AMONG WETLANDS WITH NUTRIENT ENRICHMENT AND RESTORED HYDROLOGY

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Dissolved organic matter (DOM) drives biogeochemical processes in aquatic ecosystems. Yet, how hydrologic restoration in nutrient-enriched ecosystems changes DOM and the consequences of those changes for the carbon cycle remain unclear. To predict the consequences of hydrologic restoration on carbon cycling in restored wetlands, we need to understand how local environmental factors influence production, processing, and transport of DOM. Supported by the South Florida - Caribbean Cooperative Ecosystem Studies Unit we sampled along transects in restored peat and marl wetlands in the Florida Everglades that vary in water depth, phosphorus (P) concentrations (water, macrophytes, periphyton, and soil), and primary producer biomass to understand how these drivers affect DOM composition and dissolved organic carbon (DOC) concentrations. Higher water depths led to a "greening" of DOM with decreasing concentrations of DOC and increasing algal contributions to DOM in peat wetlands and a "browning" of DOM with increasing DOC concentrations and increasing humic DOM sources in marl wetlands. Soil P was positively correlated with increasing DOC concentrations and microbial contributions to DOM in peat wetlands, and periphyton P was positively correlated with the algal contributions to DOM in marl wetlands. Despite large variation in both vegetation biomass and periphyton biovolume across transects and sites, neither were predictors of DOC concentrations or DOM composition. We show that hydrologic restoration differentially alters DOM in peat and marl wetlands and interacts with nutrient enrichment to shift the proportion of green and brown contributions to DOM.

APPLICATION OF STORM SURGE MODELS TO RESILIENCY STUDIES IN SOUTH FLORIDA

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This paper focuses on the application of the storm surge model developed in support of resiliency studies in South Florida. This model is intended to determine the impact of storm surge and sea level rise within canals and downstream of SFWMD water control structures discharging into Biscayne Bay. This model system (ADCIRC, SWAN and Delft3D) was calibrated using previous storm data and includes simulations of the detailed storm surge interaction with regional features (far field ocean, barriers islands, Biscayne Bay itself) and local infrastructure (coastal canals and water control structures). The model has successfully been used to compute current and future water levels for a variety of hurricane scenarios, including Hurricanes Wilma, Andrew, Irma and Tropical Storm Bertha, to obtain tidal coastal flood inundation maps for flood risk analysis, and for potential applications to a resilient design of the L31E levee.

LINKING TECHNOLOGIES TO MAXIMIZE DETECTION AND MEASUREMENT OF HARMFUL ALGAL BLOOMS

***Cassondra Armstrong**, Thomas Behlmer, and Zhiqiang Chen*
South Florida Water Management District, West Palm Beach, FL

The accuracy of measuring Harmful Algal Blooms (HABs) depends on the scale of the technique used. Satellite resolution may be insufficient to capture smaller blooms in confined areas such as marinas or along the edges of lakes and rivers. Discrete water quality grab samples may not capture to full extent and variability of bloom size and intensity. But by using multiple methods, an algal bloom can more accurately be assessed. The South Florida Water Management District (SFWMD), in coordination with University of South Florida and Florida Atlantic University, is working with the National Aeronautics and Space Administration (NASA), to coordinate satellite flyovers with field sampling to improve interpretation of spatial chlorophyll a data. Coupled with physical-biological models for the St. Lucie Estuary and the Caloosahatchee River Estuary, linking satellite and field data helps better understand algal bloom dynamics, particularly the potential linkage between water discharge, local forcing, and algal blooms. By incorporating state-of-the-art remote sensing, physical-biological models, and field sampling results into single data tool, the SFWMD and the U.S. Army Corps of Engineers will have better resources when making Lake Okeechobee management decisions.

A COLLABORATIVE APPROACH TO RECOVERY EFFORTS IN BISCAYNE BAY: THE ROLE OF LEADERSHIP AND GOVERNANCE IN GUIDING POLICY

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Miami-Dade County, FL

Since 1890, over 20 percent of the North Biscayne Bay watershed was filled and replaced by 30 islands and six causeways. In addition, the Miami River and North Bay canals were dredged to improve navigation. Early recognition of the impact of human-induced changes on the Biscayne Bay environment led to the establishment of Biscayne Bay's two Aquatic Preserves by the State of Florida, and the Miami-Dade County government declared the Bay an "Aquatic Park" in 1974 and the establishing of Biscayne National Park in 1980. In 1981, the Biscayne Bay Management Committee was created to counteract the substantial loss of Bay resources. The Committee's goal was to oversee restoration projects that provided aesthetic, recreational, and ecological value to the Bay. The restoration plan returned the Bay to a more ecologically stable condition, but the Committee was sunsetted in 1992. Later, the Florida Legislature included Biscayne Bay in the Surface Water Improvement and Management Act of 1997, followed by the creation of the Biscayne Bay Partnership Initiative in 1999. In 2019, the Greater Miami and the Beaches Resilient305 Strategy listed the restoration of Biscayne Bay as its principle action. Despite the many layers of the county, state, and federal protections, the Biscayne Bay watershed continues to be threatened by a lack of fresh water, nutrient pollution from storm-water runoff, sanitary sewage overflows, vulnerable septic systems, marine debris, and other contaminants. Biscayne Bay is at a tipping point and in danger of a regime shift as changes in the health of the watershed in recent years include a decline in seagrass cover, increased frequency and duration of algal blooms, unprecedented offshore stony coral disease, and annual fish kill events since August 2020 raising a new level of concern about the state of the Bay. In response, the Miami-Dade County Commission established the Biscayne Bay Task Force in 2019. The Task Force was comprised of scientists, professionals, and community members who worked to and prepare a final report in June 2020. The Task Force identified problem areas, prioritized projects, and provided a series of recommendations, including establishing an overarching permanent governing and administrative structure to implement the recommended actions. Today, County leadership oversees the Biscayne Bay Watershed Management Advisory Board working on a unified and committed effort with municipalities, state and federal agencies, and the public to set nutrient pollution reduction targets and establish a long-term course toward a healthy and resilient Biscayne Bay.

LINKING AMERICAN ALLIGATORS WITH MARSH PRODUCTIVITY, AN EMPIRICAL FRAMEWORK

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The American alligator (*Alligator mississippiensis*) is a keystone species in the Everglades playing many roles in the ecosystem as prey, predator, and ecosystem engineer. Some of the most important variables for maintaining suitable alligator habitat in this wetland ecosystem include water depth, timing of specific depths relevant to annual alligator status and condition, and prey production and availability. Restoration of more natural patterns of water quality, quantity, timing, and distribution are underway to reestablish some of the impacted ecological functions. The alligator conceptual ecological model developed for Everglades states that the two main variables driving individual condition and number of alligators (performance measures) are hydrology and prey productivity. For alligators, when and how to allocate energy entirely depends on what condition individuals are in to meet physiological requirements such as growth and reproduction, which in turn depends upon marsh productivity. Marsh productivity is determined by hydrological patterns, depth, period, and timing of inundation, and how they affect prey production and availability. In this presentation, we will discuss the effect of hydrological parameters (water depth and hydroperiod) on the two alligators population performance measures (abundance and body condition) and how this effect could be linked with marsh productivity in the Greater Everglades based on data collected during the last two decades. We will discuss the implications of our results and define an empirical framework to test those hypotheses focused on producing an integrative approach that improves alligator population management and ecosystem restoration.

FLOOD PROTECTION LEVEL OF SERVICE ASSESSMENT FOR C-111, MODEL-LAND, AND L-31NS WATERSHEDS IN MD COUNTY

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South Florida Water Management District (SFWMD) is conducting a system-wide review of its regional water management infrastructure to determine the Flood Protection Level of Service (LOS) for the SFWMD water management facilities within south Miami-Dade. The Flood Protection LOS describes the level of protection provided within a watershed considering sea level rise (SLR), future development, and known water management issues in each watershed. The information from the LOS studies will be used by SFWMD, and local partners to identify areas where improvements to the design, retrofit, construction and/or operation of water management facilities are needed or would be beneficial. This Project includes watersheds L-31NS, C-111 AG, C-111 South, Model-Land, C-111 Coastal and US1. These watersheds within the project study area are characterized with very low degree of urbanization and except for a portion of watershed C-111 AG, all watersheds are outside of Miami-Dade's Urban Development Boundary. However, the watersheds contain important features which help build the hydrological resilience of the Everglades National Park (ENP) and coastal wetlands while maintaining the flood protection level of service of the urban and agricultural interests. The hydrological resilience is important to study for future conditions of sea level rise. The presentation will summarize the LOS analysis based on results from numerical simulations of watershed hydrology and hydraulics (H&H) using an Integrated Surface and Groundwater H&H Model. The model is being used to analyze both current and future conditions. Future conditions include future hydrological conditions in the ENP, the Biscayne Bay Coastal Wetlands Restoration Project, planned changes in the stormwater infrastructure, land use changes, and potential SLR. A series of four design events were used to provide simulations of rainfall and coastal surge with return periods of 5-, 10-, 25-, and 100-years. A Performance Metrics of six indicators was applied to the design event simulations to assess the hydrologic and hydraulic performance of the stormwater management infrastructure and flood vulnerabilities within the study areas. The assessment and the model tool developed will be used to assess different adaptation and mitigation strategies.

OPTIMIZATION MODELING FOR THE LAKE OKEECHOBEE SYSTEM OPERATING MANUAL (LOSOM)

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The Lake Okeechobee System Operating Manual is a component of the Central & Southern Florida System Operating Plan by the United States Army Corps of Engineers (USACE) and is currently under development. The South Florida Water Management District (SFWMD) is the local sponsor for this project and modeling for this effort was performed by the Interagency Modeling Center, consisting of staff from the SFWMD and the USACE. The modeling process started with defining over a dozen conceptual frameworks for Lake Okeechobee operations which were derived from a robust agency and stakeholder input process and took a variety of approaches to define release guidance (e.g., decision trees, use of stage targets, inclusion of climate forecasting, etc.). These ideas were implemented, applied, and provisionally tested using the Regional Simulation Model (RSM). Since each of these conceptual concepts could achieve a variety of outcomes given different assumed inputs such as the release rates or Lake schedule lines, a batch optimization effort was pursued to test tens of thousands of unique applications of each conceptual schedule. To help ensure that model scenarios were both comprehensive and realistic, regulation schedule parameters were selected using Latin Hypercube Sampling that additionally applied operational hierarchy and known parameter correlations. Each run of the batch process generated multiple performance metrics defined by the LOSOM project team for each of the several thousand ideas tested. Utilizing this dataset, beneficial outcomes were selected and optimized further using similar batch processing techniques. Outcomes which balanced Lake Okeechobee's objectives (flood control, water supply, navigation, recreation, and preservation of fish and wildlife resources) were selected and refined. Flows to the Everglades were maximized while minimizing damaging flows to the eastern and western estuaries affected by Lake Okeechobee regulatory releases. Detailed performance metrics and maps were analyzed by multiple project teams and stakeholder groups. The optimization process proved to be understandable and flexible, allowing for new information to be added as needed.

INTERACTIVE EFFECTS OF JUVENILE SNAIL PREDATORS AND INDIVIDUAL GROWTH LIMIT *POMACEA PALUDOSA* POPULATIONS

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Abundances of the Florida Apple Snail (*Pomacea paludosa*) have been too low to support substantial nesting effort of the endangered Everglades Snail Kite since the early-mid 2000s, but the limiting factors for apple snail populations remain elusive. We hypothesized that *P. paludosa* populations might be limited by juvenile-stage predators and that seasonal differences in growth would mediate the limits that juvenile predators have on populations of *P. paludosa*. To address this hypothesis, we used a model evaluation to develop a population growth isocline as a function of variable juvenile growth and mortality which identified parameter combinations that stop *P. paludosa* population growth. Using measures of growth and mortality from the Loxahatchee Impoundment Landscape Assessment (LILA) we compared them to the predicted values from the isocline analysis. Snails were placed in mesh cages in wet and dry seasons with natural algal mats (mean TP: 131 µg/g) and allowed to grow for four weeks. Snails of various sizes were tethered to light monofilament lines in the wetland and checked daily to obtain measures of mortality rates. Similar tethering studies were conducted in two locations in Water Conservation Area 3A in the early wet season. Juvenile growth was higher in the wet season (2.1 %/day) than in the dry season (1.1 %/day) and survival was lower in the dry season (0.789 %/day) than in the wet season (0.900%/day) in LILA. The most common predators appeared to be aquatic insects and greater sirens in the dry season. When predators were excluded, juvenile survival was much higher than when predators were present. Wet season survival rates in the wetland at LILA were comparable to those in the wet season in sloughs of western WCA 3A. Despite the variation in the parameters no combinations of the two parameters from wetlands with predators could shift population projections to static states or increasing states. These results were robust even to idealized hydrologic conditions for egg laying. Future work should try to understand if spatial or temporal micro refuges or perhaps flowing water, could improve juvenile growth enough to rejuvenate populations of *Pomacea paludosa.*

FAUNAL EFFECTS ON PHOSPHORUS DYNAMICS IN THE EVERGLADES STAS: PART 1 (MECHANISMS)

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The Everglades Stormwater Treatment Areas (STAs) are constructed wetlands that reduce phosphorus (P) in stormwater runoff prior to discharge to the Everglades Protection Area. This reduction is primarily by growth and accumulation of P in primary producers and subsequent burial in the soils. Aquatic animals have the potential to alter P retention through resuspension or conversion of P into more labile forms. This research effort investigated the potential of five large fish species, Tilapia (*Oreochromis* spp.), Sailfin Catfish (*Pterygoplichthys* spp.), Largemouth Bass (*Micropterus salmoides*), Florida Gar (*Lepisosteus platyrhincus*), and Mayan Cichlids (*Mayaheros uropthalmas*); three small-bodied fish species, Eastern Mosquitofish (*Gambusia holbrooki*), Bluefin Killifish (*Lucania goodei*), and Sailfin Molly (*Poecila lattipinnis*); and one macroinvertebrate, Riverine Grass Shrimp (*Palaemonetes paludosus*) to recycle nutrients through excretion. The potential of three of the large fish species (Tilapia, Sailfin Catfish, and Largemouth Bass) to affect water column P concentration through resuspension of surface soils was also studied. Rates at which dominant P forms were recycled into the water column through excretion across diurnal and seasonal scales using controlled *in situ* experiments were measured. In addition, the relative influence of excretion and bioturbation by large fish on water column nutrients was quantified over a two-week period in separate *in situ* experiments. Small fish, macroinvertebrates, and large fish contributed similar amounts of P per unit mass through excretion. Small fish excreted more during daylight hours, while large fish excreted more at night. Seasonal patterns differed among the species studied. The amount of nutrients released through bioturbation was highest for the benthic and burrowing Sailfin Catfish, with Tilapia suspending less, and Largemouth Bass the least. Part 2 of this presentation uses these rates along with estimates of biomass and density to calculate overall areal contributions of fish activities to water column nutrients on a larger scale. These findings suggest that aquatic animals can influence P retention in the STAs to levels of concern for STA management and provide options to enhance P retention through monitoring and reduction of aquatic animal populations.

UTILIZATION OF SCOUT SNAKES AS A PRIMARY TOOL FOR BURMESE PYTHON REMOVAL IN SOUTHWESTERN FLORIDA

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Burmese pythons are negatively impacting native wildlife across the Greater Everglades Ecosystem and effective management strategies are limited. The Conservancy of Southwest Florida began a collaborative radio-telemetric python research and tracking program in 2013 to assess home range estimates and habitat preferences for adult Burmese pythons along the urban-conservation lands boundary outside of Naples, Florida. During field tracking efforts radio-tagged male pythons were observed in proximity to reproductively active females between the months of November through April. As python removal objectives expanded, the program actively hunted for pythons, responded to python response calls, and deployed male “scout snakes” to detect and target reproductive female pythons for capture and removal. Over a 10-year period the program removed 915 pythons weighing 26,235 lbs. (11,900 kg) from an area of approximately 160 mi^2 (408.2 km^2). Scout snake removals accounted for 334 adult pythons (149 M and 185 F). Scout captured males averaged 9.4 feet (2.87 m) in total length and females averaged 12.6 feet (3.84 m). Reproductive females contained an average of 46 developing vitellogenic follicles or oviducal eggs. The range of current python removal tools are limited and necessitates each bioregion to adjust the tool kit to maximize python control objectives. The scout snake technique specifically targets gravid female pythons each breeding season and reduces the reproductively active segment of the population. Implementing a scout snake component within a python removal program is a long-term investment that pays out biological dividends each breeding season.

SOURCE-SINK DYNAMICS OF SNAIL KITES DURING THE INVASION OF A NOVEL PREY SPECIES

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A general conservation goal is to increase the quality and number of source patches in the landscape. Biological invasions can have strong impacts on native species and therefore may alter source-sink dynamics over time within a native metapopulation, but evidence remains scarce. The Everglade Snail Kite (*Rostrhamus sociabilis plumbeus*), an endangered wetland raptor in Florida, has recently undergone substantial demographic changes as result of a novel non-native prey species. *Pomacea maculata*, a highly invasive apple snail, has provided a supplementary food source for Snail Kites and the increased prey availability has been linked to a recent increase in population growth. It remains unclear if and how Snail Kite source-sink population status changed throughout the course of the *P. maculata* invasion. Our objectives were to determine: 1) if and how the status and composition of source and sink populations changed during the invasion; and 2) the contributions of movement, reproduction, and survival to source-sink dynamics during the invasion. We estimated source-sink dynamics across the entire breeding range of the Everglade Snail Kite between 1996-2021 using spatial population projection models that combine data from multi-state mark-resight models for movement and survival with data on nesting effort. We found that source-sink status and the landscape composition of sources and sinks varied considerably over space and time. Before the establishment of *P. maculata* in 2004, nearly all wetlands were classified as population sinks, but by 2009 most wetlands were classified as sources. The relative contributions of movement and demography to source-sink status also varied across wetlands over time. Fecundity had a greater proportional contribution to population growth rate in times of population stability or growth than in times of population decline. Fecundity and adult survival generally increased with invasion, but juvenile survival declined since 2012. Understanding how wetlands vary in population source or sink status over time is important for determining how to manage and prioritize wetlands for Snail Kite population persistence.

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GENETIC ANALYSIS OF FEDERALLY ENDANGERED CAPE SABLE SEASIDE SPARROW SUBPOPULATIONS IN THE GREATER EVERGLADES, USA

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The federally endangered Cape Sable seaside sparrow (CSSS, *Ammospiza maritima mirabilis*) is endemic to the Greater Everglades ecosystem in southern Florida, inhabiting fragmented marl prairies. The six subpopulations (A-F) are named for management purposes. Since genetic information is lacking to inform management efforts, feather samples were collected from 114 sparrows across five subpopulations (A-E) and protocols were tested to optimize DNA extraction yields. We assessed four mitochondrial DNA markers (N = 36–69) and 12 nuclear microsatellite loci (N = 55) across 108 sparrows total. Mitochondrial DNA NADH-dehydrogenase 2 sequences revealed low haplotype diversity in CSSS and matched haplotype one found in most other subspecies and haplotype three in the Atlantic coast subspecies. Nuclear diversity was similar across CSSS subpopulations but lower than other subspecies. CSSS grouped as one population when analyzed by multivariate, Bayesian, and genetic distance analyses. Limited genetic emigration was detected; two putative migrants among subpopulations east of Shark River Slough (SRS; B, D, E) were identified using both genetic analysis and mark recapture methods. Relatedness was significantly different for sparrows west of SRS (A), likely reflecting high self-recruitment and natal site fidelity ($p = 0.003$). The low to moderate effective population size ($N_E = 202.4$; $N_E:N_C = 0.06$) and generation time estimates indicated that unique genetic variation could be lost quickly during stochastic events. However, the smaller sample sizes here limit the assessment of recent population size reductions and any subsequent loss of genetic diversity. Overall, a well-connected panmictic population with $N_E>500$ can promote subspecies resiliency.

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THE HALO PROJECT: MONITORING SEDIMENT BIOGEOCHEMICAL DYNAMICS TO INFORM LAKE OKEECHOBEE HAB AND NUTRIENT MITIGATION

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Using both conventional and innovative techniques, a variety of sediment measurements were collected as part of a multi-disciplinary effort: the Harmful Algal Bloom Assessment of Lake Okeechobee (HALO). Sediment cores were processed from several sites at biweekly/monthly time scales. In particular, sediment core profiling via conventional core separation and advanced electrochemical techniques reveals that sediments are a critical driver of the 2021 *M. aeruginosa* bloom patterns and nutrient ecology. Sediment dynamics are reflected in water column nutrient cycling over rapid timescales, and feedbacks between the water column and sediments are also evident. Sediment nitrogen appears responsible for both the initiation and decline of the bloom. We suspect that anaerobic ammonium oxidation couple to the reduction of iron oxides (Feammox) drives system N removal as the lake temperature increases, depressing the pore water N:P ratio to unfavorably low levels. Phosphate coupling, on the other hand, is governed by mineral precipitation/dissolution cycles, themselves regulated by the overall respiration intensity and/or reoxygenation processes. Advective reoxygenation/resuspension events are responsible for the regeneration of the Fe oxide mineral surface P barrier, affecting the sediment-leaving flux. In addition to helping to constrain a biogeochemical predictive model, results will be synthesized as they relate to implications for various potential HAB and nutrient mitigation protocols.

SUPPORTING ECOLOGICAL FUNCTIONS IN SOUTH FLORIDA WITH THE MINIMUM FLOWS AND LEVELS PROGRAM

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Water across south Florida is protected by Florida Administrative Code Rule through the Minimum Flows and Minimum Water Levels (MFL) program of the South Florida Water Management District (SFWMD). The Applied Sciences Bureau of SFWMD develops water resource protection criteria for water bodies whose ecosystems are at risk of ecological degradation and identifies hydrologic thresholds where further withdrawals would result in significant harm to the water resources or ecology of the water body. The SFWMD defines significant harm as the “temporary loss of water resource functions which result from a change in surface or groundwater hydrology, that takes more than two years to recover”. Waterbodies that have experienced this condition include Lake Okeechobee, the Loxahatchee River, the Caloosahatchee River, and the Greater Everglades. The process of creating or revising MFLs requires using best available data and analysis to understand cause-and-effect relationships between hydrologic variations and ecological functions. The water resource functions protected under Chapter 373, F.S., include flood control, water quality protections, water supply and storage, fish and wildlife protection, navigation, and recreation. Following the development of technical criteria, SFWMD conducts an independent scientific peer review of all scientific and technical data, methods, models, and assumptions before beginning the rulemaking process. Stakeholders have several opportunities to review and comment on the proposed rules before they are submitted to the SFWMD governing board for adoption. The process also provides a window of time after adoption for anyone to object to the rule. Prevention or recovery strategies are developed concurrently with MFLs to either maintain (prevention strategy) or achieve (recovery strategy) compliance with established MFLs. Water resource protection also includes assessing impacts of existing and projected operations and water use over a 20-year horizon using a representative (historic) range of hydrologic variability against the thresholds identified to cause significant harm to the water body.

SURVEYING ESTUARINE RESPONSES TO FRESHWATER INFLOWS: AN ALGAL BLOOM MONITORING TOOL IN THE NORTHERN ESTUARIES

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Algal blooms have been increasing worldwide with anthropogenic change being attributed as one of the main causes. This has been seen in the Everglades Northern Estuaries, which have been highly altered from their pre-development state by drainage of wetlands in the surrounding watershed for agricultural and urban uses and creation of artificial connections to Lake Okeechobee. These artificial connections have resulted in the alteration of freshwater flows to the Northern Estuaries and the ecology of these systems. Determining how freshwater inflow management strategies for the Northern Estuaries affect the ecology of these estuaries will help gain a better understanding of the dynamics of water quality at fine temporal and spatial scales and aid in monitoring for algal bloom conditions. Traditional water quality monitoring has consisted of discrete monitoring at fixed sites, but this type of monitoring does not capture what is occurring between the sites. To capture this, the use of a data sonde flow-through system can be utilized. Longitudinal transects within the St. Lucie Estuary (SLE) and Caloosahatchee River Estuary (CRE) were surveyed using the flow-through system to continuously measure chlorophyll *a*, phycocyanin, phycoerythrin, temperature, salinity, dissolved oxygen, turbidity, and fluorescent dissolved organic matter with water grab samples taken at sites along the transect for each estuary. A feature of this monitoring technique is the ability to integrate other technologies while being able to repeatedly monitor the estuary on consecutive days. By doing so, we can capture a snapshot of a bloom in real time while tracking the progress of the bloom event. Use of flow-through monitoring may be a cheaper and is a more rapid form of detection of changes in water quality parameters while also filling in the gaps found in discrete water quality sampling that may be beneficial in detecting future blooms.

HIGH-RESOLUTION WEATHER REANALYSIS AND PROJECTED CHANGES IN EXTREME RAINFALL EVENTS IN SOUTH FLORIDA

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Planning stormwater projects requires estimates of current and future extreme precipitation depths for events with specified return periods and durations. Precipitation data from statistically- and dynamically-downscaled datasets have been used by the U.S. Geological Survey to inform changes in rainfall depth-duration-frequency curves from the period 1966–2005 to the period 2050–89 in south Florida. A large variation in change factors—multiplicative changes in expected extreme precipitation magnitude from current to future period—across downscaled climate datasets was found, with change factors generally greater than one and increasing with return period. Limitations of the depth-duration-frequency curves constructed during previous analyses stem from the use of statistically-downscaled datasets—which may not respect the physics of the precipitation-generating processes—and dynamically-downscaled datasets which are based on coarse-resolution regional climate models. In response to these limitations, the U.S. Geological Survey will develop a high-resolution (1-kilometer) nonhydrostatic regional climate model using the Weather Research and Forecasting model for the southeastern United States, including Florida. The resolution of this model allows for the explicit simulation of the convective processes predominant over Florida in the summertime. Local microclimatic conditions including sea- and lake-breeze interactions and land-use changes will also be captured. Higher-resolution convection-permitting models have been shown to improve the representation of extreme rainfall, especially on sub-daily timescales and for summer high-intensity rainfall events compared to coarser-scale regional models with parameterized convection, which tend to produce rainfall that is too light and widespread. In addition, the simulation of tropical cyclones has been shown to be improved when using convection-permitting models. A reanalysis of the historical period 1975–2020 will be conducted using boundary conditions from the European Centre for Medium-Range Weather Forecasts Reanalysis Version 5 dataset. Model performance for the historical period will be characterized through various analyses including comparisons with radiosonde data and a fractions skill score analysis designed to assess the spatial forecast skill of high-resolution models. Additional evaluations will be conducted to assess predictive capability of the model with respect to hydrometeorological means and extremes for a variety of spatial- and temporal-scales. Future work would include using output from larger-scale regional and global climate models to generate boundary conditions required to simulate future projected climate.

CERP: BBCW TO BBSEER, MODELING WORLD TO REAL WORLD AND BACK

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In 2000 Congress approved the Comprehensive Everglades Restoration Plan (CERP), which included various projects to restore the Everglades Ecosystem, including Biscayne National Park. Planning for the CERP Biscayne Bay Coastal Wetlands (BBCW) Project officially began in 2002. However, work to understand the hydrodynamic, hydrologic, and ecologic needs of Biscayne National Park and Biscayne Bay has been ongoing for decades. This science formed the basis for the project that became the final BBCW Plan. The process to create the BBCW Plan, its features, and the performance measures are the result of monitoring, scientific studies, and decades-long data collection in the Bay and the watershed. This information was analyzed to gauge the potential success of the proposed features used in all modeling scenarios and to develop assumptions on potential outcome as well as developing evaluation tools. This background information and ongoing monitoring is critical to successful ecosystem restoration. This project was implemented in two Phases: the BBCW Project and the Biscayne Bay and Southeastern Everglades Ecosystem Restoration (BBSEER) Project. Reviewing historic and past information, using real world science, monitoring, and technical information resulting from monitoring the final BBCW (Phase 1) provide the basis for developing new modeling for BBSEER. This discussion will show the scope of the information used, various ways science and monitoring data were incorporated and how this is advancing our understanding of the BBSEER Project modeling results.

ACTUALLY-EXISTING RESILIENCE: MOBILIZING CO-PRODUCTION FOR PROBLEM IDENTIFICATION IN SOUTH FLORIDA ENVIRONMENTAL GOVERNANCE

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In recent years, growing interest in co-production of knowledge between scientist and other non-scientific actors has opened questions on the role of science within environmental governance. Co-production blurs the distinction between facts and values, and as a result, troubles the linear direction of scientific impact on policy, which assumes that scientific facts provide an objective and value-neutral evidence base to inform policy. While some scientists and policymakers see evolving relations between science and governance as problematic, in this paper, we suggest that they open possibilities for expanding the kinds of interdisciplinary and transdisciplinary social science research that can be conducted in contexts such as the Florida Everglades. Specifically, we explore how distinct styles of co-production can identify new problems for scientific inquiry. Distinguishing between normative (problem-solving) co-production and descriptive (problem-contextualizing) co-production, we draw on a case study of "actually existing resilience" among South Dade farming communities to identify overlooked areas for research and policy intervention. Faced with complex challenges such as sea level rise, encroaching urban development, water management, and restoration efforts, communities have developed a variety of practices to sustain and enhance their livelihoods amidst turbulent social, economic, and environmental changes. These practices of "actually-existing resilience" are frequently overlooked by conventional scientific research and government policy interventions, but offer new possibilities for policy-oriented research. We conclude with a call for greater integration of descriptive co-production into environmental governance practice, in order to supplement normative co-production's emphasis on innovative problem-solving with an equal emphasis on the need for innovative problem-identification.

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VALUING ECOSYSTEM SERVICES OF THE EVERGLADES RESTORATION: REGIONAL AND NATIONAL POLICY IMPLICATIONS

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A series of massive investment projects under the Comprehensive Everglades Restoration Plan (CERP) are expected to generate a variety of long-term ecosystem service benefits to the regional environment and society. Using the popular Ecosystem Services Assessment framework and secondary data, this study (a) quantifies the monetary values of the ecosystem services benefits associated with the Central Everglades Planning Project (CEPP), (b) conducts a benefit-cost analysis to illustrate the economic viability of the same, and finally, (c) illustrates how understanding the above ecosystem service benefits is important for the regional and national policy debates on resilient infrastructure investments, sustainable business, and climate change mitigation. The analysis uses simulated data from the regional hydrological and ecological models, government reports, and previous studies. Monetary values are assigned to socially relevant benefits derived from restoration alternatives conceived under CEPP and compared with the costs of each alternative. The preliminary analysis revealed that real-estate value improvement, carbon sequestration, urban water supply gains and recreational fishery improvements would be most significant ecosystem service benefits in monetary terms. At the end of the project's life, the combined economic values of the above benefits will exceed the costs of the restoration plan, placing the preliminary estimate of benefit-cost ratio at of 1.70. The final analysis incorporates climate and economic uncertainties and estimates their impacts on the benefits of the restoration plan. The study further argues that with the growing uncertainty around sea level rise, rainfall, freshwater flow, and regional economics, the real-estate and urban water supply improvements become more significant than ever in protecting the regional infrastructure investments from financial risks. Similarly, the carbon sequestration benefits of the restoration appear significantly large and hold potential for contributing towards the U.S. national target on greenhouse gas emission. The paper argues that realizing such benefits requires education, advocacy, and real policy changes at regional and national levels.

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SPATIAL DISTRIBUTION PATTERN OF *RHIZOPHORA MANGLE* IN SOUTHEAST SALINE EVERGLADES

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Several studies have shown that mangroves are expanding landward (mangrove encroachment) at the expense of both salt- and freshwater-marsh communities. However, the expansion process is not uniform across space and time. In order to understand the expansion process, it is critical to recognize where and which vegetation communities are being replaced by mangroves over time and the mechanisms and ecological processes that favor such replacement. With this goal, our objective was to analyze the present spatial distribution pattern of *Rhizophora mangle* (red mangrove) in the southern Florida coastal Everglades at the landscape scale as a first step. We mapped eight vegetation communities plus open water from high spatial resolution (2m) Worldview-2 satellite image of 2016 that included herbaceous vegetation, herbaceous vegetation with *Cladium jamaicense*, sparse herbaceous vegetation, herbaceous vegetation with shrub, tree, mixed mangroves, *Taxodium* spp., and *Rhizophora mangle*. We used random forest classification to map the plant communities across the study area and evaluated variable sets that included spectral data (8 bands) from uni-seasonal WV2 imagery, 9 vegetation indices, and 7 metrics derived from 2017 lidar data. Next, we analyzed the overall distribution pattern of the vegetation communities across the study area. We determined the relative class abundance in proportion of each vegetation type by utilizing kernel density estimates as function of distance from the coast as well as creeks. We also combined the two kernel density distributions relative to distance from the coast and creeks to determine the distance to where red mangroves were detected. We found that relative abundance of red mangrove is higher near the coast, then decreases in the white zone, and increases again north of the white zone. This pattern holds throughout the study area, but red mangrove cover is higher in the eastern part of the study area where the streams are longer compared to other areas. We conclude that red mangroves occur at variable distances throughout the study area but at longer distances from the coast where creeks connect the coast to freshwater marshes further inland.

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CONNECTIVITY BETWEEN SUBMERGED AQUATIC VEGETATION STRUCTURES AND PREY BASE FISH COMMUNITIES WITHIN THE COASTAL MANGROVE ZONE.

Alexander Blochel, *Jaime Gilrein and Jerome J. Lorenz*
Audubon Florida Everglades Science Center, Tavernier, FL USA

The presentation will cover my attempt to compare groups of related prey base fish species with different submerged aquatic vegetation (SAV) communities. There have been previous studies conducted in other biomes, where effects of SAV on larval fish species was shown to be of importance, and changes in SAV structures have an effect on predation prey interactions. Our intent is to figure out what we believe to be an important ecological interaction for understanding the stability of the Everglades ecosystem. That being said our sampling area is located within the Mangrove coastal zone, an environment that is highly affected by annual salinity fluxes. These influxes affect not only the fish populations but the SAV communities too. Our method is that this trophic interaction is highly controlled by a bottom-up interaction; our hypothesis is that the herbaceous community affect the community ecology of the prey base fish within the mangrove coastal zone. We are conducting analyses on data that Everglades Science Center have collected at nine sampling locations, where prey base fish and SAV that have been collected, for the past 24 years (1998 – 2022). We're also attempting to evaluate if an invasive fish species (Mayan Cichlid) is affecting dynamical interactions between SAV and the prey base fish communities.

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AFTER BULLDOZER DUST SETTLES: WOODY VEGETATION RECOVERY ON PICAYUNE CONSTRUCTION FOOTPRINTS

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Picayune Strand Restoration Project (PSRP) will hydrologically restore sheetflow to 55,000 acres in Collier County by plugging canals and degrading roads/ditches/trams to remove impediments to sheetflow. The estimated "construction footprint" of cleared-then-degraded surfaces within the entire PSRP is sizeable: 424 miles of linear features, which translates to 9,300 acres. In 2022, to evaluate recruitment of woody plant species in the cleared areas, we surveyed a third of roads and canals east of Miller Canal, mostly degraded 7–15 years ago. Within ¼ mile segments ("polygons"), we recorded cover-classes for all tree and shrub species >6ft tall. Woody species were recorded in all 286 polygons (1,730 acres along 17.5 miles) of cleared roads or canals. The hydrologic restoration status of polygons was full (39% of polygons), partial (19%), or none (42%). Of 15 tree species present, two were far more abundant: pine (in higher elevations, up to 40 trees/acre), and pop-ash (in lower elevations, up to 25 trees/acre). Of 17 species in the shrub category, the most common species were low cabbage palms (with trunks 1–6 ft tall), willow, saltbush, and Brazilian pepper. By looking at distribution maps of obligate wetland species (pop-ash, buttonbush, and willow) the location of the historic Picayune Strand Flow-way (most of which has been fully hydrologically restored) is evident. Likewise, the flow-way lacked species favoring upland environments. Plant distribution maps of upland and facultative wetland woody species show higher elevation regions to the northeast, northwest, and in the southeast corner. These plant-distribution regions align with known geographic elevated areas. Greater than 95% of all pineland habitats surveyed in construction footprints had pine tree recruits, including fully hydrologically restored pinelands that now have longer hydroperiods. The southernmost area, which is very low elevation (close to sea level), had recruitment of many obligate wetland species, regardless of hydrologic restoration status. This close-to-sea-level area has likely been less impacted by canal drainage. In the western third of the study area, roads were cleared more recently and are not yet rehydrated. The central part of this drained area had low densities of woody wetland species, and a minor historic flow-way is not yet evident in plant distribution maps. Former canals, in particular the Merritt Canal, have fewer woody plants than former roads, presumably due to herbicide treatments (including Imazapyr) to control torpedo grass. Cabbage palms (a native but unwelcome invasive species in PSRP) were found everywhere. After rehydration, the long hydroperiods of low-elevation swamps should inhibit palm seedling survival. However, most restored areas of PSRP had long delays (5-15 years) between ground disturbance and hydrologic restoration, thereby allowing palm seedlings to survive and become established. Statistical analyses are in progress.

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THE SCIENCE PLAN FOR THE EVERGLADES STORMWATER TREATMENT AREAS: A STRATEGY FOR IMPROVING PERFORMANCE

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The Science Plan for the Everglades Stormwater Treatment Areas (Science Plan) is a framework for scientific research to evaluate mechanisms and factors affecting total phosphorus (TP) retention in the Everglades stormwater treatment areas (STAs). The Science Plan was developed collaboratively with the South Florida Water Management District (District) and the Restoration Strategies Technical Representatives in 2013 and updated in 2018 as mandated under Consent Orders associated with the National Pollutant Discharge Elimination System and Everglades Forever Act permits and is specified as one of the components of the *2012 Restoration Strategies Regional Water Quality Plan.* The overarching goal of the Science Plan is to implement research that supports the design, operation, and management of STAs to achieve and sustain outflow TP concentrations that meet the water quality based effluent limit (WQBEL). Six key questions and 39 sub-questions were created to fill information gaps in the conceptual framework representing phosphorus regulating factors including physical, chemical and biological processes. From these questions, studies were developed that investigate a range of topics including hydrology and hydraulics, vegetation, soils, biogeochemistry, and wildlife and their effects on TP concentration discharged from the STAs. Since 2013, 21 studies have been undertaken: 12 have been completed and 9 are ongoing. These studies have been accomplished jointly by District staff and experts from universities and technical contracting firms. Enhancements based on the results of the Science Plan studies can be used, along with the Restoration Strategies project components to help the STAs achieve the WQBEL.

MONITORING COASTAL CHANGE ON JIM FOOT KEY IN EVERGLADES NATIONAL PARK, FL WITH SAR TECHNOLOGY

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Everglades National Park (ENP), and the assortment of nearby islands in Florida Bay are highly vulnerable to sea level rise, increased storm intensity, and coastal erosion. Physical processes like hurricanes and tropical storms have altered the coasts of these islands and while there are scattered archival records, few long-term studies have monitored coastal change for these islands. This study investigates the use of synthetic aperture radar (SAR) to monitor coastal change on Jim Foot Key (JFK), a small island in Florida Bay. SAR technology refers to a technique of producing fine resolution data through the process of emitting its own signals and measuring the strength of the backscatter returns. SAR uses active remote sensing satellites and can penetrate vegetation on the earth's surface due to its long wavelengths. It is, therefore, an excellent method for detecting coastal inundation even in vegetated areas. Additionally, the collection of SAR data is weather and daylight independent which allows for consistent monitoring regardless of season or time of day. JFK will be utilized to demonstrate the application of SAR analysis because this island has been the focus of several ongoing USGS studies, including millennial-scale analysis of change in sediment cores, remote sensing analyses, and currently is the site of surface elevation table (SET) installations with corresponding mangrove plots. The ability to combine the field studies with SAR data will allow us to determine the accuracy and utility of this methodology for water inundation monitoring in coastal settings. SAR data collected over two years is needed so that a seasonal equilibrium can be established over the span of one year, followed by a second year in which changes to the seasonal equilibrium can be detected. This presentation will describe the methods to establish a seasonal equilibrium using SAR collects from July 2022, September 2022, and February of 2023. Additionally, this poster will describe the methods used in SNAP and ArcGIS software to process SAR data, illustrate the differences in backscatter returns, and demonstrate the thresholding methods applied to determine backscatter classifications for JFK.

TRADE-OFFS AND SYNERGIES IN A PAYMENT-FOR-ECOSYSTEM SERVICES PROGRAM ON RANCHLANDS IN THE EVERGLADES HEADWATERS

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The Headwaters of the Everglades is a ~1.1-million-hectare watershed with ranchland as the dominant land use. These ranchlands are recognized as valuable not only for food production, but also for biodiversity and water services. The South Florida Water Management District (SFWMD) operates the Dispersed Water Management (DWM) program which includes the Northern Everglades Payment-for-Environmental-services (NEPES) focused on water retention and nutrient removal services in the Northern Everglades basins. NEPES was designed to pay for added water retention on private cattle ranchlands by raising the spillage level of drainage control structures to slow and reduce surface flows. We predicted that increased hydration of previously drained wetlands would benefit biodiversity, a previously unquantified but desirable co-benefit of the program. However, we expected that some tradeoffs such as loss of forage would occur. The objectives of this study were: 1) Examine biodiversity co-benefits of enhanced water retention on ranchlands in the headwaters of the Everglades; 2) Assess potential tradeoffs for ranchers including loss of forage or increased mosquitos; 3) Develop a decision support system to integrate hydrology, biodiversity, user defined preferences and implementation cost. We used general linear mixed models and model selection to evaluate the feasibility of explicit, a priori hypotheses using data from 15 wetlands sampled across four participating ranches. Our study indicated that managing for increased water retention could result in both co-benefits and trade-offs among ecosystem services. Higher water retention increased wetland plants in wetlands and was associated with reduced mosquitoes. Trade-offs included significant declines in forage plant cover and decreases in amphibian abundance with higher water retention. A decision-support-system (DSS) was developed to integrate (i) retention predicted by the hydrologic model, (ii) biodiversity responses predicted by eco-hydrologic models, and (iii) a user-defined preference scheme to assign importance weights to storage, biodiversity, and implementation cost. The DSS calculated a cumulative score for ranking PES proposals. By considering desirable co-benefits and tradeoffs, stakeholders can decide on their preferred level of services, e.g., buyer(s) may settle for less storage if there is a gain in desirable biodiversity. The DSS can identify trade-offs among services, helping stakeholders negotiate. Multidisciplinary collaboration was required to design, implement, monitor, and assess the NEPES program for trade-offs and co-benefits.

KISSIMMEE RIVER RESTORATION: STATUS AND CHALLENGES

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The massive C-38 flood control canal between lakes Kissimmee and Okeechobee in south-central Florida, constructed in the 1960s, was dredged through the original meanders of the Kissimmee River, resulting in elimination of flow in the native river channel and ending seasonal inundation of the river's floodplain, with profound negative consequences for the river/floodplain and downstream ecosystems. Recognition of these unintended impacts led to Federal legislation in 1994 to restore about 1/3 of the river and floodplain. This project, called the Kissimmee River Restoration Project (KRRP), is a joint, cost-shared, collaborative effort between the U.S. Army Corps of Engineers and the South Florida Water Management District. Restoration is taking place in two major efforts: the first is construction, which began in 1999 and was completed in 2021, to reestablish the physical template of the ecosystem, primarily by backfilling the central canal and reconnecting remnant channels to reestablish flow and allow inundation of the adjacent floodplain. In addition to this physical aspect of the project, in its second major effort the project will reestablish pre-regulation, historic hydrologic conditions for the river by changing the regulation schedule for the S-65 water control structure at the outlet of Lake Kissimmee. This change will allow storage of up to 100,000 additional acre-feet of water in the Headwaters lakes to be used for releases for river restoration and enhancement of littoral habitat in the Headwaters Lakes. This new Headwaters Revitalization Schedule (HRS) will be gradually implemented in several phases beginning in 2023 and is projected to be fully in place by 2025. A critical component of the KRRP is a comprehensive program of ecological monitoring and research called the Kissimmee River Restoration Evaluation Program (KRREP), which is designed to track hydrologic and ecosystem responses to construction and water management, and ultimately to assess the success of the project in meeting its goal of reestablishment of ecological integrity. To date, monitoring has indicated good progress for indicators dependent primarily on flow in the river channel, such as channel geomorphology, reduced floating and mat-forming vegetation in the river, and reestablishment of flow-dependent invertebrate communities; with lagging responses for metrics dependent on characteristics of floodplain inundation, including floodplain hydrology, reestablishment of the historic pattern of floodplain vegetation types, and dissolved oxygen. This is because floodplain response is dependent on hydrologic improvements that will not be seen until HRS is fully in place. This talk will present a history of construction progress and, along with other talks in this session, will discuss the current status and projected challenges for ecological response.

CARBON SEQUESTRATION IN THE EVERGLADES

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The restoration and preservation of The Everglades constitutes substantial economic value. The return on restoration investment is found to be at least 4:1 considering the value of ecosystem services restored and improved. Funding for such restoration can be difficult and complicated to acquire, and monitoring or the returns on restoration investment is a challenge. One financial mechanism that has emerged to supplement restoration funding is carbon offset credits. Carbon offset credits are payments from entities that emit large quantities of carbon, typically through their commercial activities, that are required or otherwise pressured to minimize carbon emissions associated with their activities. As an alternative to reducing emissions, these entities can pay to ensure that a comparable quantity of carbon is sequestered by other means. One mechanism for this sequestration is the restoration of ecosystems than can accrue and maintain carbon stores. Funding associated with carbon sequestration has several co-benefits, including increased water quality, habitat provision, reduced water treatment costs, increased tourism, etc., and these benefits make the elicitation of carbon credits for restoration multiplicatively valuable. This discussion opportunities to utilize carbon credits to capitalize on carbon markets to fund restoration.

MAMMALIAN DISTRIBUTIONS AND SPATIOTEMPORAL USE OF EVERGLADES TREE ISLANDS

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Tree islands have been regarded as "focused centers of biodiversity" and "keystone" habitat for Everglades fauna, but unnatural hydrology, increased nutrient and pollutant levels, and exotic species have degraded and diminished them throughout their range. The decline of Everglades tree islands poses a grave threat to the overall well-being of Everglades fauna, especially mammals because they disproportionately rely on tree islands for essential food sources, dry refugia, and breeding sites in the less hospitable marsh and slough matrix. Despite the known importance and decline/degradation of tree islands, studies on the relationships between tree islands and their constituent mammalian communities have been minimal and mostly restricted to how rodents and whitetail deer respond to high water events. This study is part of an ongoing effort to identify patterns in mammalian distributions and spatiotemporal tree island use. Trail cameras are the primary means of data collection because they offer a remote monitoring approach to analyze mammalian occurrences on tree islands while minimizing human disturbance to the wildlife and habitat under study. The study has been carried out in Water Conservation Area 3A South (3AS) and portions of the Miccosukee Reservation within Water Conservation Area 3A North (3AN) since December 2017. Tree islands were systematically selected for this study along a north-south transect because the study area has a downward sloping elevation from north-south. Thus, the study design intrinsically facilitates the comparison of mammalian use of tree islands along a gradient of elevation and water depth. Data were also collected on a wide array of environmental characteristics (e.g., water level, hydroperiod, island elevation, plant community, fruit phenology, breeding seasons) to help explain how mammalian distributions and tree island use are affected by landscape structure, habitat quality, phenological events, and short- and long-term hydrologic conditions in the Everglades. It is crucial for successful Everglades restoration and wildlife management that we study and understand the relationships between tree islands and the species of wildlife utilizing them.

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TRENDS IN AMERICAN ALLIGATOR PODS IN ARTHUR R. MARSHALL LOXAHATCHEE NATIONAL WILDLIFE REFUGE 1998-2021

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Alligators are an important component of the Everglades ecosystem serving as ecosystem engineers, predator, and prey. Their life history attributes including abundance and reproduction are tightly tied to water depth patterns. Because of the alligator's importance to ecosystem function and link to hydrology, alligators are an ecological indicator for Everglades restoration. Alligators are monitored using night-time spotlight surveys where location, size, and number of alligators are recorded. Surveys are conducted twice each spring (March/April) and fall (September/October) and provide data on trends in non-hatchling alligators and an index of reproduction (pods). I used fall hatchling data from within the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) interior marsh to describe the trend in pods from 1998-2021 and relate that trend to hydrologic parameters hypothesized to influence alligator production. Alligator production was estimated as the number of unique pods observed each fall. I defined a pod as hatchling alligators within 500 m of each other. Hydrologic parameters were selected from information in the Alligator Production Suitability Index (APSI) model and previous studies emphasizing the importance of fluctuating water depths for alligators. Parameters included yearly average water depth at the 1-7 gauge during the APSI breeding potential window (15 April of the previous year to 16 April of the nesting year), APSI courtship and mating window (16 April – 31 May of the nesting year), and range in water depth during the breeding potential window. These parameters were used as covariates along with year in a stepwise generalized linear model analysis (family poisson with loglink). Number of pods ranged from 16 in 1998 to 0 in 2011. The best model included year, average water depth during the breeding potential window and average water depth during the courtship and mating window. Number of pods declined approximately one pod per year. The model explained 46% of the variation. Higher number of pods was associated with lower breeding potential water depths and greater courtship and mating water depths. Water depth during courtship and mating had approximately four times more influence on number of pods than depth during the breeding potential window. The greater number of pods with higher water depth during courtship and mating is consistent with the hypothesis that deeper depths allow for more alligator movement, more alligator mating and more nests, which can result in more pods. Although I found relationships between number of pods and hydrologic variables, there is no clear explanation as to why the number of pods is declining. Courtship and mating water depth, which had the most influence in the model, did not show a declining trend from 1998-2021. One hypothesis is that two regional droughts (2001 and 2011) and several years of local dry conditions (2004, 2007, and 2009) have had long-term effects on recruitment.

AMERICAN CROCODILES IN BISCAYNE BAY

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The federally threatened American crocodile (*Crocodylus acutus*) is a flagship species and ecological indicator of hydrologic restoration in the Florida Everglades. American crocodiles are at their northernmost range limit in South Florida and play an integral role in the Biscayne Bay ecosystem. The ecological health of Biscayne Bay has been degraded for many years with continued urban development and reduced freshwater flow to the coastal zones and offshore communities. Report card scores for the System-wide ecological indicators for Everglades restoration for crocodilians have been red and below restoration targets in Biscayne Bay (and elsewhere system-wide) over the last 10 years because ecosystem conditions have not yet improved significantly to benefit crocodilians. Restoration projects are in the early phases of implementation, though we are seeing reductions in extreme salinity conditions with positive crocodilian responses with the implementation of the Biscayne Bay Coastal Wetlands project. We conducted a more than 40-year long-term mark-recapture study of American crocodiles within the Biscayne Bay complex, which includes Biscayne National Park, Key Biscayne and Virginia Key, Card Sound, Barnes Sound, and Turkey Point Power Plant from 1978 to 2022. We estimated nesting, survival, abundance, growth, and body condition of American crocodiles over the study period and track temporal and spatial trends in Biscayne Bay, particularly in response to salinity conditions. Over the past 40 years, significantly more crocodiles have been found in Turkey Point relative to Biscayne Bay but in the last 10 years there has been a small increase in nesting along the latter. We expect that as more freshwater is delivered to Biscayne Bay proper via the Biscayne Bay and Southeastern Everglades Restoration Project (BBSEER) that crocodiles will increase in number and respond positively in survival, growth, and body condition. Restoration efforts aimed at improving the quantity, timing, and distribution of freshwater to Biscayne Bay will improve salinity conditions and the dependent estuarine biota as well as reconnect associated freshwater and saltwater wetlands that feed Biscayne Bay, providing ecological connectivity for increased crocodilian numbers in the Bay. Our long-term monitoring of crocodiles in the Bay provides an opportunity to consistently track restoration success as ecological conditions are improved over time.

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MONITORING, DEVELOPMENT AND APPLICATION OF PERFORMANCE MEASURES FOR NEARSHORE SOUTHWESTERN BISCAYNE BAY

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Published historical information inspired a vision of hydrologic and ecological restoration for Biscayne Bay, and performance measures (PMs) based on recent field observations are guiding the way to restoration by the CERP Biscayne Bay Coastal Wetlands (BBCW) and Biscayne Bay Southeastern Ecosystem Restoration (BBSEER) projects. The goal is to restore estuarine conditions, flora, and fauna in nearshore southwestern Biscayne Bay. PMs are based on 16+ years of monitoring data on nearshore southwestern Biscayne Bay accumulated by a CERP RECOVER (Restoration Coordination and Verification) -sponsored program entitled "Integrated Biscayne Bay Ecological Assessment and Monitoring (IBBEAM)". The program has four components: 1) continuously (15-min) recorded salinity and other environmental data; 2) submerged aquatic vegetation (SAV); 3) mangrove fishes; and (4) seagrass fishes, crabs, and shrimps (epifauna). PMs are both abiotic and biotic. Abiotic PMs are based on frequency and duration patterns for Venice System Categories of Salinity, especially the oligohaline and mesohaline salinity regimes characteristic of estuaries, which are presently largely missing as functional units along the shoreline. Biological PMs are Habitat Suitability Indices (HSIs) developed mainly from IBBEAM data on SAV, mangrove fishes, seagrass fishes, and shrimp, but also on juvenile crocodiles (USFWS, based on RECOVER-funded University of Florida research). The HSIs are used to compare alternative restoration scenarios. The Interagency Modeling Center (IMC) creates output for scenario testing with the Regional System hydrologic model (RSM) by altering structures and/or operations to scenario specifications. For testing scenario effects on nearshore salinities, flora, and fauna the salinity fields for each scenario are created by inputting RSM freshwater outflow to the IMC's Biscayne Bay Salinity Model Emulator. Linking the biologically based HSIs to the salinity output allows quantification of "lift," or benefits, of these scenarios relative to Present or Future Without scenarios. To assist in evaluating scenario performance differences, a software tool known as GIDAST (Geo-referenced Interactive Data Analysis System Tool), not previously used in CERP, provides comparative dynamic visual output over multiple years of HSI quality metrics from alternative scenarios. The Nearshore Salinity PM document defines four restoration zones forming adjacent ribbons along the shoreline: 0-250, 250-500, 500-1000 meters from shore, and 1000 meters from shore to BBSEER's eastern boundary. Each zone has its own restoration goal and target. GIDAST provides visualization of this series of ribbons as they change over time as well as estimates of acreages restored.

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FISH SLAM: TEN YEARS OF COLLABORATIVE NON-NATIVE FISH MONITORING

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Dozens of species of non-native fishes are established in the waters of Florida, and new species are discovered each year. Maintaining current information on the geographic ranges of all non-native fishes is a challenging task, as many jurisdictions are involved at the state, federal, and municipal levels. There is a need to coordinate sampling, research, and management across jurisdictional boundaries while also providing up-to-date geographic distribution information to publicly accessible databases. In 2013, U.S. Geological Survey (USGS) and the Florida Fish and Wildlife Conservation Commission (FWC) began working together informally to build the Florida Non-Native Fish Action Alliance. This group is comprised of many agencies, universities, and non-governmental organizations. Twenty-three groups have participated to-date. While our agencies' missions may differ, we recognize the need to work together documenting non-native fishes in Florida. Fish Slam events, where teams of fishery professionals converge for a day of sampling, are similar to a BioBlitz. Between 2013 and 2022, we have held 14 Fish Slams, sampling over 200 locations throughout the State of Florida. Hundreds of specimens have been deposited at natural history museums around the country. Additionally, more than 600 records have been added to the USGS Nonindigenous Aquatic Species database.

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NATURAL SYSTEM MODEL ENHANCEMENTS IN SUPPORT OF A RESTORED EVERGLADES LANDSCAPE

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The Natural System Regional Simulation Model (NSRSM) simulates the hydrologic response of a pre-drained Everglades system (ca. 1850). To reproduce expected water depths and duration, the conveyance expressions were soft calibrated using landscape mosaics from historical land surveys. One of the challenging aspects of model development is representation of vegetation resistance in areas such as the micro-topographically varied ridge and slough landscapes in the greater Everglades areas. A variety of mathematical functions were used to represent vegetative resistance in these models under both laminar and turbulent flow conditions. The rate law expression used by NSRSM is based on the fundamental hydraulics of flow resistance through a patterned landscape with wetland vegetation, and therefore it can be used to parameterize models that anticipate how future changes in landscape conditions will affect flow. Flow resistance is captured in an upscaled effective roughness coefficient that takes the form of a Manning's "n" in the rate law expression which simplifies application in existing hydrologic models. The effective roughness coefficient can be calculated directly from measurements of wetland vegetation and ground elevation (i.e., microtopography) of Everglades ridges and sloughs as well as landscape factors such as ridge proportion and slough connectivity between ridges. Using a collaborative testing approach, an effort was made to use resistance functions developed for the NSRSM model to create combined parameters for a biophysical rate law expression (*BioFRE*) that could be used across a variety of Everglades hydrologic models applications. The *BioFRE* approach was compared to the conveyance expressions used in the NSRSM v3.5.2. For comparison, *Bio*FRE conveyance expressions were calculated from best estimates of pre-drainage vegetation community stem architecture and landscape characteristics including slough proportion, microtopography, slough connectivity and fractal dimension of ridge-slough edges. Benchmarking generally supported the NSRSM's soft calibration of its conveyance expressions. Leveraging advances in rate law formulation coupled with improved formulation of vegetation & landscape parameters enables conveyance expressions to better represent microtopography & roughness effects when compared to legacy modeling techniques. This higher level of spatial detail, use of advanced computational methods such as the TVDLF method to solve the nonlinear partial differential equations for regional flow, and fully dynamic flow algorithm enhancements incorporated in the latest development version of NSRSM. Additionally, this will provide the opportunity to enhance existing performance measures, such as transect magnitude/flow or depth duration, and pave the way for a broader set of evolved performance measures that inform flow regime objectives capable of creating & sustaining Everglades landscapes through restoration efforts.

PHOSPHORUS SPECIATION IN WATERS ENTERING AND LEAVING EVERGLADES STORMWATER TREATMENT AREAS AS DETERMINED BY 31P NMR, XAS AND EMPA

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A network of five large-scale treatment wetlands, the Everglades Stormwater Treatment Areas (STAs), have been constructed in south Florida to reduce phosphorus (P) in stormwater runoff before it discharges to the Florida Everglades. Two flow equalization basins (FEBs) also have been constructed upstream of the STAs to attenuate peak flows primarily during the wet season and to maintain STA hydration during the dry season. Solution state P nuclear magnetic resonance (31P NMR), X-ray absorption spectroscopy (XAS) and electron probe microanalysis (EMPA) have been used to evaluate organic and inorganic P speciation and transformation in soils. These methods, which provide more specific and quantifiable information on P forms than traditional operational fractionation techniques, were used to measure P species present in the > 0.45 mm and < 0.45 mm fractions of the inflow and outflow water from each of the 5 STAs, as well as the inflow of the two FEBs and a sampling location downstream of one of the outflows of Lake Okeechobee. The largest P component in the inflow particulate fraction > 0.45 mm was inorganic orthophosphate (~36% of P). This was followed by organic orthophosphate monoesters and diesters, which combined accounted for ~50% of total extractable P. Inorganic particulate orthophosphate concentrations decreased with distance from the inflow whereas biogenic P concentrations increased. Though not commonly documented in soil samples, polyphosphate was detected in all > 0.45 mm samples, possibly as a result of P associated with microorganisms and algae. 31P NMR only detected orthophosphate in the < 0.45 mm fraction of both inflow and outflow water at all sampling locations. XAS analyses of inflow > 0.45 mm P indicated a lack of aluminum-P and iron-P bonds, consistent with previous work, and the position and shape of sample spectra from several locations (STA-5/6, STA-3/4, A-1 FEB and L-8 FEB) resemble reference spectra from Na-phytic acid. XAS analysis of outflow > 0.45 mm P indicated the presence of hydroxyapatite in STA-2. The potential presence of apatitic minerals was supported by the co-localization of calcium, oxygen and P seen via EMPA in all inflow and outflow <0.45 mm P samples. These findings suggest that outflow inorganic P may be apatitic in nature and although “reactive” not biologically available.

ADAPTING AN AQUATIC FOOD-WEB/ECOSYSTEM MODEL TO SIMULATE P DYNAMICS IN STORMWATER TREATMENT AREA 2

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The comprehensive aquatic systems model (CASM) is a bioenergetics-based food-web/ecosystem model that was adapted to simulate phosphorus (P) dynamics in Flow Way 1 (FW1) of Stormwater Treatment Area 2 (STA-2) located north of the Florida Everglades. The model represented the physical structure of FW1 as three connected compartments that defined upper, middle, and lower spatial segments. The segments were functionally connected through simulation of FW1 hydrology described by a linked-node approach incorporated into the mathematical structure of the model. Data-driven inflows and outflows were used to derive parameters that determined daily flows through the segments, as well as corresponding simulated daily average water levels and current velocities for each of the spatial segments. The detailed biogeochemistry of P cycling within FW1 was incorporated into the model by adding state variables and functional relationships among dissolved and particulate organic and inorganic P in both the modeled water column and sediments. A key objective of the CASM STA-2 modeling effort was to examine the potential role of the consumer populations in influencing the internal P dynamics through excretion and bioturbation. The modeled food-web for FW1 correspondingly included generalized populations of phytoplankton, periphyton, submerged aquatic vegetation, emergent aquatic vegetation, zooplankton, and benthic invertebrates. Specific populations of mosquitofish, largemouth bass, grass shrimp, and tilapia were also defined. Physical, chemical, and biological data specific to FW1, as well as information and data from the technical literature and previous South Florida Water Management District studies, were used to construct necessary hydrological, phosphorus, environmental, and ecological (e.g., food web interactions) inputs to the model and derive estimates of model parameters that determined population growth and internal P cycling. The resulting CASM STA-2 simulates daily values for multiple years of growth and biomass of the food-web populations and P concentrations for the modeled P state variables. The model was calibrated using FW1 data reported for the period of 2005 – 2012 and subsequently verified with FW1 data for years 2013 – 2020. The CASM STA-2 results compared within 10-40% of the calibration target data for all the dissolved and particulate P pools, except for DIPs, in both the water column and sediments for all three segments of FW1. The model overestimated verification target concentrations for the water column DIPw and PIPw pools in the downstream segment by as much as ten-fold. Preliminary model results suggest that the effects of excretion and bioturbation on internal P cycling in FW1 are potentially important processes comparable in magnitude to physical-chemical transformations among dissolved and particulate P pools. Continued refinements and application of the CASM STA-2 can help evaluate the effectiveness of management actions on meeting regulatory requirements for total P outflows from the STAs.

MODELING PHOSPHORUS BIOGEOCHEMISTRY IN EMERGENT AND SUBMERGED HABITATS OF THE EVERGLADES STORMWATER TREATMENT AREAS

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The Everglades Stormwater Treatment Areas (STAs) currently comprise ~62,000 acres of wetlands constructed south of Lake Okeechobee. The STAs vary in size, configuration, and design and reduce incoming total

phosphorus (TP) concentrations by ~80% before discharging southward to the Everglades Protection Area. Habitat types in the treatment cells were broadly classified as either emergent aquatic vegetation (EAV) which is largely composed of cattail (*Typha domingensis*), or, submerged aquatic vegetation (SAV) which included multiple plant species. There has been much effort over the past ~25 years to study water and sediment transport, vegetation, periphyton, fauna, sediment accretion, and net TP removal. These individual components were integrated into a modeling framework to better evaluate potential changes in ecosystem attributes with projected changes in climate and/or water management. This study developed a mechanistic model of P cycling in EAV and SAV habitats that incorporates information obtained from STA research, provides a platform to explore wetland P dynamics, and can be used to explore the effect of various management options. The spatial domain was STA-2 Flow-way 1 (FW1; 1840 acres) of which ~93% was determined to be EAV. This flow-way was simulated as a landscape scale flume using measured daily rates of inflow and outflow volumes (m^3 d^{-1}), inflow TP loads (gP d^{-1}), and water depth over a period from 1/1/2005 to 12/31/2020. This period of record was divided into two equal periods of seven years for model calibration and validation. There were 14 major P pools (gP m^{-2}) within the domain including phytoplankton, cattail shoots and root-rhizomes, periphyton, and SAV as primary producers. Phosphorus was cycled among dissolved and particulate P pools in the water and soil via respiration, uptake, resuspension, sorption-desorption, and deposition. The model was calibrated by adjusting mathematical parameters so that internal sources and sinks were balanced, and the predicted pool concentrations matched available data. Final parameter values were set during validation and re-evaluation of pool concentrations and process rates. The model was used to simulate the concentrations of the 14 P pools, evaluate internal P processes, and assess relationships between TP loading and internal cycling. The model is under further development to introduce a hydrologic sub-model, improve mathematical formulations to better balance internal P sources and sinks, and refine simulation of periphyton primary production and P uptake.

SPATIAL DISTRIBUTION AND TEMPORAL VARIABILITY OF PHYSICAL PARAMETERS IN BISCAYNE BAY

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Biscayne Bay has faced an increasing frequency of water quality issues because it continues to be highly influenced by accelerated coastal development, land use, and water management practices. Therefore, the objectives of this study are to: 1) understand the influence of the freshwater flows from canals on the spatial distribution and concentrations of salinity, dissolved oxygen, and temperature, 2) identify the seasonal patterns, and 3) determine the temporal variability over the last two decades. Twenty years of monthly data measured in situ at 34 selected stations from Miami Dade County's Biscayne Bay Water Quality Monitoring Program were analyzed. Seasons (wet and dry) were classified according to precipitation patterns. The Bay was divided into 8 zones based on water quality characteristics, geography, and proximity to the coast and canals. The three zones closest to the coast and most influenced by the freshwater input were located at the mouth of the canals: North Bay, Central Bay, and South Bay Canal Mouths (NBCM, CBCM, and SBCM). The North Bay (NB) and South Bay (SB) zones are the narrow basins at the extreme ends of the Bay. From the coast to the Atlantic Ocean, the zones were: Along Shore (AS), Inshore (IS) and Main Bay (MB). Salinity showed a gradient increasing from the coast to the open Bay (SBCM>AS>IS>MB) and (NBCM >NB), and the seasonal pattern was different among the zones. The three canal mouth zones and two adjacent zones (NBCM, CBCM, SBCM, NB, AS) exhibited a marked seasonal pattern with lower salinities during the wet season and higher salinities in the dry season. The two zones (MB and IS) with the highest influence from the Atlantic Ocean did not show a significant seasonal or decadal change. Five zones including the canal mouth zones, had higher salinities in decade two. The temperature and dissolved oxygen showed a markedly seasonal pattern. The temperature was higher in the wet season and lower in dry season. In all zones, temperature was slightly higher in decade two. In Miami-Dade County, the freshwater from canals have a low concentration of dissolved oxygen due to the influence of groundwater, as the canals were dredged down into the surficial aquifer, thus the three canal mouth zones exhibited the lowest dissolved oxygen values. Dissolved oxygen was higher in the dry season and lower in wet season, as was established in previous studies. The NB, NBCM, MB and SB zones had higher concentrations in decade two. By understanding the distribution, seasonal patterns, and temporal variability of these parameters, we can characterize the health of the Bay and improve the water management practices in this accelerated phase of climate change.

THE ROLE OF DISPERSED WATER MANAGEMENT IN THE NORTHERN EVERGLADES – A RANCHER PERSPECTIVE

Wes Carlton
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The cattle industry and ranches are sustainable and best suited to assist with the State's environmental initiatives (storage, recharge, water quality, habitat, carbon sequestration). Ranchers are generationally environmental stewards and have the most noble purpose: to feed the world. Cattle ranching is the oldest ag land use in Florida, and it remains the most natural (in balance with the landscape) celebrating 500 years of cattle. Cattle production is generally a net total phosphorus exporter (more exported than imported) with relatively low nutrient concentrations, just large acreages of land. Most of the wildlife corridor is on ranchlands and approximately 40% of endangered species are only found on private land. The University of FL Institute of Food and Agricultural Sciences has estimated over $4 billion in annual value of non-marketed ecosystem services are provided by Florida pastures and rangelands for wildlife habitat, biodiversity, water storage and treatment, carbon capture and outdoor recreation. There is an immediate need for support of programs and incentives (easements, payment for environmental services) that assist landowners in continuing to provide and expand these services as a productive business venture. Land in Florida is being lost on a daily basis to development – more concrete means less habitat and food production. There needs to be a concerted effort to sustain family ranches to protect wildlife and water. Programs need to have a more simplified entry processes which will result in increased interest and participation with landowner's extensive knowledge of the landscape driving the project design. Agriculture in general needs to be able to produce and market food without excessive regulation and burden. Viable agriculture is the best assurance of a safe, secure, abundant, and reasonably priced food supply.

IMPACTS OF SUBMARINE GROUNDWATER DISCHARGE ON SEAGRASS IN FLORIDA BAY

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Florida Bay seagrasses and associated benthic habitat types within the Everglades National Park boundary are critical for commercially and recreationally important species in the region, and as indicators of Everglades restoration progress. Unfortunately, Florida Bay has faced numerous natural and anthropogenically influenced challenges over the past century, including multiple seagrass die-off events and subsequent ecological impacts that altered community structure and affected fisheries yields. Although the processes leading to massive die-offs are reasonably well known, the interaction between submarine groundwater discharge (SGD) and seagrass health in Florida Bay is not. SGD is the flow of terrestrially derived water of any composition into the coastal zone and could therefore affect coastal flora and fauna. For seagrasses specifically, discharge can provide nutrients that might stimulate plant growth and influence seagrass diversity. In addition, groundwater can be a source of fresh, or at least fresher, water that might offset hypersalinity. Alternatively, groundwater can be anoxic or hypersaline, which could exacerbate existing and/or seasonal stressors in the seagrass rhizosphere. Understanding the role that SGD plays in seagrass community composition and health could provide new insights into the mechanisms and spatial patterning of seagrass die-off and offer new ways to assess ecosystem resilience. To explore groundwater-seagrass interactions along a natural gradient of prior *Thalassia testudinum* die-off severity, we mapped SGD in west-central Florida Bay at the end of the wet (November 2021) and dry (May 2022) seasons using a natural radon tracer (radon-222). Initial surveys demonstrated variability in radon signature, suggesting high and low SGD areas in Rankin and Whipray basins. Identified SGD hotspots included the northern part of Rankin between Umbrella and Rankin Keys and the southeastern portion of Whipray Basin near Coon Key. Using SGD maps, we identified 5 high and 5 low signature sites in each basin for benthic surveys. Using the Braun-Blanquet (BB) cover abundance scale, we assessed 8 quadrats for seagrass and macroalgal community composition and coverage at each site. Preliminary analysis reinforced known differences in seagrass and macroalgal communities between basins. However, there was an interaction between groundwater and basin on *Thalassia testudinum* density, which was much higher in Whipray than Rankin, and within Whipray, density was highest at the high SGD sites. Results suggest that the impacts of groundwater on seagrasses within Florida Bay are complex and likely dependent upon several interacting and confounding factors, all requiring further exploration. Ongoing work will extend the survey approach to include Rabbit Key Basin.

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HURRICANE IMPACTS ON STRUCTURAL DEVELOPMENT AND CARBON DYNAMICS IN RIVERINE MANGROVES OF THE FLORIDA EVERGLADES

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In neotropical northern latitudes, such as south Florida, hurricanes are recurring high-energy disturbances that significantly change community structure and function of mangrove wetlands. Hurricane force winds change forest structure through defoliation, tree snapping, and uprooting, which in turn influences productivity, tree mortality, species composition, successional patterns, nutrient cycling, and potential loss in soil elevation. Despite the destructive impacts of hurricanes, these highly productive forested wetlands are well-adapted to recover quickly from disturbance due to their adaptations and intrinsic resilient traits. Here, we quantified how Hurricane Irma influenced long-term changes in productivity, structure, and carbon dynamics in riverine mangroves along Shark River estuary (SRS-4, SRS-5, SRS-6) after its passage across the Florida Coastal Everglades (FCE) in September 2017. Litterfall production decreased post-Irma at all sites, with higher impact at near-coast mangroves (SRS-6). During 2018, litterfall was 2-4 times lower at all sites compared to the long-term (2010-2016) pre-disturbance rate (3.3-5.1 MgC ha^{-1} yr^{-1}). Litterfall increased at all sites during 2019 but was 1-2 times lower compared to the 2010-2016 period. During 2020 and 2021, litterfall production was similar when compared to the pre-disturbance rate at all sites, except at SRS-6 where the rates were still lower. Aboveground biomass (AGB) decreased at SRS-6 post-Irma. In contrast, estimates at SRS-4 & 5 remained comparable during both pre- (2015-2017) and pos-Irma (2019-2021). Mean AGB at SRS-6 was 54 MgC ha^{-1} during pre-Irma but decreased by 38% during 2019 (34 MgC ha^{-1}). In 2021, AGB increased at SRS-6 by 7% due to recruitment of juvenile saplings into adult cohorts. Annual wood production was higher at SRS-6 (2.1 MgC ha^{-1} yr^{-1}) compared to SRS-4 & 5 (1.4 and 1.2 MgC ha^{-1} yr^{-1}, respectively) during pre-Irma. However, rates were 1.4 to 3.5 times lower (range: 0.6 to 1.0 MgC ha^{-1} yr^{-1}) at all sites during the immediate-post-Irma period (2017-2019). Wood production rates increased during the post-Irma period (2019-2021) at all sites and were comparable to pre-Irma rates. Total (Litterfall + Wood Production) annual NPP_T in Shark River mangroves ranged from 4.7 to 7.1 MgC ha^{-1} yr^{-1} during pre-Irma, with higher rates at SRS-6. NPP_T rates decreased drastically at all sites during the immediate-post-Irma period and ranged from 2.7 to 4.1 MgC ha^{-1} yr^{-1}. During the post-Irma period, NPP_T rates increased at all sites and were similar to pre-Irma rates, except at SRS-6 where rates were still 1.2 times lower. Our results suggest the high resilience capacity of FCE mangroves to hurricane disturbances. The interaction between hurricane physical properties and pre-storm forest structural development, species composition, and sapling recruitment will largely control the rate and timescales of recovery and change of mangrove ecological attributes following disturbance.

INCORPORATING SEA LEVEL RISE INTO EVERGLADES RESTORATION PLANNING

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Everglades restoration is complex and involves the interaction of various stakeholders with a myriad of interests and priorities and management. Restoration efforts are likely to be impacted by climate induced sea level rise, but currently, many project planning studies do not formally incorporate the potential impact of sea level rise when evaluating restoration plan outcomes. To assess the impacts of sea level rise, it is important to understand how stakeholders perceive uncertainties and risks surrounding sea-level rise and how this impacts decision making and restoration initiatives. This project will work with stakeholders from multiple agencies to identify the restoration questions that need to consider sea level rise, provide information on how to choose sea level rise scenarios most relevant to each unique project, and provide the methodology for how to incorporate chosen scenarios into the current planning processes using existing ecological models. We collected data using focus groups of 25 RECOVER (REstoration COordination & VERification) members, including managers, scientists, non-governmental and governmental organizations, and agencies that are invested in restoring the Everglades ecosystem. We identified the priorities of these RECOVER members that will be relevant for the effective restoration of the Everglades in the next decade. Insights from these focus groups can be used to develop tools that can improve stakeholders' ability to decide between competing restoration plans as Comprehensive Everglades Restoration Plan (CERP) projects continue to be implemented across the landscape.

DRUGS IN OUR FLATS: EXPOSURE OF SOUTH FLORIDA BONEFISH TO PHARMACEUTICALS

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In recent years, pharmaceutical contaminants have been recognized as an increasingly important class of emerging contaminants; however, very little is known about the presence and threats of pharmaceutical contaminants on large spatial scales in marine ecosystems. Although previous studies have established the presence of pharmaceutical contaminants in South Florida coastal waters, biomonitoring of internal tissue concentrations can allow for estimates of organismal effects that are difficult to extrapolate from water analysis alone, and importantly, is the starting point for examining toxicological effects. In order to determine the potential exposure and threat of pharmaceutical contaminants to flats fisheries, we sampled bonefish throughout South Florida from Biscayne Bay through areas west of Key West. We tested for the presence of 104 different pharmaceuticals in 93 bonefish and found pharmaceutical prevalence to be widespread, with every bonefish having at least one pharmaceutical. Throughout South Florida, bonefish are exposed to a diverse suite of pharmaceuticals from different drug classes; a cocktail of drugs that can affect important behaviors in survival and population stability. By investigating the presence of pharmaceutical contaminants on both a large and small spatial scale, this study aims to assess the extent of pharmaceutical contamination in open coastal marine systems, serve as an assessment of water quality, aid in wastewater management reform, and establish the potential threat posed by pharmaceuticals to fisheries and marine biota.

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REHYDRATING AN URBAN FORESTED WATERSHED: TREE RESPONSE TO FLOW DURING THE FIRST DECADE

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The Deering Estate Natural Area historically contained a freshwater wetland environment that fed into the Biscayne Bay through the Cutler Creek. Wetland conditions diminished over time as natural sheet flow was interrupted by fragmentation, urbanization, and drainage activities in the Everglades. In order to restore the authentic watershed of south Florida, the Comprehensive Everglades Restoration Plan's Biscayne Bay Coastal Wetlands project was developed to divert freshwater from canals into select ecosystems along the southeast coast. A Biscayne Bay Coastal Wetlands project that facilitates this aim is the Cutler Slough Rehydration Project which has been utilizing Deering Estate Natural Area land as a funnel to resupply Biscayne Bay with freshwater since December 2012. Since the Cutler Slough Rehydration Projects' implementation, the upland hardwood hammock and low elevation remnant historical wetland habitats within Deering Estate Natural Area have been continuously influenced by fluxes of freshwater which have affected the health of resident trees. In 2016, I conducted a study of tree dynamics along three transects that cross the Cutler Slough Rehydration Project's watershed. Data collected consisted of tree location, species, health status (live or dead), and diameter-at-breast height. The study revealed that the establishment of hardwood hammock species at low elevations may have resulted from the historical drawdown in the regional water table. Implementation of the Cutler Slough Rehydration Project has provided a remedy to that trend, causing substantial mortality among hardwood hammock species in low elevation regions. Between 2020 and 2021, I resurveyed the transects to document the ongoing impact of the rehydration on resident trees and collected data on the ingrowth of new trees. Continued tree mortality has led to a change in species composition, primarily in low elevation regions of the watershed. As tree mortality progressed after the 2016 study, loss of mature trees allowed for establishment of species more tolerant of seasonal flooding conditions, including Royal Palm (*Roystonea regia*). In June 2019, my colleagues and I initiated a study of the water regime created by the rehydration efforts, based on 17 Onset HOBO water level data loggers spread along the transects and across the Deering Estate Natural Area. A spatial autocorrelation analysis showed that water levels are less synchronized and uncorrelated to one another the farther away the loggers are from source of freshwater input. Due to the fluctuating water levels, and variable surface topography of the Deering Estate Natural Area, species encounter a wide range of hydrological niches, allowing hydrophytic and mesophytic species to coexist in the same watershed. This integrated monitoring program can provide much insight to where shifts in species composition and species establishment have and will occur through the course of the Cutler Slough Rehydration Project.

AQUATIC MACROINVERTEBRATE COMMUNITIES OF REFERENCE, RESTORED AND UNRESTORED WETLANDS: PICAYUNE STRAND RESTORATION PROJECT

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Aquatic and wetland macroinvertebrates are a diverse group of taxa including sponges, decapods, leaches, snails, clams, and a wide variety of aquatic insect larvae and adults. They form many trophic links in the Everglades ecosystem as grazers, collector-gatherers, detritivores, and predators and support the survival and reproduction of threatened and endangered species. Their individual habitat and life history requirements are diverse and tied to natural wetland hydroperiods. Wetland macroinvertebrates respond quickly to changes in water levels and hydroperiods and they serve as reliable indicators of restoration success (or failure). The macroinvertebrate sampling methods were derived from research conducted by the SFWMD's Isolated Wetland Monitoring Program in the 1990s. A level of experience and expertise is required for both the collection and identification of this diverse group of aquatic organisms. Baseline macroinvertebrate surveys were conducted between 2005 and 2007 at impacted wetlands in Picayune Strand and reference wetlands in Fakahatchee Strand Preserve State Park and Florida Panther National Wildlife Refuge. Habitats included graminoid (wet prairie), cypress-graminoid, and cypress. These surveys found significant differences between wetland fauna communities at unrestored and reference wetlands, with several indicator organisms identified for monitoring restoration success. For the 2021-2022 sampling period, nine reference sites, seven restored sites, and three unrestored sites were sampled three times to obtain a complete sample for the hydrologic year, August 2021 through February 2022. A total of 4,160 individual organism were identified representing 138 individual taxa, with 124 operational taxonomic units for statistical analyses. Relative abundance of each taxa was considered an important variable in the analyses but a square root transformation was used to down-weight the importance of extremely abundant taxa and up-weight rare and uncommon taxa. Unrestored wetland sites were significantly different from both restored and reference wetlands sharing less than 25% Bray-Curtis similarity with all other sites. One unrestored graminoid site was briefly inundated but no aquatic fauna were collected there. Cluster analyses using presence/absence data identified four significant groupings of sites while square root abundance found ten significant groups. Restored graminoid sites FS5 in Fakahatchee Strand and SG13 in Picayune Strand shared high similarity with and were not significantly different from reference graminoid sites. MDS ordinations showed that restored cypress wetlands are grouping with reference cypress-graminoid wetlands. Compared with baseline and 2018-2019 data, there were clear movements in ordination space toward reference conditions but significant differences between restored and reference wetlands remained. Indicator taxa were identified by the SIMPER tests and included both common and rare species.

RESTORATION BENEFITS OBSERVED FROM THE BISCAYNE BAY COASTAL WETLANDS PROJECT

Bahram Charkhian
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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 known as CERP. 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. Phase 1 of the BBCW project, authorized in 2014, is composed of three components: Deering Estate, Cutler Wetlands and L-31E Flow-way. Pump station and culvert construction at each of these sites is allowing delivery of freshwater as sheet flow to the coastal wetlands and Biscayne Bay. SFWMD has implemented various CERP Adaptive Management processes to enhance and improve project restoration benefits. SFWMD modified operation of the Deering Estate Pump station to improve hydrology and create more natural wetland hydroperiods. Other recommendations were implemented that have improved sheet flow across wetlands. Comparison of ecological monitoring data collected during the last nine years with previous baseline data indicates there is a trend toward achieving project goals. There is improved water quality to the bay as fresh water is redirected from canals to wetlands. Salinity in L-31E tidal wetlands has been reduced to below 5 and some improvement in salinity concentration within zone of influence of freshwater interim pumps has been observed. There were no exceedances of Class III marine water criteria for the Deering Estate Component or L-31E Culverts during the most recent nine-year period. Annual vegetation monitoring of seven transects within tidal wetlands of the BBCW L-31E project was completed in WY2022. Red mangrove continues to be the dominant species with red mangrove scrub being the predominant cover type. A large change in mangrove cover was not observed from WY2021 to WY2022. Vegetation in the vicinity of the Deering Estate component is responding to improved hydrology demonstrated by die-off of upland vegetation, emergence of wetland species, expansion of sawgrass, and observed recruitment of *Thelypteris patens*. Surface water salinity decreased below 1 in response to pumping of freshwater 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 as salinity decreased below 10.

EVERGLADES AS TESTING GROUNDS FOR PASSIVE AND ACTIVE DATA FUSION: IMPROVEMENTS TO GLOBAL BUDGETS AND REGIONAL PROCESSES

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Florida's "River of Grass" is a global icon of human's impact on the landscape; from the drainage of the swamps in the start of the 20th century to the restoration and conservation activities in the 21st century. The latter efforts have been largely informed by long-term data collected by numerous academic institutions and management agencies. These data primarily come from a number of site-specific locations with extremely detailed information. This information is of great value for understanding local processes, but it does not capture the large-scale landscape processes that connect upstream, downstream, and proximal habitats. To address these spatial challenges, significant efforts by the scientific community have integrated remotely-sensed observations to better understand land cover changes and cyclone impacts across the Everglades. NASA and other satellite-related agencies are also making scientific observations in the Everglades because of its rich data history over the past decades making it an important testing location. In the presentation, we will review several current and planned NASA satellite missions and projects that have focused on mapping the Everglades in unprecedent spatial and temporal detail and using that information to inform ecological processes and management efforts in similar areas around the world. This increase in detail has provided information on the 3D habitat structure, biomass density, ground elevation, and water depth in the Everglades, and results from these projects will be discussed with respect to cyclone impacts. Several NASA airborne campaigns have been or are currently being conducted to extrapolate site-level information to better quantify aspects of habitat recovery and greenhouse gas emissions using the network of ground sites as calibration and validation. In addition, active sensors like Global Ecosystem Dynamics Investigation on the International Space Station and ATLAS on NASA's ICESat-2 satellite are providing new information about the vertical structure of the Everglades over longer periods of time. Projects like "BlueFlux", funded through NASA's Carbon Monitoring System (CMS) program are developing prototype blue carbon products to inform coastal carbon management by integrating multi-scale measurements of CO2 and CH4 fluxes using chambers, flux towers, aircraft with space-based observations of forest structure and surface reflectance. Lastly, we will discuss how, in these cases, active and passive remote sensing of the Everglades are helping to improve global GHG estimates and coastal decision making.

ADVANCES IN REMOTE SENSING OF CYANOHAB IN SOUTH FLORIDA ESTUARIES: SATELLITE SENSORS, CONSTELLATION, ARTIFICIAL INTELLIGENCE

Zhiqiang Chen
South Florida Water Management District

Harmful blue green algal bloom (CyanoHAB) in South Florida estuaries can negatively impact fish, shellfish, and human health via the production of toxins and the degradation of water quality. While the use of satellite remote sensing has proven to be a beneficial tool for resource management in other study areas, remotely monitoring CyanoHAB in South Florida estuaries have been complicated by absence of satellite imagery with adequate temporal and spatial resolutions and optically complex waters in these estuaries. In this presentation, I review the latest advances in sensor design, satellite constellation and retrieval algorithms, specifically artificial intelligence, which will improve detection of CyanoHAB in the study area. As a case study, imagery from satellites of Landsat, Sentinel-2 and Planet from 2017-2022 was processed to showcase improvement of detection, tracking CyanoHAB in the South Florida estuaries. The study establishes a framework in which newly available satellite products will provide improved accuracy, spatial and temporal resolutions that can aid resource managers with monitoring water quality and protecting resources in the study area and other similar regions.

COMPARATIVE GENOMICS OF PATHOGENIC AND NON-PATHOGENIC STRAINS OF LABYRINTHULA SP

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Labyrinthula sp. (Protista, Labyrinthulomycetes) is the causative agent of seagrass-wasting disease (SWD), which is the main microbial disease of several different seagrass species around the world. In Florida, SWD has been responsible for several major die-off events. In recent years, no major damages from *Labyrinthula* have been reported from Florida, despite the fact that the pathogen is present in high concentrations. Phylogenetically, pathogenic and non-pathogenic strains of *Labyrinthula* from seagrasses seem to form two separate clusters. We isolated strains from both clusters from Turtle grass meadows in South Florida and sequenced their genomes using Illumina technology. Our goal is to identify genomic evidence for virulence factors that might explain the difference in pathogenicity of these two clusters. Here, we present genome drafts of four non-pathogenic strains and one pathogenic strain of *Labyrinthula* isolated from Turtle grasses in South Florida. Initial comparative analysis indicated a clear difference in GC content and genome content of the two clusters. Hypothesis on the difference in pathogenicity based on genome contents are presented.

BIOPHYSICALLY-BASED SIMULATIONS OF SHEET FLOW AT THE DECOMP PHYSICAL MODEL (DPM) TO ASSESS RESTORATION CHALLENGES

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A key aspect of Everglades restoration is increasing the inter-basin transfer of water to promote sheetflow that will hydrate and revive downstream wetlands. The multi-agency Decomp Physical Model (DPM) project provided a ten-year experimental program for prototyping how flow releases will affect sheet flow and associated water and ecological resources. Here we report results of simulating flows using *Bio*FRE, a biophysical flow rate expression that parameterizes flow resistance from measurements of vegetation community type and spatial arrangement of patches and microtopography at DPM. BioFRE was applied to steady-state simulations of experimental high flow releases through the gated culverts that spread water radially through the DPM's degraded ridge and slough landscape. Six high-flow releases were simulated, for which we made *post hoc* comparisons with measured flow velocity and water depth. Using a sensitivity analysis approach we evaluated controls on flow velocities, water depths, and the estimated area of sediment redistribution from sloughs to ridges. The relative importance of sheet flow controls by management factors (total culvert flow and sheet flow spreading angle) versus landscape factors (vegetation roughness, slough proportion, and slough connectivity) were quantified. Vegetation roughness was generally the most sensitive driver followed by slough proportion. Total culvert discharge and spreading angle were less important drivers for similar percent ranges in variability. Our simulations with *Bio*FRE provide insights into how restored sheet flow will adjust with an evolving ridge and slough landscape, a key aspect that can influence restoration success. Because it is based in the fundamental hydraulic drivers, e.g., effective roughness of vegetation stems and microtopography, *Bio*FRE simulations can be useful to anticipate how future changes in vegetation or landscape conditions will affect flow, without relying on calibration against present-day hydrologic data. This approach creates opportunities for scenario testing to assess how Everglades hydrology may change as a result of events such as more frequent fire, or actions such as adaptive marsh management to re-open clogged sloughs. Our results contribute to scientific understanding that can help guide Everglades restoration goals of maximizing sheet flow to hydrate downstream wetlands to improve desirable water storage and flood conveyance functions and ecological habitat.

CHALLENGES AND SUCCESSES RESTORING MARSH AND WET PRAIRIE HABITAT AT AUDUBON'S CORKSCREW SWAMP SANCTUARY

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Corkscrew Swamp Sanctuary lies central to Southwest Florida's >60,000 acre Corkscrew Regional Ecosystem Watershed. The 13,450 acre National Audubon Society sanctuary includes the largest remaining stand of old-growth bald cypress which once supported the largest Wood Stork colony in the U.S., and is recognized as a Wetland of International Importance (Ramsar) and a Wetland of Distinction (Society of Wetland Scientists). In the early 2000s, hydroperiods across the Sanctuary were shortened 17 to 29% (1.9 to 2.6 months), which models suggest was likely due to improvements in the downstream conveyance system. Over-drainage of the Sanctuary's wetlands, coupled with increased challenges conducting prescribed fire in the altered system, has encouraged shrubs (most notably Carolina willow (*Salix caroliniana*)) and trees (e.g., red maple (*Acer rubrum*), cabbage palm (*Sabal palmetto*)), to spread aggressively across marsh and wet prairie habitats. This landcover change prohibits effective application of prescribed fire by land managers, exacerbates water loss through increased evapotranspiration, and reduces habitat available for many wildlife. Audubon has spent nearly ten years developing and refining methodology to reverse this succession by removing invasive native shrubs and trees and restoring herbaceous wetland plant communities. With development of solutions to lengthen hydroperiods and reverse hydrologic alteration underway, herbaceous wetland plant communities will ultimately be maintained with return to an appropriate prescribed fire regime. We describe a three-step restoration process that has been successfully applied across over 1,000 acres of the Sanctuary: (1) mechanical mulching of aboveground woody vegetation, (2) 3 to 5 years of spot herbicide treatment to control re-growth and invasive species while re-establishing native pyrophytic vegetation, and (3) reintroduction of prescribed fire. Mulching is conducted during the peak of the dry season with lightweight, tracked vehicles to minimize soil disturbance and to allow wet season wetland re-inundation to ultimately kill the shrubs. Ecological monitoring (soils, plant communities, aquatic fauna, wading bird foraging) is underway to quantify change and evaluate restoration outcomes. We discuss advantages and limitations of this methodology, in addition to challenges and opportunities for employing these methods to help address the increasing shrubification seen across the Greater Everglades, and beyond.

INFORMING EVERGLADES RESTORATION: FROM MONITORING AND ASSESSMENT TO EVALUATION TOOLS

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REstoration COordination & VERification (RECOVER) is a multi-agency and multi-disciplinary team who organizes and applies scientific and technical information to support the goals and objectives of the Comprehensive Everglades Restoration Plan (CERP). In its mission to inform CERP, RECOVER monitors several ecological indicators expected to benefit from hydrologic restoration. The data and knowledge gained from monitoring has enabled the development of predictive ecological-based models, and RECOVER employs these models to anticipate the ecological impacts of CERP projects and to assess CERP progress. Wading birds are identified an indicator of ecosystem function because they rely on the production and availability of their prey, mainly fish and macroinvertebrates, to successfully reproduce. CERP's ecological goals include the return of wading bird nesting colonies to the marsh-mangrove ecotone in Everglades National Park (ENP) and increasing the frequency of exceptional nesting events. RECOVER currently employs the Prey-based Freshwater Fish Density Model and the Wader Distribution Evaluation Modeling (WADEM) to evaluate freshwater fish density and wading bird foraging habitat availability, respectively. However, recent observations of exceptional wading bird nesting in ENP found that increased crayfish production and availability in short-hydroperiod wetlands likely fueled the initiation of supercolonies in the ecotone in ENP. Without a crayfish model, RECOVER is unable to anticipate responses of crayfish, or the wading birds that exploit them, to hydrologic changes resulting from CERP projects. While there have been prior attempts to model crayfish dynamics in the Everglades, the latest model predicted a net decrease in crayfish production and an increase in wading bird abundance. Yet, when hydrologic conditions more closely resembled a restored ecosystem in 2018, crayfish production increased and fueled exceptional wading bird breeding activity. This discrepancy suggests that the models do not fully capture crayfish production dynamics, and the ability to identify hydrologic conditions that promote crayfish production and irruptive wading bird nesting are limited. To address this limitation, RECOVER has initiated the development of crayfish production models. The modeling effort will leverage existing datasets and collect samples from under-represented regions like the marl prairies near the ecotone in ENP. By accounting for species-specific responses to hydrologic variation and increasing the breadth of hydrologic conditions represented in the dataset, RECOVER aims to produce a crayfish evaluation tool that will more accurately predict crayfish production dynamics across the Everglades. This tool will increase the capacity of RECOVER to anticipate crayfish responses to restoration projects and will increase the probability of CERP achieving its ecological goals.

INCORPORATING FUTURE RAINFALL ESTIMATES INTO THE WATER AND CLIMATE RESILIENCE ADAPTATION PLANNING

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The South Florida Water Management District (District) is investing in a series of efforts to continue to successfully implement its mission now, and into the future. From advanced data analysis, development and application of robust tools and integrated hydraulic and hydrologic models, participative planning and implementation of infrastructure investments, the District is building resilience to communities in South Florida. Among changing conditions such as sea level rise and land development, extreme rainfall events are one important input to be considered as part of planning for resilience adaptation strategies. To support the delineation and selection of future extreme rainfall scenarios for flood adaptation planning, the District entered into a cooperative agreement with the United States Geological Survey (USGS) Caribbean–Florida Water Science Center and the FIU Sea Level Solutions Center to develop future depth-duration-frequency (DDF) curves based on available global climate model downscaled datasets. The results of the USGS-FIU-SFWMD study present a range of change factors, representing the calculated ratio (and uncertainty) of modeled future rainfall depths to historic rainfall depths for a given rainfall event. The change factors are applied as multiplication factors to the equivalent National Oceanic and Atmospheric Administration (NOAA Atlas 14) precipitation frequency estimates. Upon the evaluation of these results and the best approach to represent associated uncertainty, the District published a technical memorandum, summarizing the adoption of future extreme rainfall change factors for flood resiliency planning in South Florida, based on the 50% confidence interval of the model spread for 1-, 3-, and 7-day duration and 5-, 10-, 25-, 50-, 100-, and 200-year return frequency events using the ensemble of all model results for both medium-low and high future emissions scenarios compiled by 16 counties and 14 rainfall areas within the SFWMD boundaries as well as the Everglades National Park rainfall area, and an additional combined rainfall area for the Florida Keys and Biscayne Bay. All the results (table and spatial data), along with other supporting data, the USGS data release products, the District's technical memorandum and the final USGS technical report are published in a Web App Portal, though the District's Water and Climate Resilience Metrics Hub, with the goal of promoting regional consistency for flood resilience planning, facilitating data accessibility and advancing common practices. Future extreme rainfall conditions, along with sea level rise and land development scenarios, is now integrated into flood vulnerability assessments being advanced by the District's Flood Protection Level of Service Program, and other regional and local hydrological/hydraulic model simulations that estimate flood risks driven by extreme rainfall.

EYES IN THE SKY MONITOR CYANOBACTERIAL BLOOMS IN FLORIDA WATERS

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While field monitoring of cyanobacterial blooms can be costly, satellite remote sensing offers efficient spatial and temporal assessments. This study used satellite imagery from the European Space Agency's Ocean and Land Colour Instrument onboard the Sentinel-3 satellite series to assess cyanobacterial occurrence, spatial extent, and temporal frequency across Florida. A previously established algorithm was used to determine cyanobacteria presence for each 300-m satellite pixel and for each weekly aggregate satellite image in 2021. Cyanobacteria occurrence quantifies the percentage of lakes across an area experiencing a cyanobacterial bloom each week. Spatial extent quantifies the percentage of resolvable lake surface area experiencing a bloom. Temporal frequency quantifies the percentage of weeks across a year that a satellite pixel is experiencing a bloom. Each of these three metrics characterizes a different component of cyanobacterial blooms, assisting water quality managers in understanding how many lakes are impacted by cyanobacterial blooms (i.e., cyanobacterial occurrence), how much of the water's surface these blooms impact (i.e., spatial extent), and how often these blooms happen (i.e., temporal frequency). Each metric is shown at the state- and district-scale for each of Florida's five Water Management Districts (WMD): Northwest Florida, Suwannee River, St. Johns River, Southwest Florida, and South Florida. At the state-scale, cyanobacterial occurrence ranged from 4% in December, indicating that 4% of lakes across Florida were experiencing a cyanobacterial bloom, to 93% in February. At the district-scale, occurrence was lowest for the Suwanee River WMD, reaching a maximum of 50%, and highest for the Northwest Florida WMD, reaching a maximum of 100%. Spatial extent across Florida followed a similar pattern, ranging from 0.5% in December, indicating that nearly all of the resolvable lake surface area across the state was not experiencing a cyanobacterial bloom, to 84% in May. At the district-scale, while cyanobacterial occurrence indicated that all lakes across the Northwest Florida WMD experienced a bloom in 2021, these blooms covered only a small portion of each lake's surface area as spatial extent was lowest for this WMD reaching a maximum of 47%. Spatial extent was highest for the South Florida WMD reaching a maximum of 94%. Temporal frequency across the state averaged 53% in 2021, meaning that approximately half of weekly summaries across the year indicated a bloom was present. At the district-scale, average temporal frequency was lowest for the Suwanee River WMD, reaching a maximum of 5%, and highest for the St. Johns River WMD, reaching a maximum of 61%. Results from this research establish a full, annual assessment of cyanobacterial occurrence, spatial extent, and temporal frequency across Florida and for each of Florida's five WMDs, which can be used to inform resource management and prioritize mitigation efforts.

INSIGHTS ON PATTERN AND HYDROLOGICAL PROCESS IN THE RIDGE-SLOUGH LANDSCAPE

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The origins of self-organized pattern in the ridge-slough mosaic are central to decisions about a restored Everglades flow regime. The peculiar spatial arrangement of elongated sawgrass ridges interspersed in a mosaic of connect deep-water sloughs is crucial for landscape connectivity for water, solutes, and organisms. The loss of patterning in both the landscape and vertical dimensions, via the loss of microtopographic divergence between ridges and sloughs, occurs with both excessive impoundment and reduced hydroperiod and flow. As such, getting the water right in a restoration implies finding the control points for pattern development. In this talk, we describe the extant pattern, quantify how this has changed in response to flow modifications, explore mechanisms of pattern genesis and degradation, and highlight some persistent uncertainties that merit further investigation.

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SOUTH FLORIDA WATER MANAGEMENT DISTRICT SEA LEVEL RISE AND FLOOD RESILIENCY PLAN, 2023

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The South Florida Water Management District (District) is committed to addressing the impacts of climate change. These include sea level rise (SLR), changing rainfall patterns and evapotranspiration trends. The District's Sea Level Rise and Flood Resiliency Plan (Resiliency Plan) is the first District initiative to compile a comprehensive list of resiliency projects with the goal of reducing risks of flooding and SLR on water resources and increasing community and ecosystem resiliency in South Florida. This goal will be achieved by updating and enhancing water management infrastructure throughout the Central & South Florida(C&SF) Flood Control System and the Big Cypress Basin and implementing effective, resilient, integrated basin-wide solutions. The list of projects was compiled based on vulnerability assessments that have been ongoing for the past decade. These assessments use extensive data and robust hydrologic and hydraulic models to characterize current and future conditions, and associated risks. The District's Flood Protection Level of Service (FPLOS) Program has been advancing integrated modeling efforts in critical basins to help understand flood vulnerabilities and identify cost-effective implementation strategies to assure that each basin maintains its designated FPLOS under current and future conditions. In addition, the District's Capital Improvement Plan (CIP) has been incorporating climate change and SLR considerations into the design of infrastructure projects. Both FPLOS and CIP Programs have been successful at identifying resiliency investments that have now been organized and expanded in the Resiliency Plan. Project recommendations are based on FPLOS recommendations and water supply and water resources of the State protection efforts. These projects include basin-wide flood adaptation strategies that are needed to address the vulnerability of existing infrastructure. The District seeks to implement projects that benefit the South Florida's communities and environment by working closely with state, tribal, private, and local governments and taking into consideration the needs of socially vulnerable communities and environmentally protected areas. The Resiliency Plan includes a multicriteria ranking approach that was developed to support the assessment of vulnerable areas in South Florida, including metrics that help to identify the most critical infrastructure and vulnerable areas, while also considering basin-wide resiliency needs. The Resiliency Plan also includes strategies for implementing nature-based solutions, sustainable energy strategies, a resiliency view on ecosystem restoration efforts and associated potential carbon storage, and water supply. Additionally, the updated plan contains a revised and expanded project characterization and ranking system, and a description of the new flood damage cost estimate tool (SFWMD FIAT) used to support cost-benefit analysis as part of flood adaptation planning.

FACTORS INFLUENCING BODY CONDITION OF ARGENTINE BLACK AND WHITE TEGUS (*SALVATOR MERIANAE*) IN SOUTHERN FLORIDA

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The Argentine black and white tegu (*Salvator merianae*, formerly *Tupinambis merianae*) is a large omnivorous lizard native to South America. Tegus have become established throughout Florida and threaten native wildlife, especially ground-nesting birds, turtles, and crocodilians due to nest predation. In this study, we estimated body condition of invasive tegus as a proxy of fitness and health, and defined factors influencing tegu body condition. In addition, we compared body condition values of invasive tegus to those of tegus collected within their native range in Argentina. Body condition was calculated using Fulton's Index for 1,634 tegus collected from Miami-Dade County, FL and 623 tegus from Argentina. For tegus captured in Florida, we also evaluated temporal, environmental, spatial, and habitat variables to determine which factors best explained potential variation of tegu body condition using multivariate linear regression analysis. We found invasive Florida tegus exhibited higher body condition values compared to tegus from their native range in Argentina. Factors that explained the most variation in body condition among Florida tegus were time (capture day, month, and year), maximum monthly temperature, and distance from a location of known high tegu abundance. Our results indicate that tegus in Miami-Dade County are not facing a limitation of resources, nor do they appear to be subjected to pressures that negatively influence their overall body condition, which may allow tegus to continue to persist and disperse in Florida.

THE DIVERSITY AND DISTRIBUTION OF NON-NATIVE FLATWORMS AND A RIBBON WORM IN SOUTH FLORIDA

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The spread of the non-native New Guinea flatworm (*Platydemus manokwari*) in Florida has been a cause for concern for those charged with managing and preserving Florida's wildlife. This predatory terrestrial flatworm feeds on a wide variety of prey, but prefers to consume snails, including some of South Florida's iconic native tree snails in the genera *Liguus*, *Orthalicus*, and *Drymaeus*. In the course of a project to determine the status of native tree snail populations in South Florida and the impacts on these populations of the New Guinea flatworm, we have documented a diversity of non-native snail-eating invertebrates whose presence is not widely appreciated. These include a ribbon worm *Geonemertes pelaensis* (Phylum Nemertea) and the more commonly reported flatworms *P. manokwari* (New Guinea flatworm), and *Bipalium vagum* (a hammerhead flatworm). In addition, we have documented approximately ten species of flatworms in the genera *Rhynchodemus*, *Anisorhynchodemus*, *Dolichoplana*, and *Caenoplana* and two species of flatworms not yet identified to genus. To determine preliminary identities of these species, we used external morphology and cytochrome c oxidase subunit 1 (COI) barcodes. Identification of these species will provide insights into the ecology of these species in their native and other introduced ranges, with implications for their effects in South Florida and more broadly the United States.

DRONE-BASED GROUND-PENETRATING RADAR MEASUREMENTS TO CHARACTERIZE CARBON DYNAMICS OF PEAT SOILS IN THE EVERGLADES

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Peat soils are a critical component of the global carbon cycle that are considered one of the largest stores of carbon on the planet. At the same time, peat soils are also natural producers of biogenic greenhouse gases (e.g., methane and carbon dioxide), that accumulate within the soil matrix to be subsequently released to the atmosphere. While previous studies during the last few decades have advanced our understanding of carbon accumulation and release in peat soils, quantification of carbon stocks and fluxes can be difficult, particularly when considering the limited scale of measurement of traditional point-based methods, such as coring or flux chambers, or the limited resolution of large-scale methods (such as airborne (helicopter) geophysical surveys or eddy covariance. Some of these studies have showed the ability of non-invasive geophysical methods like ground-penetrating radar (GPR) to effectively characterize carbon dynamics at scales beyond traditional point measurements, however the method still relies on ground-based measurements that can be time consuming, particularly when systems are geographically isolated and difficult to access. In this study, we tested the ability of a drone-based GPR system to capture the spatial variability in peat soil accumulation and its potential for inferring gas dynamics. A Mala GeoDrone 80 from GuidelineGEO was tested at two locations in Water Conservation Area 2B and over fully water saturated peat soils averaging about 1 meter in soil thickness. Discrete airborne measurements were constrained with additional ground-based GPR collected over control transects as well as direct coring at selected locations. Preliminary results showed that the system was successful at capturing peat soil thickness variability while flying at different altitudes and therefore shows promise for expanding the approach to time-lapse mode and capture carbon dynamics over time, i.e., variable soil biogenic gas content inferred from contrasts in relative dielectric permittivity. The system is therefore ideal for effectively characterizing soil thickness at scales larger than ground-based methods in a time-efficient manner while maintaining vertical resolutions of about 10-12cm as typically achieved with ground-based GPR in peat soils with similar antenna frequencies.

NUMERICAL SIMULATIONS OF PUMP INTAKE FLOWS: TOWARD A NUMERICALLY-BASED DESIGN OF PUMP INTAKES

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Pump intakes are important hydraulic structures used to withdraw water from a river. Flow in pump intakes is characterized by the formation of a number of submerged vortices and, in the case of non-pressurized intakes, free surface vortices. These vortices are in many cases unsteady, intermittent and, in the case of free-surface vortices, can entrain air. The main goal of designing the pump bay containing the pump sumps is to eliminate these vortices or reduce their coherence such that there is no air, sediment or debris entrained in the pump sump and the level of swirl inside the pump column is minimal. These conditions should ensure the operation of the pumps is not adversely affected or that cavitation of the pump impeller blades occurs. The present paper focuses on using eddy-resolving numerical techniques to accurately predict flow and vortical structure at pump intakes of realistic geometry that can replace or complement scaled model studies that are generally used to design new pump intakes or improve the design of existing ones. The paper presents results of such simulations for both pressurized and non-pressurized intakes. In the later case, a volume of fluid method is used to capture the deformations of the free surface and the formation of the air-entraining free surface vortices. Both Large Eddy Simulation (LES) and Detached Eddy Simulation (DES) predictions are found to be more accurate than those predicted using classical Reynolds-Averaged Navier Stokes (RANS) models. In the case of the non-pressurized pump intake, which is by far the most common type of pump intake used to withdraw water from rivers, DES is shown to accurately predict the position and circulation of the main subsurface and free surface vortices. DES successfully captures the formation of strongly coherent free surface vortices that sometimes penetrate inside the pump column and entrain air in the low submergence/high discharge cases. By contrast, the free surface vortices predicted by unsteady RANS do not entrain air. As such, DES appears to be the best placed technique for being use as a tool for improving design of complex-geometry pump intakes as it can simulate the formation and unsteady dynamics of the pump intake vortices at much higher Reynolds numbers than LES, close to field conditions. This is an important advantage not only over LES but also over scaled model studies conducted in the laboratory which are subject to scale effects. Though the examples discussed considered only intakes with one pump sump, the existing model that is built in a general computational fluid dynamics solver with a flexible mesh generation package can be applied without any modifications to cases with multiple pump sumps and complex geometry. Overall, the paper shows that eddy-resolving techniques are mature enough to be used for design of pump intakes and for identifying the best solutions among a set of possible choices to improve the design of existing pump intakes.

LABORATORY ASSESSMENT OF SEA-LEVEL RISE EFFECTS ON MERCURY METHYLATION IN COASTAL EVERGLADES WETLANDS

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Mercury (Hg) is a ubiquitous environmental contaminant that impacts aquatic environments and human health globally. Methylmercury (MeHg), the neurotoxic form of Hg that bioaccumulates and biomagnifies up aquatic food webs, is prominent in the Everglades' waters and organisms. Drivers controlling MeHg formation in the freshwater portion of the Florida Everglades include dissolved organic matter, which complexes Hg and enhances lability for microbial methylation; sulfate (SO_4^{2-}) from agricultural inputs, which stimulate the activity of SO_4^{2-} reducing bacteria and influences Hg bioavailability; and abundant inorganic Hg delivered to the Everglades by rainfall. Climate change, however, introduces new variables such as sea-level rise to the southernmost portion of the Everglades. Continuous salinity measurements of Shark River Slough in Everglades National Park show increasing magnitude, frequency, and duration of salinity spikes due to rising sea-levels. Despite recognition of coastal wetlands as important locations for the formation of MeHg, and that sea-level rise will alter the biogeochemistry of peat soils where methylation is likely to occur, no mechanistic studies have assessed the biogeochemical response to sea-level rise in Everglades soils. Sea level rise is likely to influence MeHg production in several ways due to (1) the delivery of marine SO_4^{2-} to previously low SO_4^{2-} freshwater wetlands and (2) shifts in microbial communities that will alter dissolved organic matter biogeochemistry, peat stability, and Hg methylation. We hypothesized that sea-level rise would have a pronounced effect on Hg bioavailability in coastal Everglades wetlands, with the highest MeHg production in soils inundated by water at moderate salinity levels. To investigate the influence of sea-level rise on Hg methylation and demethylation, we collected 120 peat cores from a freshwater, low SO_4^{2-} site in Water Conservation Area-3A. In the laboratory, the cores were incubated for between 1-20 days with water at 5 relevant salinity levels from 0.1 – 6 parts-per-thousand, representing SO_4^{2-} amendments from 0.2 to 450 mg/L. The incubation water contained enriched stable ^{201}Hg and $^{204}MeHg$ isotopes pre-equilibrated with Everglades dissolved organic matter. This allowed us to quantify the rates of transformation of inorganic ^{201}Hg to $^{201}MeHg$ and $^{204}MeHg$ to ^{204}Hg. At each time point, we also quantified the partitioning of mercury between aqueous and solid phases and changes in dissolved organic matter and SO_4^{2-} concentration. Vertical $H_2S_{(g)}$, $O_{2(g)}$, $H_{2(g)}$, pH, and oxidation-reduction potential profiles of the soil cores were quantified with microelectrodes. The impacts of sea-level rise on Hg methylation will be compared between the 5 salinities and leverage biogeochemical and redox data collected on the soils and pore waters. This presentation will put these findings in context of current and projected salinity conditions in coastal Florida.

WHAT TRIGGERS IRRUPTIVE WADING BIRD BREEDING EVENTS? NEW INSIGHTS FROM LANDSCAPE-SCALE FORAGING PATTERNS

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Recovery of trophic relationships sustaining nesting populations of wading birds is a primary goal of Everglades Restoration. The Trophic Hypothesis is used by RECOVER to capture the concept that wading bird nesting is limited by the production and accessibility of aquatic prey at appropriate water depths, times, and locations. While a substantial body of literature has identified many of the key links of this Trophic Hypothesis, the mechanisms driving some of the defining characteristics of historic nesting such as exceptionally large breeding aggregations and coastal nesting remain poorly understood. Yet recent years of unprecedented hydrological conditions and nesting responses are providing new insights into wading bird reproductive ecology. A study of White Ibis nestling diet in the estuarine region of western Everglades during the banner nesting season of 2018 revealed that the crayfish *Procambarus alleni* (a short-hydroperiod habitat specialist) was key to triggering and supporting the exceptional coastal nesting event (30,420 ibis nests). During 2017, a dryer year with reduced coastal nesting (1,075 ibis nests), poor-quality estuarine crabs were the dominant prey group. Prey species characteristic of longer-hydroperiod habitats such as fishes were relatively uncommon in diets in both years. These results suggest that hydrological recovery of local short-hydroperiod habitats is critical for producing enough available prey at the right time and place to trigger large coastal nesting events. I tested this “coastal nesting” hypothesis by quantifying foraging responses of White Ibis across the Greater Everglades landscape using systematic aerial surveys. Flights were conducted weekly by helicopter from November through June over a three-year period that included a wet year with hydrological condition and nesting responses comparable to the pre-drainage period, and two dryer years with hydrology and nesting typical of post-drainage conditions. Survey locations were predetermined on a weekly basis using WADEM habitat suitability maps. I recorded spatial coordinates of foraging birds and used photography to quantify flock size and species composition. As expected, short-hydroperiod wetlands supported large numbers of foraging ibis throughout the nesting period during the year with relatively wet antecedent conditions and exceptional nesting. Critical foraging habitats included the coastal marshes, Western Marl Prairies and Lostmans Slough, but few ibis were observed in Shark River Slough. In the two dry years with limited coastal nesting, relatively few birds foraged in either short-hydroperiod or slough habitats. These results run contrary to the idea that rehydration of Shark River Slough alone will be sufficient to restore large, coastal nesting colonies and suggests that restoring hydroperiods across a broader swarth of the southern Everglades, including the Western Marl Prairies and the Lostmans Slough regions, is key to wading bird recovery.

INCORPORATING LAND MANAGEMENT STRATEGIES IN THE MITIGATION BANK REGULATORY FRAMEWORK FOR MANAGEMENT OF SALIX CAROLINIANA

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The Lake Washington Mitigation Bank comprises approximately 1,657 acres of shrub dominated floodplain marsh located in the Upper St. Johns River and Lake Washington floodplain in Brevard County, Florida. The site is east of the river channel and contiguous with the southeastern shore of Lake Washington. A dirt roadway without culverts constructed in the 1960s bisects the site. The central and western portions of the site were dominated by a sub-canopy of *Salix caroliniana* that exceeded the height of surrounding herbaceous vegetation. Woody shrub species are a natural component of a floodplain marsh community, but monocultures of shrubs can indicate prolonged wildfire suppression or changes in hydrology. *Salix caroliniana* has been known to become invasive under certain conditions within this watershed. A management plan was proposed for the site with the goal of reducing cover by *Salix caroliniana* and promoting a more diverse, native herbaceous stratum. The plan was subject to the state and federal mitigation bank permit regulatory programs administrated by the St. Johns River Water Management District and Department of the Army, Corps of Engineers. Management included the use of herbicides and prescribe fire and installation of two low-water crossings along the existing dirt roadway. A baseline monitoring event was conducted within representative portions of the site in October 2016 to establish 24 permanently referenced monitoring stations to collect baseline data prior to implementation of the plan. Data collected included vegetative species composition by strata, estimates of percent areal cover by species, and observations of general plant vitality. Management was initiated in October 2017, with herbicide treatments conducted via airboat as accessible and an aerial herbicide treatment targeting *Salix caroliniana* and larger monocultures of nuisance/exotic plant species on November 6 and 7, 2017. An aerially ignited prescribed fire was subsequently conducted on February 1, 2018. Monitoring is conducted semi-annually to quantitatively assess site conditions. Site conditions in the fall of 2017 and the spring of 2018 were characterized by a mosaic of herbaceous emergent, floating, and submerged vegetation, and notably reduced cover by woody shrubs (16.8% overall average) relative to the baseline condition (26% overall average with up to 70% cover). The dominant marsh vegetation documented in the fall 2021 and spring 2022 monitoring events was characterized by a more diverse, native groundcover stratum with an overall average shrub cover of 4.3%. Data collected to date supports the use of herbicide treatments in combination with prescribed fire to achieve the targeted management objective of reduced cover by *Salix caroliniana*. Hydrologic regimes appear to play a notable role in continued management; however, water levels cannot be controlled and are subject to natural weather events and the stage of the St. Johns River.

EVERGLADES MANGROVE MIGRATION ASSESSMENT (EMMA): A RESILIENCY PILOT STUDY

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Sea level rise (SLR) and changes in storm and rainfall patterns associated with climate change could have a dramatic impact on the remaining natural areas in South Florida. Due to its low elevation and proximity to the coast, the natural vegetation of the coastal wetland community is extremely vulnerable to changes caused by SLR. Coastal wetlands can respond to SLR in three ways: (1) peat and sediment accretion that allows coastal wetlands to keep pace with SLR, (2) submergence with landward migration of coastal vegetation and wetland habitat, or (3) submergence and loss of wetland ecosystem habitat, without habitat migration. Mangrove forests and coastal marshes within the Everglades ecosystem rely on external inorganic sediment input and autochthonous organic matter generated to maintain a vertical soil elevation that have allowed them to keep pace with SLR. The resilience of coastal mangrove ecosystems to continue to keep pace with SLR and migrate upstream into brackish and freshwater habitats will depend upon the ability of the CERP Projects to provide the hydrodynamics (i.e., increased flow and hydroperiods and lower porewater salinities) and the ecological connectivity (i.e., canal and levee removal) to foster soil accretion in coastal mangroves and marsh transformation. The Everglades Mangrove Migration Assessment (EMMA) Pilot Study is a large-scale field manipulation of sediment designed to enhance the resilience of coastal mangroves in the Everglades. The pilot study will evaluate the ability of Thin Layer Placement (TLP), an innovative nature-based management measure, to increase soil elevation, enhance net primary productivity and provide storm surge protection within coastal wetlands of South Florida. Without intervention, the current trajectory of SLR will result in major land loss, diminished flood protection and salinity intrusion into freshwater marshes. EMMA will document the effectiveness of TLP to increase resilience of Florida’s coastal wetlands and keep up with SLR. The results of this pilot study will guide implementation of large-scale mangrove migration projects that will reduce the impacts of SLR. This will be accomplished by shifting coastal plant communities to mangroves, which are resilient to higher water depths and are able to accrete peat, capture more sediments, keep up with SLR, and contribute to the overall enhancement of coastal ecosystems health in South Florida.

FIRE AND FLOODING INTERACT TO AFFECT SURVIVAL OF CROTON LINEARIS, A RARE PINE ROCKLAND PLANT

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In tropical and subtropical grasslands and savannas, such as those found in Everglades National Park, there are gradients in plant community composition along hydrologic ecoclines from dry uplands to permanent water bodies such as marshes. Along the middle of these gradients (i.e., transition zones), the hydrologic regime is seasonal. The onset of flooding is tightly coupled with the rainy season that typically begins in late May to early June, but the extent and duration are also influenced by scheduled water releases as described by the Comprehensive Everglades Restoration Plan. The hydrologic regime can modify fire regimes (e.g., frequency, intensity, and severity) and postfire recovery of plants. It is unknown how human-induced changes in fire-flooding interactions affect rare and sensitive species along hydrologic gradients. For instance, *Croton linearis* populations have significantly declined after some fires but not others, which concerns Everglades National Park ecologists because *C. linearis* is the host plant for two endangered butterfly species. We used plant monitoring data collected by Everglades National Park from 2005-2018 to determine how the timing of fire and flooding affects the population viability of *C. linearis*. The Everglades Depth Estimation Network (EDEN) was used to determine daily water surface levels for each plant population, and fire effects data was used to estimate fire severity. For the five fire and flooding events we examined, *C. linearis* survival was high when fires occurred well in advance or at least a month after the wet season onset. When *C. linearis* was burned shortly after the wet season onset, its survival declined significantly. As the wet season began, water depth increased drastically and then fluctuated until rains became more frequent and consistent, moving into late June and July. *Croton linearis* populations burned shortly after the wet season onset might have experienced large and immediate fluctuations in water depth, likely inundating the resprouting individuals. Flooding events soon after fires have caused mortality in other species, such as sawgrass, particularly if the plants could not begin regrowing before their meristems became inundated. Our results demonstrate that the interactive effects of human-modified fire and hydrologic regimes can have unanticipated impacts on rare plant populations along hydrologic gradients.

ECOSYSTEM MANAGEMENT IN VEGETATION BASED STORMWATER TREATMENT AREAS

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The Everglades Stormwater Treatment Areas (STAs) are wetlands constructed to reduce phosphorus (P) from stormwater runoff prior to discharge to the Everglades Protection area. Since the STAs were first conceived, modeled, and designed, and built, the South Florida Water Management District (District) has adapted to actual and often unforeseen challenges to create, operate, maintain, and optimize a vegetation-based nutrient retention facility on a landscape scale in southern Florida. Managing the STA landscape for efficient and sustainable P retention while also providing capacity for flood control is a complex puzzle. Meeting the demands of flood control, water supply, nutrient removal, and public access can be a difficult balancing act. These challenges are compounded by the uniqueness of each STA with flow-ways and cells consisting of different soil types, topography, vegetation landscapes, and P loading. To maintain sustainable STA P retention the vegetation management staff work closely with other groups inside and outside the District to ensure the STAs are performing as intended and provide the required P concentrations to the Everglades. District staff along with contractors strive to control the invasive and nuisance plant communities, plant desirable species and encourage natural recruitment in appropriate locations and patterns to ensure the STAs have the healthy vegetative communities needed to optimize performance and provide long term treatment capability.

BACK TO THE FUTURE: WHAT DO WE NEED TO AVOID THE TIPPING POINT

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Biscayne Bay has undergone significant alteration in terms of hydrologic connectivity, both in terms contributing water bodies and the amount and timing of freshwater over the past 100 years. Connectivity changes include connections to Lake Okeechobee and beyond and increased surface water associated with the highly connected canal systems that drain the landscape to the west. Most of the natural transverse glades that connected the land to the bay depending on hydroperiod are now gone or now disconnected. In August 2020, the Biscayne Bay incurred a significant anoxia event with a magnitude never observed before. A perfect storm of high storm water inputs, warmer the average air and water temperatures and diminished tidal flushing resulted in algal blooms followed by decomposition and anoxic conditions. Thousands of water quality samples were obtained during this event without finding a single point source of drivers such as Phosphorus inputs, likely responsible for the abrupt algal bloom. Since then, a number of additional (albeit smaller) fish kills have occurred under varying conditions. These anoxia events point to an ever-growing threat that indicates Biscayne Bay is near the final tipping point. The phase shift began decades ago when the bay transformed from a clear, seagrass dominated water body to what is now a turbid, algal dominated system. Climate change and continued human development is dangerously close to permanently degrading the bay. But things are even worse! We now know that novel, emerging chemicals such as PFAS and pharmaceuticals are present in the canals and bay itself. We don't know the extent of the sources, nor do we know what is already trapped in the sediments below. We now understand that a unified approach to Bay monitoring and management must begin immediately with the myriad, disparate water quality data combined and synthesized throughout the ever-expanding Biscayne Bay Watershed. These data should be analyzed with the goal of identifying the most significant inputs of nutrients throughout the Bay. Septic systems, heavy runoff areas, and low water quality canal inputs must be identified to help inform local, regional and state management groups of the highest priority areas for infrastructure replacement. Chemical fingerprinting as well as other new sensor platform techniques should be explored to enhance and quicken our abilities to provide this essential information.

POPULATION VIABILITY OF THE EVERGLADE SNAIL KITE UNDER FUTURE CLIMATE CHANGE SCENARIOS

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Climate change is expected to have substantial impacts on wetland-dependent species, such as those within the greater Everglades ecosystem. In particular, the Everglade snail kite (*Rostrhamus sociabilis plumbeus*) faces many threats, including rising temperatures, increased hurricane activity, as well as habitat conversion and degradation from anthropogenic changes. In terms of climate change, the most direct potential effect on snail kites may be due to changes in rainfall, as well as the frequency and magnitude of drought conditions. These changes in rainfall (intensity and frequency) may cause significant impact to the snail kite's nesting areas and prey abundance, altering snail kite demography. Significant gaps exist in our knowledge of how snail kites will respond to climate change and it is important to understand the vulnerability of snail kites under future climate scenarios. Using a spatial population viability analysis (PVA), we projected changes in population size from 2020-2050 across six analysis units that comprise the extent of the monitored snail kite population. We evaluated three different scenarios for climate over this period, three scenarios for changes in carrying capacity of analysis units that may be driven by management-related actions, and we evaluated how potential increases in demographic rates (nest success, breeding probability, and juvenile survival) may influence viability. Under a scenario of no climate change and optimistic carrying capacities at analysis units, the population was generally stable over the projected time period. However, scenarios with increasing drought, increased variability in climate, or less optimistic carrying capacities all projected a decline in population size of this species over time. Management that reduces carrying capacity or the number of analysis units also had strong effects on population size through the reduction in individuals breeding. Overall, increasing nest success increased population growth and size more so than increasing breeding probability or juvenile survival. Our results suggest that if climate change leads to increases in drought conditions or more extreme weather events in terms of wet and dry years, the population of snail kites in the United States will likely decline in the coming years. In contrast, if there is no change in climate conditions, the snail kite population may be relatively stable if management does not cause a decline in the carrying capacity of the analysis units or the overall carrying capacity of the population. The only change that led to population increases and potential recovery was increasing demographic rates. These results point to potential benefits of management aimed at managing hydrology for suitable snail kite conditions as a means to promote population recovery.

INVASIVE PYTHON SIZE DESCRIPTIONS AND REPRODUCTIVE PHENOLOGY IN FLORIDA

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Efforts to control the Burmese python in the Greater Everglades Ecosystem are ongoing but are hampered by the lack of access to and information on the expected biological patterns of the species in the wild. Over 26 years (1995‑2021) we and colleagues have been collecting and recording data from more than 4,000 wild Burmese pythons removed in southern Florida, representing the most robust dataset on this invasive population to date. Our research team has collated these data and analyzed them to characterize southern Florida's python demographics (e.g., size distribution, size at maturity, clutch size, reproduction and seasonal trends). Through this effort, we were able to expand what was previously described for the size ranges by sex and newly define expected size-stage classes. We showed that males are, indeed, smaller than females at sexual maturity and confirmed a positive correlation between maternal body size and potential clutch size. Further, we used the large dataset to develop predictive equations for ease of cross-study comparisons and to facilitate demographic predictions. We were able to refine the annual breeding season as 100 days from December into March using physical characteristics of specimens and reproductive organs (correlations of capture morphometrics with observations of seasonal gonadal resurgence and regression) paired with field observations. We could also define nesting season (oviposition timing; May) followed by the peak hatchling emergence and dispersal period from July through October. Our results define characteristics of the invasive Burmese python in Florida and provide an enhanced understanding of the ecology and reproductive biology in the Greater Everglades Ecosystem. Results can inform future population models which can then facilitate improved management options. The list of co-authors, link to the entire dataset, and research paper can be found openly available in the December 2022 issue of NeoBiota: Currylow AF; BG Falk; AA Yackel Adams; C Romagosa; JM Josimovich; MR Rochford; MS Cherkiss; MG Nafus; K Hart; FJ Mazzotti; RW Snow; RN Reed. (2022) Size distribution and reproductive phenology of the invasive Burmese python (*Python molurus bivittatus*) in the Greater Everglades Ecosystem, Florida, USA. NeoBiota 78: 129-158. https://doi.org/10.3897/neobiota.78.93788.

THE IMPACT OF UNCERTAINTY ON MODEL OUTCOMES USED FOR EVERGLADES RESTORATION PLANNING

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Natural resource managers and planners are often required to make decisions where there is considerable uncertainty in the outcome. Quantifying and comparing sources of uncertainty in predictive models is an important step in improving confidence and clarity in the decision-making process. For example, comparison between model outputs run on different scenarios may appear similar for a mean prediction, but the confidence around one prediction may be stronger than another. In the Everglades, outcomes from water management and restoration decisions are dependent on a highly stochastic environment impacted by climate change, compartmentalized management, and conflicting resource needs. Everglades restoration planners utilize predictive ecological models to assess the potential impact of alternative plans on wildlife and vegetation on the landscape. Both the inputs and outputs to these predictive models are inherently uncertain, but a formal exploration of how this uncertainty can influence conclusions is not considered during planning processes. We explored the impact of two sources of uncertainty on two different predictive ecological models used in Everglades restoration planning, KiteNest and the vegetation model within the Everglades Vulnerability Analysis (EVA-Vegetation). KiteNest predicts the relative probability of nest-site selection on the landscape for the endangered Everglades snail kite, while EVA-Vegetation predicts the probability of 6 vegetation types across the landscape. We explored the input uncertainty for each model by adjusting the modeled hydrologic inputs for each scenario in the recently completed Everglades Interim Goals/Interim Targets assessment. We considered two potential levels of error (± 10%, ± 20%) and evaluated changes in model outcomes compared to the original hydrologic inputs. To address output uncertainty, we assessed the amount of statistical error inherent in each model outcome and determined the upper and lower bounds of each prediction. We compared the magnitude of model outcome changes between the input and output uncertainties to assess the relative importance of each source of uncertainty. This exercise is an important first step to considering uncertainty in predictive modeling when planning for the restoration of the Everglades.

WHAT THE EARLY DETECTION AND RAPID RESPONSE INFORMATION SYSTEM MEANS TO THE EVERGLADES AND FLORIDA

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Several databases and reporting platforms exist for professional biologists and resource managers to report various invasive species observations. On their own, none of these existing platforms have complete national coverage of aquatic, marine, and terrestrial species, nor do they provide a clear avenue for public reporting. As such, the burden of discovery has limited the ability to detect and respond to the introduction and spread of invasive species efficiently and effectively. The under-development National Early Detection Rapid Response Information System (NEDRRIS) will curate data, facilitate collaboration, and provide decision support tools for implementing early detection and rapid response activities across the nation, including the Everglades and Florida. The System will be a one-stop, interactive resource that serves as an information-sharing hub, a decision support network, and a community of practice. By planning on integrating a broad scope of invasive species information sources, the NEDRRIS will empower science-driven approaches to protect the nation's economy, natural resources, public health, cultural heritage, and infrastructure from the harmful impacts of invasive species. The goals of the new webpage/program are to: 1) Unify access to existing databases and invasive species information sources in a single online location. 2) Accelerate action to prevent the establishment and spread of invasive species. 3) Partner and coordinate with others to promote a cohesive and comprehensive EDRR information and support network. 4) Leverage novel technology to advance EDRR management capabilities. 5) Demonstrate the sustainability of the NEDRRIS to build trust and continued support for the program. The cornerstone of the NEDRRIS is an integrated web application that offers data visualization, decision-support resources, and connection to existing and emerging EDRR products. For this presentation, we will present how this newest product in development by the Department of Interior and U.S. Geological Survey will be a central EDRR hub that can aid the ongoing research in and management of the Everglades and Florida.

LYGODIUM MICROPHYLLUM POPULATIONS AND CONTROL IN WCA-3

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An 18-year dataset encompassing 528 surveys on 409 islands from the *Lygodium microphyllum* control program was evaluated for the ecological and hydrological drivers that influence *L. microphyllum* in Water Conservation Areas (WCA) 3A and 3B. A total of 395 *L. microphyllum* populations were identified on 55 of the 409 islands surveyed. Of the 395 total populations, 109 were located on islands in WCA-3A and 286 were found on islands in WCA-3B. *L. microphyllum* was found in 98 of the 528 total surveys conducted, or approximately 19% of the time. *Lygodium microphyllum* populations were most frequently found growing on fern mounds (as opposed to soil, decaying wood, and trunk bases), but the proportion of substrate type utilized by *L. microphyllum* varied depending on its location on the island, (e.g., head, neartail, or tail). This is likely the result of hydrological influences and highlights how *L. microphyllum* prefers to grow in wet, but not fully inundated conditions. There are almost no islands with *L. microphyllum* in the southeastern region of Water Conservation Area 3A. The absence from islands in this region may be the result of island degradation and lack of elevated substrate where *L. microphyllum* most often establishes. *Lygodium microphyllum* is more frequently found on lower elevation islands but is rarely encountered (only 8% of the time) on islands that experience more than 300 days of inundation per year. Dominant canopy species diversity declines dramatically as the duration of inundation increases. *A. glabra* remains a relatively stable component of tree island communities under all inundation regimes, but species such as *Persea palustris*, *Magnolia virginiana*, *Myrica cerifera*, and *Taxodium* spp. become less frequently dominant, and *S. caroliniana* rapidly becomes the predominant canopy species with increased inundation. *Lygodium microphyllum* was most frequently associated with *A. glabra* and *Salix caroliniana* (87 and 94 occurrences, respectively). Despite being the second most frequently encountered dominant island canopy species (25% of islands), *Chrysobalanus icaco* is rarely associated with *L. microphyllum* populations (2% of occurrences). *L. microphyllum* presence is greatest under canopies of *A. glabra* and *S. caroliniana*. Whether this is a preference for canopy species or simply overlapping habitat requirements is unclear. There appears to be a preferred hydrologic range of *L. microphyllum* where island head inundation is less than 300 days per year. Since topography varies throughout islands, further analyses of the degree of individual root crown flooding (i.e., root inundation days) is ongoing.

HYDROLOGY AND TEMPERATURE INFLUENCES ON POMACEA PALUDOSA DEMOGRAPHY

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Here we present data sets derived from 1) monitoring snail egg cluster and snail densities, 2) a mesocosm study on egg production, and 3) principle component analyses (PCoA), to quantify temperature and hydrologic effects on apple snails. All of these data were collected in Water Conservation Area 3A (WCA3A). Collectively these separate studies show a negative effect of hydrologic extremes on egg reproduction. Snail densities estimated in a given breeding season reflect prior year hydrologic conditions. Atypically high-water conditions suppressed egg cluster production in relatively high snail density sites, resulting in a subsequent year >80% decline in snail densities. We analyzed an Egg Cluster Production Index (ECPI) as a function of water depths and temperatures during the breeding season. The adjusted R^2 from the gam model was 0.12 for the combined effects (F=1.3, n=31, P=0.29). Peak ECPIs were associated with depths between 11 and 51 cm. There was high variability for ECPI in these depth ranges, as influenced by temperature and possibly low snail densities (we have evidence of Allee effects). There was a significant temperature effect (adjusted R^2 = 0.73, F=19.2, p<0.001), with a distinct increase in EPCI associated with temperatures above ≈24°C. We then conducted an *in situ* mesocosm study to control for snail density and temperature. We loaded 6.7-m^2 mesocosms with snails and monitored egg production for 25-33 days with mesocosms set in water depths ranging from 26 to 110 cm. Adjusted R^2 for combined water depth and temperature effects on egg production was 0.45 ($F_{2,23}$ =11.36, p=0.0004). R^2 values for the effect of water depth on egg production for the three phases of the study were 0.86 (March-April), 0.81 (April-May) and 0.74 (May-June). Fewest eggs were associated with depths > 70 cm. Finally, we applied multivariate statistics to quantify hydrologic influences on snail densities at 70 sites, some sampled multiple times, yielding 104 total site-years. We investigated breeding season and nonbreeding season hydrologic metrics for our analyses. Principal component analysis indicated that mean water depth, maximum water depth, and total number of dry days during the apple snail breeding season described a majority of hydrologic variability across sampling events (PC1; 72.6%). Ground elevation was associated with the creation of PC2. *A priori* snail density levels (0, >0- 0.15, 0.15- 0.8, and >1.0 snails/m^2) were used to perform a one-way ANOSIM comparing hydrologic influences on densities. There were significant differences when snails were undetected compared to all other density levels; this was driven by number of dry days during the breeding season. Model selection indicated that 9 of 10 plausible models produced included dry down days during the breeding season, indicating the negative consequences of extended dry down events in explaining snail densities throughout much of WCA3A (especially at higher ground elevations).

IN MEMORY OF ROB BENNETTS: A RETROSPECTIVE ON SNAIL KITE AND APPLE SNAIL STUDIES, 1985 TO THE PRESENT

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Dr. Robert E. Bennetts (Rob) died in June 2022 following an approximately 1-year illness. Here we offer a retrospective on a career foundationally influential for Snail Kite conservation and management, but also influential well beyond the Greater Everglades Ecosystem Restoration effort. The Everglades science community knows Rob primarily as a PhD student from the 1990s. Rob is known for transforming the way we understand Snail Kite ecology, and for creating a statistically robust protocol for monitoring the Florida Snail Kite population followed to this day. His deployment of 300 VHF transmitters on kites in three years resulted in an extraordinary data set, and his skills with a rifle-mounted net gun to safely capture adult kites while operating an airboat have never been matched. What is less well known is that Rob, recently out of an undergraduate program in Zoology, started studying Snail Kites in 1985 through the Department of Wildlife, University of Florida. He first-authored (prior to attending graduate school) an impactful report on Snail Kite nesting ecology in collaboration with Dr. Beissinger (well-known for documenting ambisexual mate desertion by kites) and supervisor Dr. Collopy. Looking back today on this 1988 report, one can see a stage being set for many distinct research projects of Snail Kite AND apple snail behavioral ecology and demography that were eventually conducted in the 1990s and 2000s. Critical to Rob taking on a doctoral program in wildlife at the University of Florida (supervisor Dr. Wiley Kitchens) was completing a master's degree rooted in quantitative ecology from Colorado State University, some aspects of which we will review in detail as they influenced a decade of kite and snail research. His dissertation (a 2-volume treatise on kites) was distilled down to what many of us consider the Florida Snail Kite “bible”, a Bennetts and Kitchens US Geological Survey 1997 final report, wherein the kite population monitoring protocol applied today was initially presented to a broad audience. Rob was instrumental in launching a series of studies on apple snails, and he continued to be a key collaborator (and co-author) on snail studies well into the 2000s. As great an influence as Dr. Bennetts had on our understanding of Snail Kites in Florida, he had just as much influence, if not more so, once he left Florida to lead, as a quantitative ecologist, monitoring and adaptive management programs for the National Park Service out west. We will review a life of extraordinary experiences (not the least of which was as a smoke jumper) and professional contributions, and how Rob shared his love of nature, cooking and travel with his family and friends.

THE EVERGLADES HANDBOOK: UNDERSTANDING THE ECOSYSTEM – ITS 40-YEAR EVOLUTION

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In concept, The Everglades Handbook: Understanding the Ecosystem began in 1982 under a different proposed title. It was to be a coffee-table book featuring the photographs of Robert Hamer, with supporting text by Dr. Lodge. Unable to find a publisher, Lodge abandoned the project and successfully approached St. Lucie Press with the manuscript, mostly his own photographs, and several crude maps. His intent was to provide a primer on the Everglades ecosystem mainly for people interested in restoration, including participation in the public meetings that eventually led to the Comprehensive Everglades Restoration Plan. The book, entirely in black and white, covered the general character of the Everglades, its flora, organized by plant communities, and its fauna, organized by groups. A concluding chapter covered impacts and anticipated restoration. The book strived to standardize the names of plant communities and to answer the basic question, exactly what is the Everglades? The first edition covered only the true Everglades from Lake Okeechobee south to Florida Bay. Successive editions added chapters on geology, the Big Cypress Swamp, Lake Okeechobee and its headwaters, coastal ecosystems hydrologically related to the Everglades, the use of models for understanding ecosystem processes, and important aspects of Everglades chemistry. From the initial black and white, soft cover first edition having 228 pages and 263 references, it evolved to a full-color fourth edition of 440 pages and 884 references. A fifth edition is now in press, this time with a coauthor, Dr. Stephen E. Davis III. Together with revision, updates, and reorganization, it has expanded coverage of Everglades chemistry and a section of the final chapter on Everglades politics, but retains readability for the interested lay audience, the target of the first edition.

TRANSCRIPTOMICS ANALYSIS OF GLYPHOSATE AND PERFLUOROOCTANESULFONIC ACID EFFECTS (PFOS) ON THE IMMUNE SYSTEM OF FLORIDA MANATEES

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The immune system's role is to protect against infectious disease and antigens; exposure to chemicals may affect immune response by decreasing its ability to function normally. Glyphosate is the most used herbicide worldwide and has been found in Florida waterbodies year-round, with highest concentrations in South Florida, including the St Lucie canal and Caloosahatchee River. Previous studies have shown that more than 55% of the manatees sampled had glyphosate in their plasma. Through *in-vitro* experiments, we isolated lymphocytes from blood samples of 12 free-ranging animals sampled in December-January 2018 and December 2019. Lymphocytes were exposed to 0, 10, 1000, and 10,000 µg/L of glyphosate and simultaneously to a mitogen (phytohemagglutinin 5 µg/mL). Each animal had lymphocytes exposed to all doses. Glyphosate caused a dose-dependent reduction in the proliferation capacity of T-lymphocytes with a significant decrease at 10,000 µg/L of glyphosate with a mean reduction of 27%. We performed RNA-sequencing from lymphocytes isolated from four female manatees exposed to the same doses of glyphosate as the proliferation assay. Lymphocytes were exposed for 48 h and showed up-regulation of proinflammatory cytokines (interleukin 1-alpha, interleukin-1beta and the receptor type 1, and interleukin-6) that promote acute phase inflammatory response. The most downregulated pathway at 10 and 10,000 µg/L of glyphosate was activated T-cell proliferation. *In-vitro* data suggest that exposure of manatees to glyphosate may target their adaptive immune response by altering the ability of T-lymphocytes to proliferate and promote acute phase inflammatory response. Flame retardants such as Perfluorooctanesulfonic acid (PFOS) have also been quantified in Florida manatee plasma. We performed transcriptomics analysis from buffy coats from wild manatees exposed in-vivo to glyphosate and PFOS simultaneously (n=5) and compared them to individuals that had low concentrations of either contaminant or neither (n=15). The most significantly affected pathway was protein regulators of chemical substances and 31 immune pathways. Some upregulated genes associated with inflammation processes and stress after glyphosate and PFOS exposure were heat shock protein 70, 90, and tumor necrosis factors. Glyphosate exposure in the environment may result in synergistic effects with other contaminants such as PFOS. Our findings should be considered in the context of a threatened species that already faces other stressors affecting their immune response such as red tide and cold stress.

WHAT HAVE WE LEARNED ABOUT THE CSSS IN THE LAST 30 YEARS OF STUDY?

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The Cape Sable seaside sparrow has been the focus of extensive and intensive research and monitoring efforts spanning more than 30 years, and the species' reliance on specific habitat and hydrologic characteristics continue to make it a focal species in Everglades Restoration. Despite the remarkable amount of information on the species, determining how the sparrow will respond to Everglades Restoration and other management actions continues to prove difficult, and for nearly every criterion established to characterize their requirements, there are exceptions. The reason may be that the CSSS, both at a species level and a population level, is remarkably resilient. The sparrows have been regularly subjected to nearly every challenge possible in South Florida – flooding, drought, fire, hurricanes, and more, and in its history, there have been several documented local extirpations. The spatial extent of sparrow habitat is changing, and the locations where sparrows occur has changed, and we should continue to expect such changes. Individual CSSS respond to changing conditions by moving, and CSSS are likely aware of habitats and conditions at a landscape level. Behaviors such as juvenile flocking and aggregation may also act to facilitate adaptation to new or changing conditions at a population level. The combination of behavioral plasticity and highly variable environmental conditions combined with the species' extremely cryptic nature and the extreme logistical challenges of working in the Everglades may make it difficult to accurately predict responses to Everglades Restoration; non-traditional approaches to evaluating hydrologic effects on sparrows may be appropriate.

EXPERIMENT AND MATHEMATICAL MODEL OF CONTROL OF WATER HYACINTH

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Water hyacinth is an ecologically and economically damaging invasive aquatic plant in many parts of the globe, including Florida. To reduce the side effects from the use of herbicide, which is the most effective control measure on the short term, integrative approaches that combine herbicide treatment with biological control agents, have been proposed. To explore an integrative approach combining herbicide treatments and biocontrol to an invasive plant species, water hyacinth (*Pontederia crassipes*), we used an experiment along with simulation modeling. The objective was to determine combinations of herbicide treatment and biocontrol that are efficient at keeping invasive water hyacinth to as low as possible a level in southern Florida aquatic systems. The experiment consisted of 14 different treatments of water hyacinth in 1.67 m^2 outdoor tank mesocosms, seven herbicide treatments with and seven without the presence of biocontrol insects, the weevil *Neochetina eichhorniae*. The seven treatments involved one no-spray treatment and six different combinations of a one-time spraying of the herbicide. These six combinations were alternative use of half- and full-strength herbicide, each sprayed over 40%, 80% or 100% of a given tank; the additional two treatments were no-spray, with and without biocontrol. There were five replicates of each treatment. The idea of the design was to see if leaving certain fractions of the water hyacinth left unsprayed maintains sufficient area for survival of the weevil. An overarching hypothesis was that leaving part of a tank unsprayed would provide sufficient stable habitat for the biocontrol agent that would allow it to be effective in keeping the total water hyacinth biomass under control to a low biomass level. Water hyacinth biomass was measured on five days over the 167-day period. Data from the no-insect treatments were used to calibrate the model of water hyacinth growth. The experimental results showed that the lowest water hyacinth biomass resulted from an initial one-time treatment of half-strength herbicide treatment to 80% of the area, along with biocontrol. That limited water hyacinth to an average value of about 32% of the biomass that resulted without any control over 167 days. Because the system did not reach a steady state in 167 days, the model was used to project the dynamics of the system over a longer time span of 800 days, by which steady state was reached. The output indicated that, over 800 days, the average value of the water hyacinth under the 80% herbicide treatment with insects present was about 18% of water hyacinth under treatments without biocontrol. These results will help in the design of control strategies at larger scales in the field.

BISCAYNE BAY AND SOUTHEASTERN EVERGLADES ECOSYSTEM RESTORATION: PERFORMANCE MEASURE TARGET-SETTING INFORMED BY SEA LEVEL RISE

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The Comprehensive Everglades Restoration Plan (CERP) was authorized by Congress in 2000 to restore, preserve, and protect the south Florida ecosystem while providing for other water-related needs of the region including water supply and flood protection. A component of CERP, the Biscayne Bay and Southeastern Everglades Ecosystem Restoration (BBSEER) Project aims to improve the quantity, timing, and distribution of fresh water to estuarine and nearshore subtidal areas including the coastal mangroves and seagrass areas of Biscayne Bay. Additionally, this project seeks to restore, sustain, and reconnect the freshwater and saltwater wetlands that feed Biscayne Bay. Sea-level rise is expected to significantly impact the Everglades ecosystem, and the BBSEER coastal wetland landscape is especially vulnerable to sea-level rise due to its low elevation and proximity to the coast. Therefore, the BBSEER Project Delivery Team (PDT) developed a novel approach to incorporate the impacts of sea-level rise into the formulation and assessment of BBSEER project alternatives. In accordance with the U.S. Army Corps of Engineers planning policy, the BBSEER PDT developed the BBSEER Planning Model to evaluate project alternatives. This Planning Model utilizes performance measures developed by the PDT and reviewed by REstoration, Coordination & VERification (RECOVER) to quantify and compare the ecological benefits of the project alternatives. BBSEER is the first study to incorporate sea level change scenarios into the development and modeling of these performance measures compared to previous studies that have applied sea-level rise curves after a project alternative has been selected. This novel approach will allow the PDT to evaluate how the system will respond to each project alternative under sea-level rise conditions and quantify ecological benefits for the selection of the project alternative. Identifying ecological vulnerabilities to sea-level rise with performance measures can help inform Everglades restoration to minimize the impacts of sea-level rise including saltwater intrusion, peat collapse, and land loss while planning for a restored and sustainable south Florida ecosystem.

ISOTOPIC ANALYSIS OF AMERICAN ALLIGATORS (*ALLIGATOR MISSISSIPPIENSIS*) REVEALS NOTABLE INTRASPECIFIC NICHE PLASTICITY THROUGHOUT THE EVERGLADES

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The American alligator (*Alligator mississippiensis*) is a recognized ecological indicator for Everglades restoration. Alligator populations, distribution, and health responses are directly linked to suitability of environmental conditions and hydrologic change. Hydrologic alterations within in the Everglades have degraded alligator habitat, reduced their prey base, and increased physiological stress, with a recent study indicating alligator body condition declined across many of the management areas from 2000 through 2014. This prompted us to utilize stable isotope analysis to investigate how intraspecific foraging dynamics relates to alligator body condition. We sampled alligators from five wetlands throughout the Greater Everglades ecosystem during 2013-2020. We analyzed 687 blood and plasma samples to evaluate carbon and nitrogen isotope values and compared them among wetlands, sites, sexes, size classes, water years, and seasons via generalized linear models, MANOVA, and Akaike Information Criterion (AIC) model selection. Isotopic niches were determined by generating the Standard Ellipse Area (SEA) for each population and the characteristics of the ellipses were assessed by size class, sex, season, water year, and wetland/site. Additionally, regression models were constructed using AIC model selection with average body condition and the previously listed predictors plus Euclidean distance between centroids of the ellipses, ellipse overlap, and SEAs. We detected significant relationships between alligator body condition and their isotopic niche characteristics within the various wetlands. For example, by incorporating both freshwater and estuarine resources, alligators within the estuary had a larger niche driven by a wider range in carbon than those sampled in freshwater habitats. However, they exhibited higher body conditions during years when they had a smaller range in carbon values, indicating they were incorporating more freshwater and less estuarine resources. Within the freshwater wetlands, alligators from sites with more consistent niches among years also had more consistent body condition values, while alligators from sites with more varied niches among years exhibited more varied body conditions. Our results also indicated that while both sexes may have similar body condition values within a given wetland, each may occupy their own niche space with varying degrees of overlap, and thus dietary similarities. Males frequently exhibited a larger range in carbon values than females indicating they may need to utilize additional habitats or resources to maintain a similar body condition as females. Including information on the isotopic niche characteristics of alligators within each wetland increases our ability to interpret body condition values as a function of resource use across a dynamic and varied landscape.

CONCEPTUAL MODELING FRAMEWORK TO LINK WATER MANAGEMENT, SEA-LEVEL RISE, AND SALINITY IN CENTRAL FLORIDA BAY

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Florida Bay is a large, highly productive estuary with seagrass habitat that supports economically critical recreational fisheries. Episodes of hypersalinity have been reported to be linked to widespread seagrass die-offs and altered water quality, ultimately leading to a cascade of ecosystem effects in sponges, fish, shrimp, and spiny lobster fisheries that can persist for 10-20 years. Large die-offs are unusual events in the bay, happening only a few times in its recorded history. Each time the seagrass has slowly recovered and there is a quest to understand how future events can be prevented. The South Florida Water Management District has recently launched the Groundwater Exchange Monitoring and Modeling (GEMM) project to understand how groundwater and increases in water to Shark River Slough and Taylor Slough decrease salinities in Florida Bay. The modeling component of GEMM is expected to integrate the hydrological process and ecosystem function of Central Florida Bay (CFB) using a variety of models. Here, we present the development of the hydrological process modeling framework. The modeling framework has six stages: 1) objectives and expectations, 2) database construction, 3) development and selection of models, 4) model setup, calibration, and validation 5) model implementation, 6) operational feedback and update. The modeling objectives, identified through a series of workshops, address the uncertainties associated with landscape-scale flow patterns and impediments, surface water – ground water interactions, impacts of seepage eastward on groundwater movements south to Florida Bay, and the influence of water management on Florida Bay salinity, especially in the CFB region. Data inventory was conducted to identify the need and availability of data and information. Model development will focus on: 1) Synthesis of available data to explore cause-effect relationship among drivers and generate empirical relationship, and 2) Selection or development of computer models to capture the sea-level rise, coastal hydrodynamics, density dependent flow, inland freshwater management decisions, surface water and groundwater interactions at a practical spatio-temporal scale. Compatibility and interoperability of model input and output is critical to have a coherent and integrated set of tools that leverage common data and allow for application evaluation at a range of scales and levels of complexity to serve the intended modeling purposes. Compatibility with existing models provides the tools to examine future infrastructure and operational water management effect. Performance measures will be developed to track the validity of the models to identify their strengths and weaknesses. Feedback will be collected from the performance measures and model users to continuously improve and update the models. The progressive stage-based modeling framework provides a scalable framework that can be adopted from a simple to complex modeling endeavor.

EVALUATION OF WATER DEPTH AND INUNDATION DURATION ON TYPHA DOMINGENSIS SUSTAINABILITY: TEST CELL STUDY

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Typha domingensis is a major component of Stormwater Treatment Area (STA) wetlands constructed to remove phosphorus (P) from runoff prior to discharge to the Everglades Protection Area. To maintain the health of these emergent macrophytes their tolerance to water depth and inundation duration was evaluated. A 10-month study was carried out in 0.2-hectare wetland test cells to examine the responses of *Typha* to five water-level treatments: control (40 cm), shallow (61 cm), moderate (84 cm), deep (104 cm), and extremely deep (124 cm). Shoot density, leaf elongation rate (LER), biomass and nutrient allocation were measured. Mean adult *Typha* densities declined from 14.1 shoots m^{-2} in the control to 10.9 and 10.5 shoots m^{-2} in the deep and extremely deep treatments, respectively. However, only mean juvenile *Typha* densities were significantly different [$p<0.05$] among water-level treatments, declining from 3.2 juveniles m^{-2} in the control to 1.2 and 0.6 juveniles m^{-2} in the deep and extremely deep treatments, respectively. The lower juvenile survivability led to lower replacement of adults and lower adult densities over time in the deeper treatments as they died. Although we did not observe an inundation threshold for *Typha* survival in any water-level treatment, increased water depths above 84 cm reduced the ability of the *Typha* population to vegetatively propagate. Mean *Typha* leaf elongation rate (LER) was significantly higher in the deeper treatments, with the highest rates measured during the active growing season (July to October). LER increased from 6.84 cm day^{-1} during the baseline measurements to 8.89 cm day^{-1} in the deeper treatments after eight weeks of continuous flooding. *Typha* showed morphological plasticity to adapt to deep water conditions through changes in morphology and biomass allocation. *Typha* grew significantly taller and heavier to escape deep water-conditions and facilitate gas exchange between the above and below-ground tissues. Ramet height of *Typha* harvested at the end of the study averaged 343 and 374 cm in the deep and extremely deep treatments, respectively, compared to 285 cm in the control. Likewise, the average weight of individual adults ramets also was significantly higher in the deeper treatments (256 g $ramet^{-1}$) compared to 123 g $ramet^{-1}$ in the control. *Typha* in all treatments allocated approximately 64% of their total biomass to leaves and 36% to belowground tissues. Although none of the water-level treatments produced a total collapse of their *Typha* population, increased LER in the deeper treatments resulted in less structural support in stems, causing substantial plant lodging when water levels were lowered at the end of the study. These findings provide valuable insight into the effect of water depth and inundation duration on the health of *Typha* populations in the STAs.

PYTHON RESEARCH AND MANAGEMENT TO PROTECT ENDANGERED SPECIES IN THE FLORIDA KEYS

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The environments of the Florida Keys contain some of the most vulnerable wildlife due to issues with habitat loss, climate change, and invasive species. One such invasive species, the Burmese python (*Python bivittatus*), has colonized the northern portion of Key Largo within conservation lands that include Crocodile Lake National Wildlife Refuge. These conservation lands contain the entire global distribution of the endangered Key Largo woodrat (*Neotoma floridana smalli*) and Key Largo cotton mouse (*Peromyscus gossypinus allapaticola)*. Diet analysis and direct observations have confirmed that pythons are consuming these endemic rodents and recent survey efforts have detected a decline in the Key Largo woodrat population. Python reports have increased substantially over the last seven years in Key Largo including the first evidence of a reproducing population in 2016, though population numbers are not thought to be as high as in many parts of the Greater Everglades Ecosystem. Because of the fairly recent invasion, small size of the area and the island location, significant targeted efforts can reduce python numbers and provide benefits to native wildlife populations including endangered rodents. These actions also reduce the spread of pythons to the lower Keys where other endangered mammals are vulnerable to pythons. However, the nature of the habitat in North Key Largo, underground refugia, and the subterranean behavior of Keys' pythons complicate removal efforts. Efforts to control this burgeoning invasive population have varied over time but include Scout pythons (pythons that are instrumented to help find other pythons during the breeding season), detection dogs, night road surveys, volunteer python patrols, meso-mammal telemetered prey, remote cameras, and outreach/education of the public. This integrated approach has helped guide adaptive management efforts for python control in Key Largo and may have benefits for other areas that are facing significant python issues.

RESTORATION PROGRESS

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Substantial progress has been made over the last two years, in spite of COVID-related interruptions. Progress has been expedited by record amounts of funding. One CERP project and one major project component have been completed. Six more projects are under construction, with several expected to be completed in the next 2 to 3 years. Construction is expected to start within the next 2 to 3 years on 3 CERP projects. As multiple projects are completed, assessing progress requires a pivot from the previous focus on planning and construction to monitoring hydrological and ecological improvement. Early results suggest that completion of two non-CERP projects is rehydrating Northeast Shark River Slough and facilitating increased flow into Everglades National Park. In the Picayune Strand area, the hydroperiod and typical water levels in monitoring wells have increased, and the understory vegetation is beginning to respond and shift towards reference conditions. Notable planning actions include the development of a science plan to rigorously address uncertainties about aquifer storage and recovery and developing the Lake Okeechobee System Operating Manual (LOSOM), including evaluation of multiple criteria. LOSOM reduces the amount of water storage provided by Lake Okeechobee from that assumed when the CERP was planned. But it provides more flexibility to manipulate inflows and outflows across a broad range of lake water levels. As more projects are completed, there is a need for better and more consistent (across projects)'; analysis and synthesis of natural system responses. The committee suggests using modeling to separate responses due to natural variability, e.g., in rainfall, from those attributable to restoration. Another challenge is the need to understand the effects of reduced storage in Lake Okeechobee, climate change, and regional changes over the last 20 years on expected CERP outcomes.

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INTERNAL AND EXTERNAL LOADING EFFECTS ON WATER COLUMN P IN TREATMENT WETLANDS FOR EVERGLADES RESTORATION

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The Everglades Stormwater Treatment Areas (STAs) were constructed to retain phosphorus (P) from stormwater runoff before it enters the Everglades. Loading of P to STAs from external (inflow water) and internal (soil) sources can affect P retention, largely through vegetation and biogeochemistry of the soil environment. Declines of vegetation coverage, especially submerged aquatic vegetation (SAV), have been observed that could affect P retention in STAs. Collapse of SAV in some STA cells prompted investigation into the primary factors controlling SAV resilience and treatment efficacy of the STAs. In this study, the influence of P loading regimes on the P retention of a common species of SAV (muskgrass [*Chara* spp.]) was evaluated in outdoor flow-through mesocosms. Mesocosms inoculated with muskgrass were established in triplicate on two soils: either low or high P; and three external P loading rates: 2.4, 1.7, and 0.4 g P/m^2/year, high, moderate, and low, respectively. These 18 mesocosms were operated in parallel for approximately 15 months. Mesocosms receiving low external P loads had significantly lower outflow P concentrations than mesocosms receiving high P loads. For low internal loads (low-P soils), outflow total P (TP) concentrations of 29, 20, and 14 µg/L were observed for the high, moderate, and low external loading treatments, respectively. For high internal loading (higher soil P) conditions, the effect of external load on outflow P concentrations was diminished as outflow TP concentrations of 28, 22, and 23 µg/L were observed for high, moderate, and low external loads, respectively. Mesocosms with high P soils had similar outflow TP concentrations for moderate and low external loads, suggesting that these elevated internal loads impeded further P retention. The treatment where both internal and external P loads were low was the only treatment to reach very low outflow TP concentrations. *Chara*'s ability to reach very low outflow TP concentrations was shown to be a function of both internal and external loading, indicating that internal loading may become problematic in the lower reaches of STA outflows where external loads have been diminished.

A NOVEL INVASIVE PREDATOR THREATENING AQUATIC PREY PRODUCTION IN THE EVERGLADES.

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The working paradigm for control of abundance of small freshwater fishes and decapods in the Everglades has been that they are structured by an inverse relationship between time since marsh drying (disturbance) and top-down impacts of large predatory fishes because populations of large native fishes are sensitive to drying. This paradigm is now being challenged by the rapid spread of the Asian Swamp Eel (*Monopterus albus/javanensis;* Synbranchiformes). The Asian swamp Eel is a generalist predator with adaptations that permit it to survive at least some marsh drying events. The species was first detected in canals near Everglades National Park in 1999 but has been spreading in South Florida wetlands since 2009. Using a 26-year dataset of fish and decapod densities in Taylor Slough (Everglades National Park) we modeled the densities of the nine most abundant prey fish and decapods using hydrologic terms for the before eel period, then added the after eel (eel established) period (2015-2022) to detect effects of the eels (before vs. after). Six species declined in Taylor Slough in the after-eel period when controlling for hydrologic variability. The species did not decline in wetlands without established eels during the same time. Populations of both species of crayfish (*Procambarus alleni, P. fallax*) and two fishes (*Jordanella floridae, Fundulus confluentus*) declined dramatically after eel establishment (85-99% losses) and two other common fishes (*Gambusia holbrooki* and *F. chrysotus*) had significant density losses (44-66%). Three species were unaffected by the eel. The species that were reduced are all important prey for nesting wading birds and the species with the strongest declines were those that benefit most from drought-mediated reductions in predatory fish (predator-free times/places). It is too soon to determine whether the eel will persist at its current high numbers, but they show no sign of collapse to date. Swamp eels recently spread to the Water Conservation Areas and have been found in long and short hydroperiod sloughs, as well as far from canals soon after marsh re-flooding. The mechanisms of the effect of this fish have not been measured by experiments, but the long-term field patterns in Taylor Slough suggest that this invasive eel has eliminated the inverse relationship between dry disturbances and predator limitation and may be a stronger predator than any large native species. The conceptual model including the invasive eel is one of strong top-down impacts across the hydrologic gradient that filter the slough prey community towards smaller fishes and shrimp. If the eel impacts spread and persist, they will have important implications for evaluation and assessment of prey production and trophic functions of the Everglades.

HYDROLOGIC RESTORATION IN THE PICAYUNE STRAND RESTORATION PROJECT AND ADJACENT FAKAHATCHEE STRAND PRESERVE STATE PARK

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The primary hydrologic goal of the Picayune Strand Restoration Project (PSRP) is to restore sheetflow across a 55,000-acre failed residential development and adjacent public conservation lands impacted by that development. Restoration involves filling 41 miles of large canals to force water out onto the land surface and degrading 265 miles of roads and 60 miles of logging trams and leveling spoil associated with these features to remove impediments to sheetflow. These activities are designed to restore natural hydrologic and fire regimes to the PSRP to support long-term redevelopment of native plant and animal communities appropriate for the existing conditions. Long term monitoring via a grid of 26 PSRP continuous monitoring wells (since 2003) and 25 monthly monitoring wells (since 1987) along two 7-mile-long transects across the adjacent Fakahatchee Strand Preserve State Park have been providing data on changes in water levels pre- and post-restoration. In addition, pairs of plant community monitoring plots associated with the 26 PSRP wells are permitting assessment of changes in the hydrologic regimes of the major types of plant communities resulting from hydrologic restoration. Data from the wells have been documenting changes in wet and dry season water levels, hydroperiods, and distances from PSRP canals over which impacts are occurring within the PSRP and into adjacent lands. After the PSRP planning phase from 2000 to 2004, construction commenced, and completion of road and logging tram removal is expected by March 2023. The final canal sections are scheduled to be plugged in 2024-2025, after protection features are completed for adjacent private lands along the southwest project boundary. Water level fluctuations in wells located in fully and close-to-fully hydrologically-restored portions of Picayune showed consistent increases in wet season water levels and durations of wet season flooding compared to sites located between two open canals. Dry season water levels also increased but were more variable as a function of dry season rainfall and length of the dry season. Hydroperiods in plant community plots increased in partially hydrologically restored plots and reached or approached expected hydroperiods for plant communities in each fully restored plant community plot. Timing of these increases coincided with plugging of canals. With the very porous limestone substrates in southwest Florida, pre-drainage water table drawdowns were found to extend 1-1.5 miles from the easternmost Picayune Canal into Fakahatchee Strand during the wet season and for 2-3 miles during the dry season. The depth and extent of these drawdowns into Fakahatchee Strand have steadily declined as canal-plugging has moved westward: first plugging portions of Prairie Canal in 2004 and 2007, plugging Merritt Canal in 2015, and then plugging the Eastern Stair-Step Canal which connected Prairie and Merritt Canals to the main PSRP outlet to the Gulf of Mexico by 2021.

MOVEMENT PATTERNS AND HABITAT SELECTION OF COMMON SNOOK AND ATLANTIC TARPON IN THE COASTAL EVERGLADES

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Understanding how an animal's habitat requirements shift across its lifetime can be critical to establishing successful conservation and management strategies. Anthropogenic disturbances, however, can alter landscape characteristics and the availability of critical habitats potentially reshaping the spatiotemporal distribution of animals. Worldwide, estuaries are one such critical environment that are increasingly faced with anthropogenic disturbances such as altered freshwater delivery regimes and nutrient enrichment. Many of the estuaries of the Florida Everglades have experienced major changes relative to pre-drainage conditions. These alterations include higher salinities from reductions in freshwater and ecosystem state shifts from nutrient enrichment. It's unclear how these changes are impacting economically, and ecologically important fish species' habitat use and distribution, particularly in impacted regions like north-central Florida Bay where hypersaline conditions and persistent algal blooms have nearly become an annual occurrence. In this study, we use acoustic telemetry tracking methods to examine the movement patterns and habitat-associations of Common Snook and sub-adult Atlantic Tarpon in two adjacent subestuaries of varying environmental condition and disturbance within the north-central Florida Bay coastal Everglades. We investigate if movement patterns differ between the two recreational fish species within the subestuaries and determined which environmental drivers best explain their seasonal distribution patterns. Ultimately, this research seeks to aid in the development of a predictive framework for how hydrologic variation, restoration, and climate change impact recreational fish habitat selection and distribution.

SUMMARIZING PREY USE AND SELECTIVITY BY WADING BIRDS IN FOUR MAJOR WETLAND TYPES IN THE EVERGLADES

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Colonial nesting waterbirds are sentinels for aquatic ecosystems worldwide, partly because their feeding habits can inform managers about changes occurring at lower trophic levels. This is certainly the case in the Everglades, where previous studies have tried to link wading bird nestling diets to short-term environmental changes that influence local foraging conditions, such as water level fluctuations. These studies have improved our understanding of prey species composition, prey size distribution, and to some extent, changes in feeding strategies during periods of temporary food shortage. However, because of the vagaries of prey distribution over space and time, short-term, colony-specific studies have limited application at the scale that ecosystem restoration occurs. Thus, there is a need for community-level analyses of nestling diets, that includes data collected over relatively long periods and large areas. The goal of this study was to 1) assess interspecific, regional, and annual differences in taxonomic composition of nestling diets, 2) test whether variation in hydropatterns and prey density influenced prey composition and 3) quantify trait-based differences in prey composition using methods that others can reproduce throughout the sympatric range of the focal species. We collected 2,403 food bolus samples from five sympatric wading bird species over ten nesting seasons (2011-2020) and four wetland types (lacustrine, palustrine, estuarine, and marine) in South Florida, USA. Our dataset included 51,938 individual wading bird prey items representing 143 species. We tested for prey selection using throw-trap data from within the foraging ranges of sampled nests, used a cluster analysis to delineate foraging groups, and used a fourth corner analysis to determine which prey traits appeared more often in the nestling diets for each foraging group. Diet composition differed among species and region but exhibited little interannual variation. All wading bird species were generalists, but some exhibited a higher degree of intra-group variation than others; for example, the diet breadth of small herons was broader in palustrine than lacustrine wetlands. The fourth corner analysis revealed that variation in species composition among species is largely explained by differences in the contribution prey with different traits (prey size, benthic or non-benthic, and aggregative behavior of prey). Previous studies have documented changes to wading bird diets in response to altered hydrology, habitat loss, and species invasions, but these changes appear to be small compared to intraspecies variation among wetland types, suggesting that wading bird populations should be resilient to changes in prey composition across the system if prey community and habitat diversity remain intact.

BIOMASS DENSITY EFFECTS ON P CYCLING IN THE TREATMENT WETLAND WATER COLUMN

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The performance of Stormwater Treatment Area (STA) wetlands, constructed to remove phosphorus (P) from runoff prior to discharge to the Everglades, has been greatly driven by mid- and outflow-region SAV communities and their P retention capacity. The health and biomass of SAV are critical to efficient P removal from the wetland water column. Several SAV taxa found within the STAs can form very dense beds, such as *Hydrilla verticillata*, *Ceratophyllum demersum*, and the macroalga, *Chara* spp. SAV often occur as very dense monocultures in some STA flow-ways, but at times these monocultures rapidly decline. Loss of vegetation is detrimental to STA treatment performance, causes are not well understood, and recovery can be difficult to manage. To explore this issue, flow-through outdoor mesocosms were set up to investigate the relationships between nutrient supply, SAV biomass health and density, and P stability and storage. One set of mesocosms included low-P muck soil (P content ~ 140 mg/kg) from the eastern edge of STA-1W. Higher P content soil (P content ~1000 mg/kg, from 1W Expansion Area #2) was included in a separate set of mesocosms. Both sets of mesocosms were inoculated with 1 kg fresh weight of *Chara*, and received the same hydraulic loading rate. Triplicates of each soil type received one of three water types of varying total P (TP) concentrations: avg. TP 18, 87, and 121 µg/L, for Low, Moderate, and High external P loading treatments, respectively. The 45-cm deep water column of each mesocosm was monitored for TP, dissolved oxygen, pH, temperature, and specific conductivity. Relationships between *Chara* biomass density, nutrient supply, and subsequent effects on water physicochemical characteristics that affect P stability were evaluated. Initial *Chara* growth rate was rapid for the low-P soils receiving high external loads and all high-P soil treatments, regardless of external P load. Under Low external nutrient loads, outflow surface water TP was higher in the high-P soils (23 µg/L) where high biomass density was supported when compared to the low-P soils (avg. 14 µg/L) with sparse biomass density. Comparisons of outflow TP concentrations and SAV density for the moderate load low-P soil treatment, showed that increases in outflow TP were not entirely synchronous with lower SAV density. Stratification of the water column in mesocosms that developed highly dense *Chara* biomass resulted in prolonged anoxia and lower pH near the soil surface. Thus, while high density SAV may have greater capacity for P uptake to reduce outflow TP from the STAs, it subsequently created favorable conditions for soil-P release, posing a unique challenge to STA management by limiting the lowest achievable outflow TP. This phenomenon deserves further exploration at field scale to determine the extent of stratified conditions within dense plant beds, or if field conditions not captured by the mesocosms (e.g., wind driven water circulation) would diminish this effect.

TITLE: A REGIONAL SYNTHESIS OF SOIL ELEVATION CHANGE IN THE COASTAL WETLANDS OF THE GREATER EVERGLADES

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Coastal wetlands adapt to rising seas via feedbacks that build soil elevation, which lead to wetland stability. However, accelerated rates of sea-level rise can exceed soil elevation gain, leading to wetland instability and loss. Thus, there is a pressing need to better understand regional and landscape variability in rates of wetland soil elevation change. Here, we conducted a regional synthesis of surface elevation change data from mangrove forests and coastal marshes in the iconic Greater Everglades region of south Florida (USA). We integrated data from 51 sites in which a total of 122 surface elevation table-marker horizon (SET-MH) stations were installed. Several of these sites have been periodically monitored since the 1990s and are among the oldest SET-MH datasets in the world. Rates of surface elevation change ranged from -9.8 to 15.2 mm yr^{-1}, indicating some wetlands are keeping pace with sea-level rise while others are at risk of submergence and conversion to open water. Vertical accretion rates ranged from 0.6 to 12.9 mm yr^{-1}, and subsurface change rates ranged from -13.5 to 8.6 mm yr^{-1}. Rates of surface elevation change were positively related to subsurface change but not vertical accretion. There were no significant relationships between rates of surface elevation change and elevation (NAVD 88) or rates of sea-level rise. Site-specific examples indicate that hurricanes, plant productivity, hydrologic exchange, and proximity to sediment and nutrient inputs are critical but confounding drivers of surface elevation change dynamics in the Greater Everglades region. Collectively, our results reinforce the value of long-term SET-MH data that incorporate spatial variability for advancing understanding of surface elevation change dynamics in coastal wetlands.

FLOWING WATER EFFECTS ON AQUATIC ANIMAL COMMUNITIES: INSIGHTS FROM THE DECOMPARTMENTALIZATION PHYSICAL MODEL

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The Everglades was historically a flowing ecosystem, but our understanding of hydrological impacts on aquatic animal communities there has focused primarily on dry disturbances, time since reflooding and hydroperiods. The impacts of restoring faster flowing conditions (> 1 cm/s) to the Everglades sloughs have been little studied until the Decompartmentalization Physical Model (DPM) was created and monitored. Increases in the flow velocity could increase microbial food quality by increasing the rate of nutrient delivery/resuspension (nutrient loading) or improving the efficiency of nutrient uptake through the reduction of the diffusive boundary layer of autotrophs (mass transfer). We documented net effects of flowing water to aquatic communities as part of the experimental flows created by the Decompartmentalization Physical Model (DPM) in the 'Pocket' between the L-67A and L-67C canals in WCA 3. The DPM created a gradient of flow velocity with distance from the S-152 culvert, where low-nutrient water (TP < 10 ppb) has been seasonally discharged since 2013. Starting in 2019, we used 1-m^2 throw-traps to quantify small fishes (standard length < 8 cm) and macroinvertebrates and electrofishing to quantify large fishes (SL > 8 cm). Thirty-two sloughs were sampled across the flowing transect and two no-flow control transects on either side of the DPM flow path. These sites were sampled twice per year for three water years. We used a generalized linear model to analyze the biomass responses across treatments (transects), seasons, water-years and distance from the L-67A levee. Moreover, we used PERMANOVA to evaluate changes in community composition. Across all water years, small and large fishes had the highest biomass in sites nearest the S-152 structure and biomass decreased with distance from the S-152; this pattern was not observed in the control transects relative to distance from the L-67A levee. Macroinvertebrate biomass did not vary with distance from the L-67A levee but was significantly higher in the flow transect compared to the no-flow control transects. Biomass responses in the flow transect had a seasonal signal; fish biomass was greater during the dry season, particularly near the S-152 structure. Fish biomass in the control transects did not vary with seasonality. Macroinvertebrate biomass was also greater in the flow transect during the dry season. Large fish composition near the S-152 culvert (<800 m from the culvert) differed from all other sites and the difference was largely driven by higher biomass of large native fishes such as Bowfin and Florida Gar. Large fish assemblages in all other sloughs were dominated by Asian Swamp Eels, a relatively new invader to the area. Our results suggest that restoration of flow could increase aquatic animal production in sloughs with implications for food-web dynamics and food production for apex predators.

INVESTIGATING THE INFLUENCE OF REHYDRATION ON SOIL CARBON FLUX IN ROOKERY BAY NERR MANGROVE FOREST

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Carbon cycling and overall movement of Carbon from one pathway to another are important processes in coastal systems that result from the large amount of organic matter, or biomass, being consumed through decomposition or produced through photosynthetic use of atmospheric CO2. Studies around the world have provided general estimates of CO2 flux in mangrove ecosystems, however, to our knowledge CO2 flux from a restoration of a mangrove forest with anthropogenically altered hydrology has not been examined. Meanwhile, at the Rookery Bay National Estuarine Research Reserve (Rookery Bay NERR), a mangrove forest identified as Fruit Farm Creek, has begun undergoing restoration in the fall of 2021. Fruit Farm Creek is located between Marco Island, FL and the Village of Goodland, FL and cumulatively aims to restore 209 acres of mangrove habitat. There is a gap in understanding the quantity of CO2 released from the mangrove peat in a mangrove forest undergoing rehydration. The objective of this study is to investigate the mangrove soil conditions and CO2 emissions (“flux”) in a 10-acre section of the Fruit Farm Creek restoration and to compare the findings of the pre-restoration data and the mangrove forest rehydration data. The study has captured changes at the site from preliminary flux data, coupled with available vegetation structure and hydrology values. The CO2 flux is being quantified using a Li-Cor 8100A, Infrared Gas Analyzer produced by Li-Cor Biosciences in Lincoln, NE. Existing hydrology data and vegetation structure data used to inform the restoration were used to compare baseline data to recorded changes. This mangrove forest rehydration is not only the first of its kind in Southwest Florida but will likely inform future mangrove restoration in many other locations, including the Florida Everglades and surrounding mangrove forests.

RESEARCH DIRECTIONS OF THE FLORIDA FLOOD HUB FOR APPLIED RESEARCH AND INNOVATION

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Established by the state of Florida, the Florida Flood Hub for Applied Research and Innovation is focused on some of the state's most pressing environmental challenges. Our ultimate goal is resilience— the ability of communities to prepare for, withstand, and recover from flood events and other natural hazards. By assembling national and regional experts from across disciplines, we advance our understanding and forecasting of flooding due to sea level rise (SLR), high tides, storm surge, and changes in rainfall patterns. The Flood Hub is also unique in that it bridges the gap between policymakers, practitioners, and the public to help communities mitigate and adapt to flooding risks by providing the best available science. Key to this effort is conveying science-based information in ways that are accessible and compelling to scientists and non-scientists alike. Working in concert with the Resilient Florida Program, we evaluate data, refine models, and share expertise to support statewide efforts to protect people, businesses, natural resources, and coastal infrastructure. Science workgroups are the heart of the Flood Hub and comprise subject matter experts across the state and the nation. Individual workgroups address specific questions related to sea level rise and other contributors to flooding, identify data gaps and future data needs, assist in the development of SLR projections and other modeling products that are scale-appropriate and necessary to conduct vulnerability analyses and risk assessments. The Flood Hub has already formed its first workgroup to assist the FDEP in the development of statewide SLR projections. Using data from the most recent national assessment as a baseline, the workgroup isolated projections for Florida; identified contributions to SLR from ice melt, thermal expansion/ocean dynamics, and vertical land motion. This group finds that the Florida peninsula is, in many ways, simpler and more uniform with respect to SLR than the regional characterization in the national assessment would suggest. In essence, the east coast of Florida is more similar to the west coast of Florida than it is to the east coast of the US. Similarly, the west coast of Florida is more similar to the east coast than to other parts of the Gulf of Mexico. Basically, the Florida peninsula does not fit well with the geographically defined regions in the national assessment. A second workgroup has also been formed and is tasked with the development of statewide rainfall projections incorporating future changes to historical data, as they pertain to the depth, duration, and frequency of extreme rainfall events. This work group will initially coordinate with the USGS to extend the change factors computed for rainfall - DDF curves – for the SFWMD to the entire state of Florida. This information along with longer-term climate modeling will be used to inform the comprehensive, statewide flood vulnerability assessment to be conducted by the FDEP.

AMINO ACIDS AS BIOMARKERS OF ORGANIC MATTER DECAY AND SOURCE IN TREATMENT WETLAND LITTER AND FLOC

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Stormwater Treatment Areas (STAs) in South Florida are the largest constructed wetlands in the world. Converted mostly from agricultural land, they are designed to reduce total phosphorus (TP) concentrations in surface water before it enters the downstream Everglades Protection Area. Decomposition of litter and leaching are pathways that can affect TP retention, and the processes and drivers affecting the cycling of organic phosphorus (OP) are directly related to the cycling of organic carbon (OC) since OP species are generally bound to larger macromolecules composed of carbon. A 40-day decomposition/leaching study was carried out to investigate differences in organic matter (OM) quality in two vegetation types at various stages of decomposition using bulk elemental indices and amino acid biomarkers. In June 2022, tubes containing litter and floc material from emergent and submergent aquatic vegetation (EAV and SAV, respectively) were established *in situ* at STA-3/4 and harvested at days 0, 20, and 40. Leaching experiments were carried out at each time point in bottles containing floc and litter material and site water that were incubated in situ for 48-hours. Leachate samples were measured for total carbon (TC), total nitrogen (TN), dissolved organic carbon (DOC), total dissolved nitrogen, total hydrolysable amino acids (THAA), $d^{13}C$, and $d^{15}N$. The leaching of DOC was greatest for Day 0 litter material of both EAV and SAV (151.5µM and 324.2 µM, respectively. At Day 40, floc and litter DOC leachates were very similar for both EAV (90.5 µM and 84.4 µM, respectively) and SAV (107.7 µM and 115.5 µM, respectively), suggesting that progressive decomposition of both EAV and SAV OM results in the integration of relatively recalcitrant, decayed OM into the complex matrix of flocculent material. THAA concentrations in day 0 pre-leachate samples of site water (not containing floc or litter material) ranged from 1.07 µM for pre-leach EAV water to 3.7 µM for pre-leach SAV water. EAV water THAA concentrations in post-leachate controls (no floc or litter) increased to 1.54 µM while SAV water concentrations decreased to 1.89 µM after incubation; these values are within the same range of biomarker samples taken from previous water samples in the STAs. The amino acid sugar muramic acid (MurA) is a useful indicator of microbial activity since it is solely synthesized in bacterial cells. Concentrations of MurA decreased in Day 0 SAV water samples from pre- to post-leaching, while EAV concentrations did not change. These findings could indicate dissolved organic matter (DOM) derived from different vegetation types is cycled differently and can help with P retention in different ways. This work can provide further understanding of the influence of vegetation type on OC cycling coupled with OP cycling which can help develop management strategies in these STAs that change the balance of fluxes and further reduce the concentrations of TP in the water column.

LONG TERM DYNAMICS OF PHOSPHORUS PULSES AND THEIR LEGACIES IN THE FLORIDA COASTAL EVERGLADES

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The availability and movement of the limiting nutrient, phosphorus, in the sloughs and estuaries of the Everglades is very dynamic over most temporal scales. Water total phosphorus (TP) concentrations are highly pulsed, driven by everything from seasonal and episodic changes in water sources and flow, variable uptake and release by biota and soils, and the fluctuating transport and excretion by fauna. Over the past two decades, increased wet season rainfall, managed freshwater releases, sea level, and storm surges have altered abiotic and biotic dynamics in the Everglades. Discerning how these hydrologic and resultant ecological changes influence P dynamics is key to adaptively managing freshwater restoration, particularly as climate forecasts predict a more variable hydrologic future for South Florida. We used a 20-year dataset of monthly and 3 to 7-day integrated water TP data to evaluate how pulse dynamics are changing in Shark River Slough (SRS) marshes and mangrove estuaries and the Taylor River Slough - Florida Bay (TS/Ph) marsh, mangrove, and seagrass gradient. Pulses were evaluated as the maximum annual value relative to annual mean (amplitude), and the duration that concentrations at this time remained above the mean. The mean TP pulse magnitude and duration increased throughout the entire ecosystem from 2001-2021. Pulse amplitude increases were greatest in TS/Ph marshes, and pulse duration increased in SRS and TS/Ph marshes during prolonged droughts, after fires, and following restoration actions beginning in 2013 (TS/Ph) and 2015 (SRS). Pulse magnitude has not changed in the mangrove estuaries or seagrass meadows, although the legacies of individual P pulses associated with 2005 and 2017 hurricanes and continuous landward delivery of P associated with sea level rise contribute to a strong positive increase (a press) in water TP over the 20-year record. Although marsh TP values remain in the oligotrophic range, climate change and water management activities are increasing the availability and movement of P throughout the Everglades ecosystem. This relaxation of nutrient limitation may need to be accounted in expectations of ecosystem response to climate forecasts and restoration alternatives.

TESTING FOR CHANGES IN LONG TERM MARSH FISH PRODUCTION OVER 26 YEARS

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Anthropogenic activities in southern Florida have decreased hydroperiods, reduced habitat connectivity, introduced new aquatic predators, and reduced fish densities in the Everglades. Restoration efforts have focused on restoring fish communities to historic levels by increasing water delivery into affected habitats, but it is not known whether the system has maintained its *potential* fish productivity over time. Time series modeling has often been applied to density data to evaluate ecosystem-level responses to restoration initiatives; however, these models fail to incorporate two sources of variation: process noise and observational error. State-space models have been increasingly applied to ecological time series as they reduce bias by incorporating both sources of variation. We applied state-space models to investigate changes in fish production (proxies: density/m^2, biomass/m^2) using long-term monitoring data within three regions of the Florida Everglades: Shark River Slough (SRS, 6 sites), Taylor Slough (TSL, 5 sites), and the Water Conservation Area (WCA, 10 sites). Our goal was to determine the long-term trends in regional fish density and biomass that are not explained by local hydrology. Length-mass relationships for each species were used to calculate individual mass, and both site density and biomass were calculated using the sum of all fish collected in all throws across all plots. Sample means and variances were estimated by averaging the log-transformed metrics across throws within a site for each sample event at SRS (n=21 throws per site), TSL (n=14-21), WCA (n=15). Fish density and biomass were modeled using density-independent state-space models incorporating within site variance (obs. error), environmental stochasticity (process noise), and localized hydrologic covariates to estimate density and biomass trajectories. We used model selection to determine the best hydrological predictors of density and biomass using depth, days since last dry (DSD), log-transformed DSD, and a combination of depth and DSD. Models incorporating both depth and DSD were the best models of temporal changes at all three regions and had a high level of support compared to models lacking covariates (ΔAIC>170 for all regions). Parameter estimates of regional trajectories suggested long term declines in fish density and biomass at TSL (-0.006 +/- 0.05, -0.005 +/- 0.07) and WCA (-0.011 +/- 0.08, -0.005 +/- 0.06) and increases in both density and biomass at SRS (0.0017 +/- 0.08, 0.003 +/- 0.10). However, confidence intervals for either parameter estimates were not different from zero. Composition of fish may be changing due to invasion or other long-term changes, but our results indicate that there has been no long-term net change in total marsh fish density or biomass, when accounting for recent drying and depths, within any of the three regions. Continued monitoring of all three regions will be necessary to understand the impacts of restoration actions.

FAUNAL EFFECTS ON PHOSPHORUS DYNAMICS IN THE EVERGLADES STAS: PART 2 (SURVEYS AND SCALING)

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The Everglades Stormwater Treatment Areas (STAs) are wetlands constructed to reduce surface water phosphorus (P) runoff through retention in sediment and vegetation prior to water discharge to the Everglades Protection Area. Aquatic animals complicate the retention process by recycling and resuspending P through their normal trophic behavior and functions, such as excretion and bioturbation. Previously, P excretion and bioturbation rates were measured for known densities/biomasses of abundant aquatic animals in the STAs (covered in Part 1 of this presentation series). Using those values we scaled-up rates based on faunal population estimates to estimate system-wide effects of excretion and bioturbation. To characterize and estimate faunal populations, we conducted 6 years of sampling in the STAs. This included collecting small fish and macroinvertebrates with throw traps and collecting large fish with electrofishing. The catch-per-unit-effort electrofishing data were converted to density with an electrofishing calibration experiment to determine species-specific catch probabilities. Using environmental covariates, we scaled up population estimates from throw trapping and electrofishing to the whole-STA level. The total amount of P released into a cell through excretion and bioturbation by abundant aquatic species in each STA could then be estimated. We found that the most bioturbation-mediated P resuspension was caused by benthivorous fish species such the invasive sailfin catfish (*Pterygoplichthys* spp.), which feeds on substrate and forms burrows in the sediment. Large schools of fish that have substrate disturbing behaviors (e.g., tilapia, which excavate high densities of nests) also have the potential to increase P levels through bioturbation. Excretion contributions in each cell were dominated by small fishes, which had higher excretion rates per unit mass and higher biomasses than large fishes. Small and large fish excretion combined played a more significant role in recycling water-column nutrients than bioturbation, partly because only certain functional groups are predicted to cause high amounts of bioturbation, while every fish excretes. Bioturbation may also play a role in increasing water nutrient concentrations in locations with high densities of bioturbating fish (e.g., sailfin catfish are often caught at high densities in canals that contain water quality monitoring stations) and may have indirect effects on P dynamics in the STAs by increasing turbidity and suppressing macrophyte growth and recruitment. While excretion contributions are difficult to manage without vastly reducing the number of fish, impacts of bioturbation can potentially be mitigated by fish removals or careful water level management to reduce populations of bioturbators in outflow areas.

USING TRAIL CAMERAS TO ESTIMATE RELATIVE ABUNDANCE INDICES OF WILDLIFE ACROSS MICCOSUKEE TRIBAL LANDS

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The annual trail camera survey aims to give an insight into the wildlife present on Miccosukee tribal lands. The Miccosukee Fish and Wildlife Department have established goals of understanding population density, habitat use, home range, and demography. While data is recorded on all species, a special focus is placed on large mammals: White-tailed deer (*Odocoileus virginianus*), Florida panther (*Puma concolor coryi*), Coyote (*Canis latrans*), and American black bear (*Ursus americanus*). The study area is constrained within the Miccosukee properties: Triangle, Miccosukee Ranch West, Southwest Cattle Pastures, and Miccosukee Ranch North. Triangle is 7,000 acres of sawgrass marsh and sloughs with scattered tree islands and several cypress strands. Miccosukee Ranch West is 2,421 acres of hardwood swamp, mixed cypress forest, prairie, seasonal wetlands, and pinelands. The Southwest Cattle pastures is 2,760 acres that consist of mixed cypress forest with mesic hammocks and wet prairies. Miccosukee ranch north is 2,361 acres of mesic temperate hammock with surrounding wetlands and pasture. Trail cameras are deployed during fawning season of whitetail deer on tribal lands for an 8-week period. 50-acre^2 grid with centroids designate camera locations. Recorded data includes species occurrence, age, health, and sex. Relative abundance indices are defined as the sum of all occurrences of each species, multiplied by 100, and divided by total number of trap days. Triangle has the lowest biodiversity and lowest recorded total deer relative abundance indices are defined of the tribal lands, and bucks outnumber the does and fawns. Miccosukee ranch west shows trends of increasing relative abundance indices for bucks, does, and fawns. Southwest Cattle Pastures holds the highest relative abundance indices for panthers with decreasing doe and fawn relative abundance indices. Miccosukee ranch north holds the highest relative abundance indices values for deer and the highest RAI for coyotes. Trail cameras have proven to be a successful means of surveying wildlife presence. Continued data collection aids in understanding of spatial and temporal trends of biodiversity and species richness. Conservation practices and regulations may be implemented on tribal lands based on trends gathered from the relative abundance indices across time.

HOW THE DECOMP PHYSICAL MODEL INFORMS CENTRAL EVERGLADES PLANNING PROJECT ADAPTIVE MANAGEMENT

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Authorized by Congress in 2000, the Comprehensive Everglades Restoration Plan (CERP) aims to find the correct balance among flow characteristics throughout the Florida Everglades by changing the quantity, quality, timing, and distribution of water, leading to improved ecosystem health, and ensuring quality of life in south Florida. A fundamental aspect of the CERP is Adaptive Management (AM). CERP AM is a structured management approach for addressing uncertainties by testing hypotheses, linking science to decision making, and adjusting implementation, as necessary, to improve the probability of restoration success. The approach includes proactively documenting performance-related hypotheses about how the system is expected to respond to CERP implementation, linking monitoring to goals and objectives, assessing monitoring results to improve ecological understanding, and making adjustments to restoration actions as necessary. The REstoration COordination & VERification (RECOVER) team is a multi-agency and multi-disciplinary team who organizes and applies scientific and technical information to support the goals and objectives of CERP by applying a system-wide perspective to the planning and implementation of CERP. RECOVER implements CERP AM and will oversee AM for one CERP restoration project, the Central Everglades Planning Project (CEPP). Field scale tests are fundamental to AM to provide evidence to inform project planning and design. Initiated in 2010 to inform CERP, the Decompartmentalization and Sheetflow Enhancement Physical Model (DPM) was a large-scale field AM assessment study located within the CEPP footprint in Water Conservation Area 3B (WCA-3B) in Miami-Dade County, FL. The DPM was designed to evaluate uncertainties associated with canal backfilling and hydrologic velocities needed for restoration of south Florida ecosystems. Scientific data collected provided results related to concentrated inflows (into WCA-3B), canal-water flow across levee gaps, and ridge and slough restoration. In 2020, DPM findings outlining AM recommendations were provided to RECOVER for consideration in CERP implementation, specifically for CEPP. RECOVER worked with the CEPP project deliver team (PDT) to incorporate DPM recommendations into the CEPP AM Plan. DPM AM recommendations were evaluated using developed screening criteria. After evaluation, three DPM AM recommendations were incorporated into the CEPP AM Plan to improve monitoring effectiveness, reduce potential ecological risks, and to better guide CEPP implementation and operations.

SOIL MANAGEMENT OPPORTUNITIES TO CURTAIL PLANT CYCLING OF EXCESS SOIL P FOR WATER QUALITY IMPROVEMENT

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The Everglades Stormwater Treatment Areas (STAs) are wetlands that were constructed to reduce surface water phosphorus (P) runoff prior to discharge to the Everglades Protection Area. Vegetation plays a key role in nutrient uptake from surface waters moving through STAs, although rooted plants also acquire nutrients directly from the soil to support growth. Flux of nutrients from soil to water via macrophyte uptake and senescence may reduce the ability to reach low-level nutrient concentration goals in outflow waters. In the STAs macrophyte vegetation roots in newly-accrued soils and the underlying antecedent muck soils, which represent a large pool of plant-available nutrients. Field-scale and controlled sub-scale (i.e., mesocosms) platforms have been used for the past two decades to assess if soil management practices can reduce availability of soil nutrients, and subsequently improve outflow water quality. The first field-scale assessment involved complete removal of the muck soils overlying the limerock substrate in a 40 ha (100 acres) cell at the outflow region of STA-3/4, to reduce the potential for return soil P flux. In that system, a low-nutrient soil (~300 mg P/kg) accumulated within the wetland over 15 years of operation and annual flow-weighted mean total phosphorus (TP) concentrations in the outflow remained extremely low (8-13 µg/L). Because there are economic and technical constraints to muck removal over large expanses, "capping" of the muck soils also was tested as an alternative approach. A two-year flow-through study using STA waters in triplicate mesocosms showed capping in the absence of macrophytes can be effective, but that rooted macrophytes can access soil nutrients through a 15-cm layer of limerock on top of muck soils. Average water TP levels over capped STA muck soils containing macrophytes were elevated (12 ± 0.3 µg/L) relative to the very low outflow TP concentrations (9 ± 0.4 µg/L) observed on capped soils in the absence of macrophytes. Soil inversion, accomplished by deep tilling, also has been under investigation, although to date the benefits of this approach are equivocal. Soil core incubations indicated a promising result (low soil P flux) where low-P calcareous marl was brought to the soil surface, but inversion was ineffective where mixing of soil layers during inversion did not create a homogenous low-nutrient surficial soil layer. When converting previously-farmed land to wetland treatment area, all soil in STA-1W Cell 7 (486 ha [1201 acres]) was inverted to a target depth of 0.6 m (2 ft), while adjacent Cell 8 (450 ha [1113 acres]) was not inverted. Assessments of this large-scale soil inversion effort have been constrained by differing hydrologic and vegetation conditions between the two cells during the initial startup period. However, these cells may yet reveal valuable insights over time as the wetlands mature.

APPLICATION OF BBSM MODEL FOR NEARSHORE SALINITIES IN SUPPORT OF THE BBSEER PROJECT.

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The Biscayne Bay Simulation Model (BBSM) (Stabenau et al., 2015) is an updated implementation of the Cafe3D hydrodynamic model developed by Wang (1988; 1990; Wang et al., 2003) and has been used to evaluate the effects of proposed changes to freshwater flows on salinity in the Biscayne Bay. The Biscayne Bay and Southern Everglades Ecosystem Restoration (BBSEER) Project Deliver Team, following recommendations by the Interagency Modeling Center, adopted this model for the evaluation of near-shore salinity performance measures in support of the project. Following recommendations from a technical peer review panel, the IMC implemented a series of changes to the BBSM to improve the model's predictive capabilities relative to observed salinities in the bay. This presentation focuses on the BBSM changes associated with the groundwater and canal freshwater boundaries, adjustments of structure flow point source boundary conditions to account for lateral inflows, recalibration using observed salinity data at 34 monitoring locations, and using a zonal diffusion coefficient distribution instead of a single value for the entire model domain. Sensitivity analysis was also performed to different ground water flow regimes and distributions, salinity profiles to different model output time-step resolutions, and the response of Habitat Suitability Indexes to those salinity distributions.

WETLAND SOIL MICROBIAL RESPONSES TO LAND INTENSIFICATION AND AN INVASIVE MACROINVERTEBRATE

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Bacteria, archaea, and fungi are dominant microorganisms in wetland soils, which play fundamental roles in determining ecosystem functions and services but are shaped by multiple interacting external forces. Understanding responses of microbial communities to multiple drivers of environmental change and their interactions is crucial for wetland conservation and management, particularly for those are influenced by surrounding agricultural practices. Yet little is known about effects of agricultural land-use intensification and biological invasions on soil microbial communities in subtropical wetlands. Here, we used a field mesocosm experiment to examine individual and interactive effects of upland agricultural intensification and an invasive apple snail (*Pomacea maculata*) on wetland soil bacteria, archaea, and fungi. We asked: (1) how do taxonomic composition of soil bacterial, archaeal, and fungal communities respond to upland agricultural intensification and *P. maculata* invasion? And (2) how do variations in water chemistry and soil nutrients resulting from agricultural intensification and invasion alter the structure of microbial communities? Our results showed that upland agricultural intensification was a stronger driver in shaping soil microbial community compositions than the invasive apple snail. Wetlands embedded in intensively managed pastures had higher relative abundance of Bacteroidetes, Spirochaetes, and Crenarchaeota, but lower relative abundance of Nitrospirae, WPS-2, and Thaumarchaeota than wetlands in semi-natural pastures. The presence of invasive apple snail decreased the relative abundance of Nitrospirae, Proteobacteria, increased the relative abundance of Crenarchaeota, and interacted with upland intensification to affect the relative abundance of Mortierellomycota. Our results further revealed treatments effects on the compositional shifts in microbial communities were likely manifested through alterations in water chemistry and soil nutrients. For example, the reduction of Nitrospirae due to upland intensification and *P. maculata* invasion was associated with the water total dissolved solid concentration and soil P and S contents. Our further analysis will disentangle how interactions among microorganisms respond to intensification and invasion effects using network analysis. Our results will have implications on subtropical wetland management and conservation in the context of emerging threats from biological invasions and land intensification.

BURMESE PYTHONS IN FLORIDA: A SYNTHESIS OF BIOLOGY, IMPACTS, AND MANAGEMENT TOOLS

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Burmese pythons in southern Florida represent one of the most intractable invasive-species management issues across the globe. The difficulty stems from a unique combination of inaccessible habitat and the cryptic and resilient nature of pythons that do very well in the subtropical environment of south Florida, rendering them extremely difficult to detect. Over the past two decades we have documented extensive direct alteration of the native food web as well as some aspects of the basic biology of these constrictors, while extensively exploring methods to capture and remove this damaging species. As such, we have written a review and synthesis of Burmese python research in southern Florida, with authors from across many federal and state agencies, non-profits, and universities, representing the consensus of the scientific community regarding the python invasion. We describe python biology and control tools intended to be used for management of this invader. We conclude with a detailed focus on future research directions and development of new control tools aimed at suppression and management of this species.

PREDICTING LANDSCAPE SCALE VEGETATION CHANGE

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Ecological models are essential tools used by Everglades natural resource managers and planners to facilitate the evaluation of alternative approaches to restore the Everglades ecosystem. The multi-agency REstoration, COordination and VERification (RECOVER) science team uses ecological models to evaluate the potential effects of proposed restoration plans on natural resources. Many previous restoration planning projects focused on the inland portion of the Everglades, but regulations mandate that the impacts of sea level rise are considered in project planning covering coastal regions. Coastal vegetation communities are already shifting in response to saltwater intrusion, and ecological models can help upcoming restoration planning consider both inland and coastal changes. The Everglades Vulnerability Analysis (EVA), a modeling tool recently developed by the U.S. Geological Survey (USGS) in cooperation with the National Park Service (NPS) and U.S. Army Corps of Engineers (USACE), can help decision makers examine proposed hydrologic restoration scenarios in conjunction with sea level rise to examine inland and coastal changes over time. The EVA tool is a group of connected Bayesian networks that describes how changes in hydrology and salinity influence the ecosystem. Each Bayesian network focuses on a specific indicator of Everglades ecosystem health. These indicators include vegetation type, size of wading bird colonies, presence of alligator nests, and dynamics of sawgrass peat. The EVA vegetation module builds on a similar methodology as another vegetation model, the Everglades Landscape Vegetation Succession model (ELVeS), developed by the NPS. The EVA vegetation module produces spatially explicit output on an annual basis for inland and coastal vegetation types as well as certainty of each prediction. To enhance outputs to meet the needs of the RECOVER science team for upcoming planning projects, we recently implemented updates to the EVA vegetation module. In cooperation with USACE, we expanded the number of modeled vegetation classes from 6 to 11 as well as expanded the spatial footprint of the model to extend to the boundary of the Biscayne Bay Southeastern Everglades Ecosystem Restoration (BBSEER) project. We updated the model relationships using additional vegetation monitoring and sampling data to predict the new vegetation types. We conducted a validation and sensitivity analysis on the updated model to assess its ability to accurately predict vegetation types and changes in vegetation type with changing hydrology. Utilizing the vegetation module of the EVA, RECOVER can provide guidance during restoration planning and implementation processes related to vegetation change across the Everglades landscape.

LESSONS LEARNED: INCREASING INCLUSIVITY WITH THE EVERGLADES TREE ISLAND INDICATOR (ETRII)

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The tree islands of the Greater Everglades are elevated tree-covered mounds within the wetlands that provide some of the most biodiverse and socio-culturally revered parts of the River of Grass. These upland areas of the marsh serve a critical role in the ecosystem, such as providing nesting habitat for alligators and roosting locations for endangered snail kites. The Miccosukee and Seminole Tribes have lived in the Everglades for millennia and have historically used the tree islands for many functions, such as hunting camps and agriculture. Of critical cultural importance, the tree islands are the traditional homes of the Tribes and contain their ancestral remains. The USGS collaborated with the Miccosukee and Seminole Tribes to co-design a real-time web application to monitor tree island health. This decision support tool, the Everglades Tree Island Indicator (ETrii), will show real-time and historical flooding status to indicate tree island health. Decision makers at the state and federal levels will be able to use the tool to manage water flows and depths to protect these critical sites. One goal of this collaboration is to increase inclusivity in tool development by collaborating with the Tribes, who have historically been excluded from Everglades decision making. To date, Everglades restoration has not successfully addressed the issue of tree island deterioration and loss, which is of critical cultural importance to the Tribes in addition to biological importance in the ecosystem. ETrii provides an opportunity to move toward environmental justice by creating a tool that promotes data equity in the Everglades. In this new collaboration, many lessons were learned about increasing inclusivity, striving toward environmental justice, and working with new partners. Sharing these lessons can help the restoration community learn from our stumbling blocks and successes.

DEVELOPING EFFICIENT EVAPOTRANSPIRATION MODELING APPROACHES FOR SUSTAINABLE AGRICULTURAL WATER MANAGEMENT

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Accurate measurement of evapotranspiration (ET), which accounts for a significant portion of the hydrologic cycle, is critical for a better understanding of hydrological processes, soil-water-plant-atmosphere continuum, and other ecosystem and engineering processes. However, the direct measurement of ET remains a challenging task. As a result, there is a need to develop reliable ET modeling approaches that can be used to develop reliable agricultural water management decisions. This study investigated the strengths and limitations of three empirical ET models (Hargreaves-Samani; HS, Priestley-Taylor; PT, and Turc). In addition, three machine learning algorithms (Linear Regression; LM, Random Forest; RF, Artificial Neural Network; ANN) were evaluated for simulating daily ET using historical weather data from 42 weather stations in Florida. The results revealed considerable differences between the empirical and ML models in estimating daily ET. In addition, the study confirmed that ML algorithms could be effectively used to estimate daily ET with minimal data inputs. This presentation will highlight the strengths and limitations of different ET modeling approaches and implications on overall agricultural water use in Florida.

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APPLICATIONS OF COMPUTATIONAL FLUID DYNAMICS MODEL FOR REFINED SPREADER CANAL HYDRAULICS IN STA 3/4

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Stormwater Treatment Areas (STAs) are large, constructed wetlands with emergent and aquatic vegetations that South Florida Water Management District operates and maintains. The plants remove and store nutrients such as phosphorus that are found in stormwater runoff before it is moved out of the STA and into the Everglades. This study presents a case study of the application of Computational Fluid Dynamics (CFD) model for refined spreader canal hydraulics in STA 3/4. The spreader canal along north embankment of STA 3/4 was designed to collect the outflow from culverts G-374A, B, C, D, E and F, then distribute stormwater to treatment Cell 1A. The hydrodynamic of the spreader canal is one of the key elements that impacts flow patterns and vegetation distribution within a cell and ultimately the overall performance of the STA. In this study, a CFD Reynolds-Averaged Navier Stokes (RANS) model was used to confirm and optimize the configuration of energy dissipators which consist of semi-submerged dykes located opposite to the outlet of the inflow culverts. The objective of the energy dissipators is to limit the over-shooting of the high velocity jet exiting each culvert and prevent it from damaging the downstream vegetation. It does this by redistributing the flow in a more uniform fashion, and thus reducing the likelihood of short-circuiting as the flow enters the marsh portion of each STA cell. This successful application case has demonstrated the cost-effectiveness of CFD and its suitability as an alternative and/or a complement to laboratory and/or field study for resolving practical hydraulic engineering problems.

MONITORING OF HARMFUL ALGAL BLOOMS (HABS) USING HYPERSPECTRAL REMOTE SENSING

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Cyanobacterial blooms are a nuisance and potential hazard to human and animal health in both freshwater and marine systems. Advances in remote sensing may enhance our ability to study and monitor these events, for example, toxic and non-toxic algal taxa could potentially be distinguished based on their spectral characteristics. The U.S. Geological Survey is developing a remote sensing approach for characterizing algal blooms in inland waters. The framework incorporates both reflectance signatures for specific algal taxa recorded with a custom-designed microscope hyperspectral imaging system, and hyperspectral images acquired from satellites. This effort is being piloted in Upper Klamath Lake (UKL), a large freshwater lake in Oregon that experiences seasonal algal blooms, including the toxic *Microcystis aeruginosa*, as the community shifts from *Aphanizomenon flosaquae.* Here we highlight how both lab-based hyperspectral imaging at a microscopic scale and remote sensing at a scale of 10s to 100s of kilometers can be used to monitor water bodies such as UKL for cyanobacteria and algae. Lab-based instrumentation allows organisms to be examined in a controlled environment at high magnification and with a level of spectral detail sufficient to distinguish among algal genera based on their unique reflectances. This hyperspectral characterization could inform observations regarding timing and spatial distribution of community shifts, such as those experienced in UKL. We compiled our laboratory-derived reflectance measurements into a spectral library that served as input, along with hyperspectral satellite images, to a multiple endmember spectral mixture analysis algorithm to yield information on the composition, occurrence, and spatial distribution of algal blooms.

ELEVATED HYDROGEN PEROXIDE FORECASTS CYANOBACTERIAL BLOOMS: A GENE EXPRESSION CONNECTION

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The largest freshwater aquatic system in the state of Florida is Lake Okeechobee and its downstream waterways with the Caloosahatchee River flowing west to the Gulf of Mexico. These warm, subtropical waters experience harmful algal blooms (HABs), with frequency and severity increasing in recent decades. The most common and pervasive freshwater HAB experienced in this system is of the cyanobacterium, *Microcystis aeruginosa*. Recent studies have highlighted the importance of forecasting cyanobacterial HABs, allowing for rapid treatment by water managers at a more manageable stage. Our previous studies and others suggested that environmental hydrogen peroxide could be a predictive factor of HABs. To better understand cyanobacterial HAB ecology and associated hydrogen peroxide dynamics, we performed an in-depth field survey at Franklin Lock and Dam on the Caloosahatchee River for one year, sampling at twice monthly intervals from February 2021 through January 2022. We noted two distinct *Microcystis* HAB events which were associated with peaks of hydrogen peroxide. These events exhibited distinct cyanobacterial community assemblage patterns explained by a dominance of *Microcystis* (35.9% ± 17.3 %; mean ± SD) followed by *Synechococcus* (10.3% ± 3.3%). Additionally, distinct cyanobacterial gene expression patterns were observed. A weighted correlation network analysis (WGCNA) examined how gene expression related to water quality parameters. One module of 76 binned genes correlated to HAB indicators: microcystin (r = 0.96, p < 0.001), Chl-a (r = 0.56, p = 0.008), and algal colony density (r = 0.99, p < 0.001), as well as hydrogen peroxide (r = 0.56, p = 0.006). Genes present were broadly related to growth, including photosynthesis but with a focus on photosystem I and cytochrome c. A different module of 157 binned genes positively correlated with total phosphorus (r = 0.66, p = 0.001) and hydrogen peroxide (r = 0.66, p = 0.001). Genes present were relevant to photosynthesis and oxidative stress, although photosystem II and cytochrome b were highly abundant. Both are known to generate hydrogen peroxide via oxygenic photosynthesis. Our results indicate high rates of environmental hydrogen peroxide generation are a product of increased cyanobacterial growth, with elevated concentrations occurring prior to a bloom. This makes it a good forecasting parameter for *Microcystis* HABs. Additionally, hydrogen peroxide had an allelopathic impact on the cyanobacterial community during the bloom, as evidenced by the correlation to oxidative stress genes. Our data yield a better understanding of the functional connection between hydrogen peroxide, cyanobacteria, and HABs.

ADDRESSING THE EMERGING ENVIRONMENTAL ISSUE OF COASTAL ACIDIFICATION IN FLORIDA'S ESTUARIES: THE INDIAN RIVER LAGOON OBSERVATORY NETWORK OF ENVIRONMENTAL SENSORS (IRLON)

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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.

DRONE-BASED WATER SAMPLING AND CHARACTERIZATION OF THREE FRESHWATER HARMFUL ALGAL BLOOMS IN THE UNITED STATES

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Freshwater harmful algal blooms (HABs), caused mostly by toxic cyanobacteria, produce a range of cyanotoxins that threaten the health of humans and domestic animals. Climate conditions and anthropogenic influences such as agricultural run-off can alter the onset and intensity of HABs. Little is known about the distribution and spread of freshwater HABs. Current sampling protocols in some lakes involve teams of researchers that collect samples by hand from a boat and/or from the shoreline. These collections are often restricted to certain months of the year, and generally are only performed at a limited number of collection sites. In lakes with active HABs, surface samples are generally sufficient for HAB water quality assessments. We used a unique DrOne Water Sampling SystEm (DOWSE) to collect water samples from the surface of three different HABs in Ohio (Grand Lake St Marys, GLSM and Lake Erie) and Virginia (Lake Anna), United States in 2019. The DOWSE consisted of a 3D-printed sampling device tethered to a drone (uncrewed aerial system, or UAS), and was used to collect surface water samples at different distances (10–100 m) from the shore or from an anchored boat. One hundred and eighty water samples (40 at GLSM, 20 at Lake Erie, and 120 at Lake Anna) were collected and analyzed from 18 drone flights. Our methods included testing for cyanotoxins, phycocyanin, and nutrients from surface water samples. Representative congeners of the cyanotoxin microcystin (MC) were present in each of the lakes. Elevated phycocyanin (PC) levels were found in GLSM and Lake Anna, while phosphorus levels ranged from oligotrophic (Anna) to hypereutrophic (GLSM) with the highest variability at Lake Anna. Drones offer a rapid, targeted collection of water samples from virtually anywhere on a lake with an active HAB without the need for a boat which can disturb the surrounding water. Drones are, however, limited in their ability to operate during inclement weather such as rain and heavy winds. Collectively, our results highlight numerous opportunities for drone-based water sampling technologies to track, predict, and respond to HABs in the future.

DIET COMPOSITION OF INVASIVE ARGENTINE GIANT TEGUS (SALVATOR MERIANAE) IN MIAMI-DADE AND CHARLOTTE COUNTIES, FL

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Invasive species are a widely recognized threat to natural ecosystems, particularly in Florida, where introductions are numerous and frequent. Invasive species may negatively impact native species through predation, competition, or the spread of disease, and it is important to quantify these impacts in order to properly assess risk and allocate management efforts. Argentine giant tegus (*Salvator merianae*) are a likely threat to native species via all three of these mechanisms. Here, we focus on predation by comparing tegu diet composition of two populations in varying stages of invasion: Miami-Dade County (long-term management) and Charlotte County (containment). We identified gastrointestinal contents from 271 tegus caught between 2016 and 2021. We used a distance-based redundancy analysis to explore variations in diet related to habitat, seasonality, ontogeny, and demography. We found that habitat disturbance level and tegu body size were significant predictors of diet composition. We also found that Charlotte County tegus consumed a greater diversity of vertebrate prey and consumed vertebrates more frequently than Miami-Dade County tegus. Our findings further demonstrate the generalist nature of tegus through their breadth of prey taxa and ability to forage in both natural and degraded habitats. This flexibility will likely increase the difficulty of extirpation and therefore supports the need for swift removal efforts in response to new introductions.

PYTHON SURVIVAL AND ACTIVITY PATTERNS

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Burmese pythons (*Python bivittatus*) are a problematic invasive species that occupies much of the Greater Everglades. Demographic models have been successfully applied to inform management and control of many other damaging invasive species. Vital rates (*e.g.,* survival, lambda) for pythons are largely unknown; without these parameters we are unable to estimate population declines and the number of individuals that must be removed to achieve population suppression. Understanding fine-scale activity patterns of pythons can also assist with management decisions and resource allocation strategies. Our goals were to determine 1) adult python survival rates and 2) fine-scale activity patterns of pythons radio-tracked in the wild. For 1) we examined data from radiotracking adult pythons in Everglades National Park (ENP) using a known-fate model. We evaluated survival candidate models for effects including time of year, sex, and size. For 2) we examined data derived from acceleration data loggers (ADLs) implanted in male and female pythons Scout snakes (n=11 in three locations; Crocodile Lake National Wildlife Refuge, Key Largo; Big Cypress National Preserve; Southwest Florida). These data loggers provide second-by-second body position, temperature, and activity levels that we aggregated to derive overall dynamic body acceleration metrics. We programmed ADLs to record three-dimensional acceleration and pressure (depth) every second, and temperature every 30 seconds for the initial 110 days of their deployment. Tags were then programmed to record 3D acceleration, pressure and temperature once every minute. Results from ENP radiotracking indicated higher annual survival rates for males (81%, CI 53 - 94%, n = 19) versus females (42%, CI 25 - 58%, n = 27). These initial survival estimates for female pythons in ENP are lower than expected, even when factoring in the historic cold snap of 2010. However, confidence intervals for these survival estimates are relatively wide, and may indicate that unmeasured variables are influencing survival in this data set. Future analyses of python radiotracking data in other regions of southern Florida will provide a more complete picture of adult python survival. As with survival analyses, ADL data analyses are ongoing. To date, we recovered two ADLs in Key Largo that recorded for 216 and 113 days. Both tags recorded incidents of abnormal body positions with high degrees of roll. Continued use of ADLs will allow for optimized design of capture and removal efforts as periods of activity and rest can be defined, as well as characterization of how often feeding events occur in monitored pythons. Combined survival and movement estimates can help managers understand vulnerable periods to target for management (e.g., life stages with the greatest elasticity for targeted control). Our results can help further efforts to model python population growth rates and evaluate the effect of removals on the population trajectory.

IMPACTS OF CLIMATE CHANGE AND SEA LEVEL RISE ON SOUTHEAST FLORIDA'S GROUNDWATER RESOURCES

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Sea level rise is one of the most impacting consequences of climate change, especially in low-lying coastal areas such as southeastern Florida. Climate change alone can affect groundwater resources with the increased intensity and frequency of extreme weather events, including storms and drought. Besides, sea level rise can affect groundwater flow and accelerate saltwater intrusion processes. This study investigated how projected changes in climate and sea level can individually and collectively impact groundwater resources in southeastern Florida in the future to provide information necessary when developing water management plans and policies for improved sustainability. A three-dimensional numerical groundwater model was used to represent the aquifer system and its interaction with seawater along the coastal lines. Future climate (29 Coupled Model Intercomparison Project Phase 6 General Circulation Models) and sea level rise scenarios (IPCC Median, NOAA Intermediate High, and NOAA High) were projected and incorporated into the groundwater model. The modeling experiment showed that groundwater levels would be sensitive to the projected changes, and the impacts would vary depending on seasons and locations. The groundwater levels of coastal areas were more sensitive to sea level rise than climate change, while those of inland areas were substantially affected by climate change. Such findings suggested a holistic approach to water resource management in southeastern Florida and highlighted the water systems' dynamic nature. This study demonstrated how changes in weather patterns and resulting increases in seawater levels could directly affect local water resources.

DISTRIBUTION OF C_3 AND C_4 PLANTS ALONG HYDROLOGICAL GRADIENT IN THE EVERGLADES, FLORIDA

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In the Everglades, herbaceous plant communities are composed of two major plant functional groups, C_3 or C_4, that differ in photosynthetic pathways. These plants prefer different habitat conditions, although their distribution may overlap to varying extents. The relationship between distribution of these two plant functional groups and the hydrological gradient in the Everglades is important to understand, as changes in hydrological conditions cause shifts in plant communities. Here we ask the questions, how are the C_3 and C_4 plants distributed along the hydrological gradient within the Everglades, and have their abundances along marl prairie – slough (MP-S) gradient changed in recent decades? We hypothesized that with a change in hydrological conditions due to restoration efforts associated with the Comprehensive Everglades Restoration Plan (CERP), the proportion of C_3 and C_4 have changed along the MP-S gradient. Between 2005 and 2021, we surveyed vegetation composition along five transects (M1-M5) and collected soil samples from 43 sites along the Transect M3. Stable Carbon isotope analysis was used to determine the $\delta^{13}C$ values of the plants to identify C_3 and C_4 species. Isotope analysis was also used to determine $\delta^{13}C$ values of soil organic matter (SOM) in soil samples collected along the transect. Results showed that the distribution of C_3 and C_4 plants varied along the hydrological gradient. In relatively dry areas, the abundance of C_4 species was higher than C_3 species, while C_3 species were mainly dominant in wet areas. Together with the changes in hydrologic conditions over the past one and a half decades, the relative abundance of C_4 plants has decreased at sites that have become wetter but has increased in sites that have become drier than before. Our understanding of the shift in community composition, especially in the relative abundance of these two plant functional groups, in response to hydrologic changes will provide feedback for the adaptive management and restoration strategies in the Everglades.

SUBMERGED AQUATIC VEGETATION COVERAGE IN THE STAS- TWENTY YEARS OF SURVEY DATA

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The Everglades Stormwater Treatment Areas (STAs) are freshwater treatment wetlands built and operated to reduce total phosphorus (TP) concentrations in stormwater runoff before entering the Everglades Protection Area. They were constructed primarily on former agricultural lands and are divided into cells by interior levees to form flow-ways consisting of cells arranged in series. Reduction in TP concentration and load may be influenced by several factors including vegetation community composition, health, and density within treatment cells. Ground surveys were conducted via airboat on a periodic basis to monitor and assess the coverage of submerged aquatic vegetation (SAV) taxa within STA cells managed to support SAV communities. For over 20 years, an effort has been made to survey SAV in the downstream cells during both the dry and wet seasons. The primary intent of the surveys has been to document long-term trends. Assessments were made at a network of fixed geo-referenced sites arranged in a grid pattern within each cell. The coverage of SAV taxa at each site was evaluated based on the amount of SAV in the water column observed within the immediate vicinity of the airboat and recorded as a percentage range. SAV coverage categories were 0% (none), 1-33% (low), 33-66% (medium), and 66-100% (high). Twenty-one cells were monitored across five STAs (STA-1E, STA-1W, STA-2, STA-3/4, and STA-5/6), with the earliest survey data dating back to 2000. A total of eight SAV taxa were observed during surveys and the frequency of individual taxa was highly variable across all cells. Muskgrass (*Chara* spp.), southern naiad (*Najas guadalupensis*), and hydrilla (*Hydrilla verticillata*) were generally the most common taxa found. During the most recent 5 years, STA-3/4 had the densest SAV coverage, with most survey points falling into the high coverage category. Some seasonal trends were noted, with more high coverage survey points across all STAs occurring during the wet season. Muskgrass remained the most common SAV taxon observed in recent surveys. This extensive STA SAV data set is very useful in evaluating the health of STAs and provides insight on the effectiveness of management practices over time and the impact of major weather events. Continued STA SAV surveys are crucial in monitoring the health of the treatment vegetation and guiding maintenance activities to ensure the long-term functionality of these systems.

COASTAL CARBON FLUX: PERIPHYTON CONTRIBUTIONS AND DIATOM INDICATORS

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Coastal ecosystems are rapidly transforming as sea level rises creating an uncertain fate for critical organisms and functions including carbon storage and flux. Determining how coastal organisms respond to changing environmental conditions and feed back to influence the fate of carbon is a critical goal in coastal ecosystem science. Periphyton – a benthic community of bacteria, cyanobacteria, fungi, diatoms and other algae, and detritus - is an important component of coastal ecosystems. The degree to which periphyton contributes to short- and long-term fluxes and stores of carbon is not well understood. Further, the composition of these communities varies in predictable ways along the coastal gradient, and diatoms serve as particularly reliable indicators of the key drivers of the coastal gradient. However, whether diatoms can be used to indicate changes in periphyton contributions to carbon stores has not been investigated. This study examines periphyton contributions to coastal carbon fluxes and determines whether diatoms can be used to indicate gradients in carbon stores. Short-term rates of periphyton accretion of inorganic and organic carbon were measured on artificial substrates deployed along coastal gradients in 3 currently monitored areas of the Biscayne Coastal Wetlands in South Florida. Because periphyton is an important driver of precipitation of calcium carbonate, long-term contributions of periphyton to changing carbon stores were examined by analyzing inorganic and organic content by depth in sediment cores. The role of diatoms in indicating the magnitude of periphyton contributions to particulate inorganic carbon gradients was examined using annual collections of diatoms and related periphyton inorganic mass along the coastal gradient of salinity, phosphorus, and pH that control inorganic carbon accretion. Data suggest that periphyton-driven inorganic carbon accretion is greatest in the interior freshwater wetlands of low salinity, pH, and phosphorus. Diatoms show distinct communities along the coastal gradients sorting along pH and salinity gradients that drive inorganic carbon accretion patterns. Therefore, diatoms may provide a useful tool for determining where periphyton-driven inorganic carbon is an important contributor to soil accretion and help researchers further understand elevation feedbacks as sea levels rise. Diatoms appear to be indicating that sea-level rise is inhibiting the ability for ecosystems to accumulate inorganic carbon via periphyton accretion, reducing carbon dioxide flux to the atmosphere.

THE ECOLOGY OF THE GREATER SIREN AND THE TWO-TOED AMPHIUMA IN THE EVERGLADES

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There are two species of giant aquatic salamanders that occur in the Everglades: the Greater Siren (*Siren lacertina*) and the Two-toed Amphiuma (*Amphiuma means*). Due to their large size and abundance, they likely function both as an important prey source for top predators and an important predator for many Everglades invertebrates. The hypothetical ability of *S. lacertina* and *A. means* to structure mollusk and crayfish communities may be of immense importance to the broad restoration goals of the Everglades, as Apple snails (*Pomacea* spp.) and crayfish (*Procambarus* spp.) both provide critical food resources for wading birds during seasonal dry downs. To understand the role of the giant aquatic salamanders in the Everglades ecosystem we undertook a series of studies at the Loxahatchee Impoundment Landscape Assessment to measure population size and demographic rates, seasonal movement patterns, and dietary composition of these two species. We first undertook a multi-year mark-recapture study of the giant aquatic salamanders and used open Cormack-Jolly-Seber models to estimate demographic rates and abundances. To measure seasonal movement patterns, we radio-tracked both species during the Everglades' seasonal dry down and recharge for roughly 10 months in both 2021 and 2022. Finally, to understand the dietary composition, we analyzed 60 fecal samples from each species using both morphological analysis (N = 30) and DNA barcoding (N = 30). Between 2018 – 2022, we recorded a total of 1115 salamander captures. This number was comprised of 501 individually marked A. means that were recaptured 96 times and 476 individually marked *S. lacertina* that were recaptured 42 times. Mean annual survivorship for A. means was 39.8% (95% CI = 35% - 44.8%) with an estimated population density of 27 (95% CI = 22 – 34) individuals per hectare, while average survivorship for *S. lacertina* was 41.3% (95% CI = 37.9% - 44.8%) with an estimated population density of 49 (95% CI = 38 – 62) individuals per hectare. Our radio tracking demonstrates that both *S. lacertina* and *A. means* migrate in response to falling water levels, with 100% of *S. lacertina* and 64% of *A. means* moving to deeper habitats during the dry season. Finally, we collected 172 prey items from 30 A. means and 1544 prey items from 30 *S. lacertina* fecal samples. The most common item found in *A. means* fecal samples was crayfish (73% of samples), followed closely by Dyticids (37%), and Odonates (30%). In *S. lacertina* fecal samples, the most common item was plant material (100% of samples), followed by *Pomacea* spp. (80%), and Sphaeriidae (38%). Our results demonstrate that, at least in the northern Everglades, the giant aquatic salamanders are much more abundant than previously estimated, that their diet is primarily invertebrates and overlaps with that of wading birds, and that they follow water levels during dry downs, which may increase competition with wading birds for invertebrate prey resources.

HYDRODYNAMIC AND WATER QUALITY MODELING IN BISCAYNE BAY

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Biscayne Bay, like many of Florida's estuaries, is facing ecological challenges driven by changes in key water quality constituents (e.g., phosphorus and nitrogen). Further integration of coastal and inland predictive tools is required to capture the full feedback between coastal and inland hydrologic processes. Predictive tools that are fully validated using best available data and that couple hydro and water quality would be of great value to The Florida Department of Environmental Protection (FDEP), South Florida Water Management District (SFWMD) and other partners to answer key management questions. They also would provide a quantitative platform to assess the performance of proposed and existing projects, as well as support adaptive management strategies. The purpose of this study is to develop a Delft3D-based hydrodynamic and water quality model system for Biscayne Bay, FL. Three-level model domains, i.e., the Gulf-Atlantic domain, the regional domain, and the local domain, are set up for nesting computation. The local domain focuses on Biscayne Bay and along the canals leading up to the SFWMD structures. The water quality model (D-Water Quality) can be coupled with the hydrodynamic model (D-Flow FM + SWAN) within the software suite developed by Deltares. The same hydrodynamic mesh of Biscayne Bay in D-FLOW FM is applied in D-Water Quality as well. Vertically, the seven sigma-layers are adopted. The 3D hydrodynamic fields are imported from D-FLOW FM to D-Water Quality. In addition to salinity, temperature and sediment, various standard water quality processes and substances can be selected and included in D-Water Quality. Historical observed data (e.g., water level, current, salinity, temperature, and other water quality variables) is used to calibrate and validate the hydrodynamic and water quality models. Once the model is calibrated and validated, it can be used to support questions such as 1) What are the spatial and temporal distributions of nutrients (Phosphorus and Nitrogen) concentrations in Biscayne Bay? 2) What are the impacts of water management decisions and strategies on the water quality of Biscayne Bay? 3) What are the impacts of alternative coastal release protocols on the water quality (salinity, Chlorophyll A, total phosphorus, nitrogen, chloride, DO, NH4) in the bay? 4) What are the potential impacts of current or future environmental restoration strategies on the water quality in Biscayne Bay? 5) What is the combined effect of water management decisions and sea level rise on the water quality dynamics within the bay? This is an ongoing study. Preliminary results and most recent updates will be presented at the GEER conference.

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MOLECULAR INVESTIGATION OF THE INVASIVE BURMESE PYTHON IN THE GREATER EVERGLADES ECOSYSTEM

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Genetic assessment using molecular tools such as environmental DNA (eDNA), population genetics, and genetic biocontrol tools can be used to create a more comprehensive understanding of non-native species to inform management decisions. These tools often provide improved understanding of cryptic, low density, or logistically difficult-to-study invasive species, like the Burmese python. Environmental DNA is concentrated from shed tissues and body fluids 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. Environmental DNA was able to increase detection estimates for Burmese pythons to 80-90% from <1% using visual surveys and trapping. Ground-truthing positive eDNA detections with traditional methods is recommended to verify the correct source of positive detections. Population genetics tools applied to invasive Burmese pythons have identified low genetic diversity likely related to a founder effect, taxonomy and hybridization with Indian pythons, and putative native-range source populations. Delimiting population structure across the landscape can inform invasion pathways and source and sink populations to inform urgently needed impactful management actions. Currently, control strategies for invasive species are limited and the investigation of innovative techniques, including molecular biocontrol methods, are important to consider with research avenues. Molecular biocontrol technologies have unique benefits such as species-specific effects and their potential to self-propagate throughout the invasive population. These applications could help to address the limitations that ecosystem managers face removing invasive reptiles from the remote and mostly inaccessible Greater Everglades landscape.

MOVING WATER TO RESTORE RIVERS WETLANDS AND ESTUARIES IN SOUTHWEST FLORIDA AND THE CALOOSAHATCHEE BASIN

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National Estuary Programs work regionally and are uniquely positioned as a collaborative of governmental, non-profit, and community partners could step in to fill research gaps, taking the lead on to engage in regional issues and further climate readiness in forward-looking regional research and restoration. The Coastal & Heartland National Estuary Partnership (CHNEP) identified hydrological restoration as a key issue for Central and Southwest Florida, focusing specifically on the Caloosahatchee basin, given the unique hydrogeology of the region. However, significant challenges remain to reverse damage from development and balance limited water resources between people and natural ecosystems. CHNEP worked to create a number of watershed management plans with the goal to 'get the water right', identifying what needs to happen to restore and maintain our water supply, flood protection, water quality and water-dependent resources in the face of existing degradation and depletion, climate change factors, and continued regional growth. In order to build these plans, all available data was gathered and used to develop and refine integrated surface and groundwater hydrological models to simulate the water cycle in the natural environment, identifying how changes to the landscape and environmental conditions will impact where surface and groundwater will move in response. Climate change related impacts such as reductions in freshwater flows, alterations in rainfall patterns, changes to wetland hydroperiods, evapotranspiration and sea level rise were also accounted for. Due to the large scale, complexity, and cost of implementing the plans, most are need a multi-partner, multi-phase, and multi-year approach. The CHNEP supports continued effective coordination between agencies that manage water as well as and local, state, and federal government permitting and capital programs affecting hydrologic flow, water storage, flood control, and water quality. By focusing attention and resources on a landscape-level strategy, restoration projects can yield greater cost-benefits.

SOIL ACCRETION IN THE STAS: RELATIONSHIPS WITH VEGETATION/WATER QUALITY AND ITS ROLE IN BENTHIC P STABILITY

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The Everglades stormwater treatment areas (STAs) are constructed wetlands designed to remove phosphorus (P) from stormwater and agricultural runoff prior to discharge to the Everglades Protection Area. Past studies evaluated soil-based conditions and processes regulating concentration and internal loads of P. This ongoing study examines soil conditions and storage of non-mobile and mobile P in the surface floc and recently accreted soil (RAS) as they relate to P sorption characteristics in a range of STA flow-ways (FWs) including underperforming STA FWs [STA-1E Central FW, STA-2 FW3, and STA-5/6 FW1], and well-performing FWs [STA-1E Eastern FW, STA-2 FW4, and STA-3/4 Central FW]. Significant differences in P forms and storage were found among FWs with most accreted P being considered reactive. There were no clear patterns based solely on vegetation type. Likewise, the processes controlling P storage (P forms) are different for soil type, being related to water chemistry and vegetation (floc) and characteristics of both pre-STA soils and recent conditions (RAS). Calcium (Ca) is a major factor of P accumulation, but in some sites, there is a mixture of organic P coupled with varying amounts of iron (Fe) and aluminum (Al) and high magnesium (Mg) and potassium. Cluster analysis revealed primarily 4 categories of RAS soils with key differences in Ca content, total P, Fe and Al content, and the ratio of Ca:Mg. Chemical characteristics of these groups also align with measured P sorption parameters (isotherms) with highest P stability (sorption) occurring in soils with high Ca and low Mg. This separation of sites into clusters further allowed better quantitative prediction of P sorption and stability (Partial Least Squares Regression), which may improve models for P accretion/removal and guide strategies to improve overall STA performance.

BISECT CALIBRATION TO DEVELOP SALINITY PERFORMANCE MEASURES AND INTEGRATION WITH RSM-GL TO SUPPORT EVALUATION OF BBSEER ALTERNATIVES

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The Biscayne Bay and Southeastern Everglades Ecosystem Restoration (BBSEER) project is developed to restore the freshwater and coastal wetlands of the southeastern region of Everglades, Biscayne Bay, and adjacent areas. Saltwater intrusion due to accelerated sea level rise (SLR) and changes in upstream freshwater delivery has impacted the ecological functionality of these wetlands. To support the BBSEER study, we calibrated the Biscayne and Southern Everglades Coastal Transport (BISECT) model of 2005-2017 for groundwater (GW) and surface water (SW) stage, marsh SW salinity, and soil porewater salinity of the surficial aquifer. BISECT is a linked overland-aquifer density-dependent model with a vertically stratified model structure, that incorporates canal flow, marsh overland sheet flow, GW flow, precipitation, and evapotranspiration to represent the primary physical processes modulating water and solute transport. The BISECT calibration involved modification of source code for improved parameterization and update of model boundaries for an improved representation of these coastal processes to specifically enhance simulation of salinity at the top of the aquifer (e.g., soil porewater). We compared BISECT simulated daily stage with the daily measurement obtained from 24 USGS and DBHydro water level stations. The BISECT simulated GW salinity was calibrated against a 10-year dataset of 23 porewater salinity measurement points spaced along six southeast coastal transects. The calibrated BISECT was then coupled with the Regional Simulation Model Glades-LECSA (RSM-GL) by incorporating RSM-GL flow and canal stage outputs as inputs of BISECT. As RSM-GL includes regional water management operation rules and BISECT simulates coastal hydrodynamics and salinity, the BISECT-RSMGL crosswalk provides a valuable representation of Everglades coastal processes. Finally, applying the BISECT simulated baseline porewater salinity, a wetland salinity performance measure (PM) framework was developed to set target wetland porewater salinities for different BBSEER indicator regions (IR). The PM estimates the probability of exceedance of monthly porewater salinity within each IR across space and time, and the number of months in a year a threshold salinity is not exceeded for the 2007-2016 period. Combined, a standardized PM score enables evaluation of porewater salinity within IRs. To date, the BISECT-RSM crosswalk has produced porewater salinity datasets across the BBSEER footprint for baseline, different flow redistribution and SLR alternatives. These datasets are currently being used by the Interagency Modeling Center to train a stochastic emulator engine to predict porewater salinities. The developed model, crosswalk, and tools will provide a quantitative measure to better inform BBSEER alternatives in the face of SLR and helps to advance evaluation of SLR and saltwater intrusion in Everglades coastal wetlands as part of the Comprehensive Everglades Restoration Plan.

LABORATORY-BASED AIRBORNE GROUND-PENETRATING RADAR MEASUREMENTS TO IDENTIFY HOT SPOTS FOR GAS ACCUMULATION IN THE EVERGLADES

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Subtropical peatlands play a vital role in the global carbon budget by generating emissions and fluxes of biogenic gases, mainly composed of methane and carbon dioxide. Previous studies during the last two decades have advanced our understanding on how to predict these carbon fluxes at a variety of spatial and temporal scales in peat soils; however, the spatial variability of gas accumulation (i.e., hot spots) at the matrix level is still unclear, mostly due to the difficulties of non-invasively imaging these areas. While most studies have traditionally relied on point measurements (i.e., flux chambers) or methods like eddy covariance with large footprints that may lack the resolution to properly capture hot spots for gas accumulation and release, several studies have shown the potential of ground-penetrating radar (GPR) to non-invasively image gas distribution at the matrix scale. However, the method still relies on ground-based measurements that are time-consuming. In this study, we tested the potential of airborne GPR measurements to efficiently characterize gas distribution in peat soils and identify the presence of hot spots at the laboratory scale. This study represents a first step before deploying field-based GPR measurements from a small unoccupied aircraft system (sUAS). A high-frequency antenna was suspended over a large peat monolith (0.75m x 0.31m x 0.25m, extracted from the Loxahatchee Impounded Landscape Assessment, LILA in the WCA1, FL) using a custom-made rail system that allowed for the antenna to move autonomously and monitor changes in dielectric permittivity associated with biogenic gas build up and release at high temporal resolution. Airborne GPR measurements were combined with transmission GPR, gas traps with time-lapse cameras (to infer gas fluxes), and gas chromatography (to analyze gas composition). Preliminary results show the potential of airborne GPR measurements to isolate hot spots for gas accumulation in peat soils at the laboratory scale and thus show promise for the use of sUAS at the field scale to more efficiently characterize hot spots for gas accumulation and release in the Everglades.

CFD MODELING – THE GREATER EVERGLADES PUMP STATION DESIGNER'S BEST FRIEND

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Designing new pump stations or evaluating the performance of existing pump stations often requires extensive analyses including determining: the potential for imbalanced flows, the potential for surface and under-water adverse recirculating currents, diversion structure efficiencies, stage-discharge relationship of the control section, the adequacy of training wall heights, and the sizing of energy dissipation structures to resist erosion. For pump stations with symmetrical features, these analyses normally rely on published empirical relationships that are extrapolated from physical model studies and often include generous factors of safety to account for physical model inaccuracies and variability in the data used to establish the relationships. For pump stations with non-symmetrical features, published empirical relationships are not always valid, and designers must either rely on their judgement or conduct expensive and time-consuming physical model studies to complete their designs. Recent advances in computational fluid dynamics (CFD) software and computer hardware now provide pump station designers an incredibly powerful means of independently confirming and refining their designs. CFD modeling also provides powerful visual outputs, including dynamic video clips and digital tracers, that clearly show complex flow conditions including turbulence and recirculating waves. This presentation discusses the use of cutting-edge CFD modeling for three different pump stations in Greater Everglades and demonstrates how the results of the CFD modelling impacted the designs by exposing potential problems and guiding the designers to optimal solutions. Lessons learned from each of these case studies will be shared so that other designers, modelers, and engineers can learn from the author's experiences.

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LITTER DECOMPOSITION ALONG A RESTORED FLOW GRADIENT

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The Decompartmentalization Physical Model (DPM) is a landscape scale project evaluating the ecological benefits of restored historic flows in reestablishing and maintaining the Everglades ridge and slough landscape. To achieve more effective flow at scale, DPM also includes experimental herbicide applications, known as Active Marsh Improvement (AMI), to reconnect remnant sloughs invaded by sawgrass. Increasing water flow increases water column aeration, and, despite low water phosphorus (P) concentrations (TP <= 10 ppb), also increases P loading. Because increased oxygenation and P loading generally increase microbial activity, we hypothesized litter decomposition would increase with increased flow. To evaluate flow impacts on decomposition of predominant plant species, litter bags, containing standing dead *Eleocharis cellulosa* and leaf material of *Cladium jamaicense*, were deployed along a flow gradient in DPM in slough and ridge habitats, respectively. To compare decomposition of herbicide treated sawgrass with its naturally senescing counterpart, we also deployed litter bags of herbicide treated and naturally senesced *C. jamaicense* leaves in paired AMI and ridges along the gradient. We found a positive relationship between flow and decomposition rate and final accumulated mass loss. Average mass loss and the accumulated mass loss of *E. cellulosa* was greater than that of *C. jamaicense* during the same time. The different decomposition rates between the species helps to maintain lower and distinct slough elevations from the ridges. The TP concentration of the litter from the highest flow site exponentially increased over time, well above 500 mg/kg, a level indicating P-enrichment in sediments. Overall, sites with the greatest flow velocities (> 2cm/s), experiencing the entrainment and transport of floc downstream, also have the fastest litter decomposition rates. Increased litter decomposition at high flows likely depletes sediment accumulation, contributing to deeper, more resilient sloughs. Unfortunately, the litter that does persist is an additional source of high TP sediment to floc, already experiencing enrichment due to shifts toward P-enriched forms of algae. This extreme exponential rise in litter P concentration over time is not observed in the moderate flow treatment (1-2 cm/s). Herbicide treated *C. jamaicense* leaves had a greater P concentration than naturally senesced leaves, which increased initial decomposition rate at the lowest flow velocity site. The latter effect was overwhelmed however at the highest flow velocity site. We have learned through DPM that a tradeoff exists between increasing sheetflow velocities to benefit the slough-ridge topography and unintended impacts of flow-driven nutrient enrichment. This study confirms the mechanism also applies to litter decomposition, the remains of which are a key source material to the floc layer.

THE RESTORATION STRATEGIES SCIENCE PLAN

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The Restoration Strategies Science Plan (RSSP) is a framework for studies in the Everglades Stormwater Treatment Areas (STAs) to enhance the understanding of mechanisms and factors that affect phosphorus treatment performance, particularly those that are key drivers to performance at low TP concentrations (<20 micrograms per liter, or µg/L). The RSSP is part of the Restoration Strategies for Clean Water for the Everglades that was developed to achieve the water quality based effluent limit (WQBEL) for STA discharges. The WQBEL was established to ensure that STA discharges do not cause or contribute to exceedance of the State of Florida's numeric P criterion for the Everglades Protection Area. Originally developed in 2013 and revised in 2018, the RSSP studies support design, operation, and management of STAs to meet the WQBEL. As of 2023, 12 studies have been completed and nine are ongoing. Sixteen studies consider key aspects of STA ecological sustainability and P cycling related to aquatic vegetation, periphyton, fish, soil/water interactions, resuspended particles, and hydraulics. The other five studies consider data quality and operations that affect the STAs. This poster presents a summary of each study, their relationship to each other, and management implications.

USING WATER QUALITY MODELS TO SUPPORT DESIGN AND MANAGEMENT OF STORMWATER TREATMENT AREAS

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The Everglades Stormwater Treatment Areas (STAs) were constructed to remove phosphorus (P) from surface water runoff to achieve a P target goal before discharging into the Everglades Protection Area. Simple P models were developed prior to STA construction using data collected from Water Conservation Areas affected by surface P runoff. These models defined P net settling (K) and a base concentration (C*) to support STA design specifically sizing, vegetation composition, and operation to achieve the P goal. These models have been used extensively and revised over time to support design and management issues resulting in a few versions of the Dynamic Model for Stormwater Treatment Areas (DMSTA). As STAs were built, operated, and the biogeochemistry of P was studied, more complicated P models were created with a focus on the major plant communities: emergent aquatic vegetation, submerged aquatic vegetation and periphyton. These models demonstrated the performance of the various plant communities, including their effect on P accretion into the soils and translocation of P into the water column via rooted plants. A review of compiled reports and publications of STA research found at least 20 different P models have been used for the STAs: 16 one-dimensional (tank-in-series), 2 two-dimensional and 2 three-dimensional. These models have improved our understanding of processes affecting P retention in the STAs and have been used to evaluate effects of P loading, surface water inflow, short-circuits and plant distribution on P outflow concentration. Continued enhancement of the models through integration of STA research should support management efforts to achieve the P target goal.

DECADAL TRENDS OF MERCURY CYCLING AND BIOACCUMULATION WITHIN EVERGLADES NATIONAL PARK

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Mercury (Hg) contamination has been a persistent concern in the Florida Everglades for over three decades due to elevated atmospheric deposition and the system's propensity for methylation and rapid bioaccumulation. Given declines in atmospheric Hg concentrations in the conterminous United States and efforts to mitigate nutrient release to the greater Everglades ecosystem, it was vital to assess how Hg dynamics responded on temporal and spatial scales. This study used a multimedia approach (water and biota) to examine Hg and methylmercury (MeHg) dynamics across a 76-site network within the southernmost portion of the region, Everglades National Park (ENP), from 2008-2018. Hg concentrations across matrices showed that air, water, and biota from the system were inextricably linked. Temporal patterns across matrices were driven primarily by hydrologic and climatic changes in the park and no evidence of a decline in atmospheric Hg deposition from 2008-2018 was observed, unlike other regions of the United States. In the Shark River Slough (SRS), excess dissolved organic carbon and sulfate were also consistently delivered from upgradient canals and showed no evidence of decline over the study period. Within the SRS a strong positive correlation was observed between MeHg concentrations in surface water and resident fish. Within distinct geographic regions of ENP (SRS, Marsh, Coastal), the geochemical controls on MeHg dynamics differed and highlighted regions susceptible to higher MeHg bioaccumulation, particularly in the SRS and Coastal regions. This study demonstrates the strong influence that dissolved organic carbon and sulfate loads have on spatial and temporal distributions of MeHg across the ENP. Importantly, improved water quality and flow rates are two key restoration targets of the nearly 30-year Everglades restoration program, which if achieved, this study suggests would lead to reduced MeHg production and exposure.

HYDROLOGIC THRESHOLDS AND NEST SURVIVAL OF THE SNAIL KITE

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The Everglades are a dynamic wetland system that vary naturally and through anthropogenic management. Extensive manipulation of the natural system via canal and levee construction is being reworked to restore the system to match natural cycles more closely. Restoration will improve the timing, volume, and distribution of water with guidance from water regulation schedules for each wetland. Changes in hydrology can impact a wide variety of species that utilize the Everglades system. These changes in hydrology can have considerable impacts on populations. By identifying these effects, it will help managers minimize negative impacts and improve conditions for populations. Using data from over 5000 nests from 1996-2021, we determine the effects of changing water levels on nest initiation and nest survival of snail kites (*Rostrhamus sociabilis plumbeus*) across its breeding range in Florida. We identified benchmarks for water levels that promote nest initiation and survival using Bayesian change-point models that estimate thresholds of hydrologic effects that can vary in the number, magnitude, and form across wetlands. Overall, nest initiation benchmarks emphasize that initiation requires higher water levels than nest survival. Low water and high water, and high rates of change (declining or increasing water levels, recession, and ascension, respectively), had negative, threshold effects on nest survival. We then provide a temporally-explicit framework for assessing effects of changing water conditions throughout the year on nest initiation and survival rates using an ensemble modeling framework. This framework allows assessments of water regulation schedules, hind-casting of prior effects of changes in hydrographs, and near-term forecasting. Model validation emphasizes that predictions are more reliable for nest initiation than nest survival. Our modeling framework provides guidance for water regulation schedules and related water management activities across wetlands that may foster successful reproduction by snail kites and provide site-specific criteria for conditions where nest initiation and nest survival of snail kites are expected.

CONNECTIONS BETWEEN PLANT-AVAILABLE LEGACY SOIL P, INTERNAL LOADING AND TREATMENT PERFORMANCE IN FULL-SCALE STAS

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The Everglades Stormwater Treatment Areas (STAs) have stringent outflow phosphorus (P) concentration targets, near or below the lowest concentrations achieved by other treatment wetlands globally, to protect the historically oligotrophic Everglades from anthropogenic eutrophication. Despite the successes of the STAs over their 20-year operational history, further reductions in outflow P concentrations are required to meet regulatory criteria. The STAs must achieve very low surface water P concentrations (total P 13-19 µg/L), not much higher than the ultra-oligotrophic native Everglades (~6-10 µg/L), despite having been established mainly upon former agricultural soils with a legacy of higher nutrients. Internal nutrient loading is the mobilization of nutrients from internal reservoirs in the treatment system into active cycling in the water column. Earlier experiments estimated internal P loading in the STAs using in situ mesocosms that enclosed intact parcels of the STA marsh community. P concentrations in the water column increased when the mesocosms were deployed when initial concentrations were near local minima, evidence of an internal load. The estimated internal P loadings are great enough to affect STA outflow concentrations. This experimental approach did not differentiate the source of P, although the source was necessarily within the mesocosms: soil, plants and/or fauna. Modeling and ex situ studies indicate that translocation of soil P through the roots to the shoots of wetland plants (and ultimately to the water column) is likely a substantial internal P loading mechanism in the STAs. We hypothesize that variation in translocation of P through wetland plants among the different STAs contributes to observed differences in STA outflow water P concentrations. To test this hypothesis, we developed a soil bioassay technique. Cattail (*Typha latifolia*) seedlings of a uniform size and age were grown, ex situ, in soils from several STAs that varied in soil total P (TP) content and long-term average outflow water P concentrations. Plant growth rate, biomass development, and P concentration were measured, and the P translocation rate estimated. Plant growth and P translocation rates differed among soils from different STAs. These differences in translocation rates were unrelated to the soil TP concentration, but were consistent with the rank-order of their long-term average outflow water P concentrations from the respective STAs. This latter result supports our hypothesis. P translocation may directly affect the ability of the STAs to achieve very low P concentrations. Follow-up studies should expand this assay to additional STAs and link this bioassay “index” of plant-available soil P to the internal P loading rate in mature plant communities of the STAs to determine how this internal loading process can be addressed through soil or plant management.

DEVELOPMENT OF A PHYSICAL-BIOGEOCHEMICAL MODEL FOR PREDICTING HABS AND WATER QUALITY IN GREATER FLORIDA BAY

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Southwest Florida coastal waters and Florida Bay form an important marine ecosystem supporting abundant seagrass, coral reefs, and fish. Florida Bay is also a critical buffer zone between the Greater Everglades and Florida Reef Tract. To understand the fundamental ecosystem dynamics including nutrient cycles and phytoplankton blooms, and the connectivity through the region, a coupled physical-biogeochemical model has been developed. The physical model is based on the Regional Ocean Modeling System (ROMS). The biogeochemical model includes 2 types of nutrients (N, P), phytoplankton (4 groups), zooplankton (2 groups), bacteria, and dissolved and particulate organic nitrogen and phosphorus. The model is driven by freshwater inputs from upstream rivers and watershed runoff, surface meteorological forcing, sediment fluxes, and ocean forcing including tides and the Florida Current. A two-year (2011-2012) simulation has been performed and results calibrated with available data. Preliminary model results show reasonable agreement with observations including temporal-spatial patterns of water level, salinity, nutrients, and chlorophyll. It remains, however, challenging to get good characterizations of phytoplankton group composition (in term of biomass) and sediment fluxes, partly due to a lack of available data. These results, nevertheless, indicate clear circulation patterns in Florida Bay and connectivity through the region including a quasi-permanent clockwise recirculation cell on western Florida Bay, which is likely mainly shaped by surface winds. Model results also suggest that these dynamic patterns along with dominant freshwater transport pathways and sediment fluxes significantly impact the nutrient dynamics (e.g. dominant N/P regimes), phytoplankton blooms, and transport of organics toward the Florida Reef Tract.

SNAIL KITE AND WADING BIRD RESPONSE TO TORPEDOGRASS AND CATTAIL MANAGEMENT ON LAKE OKEECHOBEE

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Lake Okeechobee is a 448,000 acre lake with over 100,000 acres of marsh. Introductions of invasive plant species, high lake stages and increased nutrient inputs, have impacted the marsh vegetation throughout the lake. Two plants that modify vegetation communities are torpedograss (*Panicum repens*), an invasive grass and cattail (*Typha* sp.), a native species. While cattail is native, it has rapidly increased in acreage with the increase of nutrients over the last few decades. Both species, when left unmanaged, create thousands of acres of monocultures throughout the marsh. If allowed to become dense monocultures, these species result in low levels of dissolved oxygen in the surrounding water column and low fish and wildlife diversity. To combat this, agencies have primarily used herbicide to manage these species. In 2015, the Florida Fish and Wildlife Conservation Commission Aquatic Habitat and Enhancement Section (AHRE) increased management of cattail throughout the lake. In 2015, a 2,300 acre cattail herbicide treatment in Moonshine Bay, followed by a 6,300 acre prescribed fire led to a record breaking Everglade snail kite (*Rostrhamus sociabilis plumbeus*) nesting season on the lake, with 70% of the nesting and 82% of the successful nests occurring within the management area. Large numbers of wading birds and waterfowl were also observed using this area. Cattail management in following years also resulted in increased snail kite foraging and nesting within or adjacent to many of the management areas. In 2018, AHRE began largescale torpedograss herbicide management in the northwest marsh of the lake and has maintained this area annually with spot treatments. 1,500 acres are currently being managed with an additional 1,500 acres added in 2022. The torpedograss management area has resulted in the increased foraging of snail kites, wading birds and waterfowl, with a large nesting colony of snail kites forming nearby. In 2021, 60 + snail kite nests were documented in willow near the management area. In May 2021, 61% of foraging wading birds were documented using the 1,500 acre torpedograss management area. The success of these herbicide management activities, combined with appropriate water levels, led to increased foraging and nesting opportunities for many avian species within these areas. Future management and their usage will be documented.

UNINTENDED CONSEQUENCES OF HYDROLOGIC RESTORATION, WATER QUALITY CONSIDERATIONS FOR PICAYUNE STRAND RESTORATION PROJECT.

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The goal of the Everglades restoration effort is to restore, protect, and preserve the region's water resources by addressing the quantity, quality, timing, and distribution of water within the greater Everglades ecosystem. Generally, projects can be grouped into two types of projects, hydrologic restoration (i.e. backfill canals, spreader swales, pump stations, operational adjustments, etc.) or water quality (i.e. stormwater treatment areas, flow-equalization basins, etc.). Picayune Strand Restoration Project is a Comprehensive Everglades Restoration Plan generation one project (authorized in the Water Resource Development Act 2007) that will restore more than 55,000 acres (~200 km^2) of native wetland and upland ecosystems through hydrologic restoration. Restoration efforts include the construction of three pump stations, plugging canals, removing roads and logging trams, and construction of a protection feature for flood protection. However, the flood protection feature has the ability to redirect poor water quality to downstream Outstanding Florida Waters (OFWs). Outstanding Florida Waters is a regulatory designation for waters or areas (i.e. state and national parks, wildlife refuges, etc.) that deems special protection because of its natural attributes and intended to protect existing good water quality. The objective of this presentation is to discuss the potential unintended consequences of hydrologic restoration on water quality and the potential risk to protected protected areas. Existing water quality combined with modeled hydrology was used to evaluate the potential change in water quality entering Collier-Seminole State Park and other downstream OFWs. The project is expected to more than double phosphorus and nitrogen loads by redirecting discharges through new and existing infrastructure including a new structure that discharges into Collier-Seminole State Park. Moreover, based on available data and modeling it is expected that discharges will exceed the OFW baseline conditions of 310 $\mu g\ L^{-1}$ total phosphorus approximately 50% of the time. A state-funded water quality restoration project has been planned but has not yet been authorized or funded. To ensure sustainable and effective restoration both water quality and quantity should be considered.

DATA INTEGRATION OF INTERNAL LOADING RATES FROM LEGACY SOIL P IMPROVES STA NUMERICAL SIMULATION

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As demonstrated previously in this session, internal P loading rates (iPLR) have for the first time recently been quantified in a key STA FW and iPLR magnitudes appear similar to inflow PLRs. The next step is to explore how or if this new information aids in describing STA performance. Dynamic modeling is an appropriate tool for an integrated perspective of role of iPLR as it co-exists with P removal processes. Can this new information on iPLR improve our numeric simulation capability? The purpose of this presentation is to demonstrate how direct measurement of iPLR has indeed opened new doors for STA modeling. A brief review of several currently existing STA models indicates very limited performance to date in the low-P domain. Therefore, two new equations are produced, one based on the new iPLR measurements, the other a new P removal formulation, also directly data-driven. The resulting two equation model is not complete, but still very useful to begin exploring short-term calibrations and case study scenarios. Calibration and testing results are briefly presented, based on four independent datasets (6–36 month duration) including outflow P time series and internal water treatment profiles. This data-driven approach significantly improved dynamic simulations beyond the capacity of existing models. Furthermore, a modeling case study suggested that almost all outflow P (~95%) over a 36-month period was sourced internally (from iPLR) after nearly complete removal of inflow P loads in the upstream front-end region. A very different and more complete spinoff approach, also based solidly on iPLR principles, is also briefly presented suggesting further potential along this new avenue. If model testing continues in a positive direction, these new algorithms are potentially paradigm-changing, as they illuminate an apparently determinant role of iPLR in low-P STAs and bring iPLR management to the forefront of STA optimization. Further development of such approaches is limited by availability of iPLR data from the STAs, thus is recommended that this remains a research priority.

POPULATION TRENDS AND TROPHIC ECOLOGY OF INVASIVE PEACOCK EELS (MACROGNATHUS SIAMENSIS) IN THE FLORIDA EVERGLADES

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The Florida Everglades is becoming increasingly susceptible to invasions of non-native species. Because of this, it is important to determine the effects of existing invasive species and the factors regulating their populations to properly anticipate future trends and inform management actions. The invasive peacock eel is of particular interest because it likely belongs to the same guild as native sunfish, which have historically accounted for a significant portion of seasonal prey pulses in freshwater regions of the Florida Everglades. Competitive interactions that disrupt the niche of native sunfish could subsequently alter the seasonal prey pulse composition upon which major fisheries rely. Few studies have been done on peacock eels in the Everglades, and the US fish and Wildlife Service's risk assessment of the invasion has only concluded that additional information is needed to determine the impact of their introduction and establishment. To assess the magnitude of the invasion we evaluate an 18-year electrofishing dataset (2004-2022) from Rookery Branch in the Shark River Estuary, FL, to document their population trends over time, and identify environmental factors that may influence their abundance. Additionally, we analyze stable isotopes of C, N, and S using Bayesian mixing models and hypervolume analysis methods to characterize the isotopic niche of peacock eels in their invaded range in comparison to native sunfish species, with the goal of evaluating the potential impacts of their invasion on food web interactions.

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HOW ADAPTIVE ASSESSMENT AND MONITORING INFORMS CERP PLANNING & IMPLEMENTATION (AND MORE!)

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The Comprehensive Everglades Restoration Plan (CERP) is the largest ecosystem restoration program in the world. It is a programmatic 50/50 partnership between the federal government and the state of Florida designed to restore, preserve, and protect water resources in central and southern Florida. The South Florida Water Management District is the lead state agency, and the US Army Corps of Engineers is the lead federal agency in this effort, which will improve 2.4 million acres of the south Florida ecosystem, improve freshwater inflow patterns to the estuaries, southern coastal systems, and enhance water supply. Ecological monitoring and applied science are essential throughout the planning and implementation of CERP project components. CERP Programmatic Regulations set forth requirements to ensure that the goals and purposes of CERP are achieved, and that new information is regularly considered and incorporated into implementation. In response, CERP Restoration Verification and Coordination (RECOVER) developed an adaptive assessment program that: assesses system responses to CERP implementation, measures status and trends towards achieving CERP goals and purposes and utilizes the information as a basis for conducting assessment tasks. This adaptive assessment and monitoring plan is described in the RECOVER Monitoring and Assessment Plan (MAP), to provide a single, integrated, system-wide plan. The scientific and technical information generated from MAP data provide a process for RECOVER to assesses the performance of the South Florida ecosystem as it responds to CERP implementation phase and produce assessment reports describing and interpreting these responses. During the CERP project planning phase, MAP data inform the evaluation of project alternatives and the formulation of adaptive management strategies. Throughout these phases, information from MAP is applied to updating and developing Performance Measures, Conceptual Ecological Models, and predictive ecological modeling tools used in CERP evaluation and assessment processes. MAP information also informs broader restoration and management decisions, such as contributing to the biennial South Florida Ecosystem Task Force System-Wide and Stoplight Indicator Reports and informing system Water Control Plan development and weekly water management recommendations. Initiated in the early 2000s, MAP has undergone periodic revisions and continues a cycle of updates to incorporate new information. Through the ongoing efforts of the CERP RECOVER program, new knowledge gained will help to inform the adaptive assessment nature of MAP, to ensure we are effectively tracking system responses to restoration. By collaboratively working with a team of subject matter experts, RECOVER continues to apply the best available knowledge, new information from data and models as CERP planning efforts and implementation progress, restoring historic characteristics across this diverse landscape.

INTERACTING CONTAMINANTS CAN INFLUENCE MERCURY BIOACCUMULATION IN THE EVERGLADES MARSH

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Differences in environmental conditions can alter mercury concentrations in the food web of the freshwater Everglades marsh, as shown by a multi-decadal study conducted by the United States Environmental Protection Agency. About 1000 random locations throughout the marsh have been sampled for the Everglades Regional Environmental Monitoring and Assessment Program ("REMAP") since 1995. REMAP sampling is synoptic and multimedia, including an abundant prey fish (eastern mosquitofish, *Gambusia holbrooki*) as an indicator of mercury bioaccumulation. Mercury accumulates in the food web after it has been methylated by sulfate-reducing bacteria as a by-product of their anaerobic metabolism of organic carbon. We used Generalized Boosted Models on the REMAP data to estimate how much of the mercury concentration in mosquitofish could be explained by water quality constituents or indicators of ecological health (covariates). The resulting model accounts for 60 % of the environmental influence on variation in mosquitofish mercury. Of the eight most influential covariates, two were methyl mercury (the bioavailable form) in periphyton and in water, two can be indicators of trophic state and therefore habitat quality (alkaline phosphatase activity and chlorophyll-*a*), one can be a marker of stormwater transport (conductivity), and two can be enablers of mercury methylation (sulfate in soil and in water). While these covariates had an average individual influence ranging from 4.0 % to 10.1 %, together they accounted for 52.2 % of the total relative influence. Water with low phosphorus, but with sulfate and organic carbon above background, moved via modifications to the existing water management system into the less disturbed parts of the Everglades, where food webs are more complex, could increase mercury bioaccumulation in those parts of the marsh.

REMOTE SENSING OF HABS IN THE INDIAN RIVER LAGOON, FL: UAS HYPERSPECTRAL TO SATELLITE MULTISPECTRAL

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With an increasing frequency of Harmful Algal Blooms (HAB) in the Indian River Lagoon (IRL) over the last decade, the identification of HAB triggers and behaviors is vital to efforts to manage the watershed. The use of satellite and Unmanned Aircraft System (UAS) remote sensing technologies are a cost-effective and encompassing approach to provide rapid identification of HAB formation, the lifecycle of the HAB, and then identify hotspots of HAB occurrences. The purpose of this project is to provide the framework for the use of the European Space Agency (ESA) Sentinel-2 and Sentinel-3 satellite data to provide early warning of HAB formation in the IRL. This presentation will include the lessons learned from evaluating historical Sentinel satellite data, findings from UAS flights, and implications for use in water resources management. Imagery from the Sentinel satellites was evaluated with St Johns River Water Management District water quality data from 2016 to 2021 to identify the most effective algorithms for estimating HAB intensity, duration, and extent. A hyperspectral camera equipped UAS was also flown throughout 2022 to provide additional high-resolution data both to aid in the evaluation of HAB estimation algorithms and develop a spectral library of estuarine features of the IRL. The rapid collection and analysis of HABs through a fusion of satellite and UAS provide can provide managers with the data needed to make informed decisions regarding public safety and prevention of future blooms. Then leveraging ESRI ArcGIS Online services, weekly HAB reports were disseminated to the public to increase awareness of the lagoon's residents. The collected spectral data can also be examined to aid in the identification of other photosynthetic organisms such as Submerged Aquatic Vegetation (SAV). Within the IRL, there has been a concurrent change in SAV taxa, density, and extent over the last decade. These changes are likely closely tied to patterns in HABs. With reduced water clarity and increasing macroalgae coverage there is a need for the development of additional tools to provide data for the characterization of SAVs. The use of satellite remote sensing can be a cost-effective approach to supplement the delineation of SAV and other benthic covers in the complex waters of the lagoon and provide context to changes in the SAV communities.

PASSIVE ACOUSTIC MONITORING OF VESPERTILIONID AND MOLOSSID BATS ON MICCOSUKEE TRIBAL LANDS

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The ecology of Vespertilionid and Molossid bats is poorly understood in the South Florida ecotone. The harsh landscape coupled with increased habitat fragmentation has made invasive survey techniques such as mist-netting difficult to implement. However, passive acoustic monitoring can provide non-invasive survey techniques for investigating bat occupancy across habitats. To date, no systematic acoustic monitoring paradigm has been implemented on Miccosukee Tribal Lands. Our goal was to use passive acoustic monitoring to undergo the first bat species inventory completed on the Miccosukee Reservation. The Miccosukee Fish & Wildlife Department used Wildlife Acoustics SM4BAT passive acoustic monitors across 453 sample nights for species abundance data. Species accumulation curves across the Miccosukee Tribal lands were calculated using clench and linear dependence models. Across 453 sample nights, the clench and linear dependence models estimated an average 10.95 resident species of bat occupy the area with immigration and emigration of migratory bats possible. Of the species observed, Brazilian free-tailed bats (*Tadarida brasiliensis*), evening bats (*Nycticeius humeralis*), and Northern yellow bats (*Lasiurus intermedius*) were the most abundant. Our northern properties exhibited high abundances of the soon-to-be-endangered tricolored bat (*Perimyotis subflavus*) and the Southeastern myotis (*Myotis austroriparius*). Presence of the endangered Florida bonneted bat (*Eumops floridanus*) was observed on all properties south of Lake Okeechobee. While not regularly occurring, positive identification of the velvety free-tailed bat (*Molossus molossus*) was found in the extreme southern region of the Miccosukee Reservation. Passive acoustic monitoring has shown to be an effective survey tool for habitats where standardized survey methods are not feasible. A prerequisite for monitoring spatial and temporal trends of bat biodiversity is to assess the true species richness. Our findings constitute an important step toward successfully implementing a management plan that provides accurate inventories of bats.

HORTICULTURAL NURSERIES-BASED POLLUTION DYNAMICS AND APPORTIONMENT IN CANALS OF SOUTH MIAMI DADE, FLORIDA

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The South Miami-Dade agricultural nursery area lies between the Everglades national park (ENP) and Biscayne Bay, which are both highly protected, natural areas. The nurseries in this area have been shown to be a source of nutrients in canals and subsequently Biscayne Bay. Understanding how much nutrient load canals receive from agricultural nurseries can lead to better management decisions and consequently more control over nonpoint source pollution that impacts naturally oligotrophic Biscayne Bay. To understand the relative impact of agricultural nurseries, an assessment of agriculture in Miami-Dade County was completed by compiling the amount and area of agricultural land use during the 2004-2005, 2007-2008, and 2014-2015 land use surveys. To understand the interaction of groundwater and canals, a flow map was created that shows a strong relationship between groundwater coming from the ENP and canals during the wet season. A multiple regression was completed to determine the relative contribution of NOx in the C-103 N canal from both agricultural nurseries and other types of agriculture. The data were then extrapolated throughout all the canals in South Miami-Dade County to determine the load of NOx in each canal due to agriculture and agricultural nurseries. A principal component analysis was then completed with the results input into the APCS-MLR model to identify the sources of the pollutants within the canals. The results have shown a positive correlation between both types of agriculture and NOx in canals, with other agriculture contributing over 3.5x more than agricultural nurseries per unit area.

QUANTIFYING IMPACTS OF ANTHROPOGENIC AGRICULTURAL NUTRIENT ACCUMULATIONS ON PHOSPHORUS LOADS IN A LAKE OKEECHOBEE SUB-WATERSHED

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Nutrient accumulation in soils over time due to anthropogenic applications, a.k.a. legacy nutrients, is a global problem which is now being recognized as one of the factors posing challenges to attaining water quality targets through implementation of conservation practices and basin management programs. Legacy Phosphorus is more challenging due to limited recycling pathways and decadal retention times. Accounting for legacy nutrient dynamics in watershed scale models has received attention only in the last few years and is currently an active area of research. A comprehensive US wide nutrient accumulation dataset indicates that areas in central Florida region, that encompasses Lake Okeechobee watershed, have accumulated over 400 kg/ha of Phosphorus since mid-1950s and has some of the highest rates of agricultural surplus applications. This study aimed at quantifying contribution of legacy Phosphorus to Phosphorus loads in Fisheating Creek basin – a Lake Okeechobee sub-watershed. Fisheating Creek basin is located on the western-northwester side of the lake and drains 1287 sq. km. land into the lake. Agriculture is the most dominant land use in Fisheating Creek with Improved Pastures, Unimproved Pastures, Woodland Pastures, and other agricultural land uses covering 32%, 11%, 8%, and 9%, respectively, of the basin. The remaining watershed is mostly in natural state (37%) with less than 2% developed area. Fisheating Creek basin is characterized by Spodosols with Immokalee, Myakka, and Basinger being the most dominant soils. These are coarse textured poorly drained soils with less permeable spodic horizon and poor Phosphorus retention capacity in surface layers. In this study, a previously calibrated implementation of the Watershed Assessment Model (WAM) to Fisheating Creek basin was used as evaluation tool. WAM uses a field scale model, called EAAMOD, that is used to simulate parts of the basin represented by combination of agricultural, urban, and some natural land uses with spodosols. A unique characteristic of EAAMOD is it's explicit parameterization of legacy nutrient concentrations. In the case of Fisheating Creek 52% of the basin has substantial higher Phosphorus accumulation (at least twice the background soil Phosphorus levels) that was simulated with EAAMOD. To quantify contribution of legacy Phosphorus to current Phosphorus loads going into the lake, an alternative scenario was created. Under this alternative scenario high legacy Phosphorus values were changed to pre-development soil Phosphorus estimate of 25 kg/ha. Results showed that average annual Phosphorus load of 57.9 mt/y under the existing conditions would reduce by 22.5% to 44.9 mt/y if agricultural soils did not have Phosphorus accumulation. Wetlands cover is substantial in Fisheating Creek and impact on wetland Phosphorus dynamics is likely playing a role and needs further modeling investigation to project corresponding contributions.

STAS 101: THE STORY OF THE EVERGLADES STORMWATER TREATMENT AREAS

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The Everglades Stormwater Treatment Areas (STAs) are the largest constructed treatment wetlands in the world currently encompassing over 62,000 acres. They were designed with the primary goal of reducing total phosphorus (TP) concentrations from agricultural and stormwater runoff prior to discharge to the Everglades Protection Area. These STAs are an integral component of Everglades Restoration efforts and have been extremely successful at reducing nutrient loads to the Everglades. This presentation will provide an overview of the State and Federal mandates for the construction and operation of the STAs and will focus on their development, operation, maintenance, research and monitoring efforts to ensure performance objectives are met. The first STA, the Everglades Nutrient Removal Project, (STA-1E) was created through recommendations to the District from the Lake Okeechobee Technical Advisory Panel in 1988. The STAs have continued to expand into the present and are mandated under the 1992 Settlement Agreement/Consent Decree and 1994 Everglades Forever Act. District scientists, engineers, and water managers meet weekly to review the STA vegetation conditions, phosphorus loading rates, and inflow and outflow TP concentrations, as well as ongoing vegetation management activities, construction projects, and research activities to determine priorities for inflows to the treatment flow-ways. Staff regularly monitor STA vegetation health, perform vegetation rehabilitation work, perform treatments to reduce exotics, and plant vegetation in open water areas. STA research efforts fall under the Restoration Strategies Science Plan, developed in 2013 and updated in 2018, as a framework to evaluate critical factors governing P treatment performance; help improve understanding of existing data, design, and operation of these systems; and identify information gaps and research areas to achieve the mandated water quality based effluent limit (WQBEL) for each STA's discharges. In addition to water quality improvements, these systems also have a significant public use component and are world renowned for birders, alligator and waterfowl hunting, and provide miles of hiking and biking trails. To date, the Everglades STAs have treated approximately 24.2 million acre-feet of water (~ 7.9 trillion gallons) and retained 3,089 metric tons of TP, equating to TP load reduction of 77%. This presentation will provide an important foundation and background for many of the STA-related GEER conference presentations.

HIGH-RESOLUTION, GLOBAL OCEAN-ATMOSPHERE MODELS OF HISTORICAL AND PROJECTED CLIMATE

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Increasingly, high resolution observations and coupled model experiments with eddy-resolving oceans indicate that western boundary currents (WBCs) are regions of strong ocean-atmosphere interactions that are critical components of the climatic mean state and variability. The high SSTs and strong SST gradients couple with the atmosphere to pump moisture into the marine boundary layer, accelerate winds, sharpen SST fronts, and introduce significant decadal climate variability that affects the frequency and intensity of extreme events (e.g., heat waves, cold spells, droughts, floods, extreme winds) at remote locations and the forced climate response. This talk describes very-high resolution global coupled climate model simulations including the pre-industrial control, the 20th Century historical, and climate projections out to 2100. The results are compared with the standard (i.e., lower resolution) CMIP simulations. The results presented will cover both the mean changes through 2100 and changes in extremes with comparisons with observational estimates and a focus on precipitation and coastal flood risk.

INTEGRATION OF MONITORING TO SUPPORT THE INDIAN RIVER LAGOON-SOUTH AND C-43 RESERVOIR CERP PROJECTS

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Integration of the Comprehensive Everglades Restoration Plan (CERP) monitoring is vital for leveraging the best-available science and the application of knowledge gained to support Everglades restoration. CERP will soon enter a new era as project components become operational. A thorough review of current monitoring efforts ensures that changes to system hydrology and ecology because of CERP restoration are assessed to identify adaptive management opportunities and determine project success. The northern reaches of the greater Everglades system, the St. Lucie Estuary and southern Indian River Lagoon on the Atlantic, and the Caloosahatchee Estuary on the Gulf coast, experience altered inflows and salinity due to the highly channelized Central & South Florida (C&SF) Project system. The estuaries serve as endpoints of flood control measures upstream by “sending water to tide,” resulting in high inflows and low salinity especially in the wet season. The Caloosahatchee Estuary will also experience low flows and high salinity in the upper estuary during the dry season. The altered flows push salinities outside of the optimal ranges for fish, oysters, benthic infauna, and submerged aquatic vegetation, impacting the function and overall health of the estuary. As a result of CERP, the Northern Estuaries are expected to experience improvements in the magnitude, timing, quality, and distribution of freshwater inflows with operational project components from the Indian River Lagoon-South (IRL-S) and C-43 West Basin Storage Reservoir (WBSR) projects. IRL-S includes reservoirs and stormwater treatment areas in the C-23, C-23/24, and C-44 basins, oxbow and backwater habitat restoration in the St. Lucie River, and muck removal and substrate augmentation (e.g., oyster cultch) in the estuary. The C-43 WBSR project will receive and store excess water from Lake Okeechobee releases and C-43 basin runoff to the Caloosahatchee Estuary and release supplemental flow during the dry season. To ensure projects meet stated objectives, CERP project managers and ecosystem scientists from CERP’s Restoration, Coordination, Verification (RECOVER) program undertake monitoring crosswalks, one of several vital interaction points between project teams and RECOVER required by CERP during project implementation. Project-level monitoring includes ecological, water quality, and hydrometeorological monitoring to assess the impacts from specific project components. At the system-wide level, RECOVER’s Monitoring and Assessment Plan (MAP) includes monitoring of target species and habitats as indicators of hydrologic restoration from CERP across the south Florida landscape. Monitoring crosswalks establish that adequate monitoring is in place to assess project performance, leverage available data between the projects and the MAP, and identify monitoring gaps.

THE ROLE OF BENTHIC PERIPHYTON MATS IN REGULATING MACROPHYTE COMMUNITIES IN A MARL PRAIRIE WETLAND

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Primary producers in oligotrophic systems receive periodic nutrient subsidies from pulses of rain and water inflow. This influx into shallow-water ecosystems regulates water depth and length of inundation, which characterizes the system's hydrologic regime and creates a favorable environment for producer interactions. Macrophytes and periphyton mats are crucial wetland engineers, and the dominance of one over the other could alter nutrient cycling and storage, habitat heterogeneity, and shift energy allocation at higher trophic levels. Macrophyte-mat interactions are inconsistent across a landscape as freshwater presses and pulses are spatially heterogeneous. In the Everglades, short-hydroperiod marl prairies contain the most productive periphyton mats, which coexist with abundant *Cladium jamaicense* and *Muhlenbergia capillaris* var. *filipes*. Understanding how hydrology regulates production by macrophytes vs. mats is crucial for determining the outcome of macrophyte-mat interactions in highly oligotrophic ecosystems like the Everglades. A three-year harvest experiment took place at three locations in the Everglades marl prairies to investigate how macrophytes and mats influence each other's biomass along a hydrologic gradient. Periphyton or macrophytes were removed from plots bimonthly for one year and then pairs of plots were harvested bimonthly for two years to assess the effects of removal. Macrophyte absence significantly increased mat biomass, while periphyton removal significantly decreased macrophyte total biomass at the shallowest, shortest-hydroperiod sites. *C. jamaicense* stem density was lower where mats had been removed, while the density of less dominant species increased. For both removal types, the shortest hydroperiod site had significantly greater macrophyte biomass and lower mat biomass than the deeper, longer-hydroperiod sites. All sites experienced directional change in mat biomass over time, with increases during wet periods and decreases during dry periods. Macrophyte and mat removal effects were more pronounced in habitats with lower water level and shorter hydroperiods, suggesting that periphyton may protect macrophytes from desiccation and/or UV radiation, and that freshwater pulses may influence macrophyte-mat interaction intensity with ramifications for ecosystem biomass allocation. Not only has this federally funded project supported my dissertation research, but it has allowed me to connect with federal agency professionals through my involvement in the South-Florida Caribbean Cooperative Ecosystems Studies Unit (SFC-CESU). The SFC-CESU has provided me the opportunity to establish working relationships with federal employees, to initiate interagency collaborations, and to broaden the audience I communicate science with. My participation in the SFC-CESU has expanded my professional network to include the federal sector, which will be particularly beneficial after graduation as I pursue a governmental position.

LINKAGES BETWEEN SEAGRASS TISSUE O_2 DYNAMICS AND ECOSYSTEM OXIDATION AND FEEDBACKS ARE REVEALED USING MICROSENSORS IN SITU

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Water column hypoxia, low tissue pO_2 and H_2S intrusion, a known phytotoxin, are linked to global seagrass decline. While many lab experiments have examined these relationships, only field studies capture the complexity of gas dynamics *in situ*. We examined internal pO_2 and H_2S dynamics in a dominant tropical seagrass *Thalassia testudinum* using microsensors. Based on 12 field deployments (48–72-h) across seasons, we show that *T. testudinum* has a high capacity for daytime leaf oxidation (42-53 kPa) that sustains oxic conditions in its tissues and supersaturates the water column with O_2 (>21 kPa). While internal daytime O_2 is consumed near sunset, positive feedback between seagrass O_2 production and the supersaturated water column going into the night contributes to buffering of internal plant hypoxia in the beginning of the night. Leaf meristems went anoxic/hypoxic (0.6 kPa) at night even with high daytime irradiances, indicating a high ecosystem O_2 consumption, and reliance on water column pO_2 (19 kPa) through leaf pO_2 (9 kPa) to prevent H_2S from entering the meristem at night. Newly recruiting shoots into bare sediment also had the ability to minimize H_2S intrusion. At ambient irradiance, we only detected H_2S in the meristem when water column pO_2 was hypoxic (<2 kPa) coincident with maximum water column temperatures (33 ^{o}C), an occurrence likely to increase with global warming. These data reinforce the importance of water quality management to sustain seagrass-dominated systems, particularly in nutrient-enriched estuaries and coastal lagoons.

COLLABORATIONS AND LANDSCAPE-SCALE ADAPTIVE MANAGEMENT OF INVASIVE PHRAGMITES AUSTRALIS: INSIGHTS FROM THE GREAT LAKES

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Non-native *Phragmites australis* (common reed) is among the many invasive species found in and around the Everglades region. Although it may not be a significant management concern currently, it is a species taking over wetlands and disturbed areas throughout the U.S. and Canada. This species can degrade fish and wildlife habitat, reduce property values, and increase fire hazards. It is well established in the Great Lakes region and management of this invasive species is a high priority for resource managers, but landscape-scale collaboration and learning among managers has been difficult. To address this challenge, the U.S. Geological Survey, Great Lakes Commission, and other regional partners formed the Great Lakes *Phragmites* Collaborative (GLPC) in 2011. The GLPC maintains a website (http://greatlakesphragmites.net/) as a central resource hub that hosts a research- and management-focused webinar series, creates newsletters and blog posts, maintains a 770+ member listserv, and supports research and advisory teams. Members of GLPC recognized that data-driven best management practices were not readily available and uncertainties around optimal treatment options continued to exist, so the *Phragmites* Adaptive Management Framework (PAMF; http://www.greatlakesphragmites.net/pamf) was initiated in 2017 as a participatory science program designed to reduce uncertainty about what *Phragmites* treatments are most effective given individual site conditions. Each year, PAMF participants monitor their *Phragmites*-impacted site and upload data to a centralized web hub. Those data update a model, which then produces site-specific management guidance for the upcoming year. Over 250 management units have been enrolled in PAMF, representing participation by governmental agencies, NGOs, non-profits, and private citizens. In addition to receiving management guidance, participants receive yearly reports detailing the progress of their management units over time. Together, the GLPC and PAMF provide opportunities for managers to track and report on their progress managing this invasive plant. Adaptive management approaches reduce uncertainty about the impacts of existing treatments and set the stage for analysis of innovative new treatments being developed. For example, a multi-agency team is developing a new species-specific and environmentally benign control strategy that is based on the natural plant process of RNA interference. Similarly, another collaborative team is developing a non-toxic bioherbicide that targets the microbes helping the plant outcompete native plants. New treatments based on these technologies will offer managers additional options for managing *Phragmites* throughout the nation and build a foundation for technological adaptation and extrapolation to other invasive plant species. The approaches taken in the Great Lakes region may offer insights helpful for managing the invasive *Phragmites* and other invasive species in the Everglades region.

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EVERGLADES MERCURY SCIENCE: TOWARD AN INTERNALLY CONSISTENT PARADIGM

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In the mid 1980's scientists from across the world made similar observations regarding elevated mercury (Hg) levels in fish from a variety of aquatic ecosystems, and some of the highest reported levels were from the most remote locations with no known Hg sources. By the mid-1990's researchers had assembled a paradigm that pointed toward aquatic ecosystems with organic-rich sediments - particularly those with abundant wetlands - as sites that were especially prone to have elevated fish Hg levels. Concurrent monitoring efforts in the Everglades confirmed that fish were elevated in Hg, and soon thereafter a multi-disciplinary research team was assembled by the South Florida Water Management District, the USGS, and the EPA to investigate the problem. Many of the discoveries this team made in the Everglades served as foundational science for investigations not only across the US, but across the world. Indeed, the work in the Everglades was among the first to link air, land, and water uses and management strategies and their impacts on Hg cycling and bioaccumulation. Detailed sampling of all environmental media (air, water, biota) over both time and space domains pointed toward three primary drivers: elevated atmospheric Hg deposition (among the highest in the world); sulfate loading from upgradient agricultural fields served to stimulate sulfate reducing bacteria (SRB) that were generally held as the primary methylators of Hg in the environment; and the accumulation of elevated dissolved organic carbon (DOC) levels in surface water that stabilized Hg and promoted its availability for methylation. Those observations led to extensive use of in-field mesocosms involving the additions of isotopically enriched inorganic Hg, sulfate, and DOC. The experiments clearly showed that all three of these chemical drivers led to the production of MeHg and its subsequent bioaccumulation in fish. Those experiments verified the previously proposed "Goldilocks" response of Hg methylation to sulfate loading, whereby at low sulfate concentrations methylation was limited; at high sulfate conditions production of high sulfide limited methylation; and, at moderate sulfate levels conditions were optimal to produce MeHg. Importantly, the inferred location of methylation from these studies (as well as others around the world) was the near surface sediments, where microbial activity was highest. More recently, however, Everglades Hg research has revealed three novel observations: SRB do not have the requisite genes (*hgcAB*) to methylate Hg; at most sites the methylation process is predominantly in the water column; and, unlike most other areas of the U.S., Hg deposition in south Florida is not decreasing. This presentation will harmonize and link 25 years of Hg research in the Everglades that point toward a consistent paradigm on underlying processes governing MeHg levels in water and biota and will discuss how Hg cycling relates to the Everglades restoration program.

QT-AMP: SEQUENCING PCR AMPLICONS FROM QUANTI-TRAY WELLS TO ANALYZE ENTEROCOCCI COMMUNITIES

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One of the most common water quality impairments in Florida from the regulatory perspective is high fecal indicator bacteria (FIB) which are used as a surrogate for human pathogens in wastewater; the primary FIB being *Escherichia coli* and *Enterococcus* spp. (enterococci, hereafter). Enterococci levels in Florida tend to be elevated compared to other regions in the U.S. but there isn't always a clear reason why since they have many sources. High-throughput 16S rRNA sequencing allows researchers to describe microbial community compositions typical of certain sample types which can be helpful in FIB source tracking but these methods are usually not sensitive enough to pick up the low concentrations of FIB in the environment. To address this, we developed a new approach to characterize enterococci using high-throughput 16S rRNA gene amplicon sequencing from Quanti-Trays which are commonly used for FIB counting. We named this method QT-AMP (Quanti-Tray-based amplicon sequencing). To test this approach, we used water samples taken from three tropical rivers (2020-2021) in addition to post-Hurricane Ian landfall samples (2022). In our pre-hurricane sampling, Enterococci had a median relative abundance of 82.7%. *E. faecalis* and *E. faecium*, commonly found in tandem in wastewater, had a higher ratio in the Estero than in the Imperial River. *E. casseliflavus* (typically naturalized in rivers) had lower relative abundances in the Imperial River compared to the other two rivers. QT-AMP had a sensitivity four orders of magnitude greater than standard 16S rRNA sequencing for enterococci. In our post-Hurricane Ian sampling, *Enterococcus* relative abundance ranged from 0.4 to 99% and *E. casseliflavus* had the greatest median relative abundance in all samples. Over half of the samples had an *E. faecalis* : *E. faecium* ratio $\leq$ 1. *Vibrio vulnificus* was the primary *Vibrio* species detected and in seven samples had relative abundances greater than 20% (range: 21 to 98%) while human pathogens like *Clostridium sartagoforme*, *C. septicum*, *C. tertium*, and *V. cholerae* had high relative abundances in at least one sample each. *E. faecalis* is usually more abundant than *E. faecium* in the gut of birds, so their ratio may be useful in discriminating between wastewater versus bird-sourced enterococci. Taking this into account, the Estero and Caloosahatchee (which had *E. faecalis* present in only one sample) enterococci appeared to be sourced from bird feces while the Imperial River and many of the post-hurricane samples indicated wastewater influence. FIB studies in Florida have found on numerous occasions that birds were the source of FIB so QT-AMP may be a solution to this source tracking issue along with other non-human sources. The high pollution in the post-hurricane samples showcases that QT-AMP may be beneficial for direct pathogen detection in water samples, but more research should be done to see if QT-AMP can be used as a useful microbial source tracking method.

HOW OPERATIONAL FLEXIBILITY REPLENISHED SUBMERGED AQUATIC VEGETATION ON LAKE OKEECHOBEE IN 2019

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Ecological conditions on Lake Okeechobee in the fall of 2018 were grim after going through unprecedented extremes and unique circumstances in the last several years. These extremes included climate oscillations which caused both high and low water conditions (between La Niña and El Niños), high water and other impacts associated with Hurricane Irma in 2017, and a large algal bloom. Additionally, the Herbert Hoover Dike was undergoing rehabilitation and had a large number of active construction sites. The lake had a record low coverage of submerged aquatic vegetation (SAV) of about 5,200 acres compared to the 2015 level of 33,000 acres and much below 2013 of 45,000 acres. Based on the 2020 RECOVER Lake Okeechobee Ecological Stage Envelop Metric, the triggers for entering a recovery year had been met. Based on these extenuating circumstances the U.S. Army Corps of Engineers (USACE) began implementing Additional Operational Flexibility by making releases out of Lake Okeechobee to lower lake levels before the beginning of the 2019 wet season. Throughout the 2018-2019 dry season an additional 360,000 acre-feet of water was released from the lake than would normally have been released and the lake receded to 11 feet in June. Throughout the operations the USACE engaged partner agencies and the public to help inform the process. As a direct result of the stage reduction the SAV began to recover, and the lake saw much improved conditions for wading birds that year. SAV surveys in 2019 reported approximately 26,000 acres, five times the coverage in 2018. The presentation will outline the actions the USACE took, how the operations were implemented, and how conditions were assessed throughout.

HOW FLOW RESISTANCE MODELING CAN IMPROVE WATER MANAGEMENT

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In the numerical and analytical models developed for south Florida, flow resistance behavior is captured using equations built around the Manning's equation developed for river flow. This equation assumes that depth averaging is valid when the equation is used to calculate flow. With this assumption, all flow resistance effects, including effects of turbulence, microtopography, vegetation resistance, and surface friction, are captured using one parameter called the Manning's roughness coefficient. Many examples can be presented from south Florida and the Everglades to show that more work is needed to reduce the uncertainty created by these assumptions regardless of the model or method used to estimate flow. While stem-drag-based methods and various other methods are becoming available in the literature to solve problems associated with vegetation resistance, experiments were conducted by the SFWMD to estimate bulk flow behaviors in wetlands using generated waves that travel through a wetland. The results are used to obtain comprehensive descriptions of the discharge as a function of water depth and energy slope using spectral theory and linear analysis. These results can be interpreted to demonstrate the presence of both laminar and turbulent flow behaviors at different depth and slope regimes. The experiment shows that power-law-type equations with three parameters are better at representing the flow resistance behavior, while a drainage slot, possibly rectangular in shape, is better at explaining flow below the average ground level due to microtopographic features. It also shows that resistance parameters do not just describe the discharge rate but, more importantly, the propagation speed and the decay rate within the vegetated medium. All these properties are important when managing a dynamic flow system such as the Everglades to catering to complex ecological needs. The results from the field tests allow for the classification of the hydraulic system as diffusive or advective (kinematic), making it easier to determine the appropriate water management approach in a given situation. The analytical tools developed for the flow resistance experiments have the potential to become useful in investigating the weaknesses in the flow ways of the Everglades, taking water from the north to the south through the levees, structures, and the urban corridor. This could be accomplished by using natural and managed flow pulses or bubbles that pass through the system. These pulses have predictable discharge, timing and attenuation behavior that can be calculated when the full vegetation resistance properties are known. If successful, this approach can be used to send targeted quantities of water to designated areas in the south. While numerical models using the same resistance equations are useful in detailed simulations, bubbles of water designed using analytical models may have the additional attractiveness because of their perceptibility.

ASSESSING VULNERABILITY OF EVERGLADES COASTAL PEAT MARSH: A FRAMEWORK FOR LOCAL-TO-REGIONAL SCALE EVALUATION

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Coastal sawgrass peat marshes in Everglades National Park (ENP) along the Gulf coast are becoming increasingly susceptible to accretion deficits from the hydrologic stress of sea-level rise, potentially driving broad-scale transitions of marsh habitat to open water through "peat collapse". Much has been experimentally uncovered about the drivers of peat collapse, yet we lack an assessment at any scale of marshes vulnerable to conversion to open-water across the Gulf coast of ENP, where sawgrass marshes with deep peat deposits can be widely found on the interior-side of mangrove forests. A multi-scale framework for evaluating the vulnerability of marshes to collapse would provide guidance to stakeholders and water managers on the current state of peat marsh vulnerability and where these accretion deficits may be occurring. Using a combination of modeled landscape-scale hydrology, multi-spectral satellite data, airborne LiDAR data, and fine-scale sampling of eco-hydrogeomorphic properties across multiple sites, we show how spatial analysis can be used to integrate data products across scales in order to understand coastal vulnerability. Our framework includes two-steps. (1) Step one identified areas within sawgrass peat marsh that may be exposed to high salinity stress annually from 2014-2017, based on the Biscayne and Southern Everglades Coastal Transport (BISECT) model. Multi-spectral satellite data derived land cover maps were then used to calculate the unvegetated to vegetated marsh ratio (UVVR) across spatial extents of < 10 ha within sites along a salinity gradient from 0 ppt to > 20 ppt. Sites with higher salinity stress were expected to have higher UVVR values. (2) Step two evaluated local-scale coastal vulnerability by conducting fine-scale eco-hydrogeomorphic surveys of emergent aboveground biomass, elevation, and porewater salinity, within three sawgrass peat marsh field sites. These sites also serve as long-term monitoring sites of hydrogeomorphic condition and adaptive capacity, through installations of permanent wells and surface elevation tables. Corrected LiDAR datasets for each site were then used to model porewater salinity, while satellite imagery was used to model and map vegetation, aboveground biomass, and compute the UVVR. We then assessed how relative vulnerability scaled locally across sites, as well as across the Gulf coast region of ENP. Our goal is to show how field-based, and model-based methods can be integrated from local-to-regional scales to better understand coastal vulnerability in peat marshes, in an era of unprecedented change across the coastal Everglades.

WOODY VEGETATION MECHANICAL TREATMENT: RESTORING THE SAWGRASS MARSH

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Freshwater sawgrass marsh is a major habitat type in the northern Florida Everglades; however, it can be susceptible to encroachment by woody vegetation due to hydrological changes and fire suppression. Holey Land Wildlife Management Area (HWMA) is a 35,340-acre area in the Everglades ecosystem, primarily comprised of dense sawgrass marsh and freshwater slough interspersed with cattail (*Typha spp.*), Carolina willow (*Salix caroliniana*), and hydric hammock tree islands. The most common native woody species are red maple (*Acer rubrum*), dahoon holly (*Ilex cassine*), Carolina willow, and wax myrtle (*Morella cerifera*). Nonnative Peruvian primrose-willow (*Ludwigia peruviana*) is a growing problem, as this invasive woody plant can rapidly expand its coverage within marsh habitats. In HWMA, woody vegetation encroachment has primarily been observed along the southern and western portions of the area that border water management levees. Carolina willow is the dominant invasive woody species in these portions of the area, forming a dense monotypic canopy. Since 2018, area biologists have been using mechanical treatment (e.g., mulching) to reduce woody species and promote desirable vegetation with the long-term objective of management with prescribed fire. Following mechanical treatment, regrowth in most of the treatment areas was dominated by the desired Jamaica swamp sawgrass (*Cladium jamaicense*), which is a fuel for burning. Other desirable herbaceous wetland species such as pickerelweed (*Pontederia cordata*), swamp fern (*Acrostichum aureum*), and green arrow arum (*Peltandra virginica*) also proliferated. Wildlife have been documented extensively using the treated areas. One treatment area was less successful when the mechanical treatment was followed by an extensive wildfire during the dry season, causing an invasion of the nuisance native cattail that grew quickly into a monoculture. Chemical treatment was evaluated; however, there was little success in woody vegetation reduction and native plant regrowth and this treatment method was considered ineffective. Although there are some challenges, (e.g., cost, access), mechanical treatment was more effective in restoring desirable marsh vegetation fuels that increase the ability to apply prescribed fire within a short amount of time post treatment. Fire is the most effective habitat management tool for maintaining desirable marsh vegetation and controlling woody vegetation encroachment. A combination of mechanical treatment and prescribed fire may provide managers with success in restoration of marshes and improvement of wildlife habitat.

IMPACTS OF THE INVASIVE BURMESE PYTHON ON THE EVERGLADES FOOD WEB

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Species invasion can alter ecosystem structure and function by impacting trophic interactions within native food webs. Therefore, the establishment and subsequent invasion of the Burmese python in the Greater Everglades ecosystem has become a topic of concern among restoration efforts across multiple agencies. To assess the impact of this invasive top predator on the structure and function of the native food web, we constructed two quantitative energy flow models (pre- and post-invasion) for the graminoid habitat within Everglades National Park (ENP). Here, we use ecological network analysis (ENA) to quantify ecosystem structure and function through analyses of energy (or carbon) transfer between living and non-living compartments in each of the two network models. Results from ENA demonstrate little to no shift in system-level attributes, indicating that the Burmese python exhibits a limited impact on overall system function. Additionally, overall trophic transfer efficiency of the system remains relatively constant pre- and post-invasion. Analysis of the relative impact (positive or negative) that the Burmese python exerts on compartments through both direct and indirect interactions showed that the python exhibited the greatest negative impacts on prey compartments followed by compartments containing competing predators. The python also exhibited positive impacts on several compartments as top-down control by the Burmese python decreased predation and competition pressures. These results demonstrate a trophic cascade effect within the native trophic community, while the limited impact on ecosystem function could be due to a system specific response as the graminoid system is characteristic of high detritivory, where most of the carbon coming in through primary production is deposited directly into detritus compartments. Together, these analyses allow for a holistic understanding of the effects of the Burmese python invasion on the Everglades trophic community that can inform future management decisions as restoration of the Greater Everglades ecosystem progresses.

ASSESSING CHALLENGES AND THE POTENTIAL FOR WETLAND RESTORATION USING A DATALOGGER NETWORK

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Impoundments have greatly modified natural flow regimes in the Everglades. Direct impacts of impoundment include too-wet or too-dry conditions for extended periods and rapid changes in water depth between extreme water levels. Also, the design and operation of water control structures can alter the physicochemical characteristics of surface water downstream in the marsh. Altered flow regimes, construction, nutrient enrichment, and human traffic have modified the ecosystem and created preferential flow paths, restricting surface water from spreading across the broader landscape. To facilitate restoration, understanding water movements and how they relate to the natural responses of wetland ecosystem is critical. District hydrologists, modelers, and ecologists developed a spatially extensive monitoring network of water pressure, temperature, and conductance in Water Conservation Area 2A. The spatial domain was divided into a triangular mesh and 40 submersible probes were deployed at each node of a triangle, 4 km apart. Established in October 2020, the primary objective of the network is to identify seasonally, spatially, and interannually distinct flow patterns and hydrologic regimes. The network demonstrated how a peat and sand berm downstream of inflow structures acts as a barrier to sheetflow from the canal into the marsh and causes preferential canal flow to the east during relatively dry conditions. The network also highlights a west-to-east conductivity gradient dependent on operational conditions of inflow structures with different water sources such as rainfall or agricultural runoff. High interannual variability in spatial water depth coverage, under the same stage conditions at a regulatory gauge, highlights that a greater understanding of water movement in response to operations is needed to regulate basin-wide hydrologic conditions. These results, where applicable, will be compared with the Everglades Depth Estimation Network to improve the model’s capacity to effectively manage the system.

FRESHWATER DISCHARGE DISRUPTS LINKAGES BETWEEN THE ENVIRONMENT AND ESTUARINE FISH COMMUNITY

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Freshwater diversions and damming have altered coastal ecosystems greatly, resulting in fundamental changes in salinity, eutrophication, and ensuing shifts in ecological communities. Recently, efforts to restore water delivery and water quality in coastal systems have increased. To explore the impacts of altered freshwater discharge to a subtropical estuary, here Bayesian structural equation models are used to quantify the relationships among water quality properties, nutrients, and predator (sport) and prey (forage) components of the fish community. During periods of relatively low freshwater input, predatory sport fish and lower trophic level forage fish guild dynamics were tightly coupled with water quality and one another. In this low freshwater discharge system, water quality and nutrients were the most strongly linked components of the system. Conversely, during periods of high-water discharge, there was virtually no link between water quality and sport or forage fish guilds, and the sport fish and forage fish guilds became the most tightly coupled components. Ultimately, freshwater discharge disrupted existing linkages within the broader ecosystem. As restoration of estuaries and rivers continues globally, freshwater delivery to downstream systems will be altered. Following the approach presented here, Bayesian structural equation models can be used to generate insight regarding potential system wide shifts following alteration of freshwater delivery, thereby providing a critically important tool for evaluating management strategies.

SPATIOTEMPORAL COMPARISONS OF HYDROLOGIC MODEL OUTPUTS TO INFORM WATER OPERATIONS IN THE EVERGLADES

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Urbanization and agricultural development have imposed extensive hydrologic alterations to the Everglades, diminishing ecosystem benefits for a wealth of species. To combat these adverse effects, federally authorized restoration efforts were initiated with the key goal of restoring historic water flows to improve ecosystem function. These efforts involve a combination of infrastructure modifications and changes to water operational plans, which detail how agencies move water across the landscape. Hydrologic modeling is central to selecting optimal water operational plans that meet ecological, municipal, and agricultural needs, and form the basis of restoration decisions and evaluations. The objectives of this project were to identify how hydrologic model baseline conditions in the Everglades have changed over time and to determine how closely model outputs approximate observed hydrologic conditions. We compared baseline model outputs of existing hydrologic conditions developed in 2016, 2019, and 2021 to identify differences in model assumptions and assess their implications on modeled hydrology. Specifically, we compared annual hydroperiod, the number of days in a calendar year that the soil surface was flooded, across the central and southern Everglades. We quantified the spatial extent and magnitude of hydroperiod differences over time and examined model assumptions to determine if differences were attributable to changes in water operations or updates to basal model assumptions. We found that major differences among baseline model outputs often occurred along canals or other physical boundaries (e.g., conservation area borders). Water operations likely drive differences between baseline model outputs in northern and eastern Everglades National Park, while updates to basal assumptions likely drive differences in the western basins and Big Cypress National Preserve. The greatest differences between modeled and observed hydrology also often occurred near boundaries or in central Big Cypress National Preserve. Understanding these differences will aid in forming accurate assessments of the impacts of water operations on federally endangered species listed under the U.S. Endangered Species Act and determining how well restoration goals are being met.

FLOOD PROTECTION LEVEL OF SERVICE FOR CENTRAL/NORTHERN MIAMI-DADE COUNTY FOR CURRENT AND FUTURE SEA LEVEL RISE CONDITIONS

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The South Florida Water Management District is conducting a system-wide review of the regional water management infrastructure to determine the flood protection level of service (FPLOS) being provided by existing infrastructure under current and future conditions. The FPLOS describes the amount of protection provided by the water management facilities within a watershed considering sea level rise (SLR), future development, and known water management issues in each watershed. Notably, the SLR scenarios will also consider associated changes in groundwater levels and land-use changes. This project involves preparing a FPLOS analysis for the roughly 200 square mile area in central Miami-Dade County defined as the C2, C3W, C5 and C6 watersheds. This effort involves developing a calibrated and validated hydrologic and hydraulic (H&H) model of the subject watersheds. The subject region includes a significant extent of flood protection infrastructure including an extensive primary canal network with District owned and operated control structures throughout the highly managed system. Although the District canals and structures represent the primary infrastructure for providing flood protection in the area, the secondary drainage system is a significant component. In particular, there are large canals, culverts and pumps in the project area that are owned and operated by Miami-Dade County and the municipalities of Belen, Sweetwater and West Miami. The results of the simulations of design storm events for existing conditions and for future conditions will be presented demonstrating the FPLOS based on a series of performance metrics regarding the extent of flooding and available conveyance capacity. The future conditions simulation will incorporate SLR, projected land use, and projected groundwater levels. The eventual goal of this study is to develop flood mitigation strategies that address current and future conditions in the study area as well as future Sea Level Rise.

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THE IMPACT OF THE NEW GUINEA FLATWORM: APPARENT LOCAL TREE SNAIL EXTINCTIONS IN CONSERVATION LANDS

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Worldwide, invasive species are causing devastating ecological impacts that include the extinction of native species. The New Guinea flatworm (NGF) (*Platydemus manokwari*), recognized in the Global Invasive Species Database as one of the 100 worst invasive species, was first documented in Florida in 2012 and reported in 2015. Since that time, NGF populations have been found in numerous urban and natural environments in Florida. Here we report on the distribution, densities, and abundance of NGF populations and on their adverse ecological impact on native tree snails in isolated and/or fragmented hardwood hammocks on conservation lands in Miami-Dade County (MDC), including those that are part of the Environmentally Endangered Lands Program. Using day surveys and night-quadrat surveys, we found NGF populations in all 26 (100%) protected hardwood hammocks all found within 18 (100%) conservation lands that we surveyed in MDC, with NGF densities and abundances larger than other surveyed conservation lands in south Florida. We also found evidence of apparent local native tree snail extinctions of *Liguus fasciatus* and/or *Orthalicus floridensis* occurring in at least 10 (38.5%) of these protected hardwood hammocks belonging to seven (38.9%) conservation lands, with an estimated local extinction time range of about four to six years since the last time living snails were observed. The apparent local extinctions of native tree snails from these isolated and/or fragmented natural forests (hardwood hammocks) and conservation lands indicate a trend that threatens tree snail populations found in other conservation lands in south Florida, including Everglades National Park where we have found hammocks showing similar outcomes. These findings should alert conservation and land managers in south Florida to monitor and prevent the spread of NGF populations to minimize the risk of additional local native tree snail population extinctions, including the extirpation of unique genetic pools of varieties of *Liguus fasciatus*.

DEGRADATION OF ROSEATE SPOONBILL FORAGING QUALITY BY INTRODUCED MAYAN CICHLIDS HAS BEEN EXACERBATED BY SLR

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As presented at GEER 2021, tracking data of nesting Roseate Spoonbill's (*Platalea ajaja*) in Florida Bay indicated that spoonbills have altered their foraging patterns in recent years. Tracking studies from three time periods (1987-1992, 2006-2009 and 2019-2023) indicated that both the timing and location of foraging sites used in the bay have changed. During the earlier two time periods foraging occurred primarily from November to February and was highly directed toward the dwarf mangrove habitat that fringe the mainland of northeastern Florida Bay. In the most recent time period foraging occurred primarily from January to April and was focused on locations either further inland and westward toward central Taylor Slough or in the interior ponds of bay keys. Also, during the latter time period, the traditional foraging grounds was only used very late in the dry season (April and May). Analyses of 30 years of water level data at 4 hydrostations located at traditional spoonbill foraging sites on the mainland indicated that, during the first two tracking periods water level declined to the point where prey fish species were concentrated into remaining ponds and creeks at these locations and were available for nesting spoonbills. In the most recent period, water remained too high to concentrate prey until very late in the dry season resulting in spoonbills foraging elsewhere. Preliminary data were presented that suggested this was due to differential sea level rise (SLR) that has been documented in southern Florida. We also suggested that this higher water level on these wetlands has led to changes in the prey fish community, changes that are unfavorable to foraging spoonbills. In this talk, we will 1) briefly review the findings from the tracking studies as an introduction; 2) present a more robust analyses linking the increased water levels on the coastal wetlands to SLR and 3) delve into how the fish community structure has changed these wetlands from a more diverse native fish community that included smaller immature non-native Mayan cichlids that spoonbills could exploit, to a near monoculture of large adult Mayan cichlids that are too large to be spoonbill prey. Given time, we may also present preliminary water level from hydrostations that have recently been established within bay keys that currently serve as foraging sites and suggest possible reasons why these habitats are now preferable to traditional foraging sites.

THE EFFECT OF VERTICAL GROUNDWATER SEEPAGE ON OUTFLOW TP CONCENTRATIONS IN EVERGLADES STORMWATER TREATMENT AREAS

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The Everglades Stormwater Treatment Areas (STAs) were designed and constructed to reduce total phosphorus (TP) loading contribution from agricultural and urban stormwater runoff to the Everglades Protection Area. Although phosphorus (P) loads to the water column of STAs are contributed primarily by surface runoff due to lateral inflows from pumps and structures, additional P loading to STAs includes resuspension and/or diffusion from the STA soils, decomposition of litter and sloughing from vegetation. One additional source may be vertical advection from groundwater seepage. The effect of vertical seepage flow and associated TP concentration on STA discharge TP concentrations was evaluated using a data-driven wetland P removal model: the Low-P Wetland Event Model (LPWEM). The one-dimensional hydraulic framework of the model consists of six tanks in series. The model can simulate daily average water depth, wetland discharge, and outflow TP concentration time series of each completely-mixed tank. The model consists of two major equations of the mass balance of water and the mass balance of TP for each tank in series. STELLA was used to numerically solve the mass balance equations for water and TP in the series of tanks. The effect of vertical seepage on TP concentrations of STA-2 FW3 discharges was evaluated through a sensitivity analysis of vertical seepage rate and seepage TP concentration. Observed data including the structure inflow and associated TP concentration data, seepage flow derived from the flow balance analysis, assigned seepage flow TP concentration, and the calibrated key model parameters values from previous work at STA-2 FW3 were used. Steady-state simulations were performed using various combinations of the inflow structure flow and associated TP concentrations, and the seepage flow and associated TP concentrations. The modeling results indicate minor changes in STA discharge TP concentration over a substantial range of seepage, inflow and dissolved soil P conditions, suggesting that vertical advection is not a significant factor in STA discharge TP concentrations.

MICRO-SCALE SPATIAL PATTERNS OF PLANT INVASION DYNAMICS AND ITS CONTROLLING EFFICIENCY

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The invasion of an ecosystem by an alien plant species can often strongly alter the vegetation dynamics of the invaded ecosystem, since it may alter basic ecosystem properties once it has become established. In principle, this can cause a regime shift that cannot be easily reversed. Here we use spatially explicit agent-based modeling to simulate the invasion of an introduced tree species to a habitat occupied by a native species. The model is inspired by the invasion of *Melaleuca quinquenervia* in southern Florida habitats. Biocontrol agents have been introduced to try to control the *Melaleuca*, which has significantly reduced the invasive's reproduction rate and increased its mortality rate. These effects are included in the model. Two major aspects are investigated here. First, we investigated how mean seedling dispersal rate affects spread of the invading species into a pure stand of natives, if the different seedling dispersal distance will affect the regime shift rate. Secondly, we considered an increasingly important and far understudied aspect of forestry – standing dead – which is included in the model and tested for its effect on the dynamics, including its influence on the possibility of a regime shift. Our simulations show that added biocontrol will significantly delay the invasion process, and even help native outcompete the invasive in the future; a legacy of standing dead may delay the vegetation shift. Our results show that agent-based modeling is essential for examining fine-scale interactions among trees, predicting trajectories of invaded forest communities, and our findings can inform management and policy focused on preserving invaded plant communities.

A NEW SIMULATION PLATFORM FOR TIME-EFFICIENT, COST-EFFECTIVE, AND EQUITABLE FLOOD ADAPTATION

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Climate change is intensifying flood risks but achieving flood adaptation that is both effective and equitable is extremely challenging. Flooding dynamics are complex and uncertain, decision-making is limited by sociopolitical and institutional constraints and power structures, and participatory processes are very time consuming. To date, neither the processes nor the outcomes of flood adaptation have delivered upon aspirations for environmental justice. It is reasonable to be skeptical that future investments in flood adaptation will offer greater benefits to underserved communities than past projects—or that they will sustain lasting benefits in a warming climate. To address the need for effective, time-efficient, and equitable flood adaptation, we present an innovative collaborative flood modeling platform consisting of a fast-response flood simulation engine and an equitable-access, participant-driven control mechanism. The platform is designed to support interactive and inclusive exploration of adaptation options and pathways at neighborhood to regional scales. The platform, which is being deployed across South Florida, fills a gap in flood simulation methods between regional modeling tools lacking detail required for adaptation planning and local-scale modeling tools impractical to apply at the metropolitan scale due to computational bottlenecks. Breakthrough simulation speeds are made possible by the Parallel Raster Inundation Model (PRIMo), which can be flexibly configured to explore relevant flood scenarios (e.g., combinations of rainfall and storm surge, across different time horizons, for extreme versus frequent events), and the responses desired by community stakeholders across geographical locations (e.g., infrastructural options, nonstructural adjustments, policy/management options). Performance metrics such as flood depth, frequency, and intensity can be measured with household-scale resolution across scenarios. Currently, pilot studies are under development in Miami-Dade County to quantitatively measure the benefits of the new platform such as increasing participation of underserved groups in flood adaptation planning, shortening planning timelines, and more equitably distributing benefits and costs of flood management measures across individuals and neighborhoods through time. Widespread adoption of the approach could help climate adaptation across the United States and beyond to be more time-sensitive, equitable, and cost-effective.

MODELING ANALYSIS OF ALGAL BLOOM EFFECTS ON LIGHT AND SEAGRASS PRODUCTIVITY IN FLORIDA BAY

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Shallow Florida Bay was historically an oligotrophic, seagrass-dominated system with low phytoplankton abundance (<2 µg L^{-1}) and high water clarity. Recently a long-term algal bloom, primarily the non-toxic cyanophyte *Synechococcus*, developed in the central bay, south of the Everglades ecotone boundary with Florida Bay. Beginning in late 2021 the bloom was confined to a small area near the coast. However, in 2022, the patch expanded to ~3 x 1 km in spring and to ~10 x 6 km in summer under high temperatures and wet season flows. The bloom dimensions peaked in the late wet season at ~50 x 10 km, possibly influenced by the passage of tropical storms and increased flows. It expanded across Florida Bay to the Lower Keys before receding during the dry season. Based on high resolution chlorophyll a (chla) mapping by SFWMD, extrapolated to NOAA Sentinel remote sensing imagery, chla concentrations ranged from 10-25 µg L^{-1} peaking in October 2022. We assessed the bloom effect on light levels and benthic plants using *in situ* measurements and modeling. Recent work using micro-electrodes implanted in leaf and meristem tissues shows light saturation in *Thalassia* occurring at ~1,000 µmol photons m^{-2} s^{-1}. *Thalassia* photosynthesis is sensitive to even moderately lower light levels, with peak O_2 concentrations in the leaf declining at irradiances below ~1,000 µmol photons m^{-2} s^{-1}. Consecutive low-light days below 200 µmol m^{-2} s^{-1} allowed enhanced intrusion by the phytotoxin H_2S into the shoot meristem, which contributes to seagrass die-off. We used the SEACOM ecological model to simulate the effect of observed chla concentrations on the underwater light climate, light attenuation, downwelling irradiance and seagrass community productivity and survival. A range of simulated concentrations observed in the bloom, 3, 12 and 20 µg L^{-1} chla, attenuated maximum daily light at canopy height to 1800, 500, and 50 µmol photons m^{-2} s^{-1}, reducing seagrass productivity significantly. Model projections show that a prolonged algal bloom curtails positive *Thalassia* production and reduces resistance to H_2S intrusion into the meristem. The model also showed that blooms persist in basins with low flow and long residence times. Model residence times below 40 d in the simulated central basins limited bloom formation. It is unknown whether nutrient sources for the bloom derive from restoration freshwater deliveries upstream or the flushing of decaying and legacy nutrients stored in the adjacent ecotone itself. The lack of algal blooms in the eastern bay at the ecotone, which routinely receives higher inputs of restoration flows than the bloom area, supports the supposition that bloom-generation was not associated with upstream nutrients from restoration flows. More likely, the continuing decay of dead mangrove and belowground seagrass biomass from a hurricane in 2017 and a seagrass die-off in 2015 are contributing nutrients to the bloom.

DISPERSED WATER MANAGEMENT – A PROGRAMMATIC PERSPECTIVE

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To facilitate habitation and economic development, much of South Florida's historic storage in depressional wetlands, sloughs, and floodplains has been altered, channeling water efficiently to downstream receiving waterbodies. To reverse some of the negative effects, the Northern Everglades and Estuaries Protection Program (NEEPP) was initiated to protect and restore surface water resources and achieve and maintain compliance with water quantity goals and quality standards in the Northern Everglades. While large-scale regional water storage and treatment projects are important to meeting these goals, restoring "dispersed" storage upstream throughout the watersheds has numerous benefits. In coordination with Florida Department of Environmental Protection and Florida Department of Agriculture and Consumer Services, the South Florida Water Management District (SFWMD) implements watershed construction projects, such as those in the Dispersed Water Management (DWM) Program, to help achieve the NEEPP water quality and quantity objectives. Successfully launched in 2005 as the Florida Ranchlands Environmental Services Project, the DWM Program encourages private property owners to detain, retain, or accept regional runoff for storage on their land rather than drain it. The primary objectives of this program are to manage water delivered to Lake Okeechobee and to coastal estuaries and help restore more natural stormwater runoff patterns, benefitting groundwater recharge, surface water quality, and timing of water flow. Many DWM projects are partnerships between water managers and private landowners that have been established for over a decade. The program benefits the local economy through cost-share cooperative projects or payment for environmental services to landowners. These privately owned project advantages include increased opportunities for projects throughout watersheds, maintaining properties on tax rolls, and sustaining agriculture or other compatible uses on the land. Additionally, these projects provide environmental benefits and services such as habitat restoration, as well as wildlife corridor preservation and enhancement. However, these secondary project benefits have not been quantified. Achieving goals will require collaboration to seek opportunities for new DWM projects, quantify secondary project benefits, and consider innovations to enhance existing projects. While NEEPP goals are defined in terms of storage volume and nutrient load reduction, challenges remain in how those are defined, estimated, and progress toward meeting goals is tracked. Additionally, there is a desire to improve the valuation of secondary environmental services and benefits. From a programmatic perspective, a more comprehensive valuation of the array of benefits provided by DWM projects should evolve, but there remains a greater urgency to act on the primary program objectives to benefit Lake Okeechobee, St. Lucie River Estuary, and Caloosahatchee River Estuary.

MANGROVE FORESTS ARE AN UNLIKELY SOURCE OF CH_4 TO THE ATMOSPHERE IN THE SUBTROPICAL FLORIDA EVERGLADES

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Carbon-rich and highly productive coastal ecosystems are important for mitigating climate change. While coastal wetland ecosystems can be a sink for carbon dioxide (CO_2), the frequently inundated soils which favor high CO_2 sequestration can also support methane (CH_4) emissions. Currently, wetlands are the largest natural source for CH_4 compared to other ecosystem types and they contribute 80 to 280 Tg CH_4 yr^{-1}. The high degree of uncertainty in emission estimates from wetlands is partially due to our incomplete understanding of the relative impact of freshwater and tidal controls on CH_4 fluxes. Although mangrove forests are thought to be among the most efficient natural carbon sinks, they may also be a significant source of CH_4 to the atmosphere. The primary objective of this study is to evaluate the potential for coastal mangrove forests to be a sink or source for CH_4 to the atmosphere. In the Florida Coastal Everglades (FCE), mangrove vegetation is influenced by the interaction of environmental gradients, freshwater availability, tidal forcing, and natural disturbances (i.e., hurricanes), creating an array of distinct riverine and scrub mangrove ecotypes across the coastal landscape. As a result, Everglades mangrove forests fluctuate from being a small sink to a small source of CH_4. In these ecosystems salinity levels change seasonally and higher salinity in the dry season (December-May) suppressed CH_4 production. Annually, mangrove forests were a sink for both CH_4 and CO_2. Although mangrove forests were a stronger source of CH_4 in the wet season, CH_4 emissions were offset by CO_2 uptake rates in the wet season. Our results underscore the relative contribution of riverine mangroves in the FCE as an important C sink. This finding is relevant when assessing the economic value of C storage and sequestration and the capacity of these forested wetlands to offset rising greenhouse emissions under current freshwater restoration scenarios in the region and a warming climate.

RECONNECTING EVERGLADES VEGETATION COMMUNITIES AND DETERMINING EFFECTIVE MAINTENANCE CONTROL OF CATTAIL.

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Our habitat restoration efforts in the northern Everglades (WCA-2A), have focused on applying herbicide and prescription burning to accelerate the recovery of areas degraded by southern cattail (*Typha domingensis* Pers.). We have found that at a rate of 32oz. per acre, the herbicide imazamox is selective towards controlling cattail while retaining desirable marsh vegetation, allowing for spatial recovery and the potential for landscape patterning recovery. With any opportunistic plant where control is desired, maintenance is warranted; however, we currently have not pinpointed the most effective season to conduct applications, the most beneficial application frequency or which method – aerial or ground application achieves better rehabilitation. We will summarize the findings and lessons learned while introducing our current approaches to refine our treatment strategy with imazamox; specifically, comparing the timing of aerial applications and maintenance plans using either aerial or ground spot application. In rehabilitating marshes in the Everglades, the applications additionally reconnect adjacent communities to maximally benefit vegetation and wildlife.

EVALUATION OF DISSOLVED OXYGEN TRENDS AND POTENTIAL DRIVERS OF HYPOXIA WITHIN THE KISSIMMEE RIVER RESTORATION AREA

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Dissolved oxygen (DO) concentrations in the Kissimmee River have been measured before, during, and after restoration construction as a potential indicator of restoration success. Before restoration began, monthly grab samples from multiple river sites established a baseline period (1996-1999) average wet season daytime DO concentration of 1.1 mg/L, which saw a significant increase to 2.8 mg/L in the period after Phase I construction was completed (2001-2021, $p < 0.01$). Additionally, continuous monitoring sondes at several sites on the river have now collected a 15-year dataset of DO concentrations. In the wet season of all 15 years, at least one event in which average river DO concentration fell below 2.0 mg/L was observed, lasting an average of 63 days. When DO concentrations fall below 2.0 mg/L, conditions become stressful to sunfish (largemouth bass and bluegill) in the river, and concentrations below 1.0 mg/L are potentially lethal to these species. Initially it was hypothesized that these DO “sags” were being caused by upstream conditions because their timing coincided with increases in flows from S-65A, the gated spillway controlling flow to the restoration area. While upstream water quality undoubtedly has some influence on downstream DO levels, data have indicated that the DO sags typically occur independent of upstream DO levels. An example of this occurred after a rain event in July of 2007 when DO levels on the river dropped from above 4.0 mg/L to below 1.0 mg/L despite there being no flow coming from S-65A at that time. Our primary hypothesis for the cause of these sags is currently centered on an increase in biochemical oxygen demand (BOD) that occurs when organic material is released as the floodplain becomes inundated when the riverbanks are overtopped. This is supported by the finding that across the 15 wet seasons of continuous data, when S-65A discharge was greater than the approximate bankfull discharge of 1,400 cfs, average daily DO saturation was 23.4 %, which was significantly lower than the daily average of 48.0 % when discharge was below bankfull ($p < 0.01$). To better understand the interactions between river and floodplain DO, 21 sensors were installed in a network across the floodplain during the 2021 wet season. Out of the 21 floodplain sites, 16 had DO concentrations that were less than 1 mg/L shortly after inundation and remained low throughout the wet season, suggesting a potentially high level of BOD in water on the floodplain. Further monitoring and analyses will lead to a better understanding of the DO dynamics of this system and may inform how we can better manage the flows into this system to reduce the length and severity of DO sags in the future. Additionally, the full implementation of the Headwaters Revitalization Schedule may provide more options for controlling DO levels in the river as it will allow for more flexibility in storing and releasing water from the lakes that feed the Kissimmee River.

FACTORS INFLUENCING MOVEMENT PATTERNS OF THE INVASIVE ARGENTINE BLACK AND WHITE TEGU (SALVATOR MERIANAE)

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The Argentine black and white tegu (*Salvator merianae*), a large, omnivorous lizard native to southeastern Brazil, Uruguay, eastern Paraguay, and Argentina, has become a recent threat to the Everglades ecosystem. Tegus were introduced to South Florida through the pet trade and were first confirmed established in 2011. The recent increase in tegu observations, especially near ecologically sensitive areas such as Everglades National Park, makes informed management critical to contain the tegu population. We tracked 24 tegus in the Southern Glades Wildlife Management Area and Redland Agricultural Area in Homestead, Florida using Very High Frequency (VHF) and Global Positioning System (GPS) telemetry from March 2016 through November 2018 and March 2021 through January 2022. We used generalized additive models to determine factors that drive tegu movement to inform managers when traps and surveillance plots are most likely to be effective. Our top model included temporal (time of day and time of year), environmental (air temperature, relative humidity, and wind speed), biological (sex), and spatial (track location) variables. This model explained at least 28.5% of the deviance in tegu rate of movement (ROM). We determined that tegus were most active between March and May, and tegu ROM positively correlates with air temperature. We also observed a slight positive trend between tegu ROM with both relative humidity and wind. Tracking location, rainfall, and sex were not important variables in the model. We recommend natural resource managers use our results to target tegu removal and surveillance during high activity periods to maximize resource use.

PREDICTING DISPERSAL PATHS OF THE INVASIVE ARGENTINE BLACK AND WHITE TEGU USING CIRCUIT THEORY

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The Argentine black and white tegu (*Salvator merianae*) is a large, omnivorous lizard native to South America (southeastern Brazil, Uruguay, eastern Paraguay, and Argentina) that has been introduced to South Florida through the pet trade with breeding populations confirmed since 2011. Informed tegu management in South Florida has become increasingly important as the population spreads into Everglades National Park and Turkey Point Power Plant where tegus threaten native wildlife through competition for food, burrow use, and direct predation. We used circuit theory, which uses movement flow through a map of habitat resistance values, to identify where movement is funneled in the landscape. To calculate resistance values, we used a Step selection analysis conducted on tegu telemetry data, collected between 2016 and 2021, on ten habitat types. Tegus had the highest preference for dry, vegetated habitat including upland, rural vegetated, freshwater forested wetland when dry, roads without barriers (i.e. no bordering fences or road medians), and rural barren. Wet habitat including marsh and water had higher resistance and urban had extremely high resistance to tegu movement. Based on our resistance values, we created a circuit theory map which identified numerous areas with high dispersal probability, especially along a disturbed forested strip of habitat south of agricultural land and levees which are artificially raised, interconnected habitat adjacent to canals and marsh habitat. Identification of locations that have the highest probability of use during tegu dispersal behavior across natural, disturbed, and agricultural interfaces can inform targeted science-based control efforts that maximize resource use.

THE NORTHERN STAS – HELPING IMPROVE WATER QUALITY IN LAKE OKEECHOBEE AND THE ST. LUCIE RIVER

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The northern stormwater treatment areas (NSTAs) are wetlands in the Lake Okeechobee and St. Lucie River watersheds constructed to reduce nutrients in stormwater runoff. At just under 13,000 acres combined, the NSTAs currently consist of 5 projects – Taylor Creek STA, Lakeside Ranch STA, Nubbin Slough STA, Ten Mile Creek Water Preserve Area (WPA) and the C-44 Reservoir and STA. The NSTAs began operation in 2008 with the pilot project Taylor Creek STA. Lakeside Ranch STA was next, followed by Nubbin Slough STA, Ten Mile Creek WPA and then in 2021, the largest of the NSTAs, the C-44 Reservoir and STA. Operational and performance data, including inflow and outflow nutrient concentrations, phosphorus loading rates, hydraulic loading rates and nutrient load reductions will be presented for each of the Northern STAs. Two programs are integral to the creation and operation of the NSTAs – The Northern Everglades and Estuaries Protection Program (NEEPP) and the Comprehensive Everglades Restoration Plan (CERP). NEEPP protects and restores surface water resources to support water quality improvements in the Northern Everglades region—comprised of the Lake Okeechobee, St. Lucie River, and Caloosahatchee River watersheds and downstream receiving waters while CERP is a framework for restoring, protecting, and preserving the greater Everglades ecosystem. The NSTAs and their successful nutrient load reductions are important components in the overall effort to achieve the water quality goals in the Northern Everglades region.

GETTING THE TIMING RIGHT: MATCHES AND MISMATCHES FOR CONSUMERS AND PREY SUBSIDIES IN THE EVERGLADES

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Seasonal movements of fishes among habitats often correspond to shifting resource availability and can occur in response to cues such as fluctuating freshwater inflows in coastal systems. Movements into high-quality foraging areas provide resources that increase fitness, yet hydrologic variability can influence the movement patterns of both consumers and their prey. Shifts in the timing of consumer/prey movements driven by climate change and water management practices may lead to a potential mismatch of resources, carrying consequences for the growth, survival, and reproduction of economically and ecologically valuable fish species. In this study, we use long-term electrofishing data (2004-2022) from the Shark River in the coastal Everglades to examine how the body condition of the popular sport fish Common Snook, *Centropomus undecimalis*, is affected by the timing and magnitude of key prey subsidies (sunfishes, *Lepomis* spp.) that are concentrated into river channels by marsh drying. Further, we investigate how body condition relates to hydrologic variation which influences both the movements of Snook into upper river foraging areas and the availability of prey subsidies. We used GLMMs to model Snook body condition in relation to variables quantifying prey availability (sunfish biomass at time of sampling, peak sunfish biomass each year, timing of peak biomass), hydrologic conditions (temperature, water level, duration of marsh flooding prior to fish sampling), Julian day, and fish size (Snook standard length). Our results indicate that Snook body condition is best explained by a combination of these factors, with condition increasing with fish size, higher sunfish biomass, lower water levels, and following periods of longer marsh inundation which results in higher prey production. Everglades National Park is the focus of large-scale restoration efforts that seek to restore freshwater flows that have been reduced by land use change, and research describing the environmental conditions required to maintain balance between consumer movements and prey availability can help inform water management decisions aimed at preserving biodiversity and economically important fisheries.

CENTRAL EVERGLADES PLANNING PROJECT - NORTH: HOW TO ENGINEER THE BUILDING OF AN ENGINEERED VEGETATED HAMMOCK

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Authorized by Congress in 2000, the Comprehensive Everglades Restoration Plan (CERP) aims to find the correct balance among flow characteristics throughout the Florida Everglades by changing the quantity, quality, timing, and distribution of water, leading to improved ecosystem health and ensuring quality of life in south Florida. RECOVER (REstoration COordination & VERification) is a multi-agency and multi-disciplinary team that organizes and applies scientific and technical information to support the goals and objectives of the CERP. RECOVER applies a system-wide perspective to the planning and implementation of CERP and communicates and coordinates the results of evaluations and assessments to managers, decision-makers, and the public. RECOVER planned and hosted a workshop as a forum for presenting and discussing science and knowledge gained to inform the design, construction, monitoring, and maintenance of a CERP project, the Central Everglades Planning Project – North (CEPP-N). More specifically, the workshop aimed to inform the design and implementation of CEPP-N features associated with the backfill of the Miami Canal and the building of engineered vegetated hammocks. Scientists, engineers, managers, stakeholders, and other experts were invited to the two-day workshop. Participants were also invited to attend a field visit to the Loxahatchee Impoundment Landscape Assessment (LILA) at the Arthur R. Marshall Loxahatchee Wildlife Refuge in Boynton Beach, Florida, to learn more about tree islands that were constructed as a part of a working model of the Everglades. As a result of this workshop, RECOVER developed a series of products in the form of recommendations for the CEPP-N project delivery team (PDT) to consider during implementation of the engineered vegetated hammocks. Products included design schematics for the size, elevation, and location of engineered vegetated hammocks, planting schemes and species lists, a list of construction considerations, components to be included in the monitoring and maintenance plans, review and update of management options associated with adaptive management of the project, and development of the definitions of success and associated criteria for assessing the success of engineered vegetated hammocks. The intended audience for these workshop products includes the CEPP-N PDT, research scientists, and agency leadership. Recommendations for future coordination of the workshop products included the replacement of the term “tree island” with “engineered vegetated hammocks” to address concerns by the Seminole Tribe of Florida, establishing an eco-subteam for CEPP-N to further refine workshop products and provide additional consultation, and consideration of the workshop products as an initial step to an open and continued dialogue between RECOVER and the CEPP-N PDT as design and construction progresses.

BODY CONDITION INDEX VALIDATION IN THE ARGENTINE BLACK AND WHITE TEGU (SALVATOR MERIANAE)

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The body condition of an organism is a measure of health and fitness represented by available energy stores, typically fat. Because direct measurements of fat may not be available, body condition is often estimated by calculating body condition indices using mass and body length. Body condition indices may be used to evaluate the general condition of individuals and populations, but the utility of body condition indices is contingent on their relationship with fat. We evaluated the use of 11 body condition indices in 883 Argentine black and white tegus removed from South Florida. We asked, 1) which measure of coelomic fat (percent, residual, or scaled fat) was the least-associated with snout-vent length, 2) which of the 11 body condition indices was the most associated with coelomic fat and least associated with snout-vent length, and 3) if splitting the data into size class groups improved the performance of body condition indices. We identified percent fat as the measure of coelomic fat stores least-associated with snout-vent length and used it to validate the performance of the body condition indices. Fulton's K was the best-performing body condition index, explaining up to 19% of the variation in fat content. Overall, we found that body condition indices maintained relatively weak relationships with measures of coelomic fat stores and that splitting data into size classes reduced the association of fat with snout-vent length but did not improve body condition index performance. We postulate that the weak performance of the tested body condition indices was likely due to the weak association of fat with snout-vent length, the body plan and life-history traits of tegus, and inadequate accounting of available energy resources. We caution against the use of body condition indices for management of invasive populations without conducting similar validation studies or using complimentary measurements of health or fitness.

A VEGETATION RESPONSE TO MECHANICALLY AND CHEMICALLY TREATING WILLOWS INVADING MARSHES IN SOUTHWEST FLORIDA'S CORKSCREW WATERSHED

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Florida freshwater herbaceous marshes are inundated approximately 6–10 months per year, have predominantly organic soils, and are maintained by fire which restricts invasion by woody plants. Marshes are becoming dominated by willow (*Salix caroliniana*) throughout Florida. Corkscrew Swamp Sanctuary and Corkscrew Regional Ecosystem Watershed Management Area treated willows in marshes from 2008 to 2016 with helicopter herbicide treatments and mechanical shredding. Our objective was to determine if treatments were shifting vegetation closer to a desirable marsh community with burnable fuels. Untreated areas were compared with (1) all herbicide and all mechanical treatments, (2) imazapyr/glyphosate mixes and other herbicides, primarily glyphosate, and (3) three imazapyr/glyphosate combination mixing rates. Mechanical treatment areas had more desirable vegetation, sawgrass (*Cladium jamaicense*), and grasses/sedges than herbicided areas. Herbicided areas had more cattails (*Typha* spp., a nuisance species), and less sawgrass and grasses/sedges than untreated areas. Imazapyr/glyphosate and other herbicides (mostly glyphosate and a longer time since treated) had less cover of sawgrass and grasses/sedges than untreated areas, while other herbicides also had less desirable species cover than untreated areas. Sample sizes were small for the three imazapyr/glyphosate mixes, but the strongest mix had more cattails and the weakest mix had less willow than untreated areas, while both had less grasses/sedges than untreated areas. Although more expensive and difficult, mechanical treatments better retained and/or restored desirable marsh vegetation which was our primary objective. Fire is the most effective land management tool for retaining desirable native vegetation in freshwater marshes and suppressing willow encroachment. Sawgrass and other grasses and sedges are excellent fuels for burning. Sawgrass was found in only 1 of 21 herbicide-treated transects, while it was found in 4 of 6 mechanical-treated transects and 9 of 10 untreated transects. Mechanical treatments also have significantly more cover of grasses and sedges than herbicide treatments, increasing the ability to burn hot and frequently. Based on these data, mechanical treatments with more grass and sedge cover including sawgrass, would allow managers to better control willow long-term with prescribed fire.

FIRE HISTORY AND CLIMATE DRIVE PATTERNS IN POST-FIRE RECOVERY

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In the fire dependent ecosystems of the Florida Everglades, regular disturbance by fire is critical for maintaining biological and structural diversity, supporting ecosystem function, and maintaining landscape resilience. The timing of fire is thought to be controlled primarily by 1) regional climate trends and 2) fire management, both of which drive plant community composition. Historical changes in fire management have altered the way ecosystems respond to fire, and changes in climate are predicted to further complicate future fire regimes. Assessing how ecosystems respond to different fire regimes can help us understand the capacity to cope with regime change. The objective of this research is to determine how fire history influences rates of post-fire vegetation recovery in upland ecosystems of the Florida Everglades. To do this we leveraged 72 years of fire history data from Everglades National Park and Big Cypress National Preserve (1948-2020). Using remotely sensed spectral imagery from the National Aeronautics and Space Administration (NASA) Landsat mission, and long-term climate data from DAYMET and the Palmer Drought Severity Index (PDSI), we provided a landscape-scale assessment of post-fire vegetation recovery under varying fire history and climatic conditions. Recovery was measured as the time required in years for the spectral signature of a burned area to reach a baseline value for long-unburned locations. This represents a novel approach to assessing post-fire recovery that is scalable and can be applied across ecosystems. We used generalized additive models to test which aspects of the fire history and climate drive variation in recovery time. We hypothesized that recovery time is positively correlated with time since fire, and negatively correlated with fire frequency. Both droughts and extreme precipitation events during the recovery period were expected to negatively impact post-fire recovery time. This study shows the importance of integrating fire history into studies of post-fire recovery and provides a framework for studying spectral recovery in forests throughout the southeastern US and Caribbean Basin where adaptive fire management is essential for restoration goals.

TEMPERATURE AND DISSOLVED OXYGEN PROFILES IN AN EVERGLADES SLOUGH

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Detailed understanding of flow, particulate carbon transport, and community metabolism in sloughs of the Everglades "Ridge and Slough" landscape has the potential to help guide restoration planning and diminish loss of this landscape. The *in situ* robotic system ("Floccometer") that we have designed and constructed in southern Water Conservation Area 3A (WCA 3A) has proven successful in automatically profiling both the water column and the floc layer of a slough, with millimeter vertical precision and repeatability. The maximum profile frequency is approximately once per hour, with this frequency permitting sensor equilibration as well as a sufficiently slow vertical travel velocity (0.35 cm/sec) to avoid artificial vertical mixing of the water column. Profile parameters currently include elevation of the floc layer surface, elevation of the peat surface, borescope videography at each measured depth, temperature (T) and dissolved oxygen (DO). Vertical profile increments can be remotely programmed and currently vary between 1 and 5 cm, for a total of ~42 vertical points per profile. The measured T and DO profiles suggest that the automated Floccometer system has sufficient vertical resolution to capture a complete picture of the water column and floc layer. Overall, in both time and space, the measured data almost always suggested that increased resolution would not have added increased information. Profiles recorded in September 2020 suggest that much of the time, the slough profile consists of three vertical zones: (1) a surficial zone 6-12 cm thick; (2) a "bulk zone," ca. 45 cm thick; and (3) a benthic "floc layer" zone, 6-9 cm thick. The Floccometer profiles indicated that the surficial zone was transitional, with DO and especially T values typically curving between the endpoint values at the water surface and the top of the bulk zone. In contrast, within the bulk zone, the profiles showed a strong tendency toward vertical uniformity, especially at night. During the day, the bulk zone warmed from the top down and DO increased to a maximum of 6-7 mg/L. It is not yet clear if the observed bulk zone vertical uniformity reformed nightly through advective mixing or through diffusion. Through the course of the night, the vertically uniform DO concentration of the bulk zone decreased from about 5.5 mg/L to about 3.5 mg/L. The benthic flocculent layer was very different. The layer was completely anaerobic; we have never measured an oxic DO concentration anywhere in this benthic layer. In terms of light transmission, visual appearance, temperature, and dissolved oxygen, the transition from water column bulk zone to benthic flocculent layer is very abrupt, with the transition occurring within 1 mm. Additional multi-year, on-site measurements of water stage, solar radiation, specific conductivity, meteorology, and water velocity help quantify driving forces potentially affecting the detailed vertical profiles.

SPATIAL AND TEMPORAL TRENDS IN MAMMAL COMMUNITIES IN AN ECOLOGICALLY IMPORTANT WESTERN EVERGLADES SANCTUARY

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Audubon's Corkscrew Swamp Sanctuary is a 13,450 acre matrix of uplands and wetlands, located central to the >60,000 acre Corkscrew Regional Ecosystem Watershed in Collier County, FL. The value of this Western Everglades ecosystem, which includes the largest remaining stand of old-growth bald cypress, has prompted recognition as a Wetland of International Importance (Ramsar), a National Natural Landmark (Department of the Interior), and a Wetland of Distinction (Society of Wetland Scientists). Long-term monitoring of large- and medium-sized mammals within the Sanctuary began in 2013 to provide population and community data of mammal use concurrent with regional land use changes. Using nearly six years of camera trap data, we describe mammal communities across the Sanctuary's hardwood hammock, pine flatwoods, wet prairie, marsh, and cypress forest with species- and community-level variation in response to multiple drivers, including community variation across habitats, community shifts with annual water level fluctuation, and increased habitat use following prescribed fire and wetland restoration. Data also provide documentation of breeding in many species, including wild hog, Florida panther, Florida black bear, and bobcat. We have failed to detect large, non-native reptiles within the Sanctuary using camera traps or any other survey methods, including monthly EIRAMMP (Everglades Invasive Reptile, Amphibian, and Mammal Monitoring Program) surveys and incidental field observations. We discuss the potential for spatial and temporal changes in mammal populations with introduction of large, non-native reptiles and a strategy for employing early-detection, rapid-response (EDRR) to protect native wildlife. These community-level mammal data will continue to be instrumental for evaluating land management strategies and understanding the regional importance of privately-held conservation lands, like the Sanctuary, in the network of conservation lands across the Greater Everglades.

ENVIRONMENTAL HETEROGENEITY AND SPATIAL PATTERNS OF WOODY VEGETATION IN THE GREATER EVERGLADES

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Understanding the factors that drive wetland vegetation patterns and succession is important in the development of ecosystem restoration management. Hydroperiod, water depth, nutrients, and disturbances such as fire are some of the most important factors influencing community structure and composition in wetlands. We know little about the spatial distribution of tree communities and woody plants and how they vary across environmental gradients in the greater Everglades National Park (ENP) at different spatial scales.
The objective of our study was to conduct a multi-scale analysis of woody vegetation to understand the spatial patterns and the environmental drivers behind these patterns. We first mapped spatially-explicit patterns of plant communities from Worldview 2 and 3 data in combination with bias-adjusted LiDAR data. We differentiated functional types of plant communities separating woody species dominated by mangrove species (including buttonwood), cypress, pine, hardwood hammock species or bayhead swamp species. Herbaceous communities included classes for open marsh and herbaceous emergent vegetation. We then modeled the woody cover type density as a function of hydroperiod, water depth variables, and fire frequency. Even though hydrological variables were identified as important predictors of percent woody cover, the dominance of woody cover type along the hydrological gradients showed a strong spatial dependence across the landscape.

THE PRECARIOUS STATUS AND FUTURE OF THE U. S. SNAIL KITE POPULATION

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Despite 55 years of federal Endangered status, the future of the U. S. population of Snail Kites remains highly uncertain. We consider factors contributing to concerns that depressed reproduction resulting from unfavorable hydrologic conditions and, thus, reduced Apple Snail availability, could result in local extirpations and the eventual loss of Snail Kites from the species' U. S. range (i.e., peninsular Florida). These factors include but are not limited to: the lack of a cogent range-wide recovery and sustainable management strategy that recognizes the high between-year spatial variability (natural and anthropogenic) in local water conditions; the lack of implementation of effective science-based management practices derived from millions of dollars of publicly funded academic research, that simultaneously promote Apple Snail production and protection of Snail Kite nests from predators; the limited extent of federally designated Critical Habitat areas due to the omission of tens of thousands of acres of suitable occupied habitat; the extent to which large-scale wetland eutrophication from agricultural run-off and altered hydrologic regimes have reduced the occurrence of native Apple Snails; conflicting recreational and vegetation management practices in presently available habitat; etc. We refer to available literature; the recently conducted Species Status Assessment; and ARCI's research since 2007 on seasonal movements and mercury concentrations in Snail Kites, and Apple Snail densities in the Everglades.

INVESTIGATING BREEDING STATUS AND DISTRIBUTION OF EASTERN BLACK RAIL (LATERALLUS JAMAICENSIS JAMAICENSIS) ON MICCOSUKEE TRIBAL LANDS

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The Eastern Black Rail (*Laterallus jamaicensis jamaicensis*) is a small, secretive marsh bird and is listed as threatened in the state of Florida and on the federal level under the Endangered Species Act. They are mainly found from the eastern coast of North America to the Texas coast of the Gulf of Mexico, including some islands of the Caribbean. Black Rail inhabit fresh and saltwater marshes, and wet meadows where stable water levels range from moist soil to two inches deep. They feed on aquatic invertebrates and need dense herbaceous vegetative cover that allows movement underneath the canopy. They usually walk or run through the marsh and are rarely seen in flight. Females lay between four and thirteen eggs which are incubated seventeen to twenty days in a nest made of fine woven grasses, sedges, and rushes placed directly on or close to the ground. Black Rail are highly elusive, rarely seen, and considered one of the least understood bird species in North America. One of the first steps to conserve the species is to document where it exists and to protect those areas from current and future threats. We conducted audio broadcast surveys during dusk and dawn from 4 January through 17 August 2022 in potentially suitable Black Rail habitat to determine their distribution and breeding status on Tribal lands. A total of 154 different locations were visited on average 2.75 times (range: 1-9) for a combined 425 points surveyed, equating to 70.8 survey hours. Of the 425 points, 290 and 135 were surveyed during the morning and evening hours, respectively. Five King Rail (*Rallus elegans*), three Sora (*Porzana carolina),* and zero Black Rail were detected. Factors that may have influenced the absence of Black Rail detections in our study area include, but are not limited to, current water management strategies (e.g. flooding and drought), invasive species, low detectability (i.e. rare and cryptic), and site inaccessibility. On average, the Black Rail population across the Atlantic Coast range has experienced an estimated annual decline of 9% with a total estimated population loss of >90% since the early 1990s. Their decline is likely due to increased development in coastal areas, which has caused habitat loss and degradation of suitable breeding areas. In 2016, the Atlantic Coast population size was estimated at 355-815 breeding pairs with Florida accounting for possibly 60%; yet they have been detected at only a few sites in southern Florida. Threats include habitat loss, sea level rise, and tidal flooding from increasing storm frequency and intensity. Our goal is to determine their distribution and breeding status on Tribal Lands in an effort to protect those sites from further degradation.

WET-SEASON HYDROLOGY PREDICTS MERCURY CONCENTRATIONS WITH EFFECTS ON BREEDING SUCCESS OF CAPE SABLE SEASIDE SPARROW

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Cape Sable Seaside Sparrow (CSSS; *Ammospiza maritimus mirabilis*) population sizes have failed to recover despite decades of scientific research identifying key components needed to maintain their nesting habitat and survival. Management of CSSS has tried to promote favorable nesting conditions by maximizing the length of time the marsh is dry during their breeding season (March – July). Even under dry conditions the breeding success of CSSS remains variable among years so further work is needed to understand alternative factors influencing CSSS individuals. Mercury (Hg) is a pervasive contaminant in the Everglades and non-lethal concentrations have been shown to reduce the reproductive success of avian wildlife. Our study aimed to describe mercury concentrations in CSSS populations, determine if Hg concentrations were influenced by hydrology, and if Hg impacts different end points of CSSS nesting. Body feathers were collected from CSSS adults and hatch-year individuals during 2016-2018 breeding seasons at five of the six subpopulations. We constructed generalized linear mixed models (GLMMs) *a priori* to predict individual Hg concentrations, mating status, total number of nests attempted, egg hatch success, and total number of chicks fledged and compared them to a null intercept model with Akaike Information Criteria (AIC). Feather Hg concentrations ranged from 0.6 to 28.6 ug/g and was highest in 2017. There was a positive relationship between the average water depth during the previous non-breeding season and feather Hg concentration. We found that Hg had a negative impact on CSSS breeding success by lowering the probability an individual male finds a mate, but no effect on nesting success or total number of chicks produced. This research highlights the need to better understand the role food availability and Hg exposure have on CSSS populations.

INCREASING MARINE HYDROLOGIC CONNECTIVITY INFLUENCES PHYSICAL AND BIOGEOCHEMICAL PROCESSES IN COASTAL MANGROVE SOILS

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Accelerating sea-level rise and altered freshwater availability are exposing coastal wetlands to increased marine forcings with uncertain long-term impacts. The need to understand the effects of altered historic freshwater flow and increased influence of marine hydrologic inputs on coastal mangrove forests is critical given rising rates of sea level above that of soil elevation. The coastal mangrove forests of Biscayne National Park (Florida, USA) are ideal ecosystems to measure and test how enhanced marine hydrologic connectivity influences mangrove coastal geomorphology and biogeochemistry given their physical restriction from expansion by a levee, rising rates of sea level, but also potential to receive restored freshwater sheet flows. From 2011 to 2022, the National Park Service Inventory and Monitoring Division has maintained two mangrove Sediment Elevation Table (SET) long-term monitoring sites (BISC1, BISC2) to quantify soil patterns and trends in fringe mangrove forests. We measured similar water levels at both sites (median $\pm$ SE: BISC1 0.0910 m $\pm$ 0.0036; BISC2 0.1180 m $\pm$ 0.0042), however, BISC2 had a higher inundation frequency than BISC1 from 2018 to 2022. A decade of semiannual sampling showed temporal differences between sites for soil elevation absolute changes (BISC1 0.62 mm yr^{-1}; BISC2 1.92 mm yr^{-1}) and soil accretion changes (BISC1 1.90 mm yr^{-1}; BISC2 4.29 mm yr^{-1}). Low rates of elevation increases suggest these sites will not keep pace with the relative accelerating sea-level rise of 6.3 mm yr^{-1} (NOAA Key West Sea Level Monitoring Station) and 5.9-9 mm yr^{-1} (Virginia Key Sea Level Monitoring Station). The capacity of mangroves to capture autochthonous and allochthonous sediments and detritus is an important biophysical control on mangrove soil elevation and accretion. For nearly a year, monthly surveys were conducted at both SET monitoring sites to characterize and measure benthic detritus accumulation in plots distributed along landward gradients. Seagrass (*Thalassia testudinum*) and mangrove leaves (*Rhizophora mangle*) were deployed along transects to measure mass loss. Standing stocks of detritus were highest at BISC2 and nearest the coastal fringe of transects at both sites, ranging from 0-85% benthic detritus surface soil cover. Litter breakdown rates were higher for *R. mangle* than *T. testudinum* and at BISC2 than BISC1 but did not vary along transects, ranging from 0.076-1.737g mass loss. Higher soil elevation and soil accretion rates coincided with areas of higher wrack and lower organic matter decay rates. Increased soil accretion rates had similar amplitudes as water levels and marine and mangrove wrack cover, suggesting that these inputs contribute to soil elevation differences between sites. Expanded spatiotemporal scales of patterns and mechanistic effects of increased marine connectivity in coastal mangroves are needed to predict the adaptive capacity and trajectories of these ecosystems.

IMPROVEMENTS FOR THE BISCAYNE AQUIFER MODEL OF URBAN MIAMI-DADE COUNTY, INCLUDING EFFECTS DUE TO BISCAYNE BAY SOUTHERN EVERGLADES ECOSYSTEM RESTORATION (BBSEER)

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The Biscayne Aquifer is a heterogenous and highly productive aquifer that underlies Miami-Dade County and forms its main source of drinking water. Due to its highly permeable units and high-water table, it is sensitive to changes in precipitation, canal operations, sea level, and Everglades water levels. Groundwater levels are affected by the water level of the highly managed canals that serve as the region's drainage and recharge. As sea level rises, Everglades water levels increase due to the Comprehensive Everglades Restoration Program (CERP), as does regional demand for drinking water due to rising population density. A better understanding of groundwater levels, storage, and canal operation structures are important in protecting urban areas from flooding, ensuring a healthy Everglades ecosystem, and managing withdrawal of drinking water for adequate water supply. Because of the complexity and unique conditions of the aquifer, the U.S. Geological Survey developed a coupled surface model in 2014; that model served as the parent model in this study. When the groundwater model is then coupled with surface water, the accuracy of groundwater model can suffer. This study is therefore focused on modeling groundwater levels without surface canal routing, instead using the river package as the boundary condition while emphasizing the canal-aquifer budget and use as a calibration parameter. The model is discretized into two additional layers, for a total of five layers for a more refined discretization of the hydrogeological conditions of the aquifer. Improvements to the aquifer recharge, evapotranspiration, and runoff calculations were made using a water budget of the crop root zone (Agricultural Field Scale Irrigation Requirement Simulation, AFSIRS). The model was then calibrated using parameter estimation software (PEST) with historical data as a function of the hydraulic conductivity, canal conductance, and storage parameters. After model calibration and accuracy improvements, the BBSEER scenario was modified according to the Bay's changes in water delivery timing and volumes. The scenario change includes adjusting the groundwater and canal boundary water levels, and creating a lake that serves as water storage, which includes new operational structures. Uncoupling the canal surface water model from the groundwater model, the run time decreased by a factor of 10, significantly improving groundwater level calibration. The results of the scenario run were used to assess which of the BBSEER alternative features are enhancing the hydrologic conditions, including the prevention of saltwater intrusion without negatively impacting the wellfields. Choosing the right BBSEER alternative will preserve the Biscayne Aquifer's water supply, meeting the region's increasing drinking water demands without affecting the overall health of Everglades ecosystem.

COASTAL COMMUNITY TRANSITIONS ACROSS A SALINIZING COASTAL FRESHWATER SHORT-HYDROPERIOD WETLAND IN THE SOUTHEASTERN EVERGLADES: IMPLICATIONS FOR ECOSYSTEM STRUCTURE AND FUNCTION

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Coastal freshwater wetlands provide numerous valuable ecosystem services that can increase resilience along coastlines. The Intergovernmental Panel on Climate Change has projected sea level rise (SLR) of 0.4 m by 2040 and 1.0 m by 2070. These projections are predicted to lead to more frequent and extreme storm surges, increased inundation of coastal wetlands, coastal shoreline erosion, and saltwater intrusion into coastal aquifers and wetlands. With the increasingly relevant threats of accelerating SLR and associated saltwater intrusion compounded by historical reductions in freshwater delivery, these ecosystems are becoming highly vulnerable to degradation. To date, while we know there are differences in total ecosystem production and nutrient storage across specific wetland sites of marsh and mangrove ecosystems of the Everglades landscape, these patterns have not been explored at fine-scale across a salinity intrusion gradient within the same salinizing coastal freshwater wetland ecosystem. These coastal community transitions are hypothesized to modulate ecosystem structure and function, including ecosystem carbon production and nutrient storage, however the geomorphic and ecological context for these shifts can be highly variable and specific to local hydrologic management. Here, we are examining variation in total ecosystem carbon production and nutrient storage among coastal vegetation communities along a saltwater intrusion gradient in marl-forming wetlands of the southeastern Florida Everglades. An additional objective is to examine the trade-offs in production and nutrient storage among marsh and mangrove ecosystems in response to saltwater intrusion modulated by increased SLR and freshwater diversion from the coastline. Initial results illustrate that there has been a shift in vegetation community composition from graminoid species (*C. jamaicense*) *to* more woody vegetation (*R. mangle*), as well as an extension of saline conditions into a previously freshwater wetland. By quantifying ecosystem production (as dry biomass and carbon) and nutrient storage of these different vegetation communities, inferences can be made about the consequences of SLR and saltwater intrusion on coastal wetland environments. With increasing rates of SLR and saltwater intrusion in coastal wetland environments, being able to understand how ecosystem production changes along a salinity gradient is essential for future wetland management and planning. Maintaining and preserving these freshwater ecosystems in coastal environments is critical for mitigation of and adaptation to SLR and climate change. The information yielded from this study will also provide a valuable tool to fill in the significant knowledge gap of understanding how carbon stocks and nutrient storage change across a salinizing wetland within marl-forming coastal environments in the southeastern Florida Everglades.

CHARACTERIZING BIOMARKERS OF LITTER AND FLOC DECOMPOSITION: RESULTS FROM A DOM LEACHING EXPERIMENT

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The Everglades Stormwater Treatment Areas (STAs) are wetlands that were constructed to reduce phosphorus (P) in stormwater runoff prior to discharge to the Everglades Protection Area. P retention in these wetlands is affected by decomposition of litter and floc. These processes can contribute dissolved organic matter (DOM) to surface waters, which may subsequently influence P cycling and retention. To understand DOM processes within the STAs, a decomposition and leaching study was conducted in the summer of 2022 to evaluate biomarkers of litter and floc decomposition. The study also assessed the composition of DOM released from litter and floc at three different time points and the relationship of DOM to internal nutrient cycling. Litter and floc material was collected from both emergent aquatic vegetation (EAV; *Typha domingensis*) and submerged aquatic vegetation (SAV; *Chara* spp.) habitats, at an outflow site within STA-3/4. Fresh material was used for the initial timepoint (Day 0; D0) and additional litter and floc were placed in litter/floc bags which were then allowed to decompose *in situ* for 20 (D20; intermediate decomposition) or 40 (D40; late-stage decomposition) days. At the initial, intermediate, and late stages of decomposition, fresh material (D0) or litter/floc bags (D20 and D40) were retrieved, transported to the laboratory, and used as substrate for a leaching experiment. After 48 hours, DOM released from the floc or litter was collected and evaluated for a suite of geochemical parameters and biomarkers to assess DOM composition and its relationship to internal nutrient cycling. Previous work in the same STA found that biomarkers, such as amino acids and pigments, provided useful information on the quality and lability of organic material in the STAs. We present how biomarkers relate to changes in nutrient concentrations over the course of the decomposition and leaching study, including a discussion on the relationship between biomarkers and internal nutrient cycling within the STAs. We found that after leaching, EAV released more total dissolved phosphorus when compared to SAV, and comparison with EAV and SAV biomarkers is ongoing. Overall, this approach provides detailed insights into the composition of dissolved material released from STA vegetation at different stages of decomposition and its potential relationship to P concentrations within treatment wetlands.

MAINTAINING CONTROLLABILITY IN TREATMENT WETLANDS WHILE ACHIEVING SUSTAINABILITY

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The Everglades Stormwater Treatment Areas (STAs) are wetlands constructed to reduce total phosphorus (TP) concentrations from runoff prior to discharge to the Everglades Protection Area. Experience with these STAs shows that the treatment process depends on many naturally varying factors, such as the biota and wetland soil, as well as other factors such as the timing, quantity, and nutrient content of the inflow water. Considering the large size of the STAs, maintaining the vegetation and optimizing operations to achieve the required discharge TP concentration can be challenging. Previous field tests conducted in the STAs provided tools to aid in the task of developing operational guidance to optimize treatment. The depth-energy slope-discharge plot is one such tool that describes theoretical hydraulic states for an STA. While the analytical wave speeds and decay rates have proven to be useful to design pulsed flows with predictable behaviors, the goal of this study is to introduce measured amounts of treatment, transport and mixing (i.e., diffusion and dispersion), and to achieve the target level of treatment by mathematically combining the hydraulic and treatment characteristics. An optimum pulse flow would provide the depth and duration essential for maximum treatment by providing increased mixing of unevenly treated water. Without such optimal operations, some areas of the STAs do not contribute to treatment due to geometrical and topographical anomalies. This study uses two flumes constructed in a 0.2-ha STA test cell. Results obtained from this experiment are intended improve understanding of the effect of flow rates, water depth and plant density on P transport, mixing and retention in STAs. The ability to use controllable variables to optimize P retention and data from this experiment could provide information to help enhance P retention in the STAs.

2020 COMBINED OPERATIONAL PLAN BIENNIAL REPORT: CONNECTING THE DOTS BETWEEN OPERATIONS, MONITORING, AND FUTURE PLANNING.

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The purpose of the Combined Operational Plan (COP) is to define water management operations for the Water Conservation Area (WCA) 3A and WCA 3B outlets, structures in the L-31N and C-111 basins constructed as part of the Central and Southern Florida Project and the recently constructed components of the Modified Water Deliveries to Everglades National Park (ENP) and C-111 South Dade Projects. The COP Water Control Plan (WCP) was first implemented on September 1, 2020. The implementing agencies [U.S. Army Corps of Engineers (Corps) and South Florida Water Management District (SFWMD)] along with ENP published a Biennial Report as outlined in the Adaptive Management and Monitoring Plan of the COP Final Environmental Impact Statement (FEIS). The Biennial Report covers the period from September 1, 2020, through April 30, 2022. The Biennial Report provides a quantitative summary of water management operations, monitoring results and ecosystem status with the intention of gathering information to answer the fundamental question: *Is the COP achieving its project objectives and are adjustments recommended?* Hydrologic performance measures such as inundation duration, amount, and distribution of flows into ENP, and Florida Bay salinity used during the planning effort were evaluated using real-world data and compared with the baseline years as well as with modeled results from the 2020 COP FEIS. Biological endpoint performance measures such as slough vegetation suitability, wood storks and wading birds, and freshwater fish were also evaluated, as well as adaptive management uncertainties, although such a brief implementation window makes conclusions difficult. Highlighted concerns and recommendations have been provided to the Central Everglades Planning Project (CEPP) Operational Plan project delivery team to further inform scoping efforts for the update to the 2020 CEPP Draft Project Operating Manual.

ESTABLISHING MODERN PEAT ANALOGS TO DECIPHER MANGROVE SUB-HABITATS FROM HISTORICAL PEATS

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In mangroves of South Florida, plant debris accumulates and humifies to form peat. The structure and composition of mangrove peat differs among mangrove sub-habitats, leading to categorically distinct peat types reflective of the modern mangrove depositional environment. The preservation potential of *in situ* plant debris that forms peat is influenced by the taphonomically active zone (TAZ: the zone near the surface of the substrate where taphonomic processes actively modify and degrade accumulated detritus). Taphonomic processes shape peat until it is sequestered into the depth of final burial (DFB), where decomposition is negligible. Preserved peats in the sedimentological record provide historical archives and the palaeoecological context of peat formation. These peats are used to reconstruct mangal depositional environments. Downcore trends in preserved peats are used to inform long-term perspectives on how mangal environments responded to environmental change. However, as peat passes through the TAZ and is sequestered into the DFB, information about the precursor mangrove environment is reduced, or even lost, which skews interpretations of past mangrove sub-habitats and leads to imprecise reconstructions of mangrove communities. To better understand the influence of the TAZ on peat constituents during the peat-forming process, we analyzed plant organ- and taxon-based measures to characterize the structure and composition of surficial mangrove peats with depth from two contrasting mangrove sub-habitats in Barnes Sound, Florida: a tidally influenced, *Rhizophora*-dominated fringe sub-habitat located on the periphery mangrove community; and an inundated, interior mixed forest basin sub-habitat that experiences limited tidal activity. We found that (1) peats formed in basin sites have greater proportional abundances of leaf litter and other aerial plant debris, which correlates with reduced tidal activity and restricted detritivore access to the leaf litter layer; (2) peats formed in fringe sites generally have higher root percentages, and these ratios provide a reliable method to differentiate between peats at depth, and (3) organismal signals, such as foraminifera and insect parts, provide a means for deciphering precursor mangrove sub-habitats from sequestered peats. Analyses of these surficial cores allowed us to establish modern peat analogs needed to better decipher mangrove sub-habitats preserved in historical mangrove peats. Comparisons of samples from our surficial cores to those from historical, deep cores from other South Florida mangrove peat deposits suggest that few aerial plant debris survive the TAZ and sequestered peats are biased towards root-rich peats characteristic of fringe sub-habitats; however, sequestered peats that retain comparatively lower root percentages indicate peats rich in aerial plant debris that were formed in basin sub-habitats.

PRESCRIBING FLOW-PRELIMINARY RESULTS FROM AN IN-SITU FLUME WITHIN THE EVERGLADES

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Reintroducing flow to the Everglades ecosystem is fundamental to restoration. Results from the Decomp. Physical Model highlight that unconstrained, excessive flows, even with phosphorus concentrations ≤10 µg/L, cause locally elevated loading rates. These high rates caused periphyton community shifts and enriched sediments, similar to those observed in enriched cattail-dominated regions. As a result, we questioned whether there is a combination of water velocity, concentration, and phosphorus loading that could maintain oligotrophy in sloughs. Would enrichment result if high velocities occurred at much lower inflow phosphorus concentrations? Answering these questions could improve how flow structures are operated and how flows from point sources are dispersed. However, to address these questions, conditions of high velocities (≥3 cm/s) and low phosphorus (≤6 µg/L) are needed. This could not be accomplished using structure flows alone because of covarying gradients of water column phosphorus and velocity with distance from inflow. To quantify ecosystem responses to the missing puzzle piece: high velocities and low water phosphorus, we constructed an in-situ flume within the Decomp. Physical Model footprint. The primary objective of the flume is to determine optimal combinations of flow, water phosphorus and phosphorus loads that restore, without enriching, the ridge and slough landscape. Approximately 60 m long (north to south) and 40 m wide at its downstream base, the flume was constructed of vinyl material, clamped to PVC poles, driven into the peat. The conceptual approach of the flume was to concentrate or "funnel" flow, using hard and natural barriers, to generate elevated flow velocities above a target of 3 cm/s. Sampling employed a Before-After-Control-Impact design, with two low-flow control sites and three sites in the high flow pathway. Flow velocity and biogeochemical characteristics (surface water, floc and periphyton) were measured. With the first year of monitoring now complete, the flume was successful both as a proof of concept—manipulating localized flow velocities—and in providing a glimpse at the scientific objective—pinpointing the optimal, restorative envelope of velocity, concentration, and phosphorus-loading. Water velocities achieved the target of >3cm/s, and phosphorus was in the desired range of 4-6 µg/L. Phosphorus loads at flow sites achieved target loads of >10 g-P/m/d. Decreased phosphatase activity was observed at flowing sites, indicating less energy directed to phosphorus acquisition. Evidence of reduced phosphorus limitation was also supported by higher phosphorus concentrations in periphyton. Additional data are needed to determine whether the observed biological responses are early warning indicators of enrichment, or whether the system will remain in an oligotrophic state despite higher flows and loads.

BISCAYNE BAY AND SOUTHEASTERN EVERGLADES ECOSYSTEM RESTORATION PROJECT

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The Biscayne Bay and Southeastern Everglades Ecosystem Restoration (BBSEER) Project is part of the Comprehensive Everglades Restoration Plan. The project area includes the Model Lands and the C-111 South Dade, C-111 Spreader Canal Western, Modified Water Deliveries, and Biscayne Bay Coastal Wetlands Phase 1 Projects. Currently in Planning, the BBSEER Project is evaluating opportunities to incorporate water storage, active and passive water management features, water quality features, and alterations to existing canals and levees to: (1) improve quantity, timing, and distribution of freshwater to estuarine and nearshore subtidal areas, including mangrove and seagrass areas, of Biscayne National Park, Card Sound, and Barnes Sound to improve salinity regimes and reduce damaging pulse releases, (2) improve freshwater wetland water depth, ponding duration, and flow timing within the Model Lands, Southern Glades, and eastern panhandle of Everglades National Park to maintain and improve habitat value, (3) improve ecological and hydrological connectivity between Biscayne Bay coastal wetlands, the Model Lands, and Southern Glades, and (4) increase resiliency of coastal habitats in southeastern Miami-Dade County to sea level change. Eight project-specific performance metrics will be used to evaluate the degree to which alternative plans meet the four restoration objectives for the BBSEER Project: (1) salinity in the nearshore waters of southwestern Biscayne Bay, (2) direct canal releases, (3) timing and distribution of flow sources to Biscayne Bay, (4) hydroperiod, (5) water depth, (6) wetland salinity, (7) adaptive foundational resilience, and (8) ecological connectivity.

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REHYDRATION DRIVES LANDSCAPE-SCALE SHIFTS IN WETLAND VEGETATION RELATIVE TO PATCH-SCALE EFFECTS OF CHEMISTRY AND FIRE

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Rehydration of the northeast portion of Everglades National Park (ENP) was defined as a goal in the Everglades National Park Protection and Expansion Act of 1989 (Public Law 101-229), which added 109,000 acres of land to Everglades National Park. Over the subsequent three decades, ENP and SFWMD managers made a series of modifications to the newly created eastern boundary of ENP in preparation for the Comprehensive Everglades Restoration Plan (CERP). As construction neared conclusion in fall 2015, long awaited changes to hydrologic conditions in the newly added northeastern portion of ENP were initiated with an incremental testing period, followed by the adoption of the Combined Operational Plan in 2020. The majority of increased water flows have been delivered, through the L-29 canal, to a region of ENP called Northeast Shark River Slough (NESRS). In the present study, we analyzed the magnitude and direction of changes in wetland chemistry, and wetland vegetation structure and composition at the landscape scale from 2015 to 2021 in NESRS. Correlations between the observed changes and ecological drivers of change, such as hydrology, fire, and chemistry were also investigated. We expected to see shifts in vegetation towards more hydric communities as a result of the magnitude of the hydrologic change induced by the new operations. The observed biogeochemical shifts were mostly driven by hydrology, and to a lesser extent by fire. Of particular interest, mean total phosphorus concentrations in the floc and soil decreased while soil carbon:phosphorus and nitrogen:phosphorus ratios increased at sites further away from the L-29 canal water inflow. Nonetheless, increased soil phosphorus concentrations were observed at a few sites in close proximity to the water inflow source. Abundance of macrophyte species typical of short-hydroperiod prairies strongly decreased, while the expansion of dominant long-hydroperiod species, such as *C. jamaicense* and *E. cellulosa*, was facilitated by fire. *T. latifolia*'s abundance increased at a number of sites in proximity of the water inflow source, but did not expand to sites further away from the L-29 canal; the expansion of *T. latifolia* was driven by phosphorus enrichment and facilitated by fire. Hydrology was the dominant driver which produced observable shifts in vegetation communities at the landscape scale during the first six years of rehydration, while wetland chemistry and fire were identified as critical drivers of vegetation communities at the scale of individual habitat patches.

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MERCURY IN EVERGLADES PYTHONS

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Elevated mercury (Hg) concentrations in fish and wildlife tied to aquatic ecosystems is a long-standing environmental concern. Within the Florida Everglades, abundant organic peat soils, atmospheric Hg deposition, and elevated dissolved organic carbon (DOC) and sulfate in surface waters exacerbate Hg bioaccumulation such that the entire ecosystem is under a fish consumption advisory. While Hg burdens and cycling has been extensively studied in fish and avian species, little is generally known about Hg in reptiles. Pythons are top predators, which often results in elevated Hg levels in muscle tissue. Past data have shown that python Hg concentrations within the Everglades can reach 28 $\mu g\ g^{-1}$, higher than biota Hg concentrations at industrially contaminated sites. While we know that these concentrations in pythons are of concern for human and wildlife health, the factors driving elevated bioaccumulation are still relatively unknown. As part of this study, we wanted to understand the spatial controls of Hg bioaccumulation within pythons and determine if differences in biogeochemistry across the Everglades also related to higher python Hg burdens. To examine this topic, we compiled and analyzed historical (2007-2009) and contemporary (2017-2019) python Hg data across a large spatial range within and surrounding Everglades National Park. Areas with elevated Hg, DOC, and sulfate in the water column were targeted for python selection, including the S-12 and L-67 canals. In addition, python tissues were examined for both methylmercury and total Hg to determine if there was any evidence of internal detoxification within the organisms. Historical data demonstrated that the highest python Hg concentrations were observed within Everglades National Park near the Shark River Slough, whereas pythons captured near coastal boundaries or outside the park displayed lower levels. In addition, the percent of methylmercury in python muscle tissue present as total Hg (e.g., % MeHg) ranged from 41-100% in juvenile pythons, potentially indicating diet derived differences or internal detoxification. With the addition of more recent python data, this research will fill critical data gaps at the northern boundaries of Everglades National Park and assess %MeHg variability in adult pythons. Examining python Hg concentrations across a biogeochemical gradient in the water column will aid in our understanding of how Hg enters the food web and inform if hydrologic changes or ecosystem restoration will alter bioaccumulation.

MANGROVE FOREST RECOVERY IN ROOKERY BAY NATIONAL ESTUARINE RESEARCH RESERVE 5 YEARS FOLLOWING HURRICANE IRMA

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Mangrove forests in south Florida are frequently impacted by hurricanes, and although adapted to physically stressful environments, climate change is exposing them to increased storm frequency and intensity. The resilience of these systems is challenged by the cumulative effects of climate change, urbanization, and regional water management. Rookery Bay National Estuarine Research Reserve (NERR) in southwest Florida contains approximately 30,000 acres of mangrove forest located at the lower end of a highly modified drainage basin, in the Greater Everglades Ecosystem. These forests were heavily impacted by Hurricane Irma (2017), and most recently by Hurricane Ian (2022). Variable impact and recovery were noted in the first several years following Hurricane Irma. To understand the drivers of hurricane impact and recovery of the mangrove forests in the Reserve, the Mangrove Coast Collaborative (MCC) project, funded by NERRS Science Collaborative, was initiated in 2020. From the onset, the MCC project team understood the importance of engaging diverse experts and stakeholders (scientists, natural resource managers, agency personnel, practitioners, and NGO representatives) to provide localized expertise and input of the ongoing impacts to the mangrove ecosystem. During 2022 and 2023, seventy 100m^2 plots in Rookery Bay NERR were evaluated for impact and recovery using a suite of biometrics recommended by a technical project advisory committee. The majority of locations were selected via a random sampling design stratified by geographic location within the Reserve and dominant species composition (red, black, mixed mangrove forests). Metrics sampled at each site included forest composition, structure, canopy closure, regeneration (seedling and sapling counts), canopy height, and stem mortality/damage. During a workshop held in 2021, a conceptual model of the relationships between drivers, antecedent conditions, and recovery from Hurricane Irma was developed. This model serves as the hypothesis for subsequent statistical analysis of the data using structural equation modeling (SEM). Preliminary data analysis shows geographic trends with increased tree damage and mortality attributable to Hurricane Irma located in the eastern and central areas of the Reserve. Areas of low recovery (as measured by the extent of regeneration or number of seedlings/saplings) have been identified in multiple locations within the Reserve, often associated with either natural or anthropogenic barriers resulting in tidal restriction. Initial impacts from Hurricane Ian were minimal to the mangrove forest in Rookery Bay NERR, resulting only in partial defoliation and fine branch damage. Effects were most prevalent in the northern portion of the Reserve. Further work to assess the hydrologic regime at sites of continued low recovery is recommended.

PARTICULATE AND PHOSPHORUS DYNAMICS IN THE WATER COLUMN AND SEDIMENTS OF GREATER EVERGLADES ECOSYSTEM CANALS

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The Greater Everglades Ecosystem (GEE) contains areas of agricultural, urban, and natural land uses that are connected by canals whose discharges are managed through drainage structures to meet the needs of the region. The purpose of this study was to evaluate and quantify how such discharges influence the export of suspended particulates and phosphorus (P) in GEE canals. Studies have shown that high discharges can increase phosphorus export via the transport of suspended particulates and the resuspension of bed sediments. Discharge and phosphorus data in selected canals across three land uses of the GEE were subjected to concentration-discharge (C-Q) relationships to determine the canal discharges that can increase the transport of P. Additionally, in the L-29 canal (Tamiami canal at northern border of Everglades National Park) trapped suspended particulates and cored benthic sediments were characterized, and analyzed for P to assess their ease of transport, settling, and P sequestration, in relationship to canal discharge events and proximity to the inflow structures. Results showed that in all canal sites except one, higher discharges increase phosphorus concentrations in the water column and transported suspended particulates farther downstream from the inflow structure. Furthermore, sites closest to the inflow structure had heavier, denser, and lower P content in the top layer of the bed sediments compared to the more downstream sites, indicating that canal discharge releases resuspended and transported lighter, more organic P-rich material. Results also showed the extent of hydrologic versus biogeochemical dominances on P availability and export via the discharge thresholds on C-Q relationship slopes and suspended and benthic sediment characteristics in the canals. Identifying the discharges that can increase the mobilization of P, transport P-rich suspended particulates, and resuspended bed sediments, is crucial to achieving the Everglades restoration goal of increasing freshwater delivery while reducing downstream P export.

LIGNIN PHENOLS AS MARKERS OF SEAGRASS HISTORY IN FLORIDA BAY SEDIMENTS

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Events of seagrass die-off and microalgal blooms in Florida Bay have focused attention on the ecological health of this ecosystem. Historical changes in seagrass abundance in Florida Bay may provide information on how seagrass beds have evolved over time and provide insight on stressors to seagrass beds and how future changes to the physical environment in the bay may impact seagrass abundance. The purpose of this study was to explore the use of lignin phenols as a proxy to examine historical changes in seagrass abundance. Sediment piston cores were obtained in June 1996 from two sites in Florida Bay: Pass Key and Bob Allen Key, and sectioned in 2-, 5-, or 10-cm intervals. Sediment samples were wet-sieved into three fractions: >850 μm, 850-63 μm, and <63 μm to separate out the coarse sediment fraction (seagrass fragments and shells) before laboratory analysis. Samples of living seagrass and mangroves were also collected. Duplicate sediment cores were collected for ^{210}Pb and ^{137}Cs dating, with sedimentation rates calculated using the constant rate of supply (CRS) model. Lignin phenols were determined using CuO oxidation at 170° C in mini-bombs to release the free phenols from the lignin biopolymer, followed by extraction into diethyl ether, and analysis by gas chromatography/mass spectrometry. Results indicate that the dominant seagrass of the bay (*Thalassia testudinum*) has a lignin composition that readily distinguishes it from the other major lignin sources (mangroves, sawgrass) to Florida Bay. Lignin in *Thalassia* contains little or no syringyl phenol content (syringyl/vanillyl phenol ratio $\cong$ 0.02), similar to gymnosperm lignin. *Thalassia* lignin is distinctly different from that of angiosperm vegetation, such as mangroves (syringyl/vanillyl $\geq$ 0.5), which dominate the higher plants contributing lignin to the bay. Lignin phenol contents of sediments were examined from the seagrass-covered areas at Pass and Bob Allen Keys. Total lignin contents were significantly higher at the Pass Key compared to Bob Allen Key sediments. Syringyl/vanillyl ratios were also generally higher at Pass Key. These results suggest that Pass Key is receiving substantially more lignin input from terrestrial runoff (i.e., angiosperm lignin), consistent with its greater proximity to the coast and Taylor Slough. At both sites, historical changes in total lignin phenol content of sediment showed a decreasing trend in recent times. At Bob Allen Key, this trend was accompanied by a concomitant general decrease in syringyl/vanillyl ratios toward the surface, suggesting that the recent decrease in total lignin was the result of a decrease in angiosperm lignin (probably of mangrove origin). At Pass Key, the changes in lignin phenol content and composition may reflect changes in freshwater inflow to the bay. The study illustrates the utility of lignin phenols as a proxy for historical changes in seagrass abundance.

AN OVERVIEW OF THE ROLE OF PHOTOLYSIS IN DISSOLVED ORGANIC MATTER CYCLING IN STORMWATER TREATMENT AREAS

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The role of natural sunlight, especially the high energy UV portion of the spectrum, is known to play an important role in the diagenesis of dissolved organic matter. Photolysis, a process of breaking structural bonds in complex organic molecules with high energy UV light, can reduce large recalcitrant organic molecules into smaller, more bioavailable forms. This process can also change the reactivity of the bulk dissolved organic matter pool, as well as liberate nutrients such as phosphorus and nitrogen. Hence, photolysis is thought to play a significant role in diagenesis of dissolved organic matter and the associated nutrients in the Stormwater Treatment Areas of south Florida. Two different series of laboratory experiments have been conducted to determine the potential of photolysis to influence dissolved organic matter dynamics in the Stormwater Treatment Areas using bulk waters from canals and various portions of flow-ways managed for both submergent and emergent aquatic vegetation. These waters were subsequently exposed to UV light in a solar simulator under controlled laboratory conditions. Bulk dissolved organic matter characteristics and nutrient mineralization were monitored in all experiments with exposure time (UV dose) as a variable. In all experiments, dissolved organic matter characteristics were observed to change with exposure. Further, mineralization of phosphorus and nitrogen was observed at higher doses of UV light. Phosphorus mineralization, while measured, proved more difficult to assess due to the amounts of soluble reactive phosphorus observed being close to the practical quantitative limit of laboratory analysis.

SEA-LEVEL RISE THRESHOLDS FOR WETLAND LOSS AND TRANSFORMATION: WHEN COULD TIPPING POINTS BE CROSSED?

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Accelerated sea-level rise threatens coastal wetlands in the Greater Everglades, but the timing and extent of wetland loss and transformation are unknown. Coastal wetlands have the potential to adapt to moderate rates of sea-level rise via vertical accretion and landward migration. However, higher rates of sea-level rise can lead to coastal wetland drowning and transformation. Recent data syntheses have clarified future relative sea-level rise exposure as well as sensitivity thresholds for wetland drowning. We integrated these advances to examine when and where sea-level rise may exceed thresholds for wetland drowning in the Greater Everglades and the rest of the conterminous United States. Our results clarify the potential timing and extent of coastal wetland loss and transformation, underscoring the need to minimize sea-level rise acceleration while maximizing the potential for adaptation via vertical accretion and landward migration.

STATUS OF IMPLEMENTATION OF RESTORATION STRATEGIES

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The South Florida Water Management District's (district) $880 million Restoration Strategies Program is improving water quality flowing into America's Everglades by implementing flow equalization basins (FEBs), stormwater treatment area (STA) expansions, and conveyance improvement projects. The program includes a robust Science Plan focused on investigating the critical factors that influence phosphorus reduction and seeking a better understanding of improving treatment performance at low phosphorus concentrations. The program includes investigation of additional sub-regional source controls – where pollution is reduced at the source – in areas where phosphorus levels in stormwater runoff have been historically higher. In September 2012, the FDEP issued watershed National Pollutant Discharge Elimination System (NPDES) and Everglades Forever Act (EFA) permits to the district to continue to operate its five Everglades STAs. Consent Orders were issued with these permits that require the district to construct 13 projects on an aggressive timeline to be completed by December 2025 with specific milestone due dates for each project activity. To date, nine projects and 89% of the Consent Order activities have been completed. Upon completion of all Restoration Strategies projects, the permits require that each STA meet the Water Quality Based Effluent Limit (WQBEL), to ensure that the State's water quality standard for the Everglades is achieved. In addition to the Restoration Strategies projects, the district is enhancing the performance of all five STAs through construction projects to refurbish, rehabilitate, and renew large portions of the STAs, which have been in operation between 17 to 28 years. Refurbishments have been completed at STA-1E, STA-1W, and STA-3/4. This presentation will provide an overview of the status of the implementation of the Restoration Strategies Program designed to meet the WQBEL.

C8 AND C9 WATERSHEDS FLOOD PROTECTION LEVEL OF SERVICE -ADAPTATION AND MITIGATION PLANNING

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The objective of this comprehensive study is to develop flood adaptation strategies and mitigation projects for the C8 and C9 watersheds to maintain or improve the level of flood protection provided by the South Florida Water Management District (SFWMD) operated flood control infrastructure, both under current conditions and in anticipation of future conditions including land use changes and sea level rise (SLR) through a systematic process including stakeholder workshops, hydrologic and hydraulic modeling, economic analysis, flood damage assessment, and adaptation pathway planning. This study evaluated the performance of the C-8 and C-9 Watersheds for the 5, 10, 25, and 100-year rainfall events under existing conditions and three future sea level rise conditions, with and without adaptations or mitigation projects. Numerical modeling was used to determine the impact to flooding from future land use, sea level rise, increased groundwater elevations, and tidal storm surge. Potential projects were then incorporated in the simulations to mitigate the observed increase in flood risk. Potential projects included conceptual local micro-scale projects developed by stakeholders, regional-scale projects, planning level projects and span both traditional grey infrastructure, and natural and nature-based solutions. This study assessed flood impact upstream and downstream of the coastal structures and addressed potential water quality implications to Biscayne Bay of the different mitigation strategies. The recommended adaptation strategies and mitigation projects includes changes to operations of existing assets, improvements to canal conveyance, improvements to secondary drainage features, addition of new assets including forward pump stations, tie back levees, and refurbishment or replacement of flood control structures. The recommended strategies are comprehensive and span the primary, secondary, and tertiary flood control systems. The implementation of the strategies will be a collaborated effort from SFWMD, counties, local drainage districts and other stakeholders.

MICROPLASTIC SEQUESTRATION BY MANGROVES IN THE L-31E FLOW-WAY OF BISCAYNE BAY

***Melinda Paduani**, Michael Ross, Stefanie Landeweer, Piero Gardinali*

Globally, legislation has emerged to reduce unsightly marine debris. Microplastics (MPs, < 5 mm in size) are less conspicuous, yet they pose a more insidious threat at all levels of the food chain. Pilot studies documented debris sequestered within mangrove forests of Biscayne Bay, Florida where it is unlikely to escape, and MPs were also found buried below the soil surface. Similar to their capacity to filter excess nutrients from the water column, it is hypothesized that mangroves act as a sink for MPs as a novel ecosystem service. The Biscayne Bay and Southeastern Everglades Ecosystem Restoration (BBSEER) project will deliver water through culverts into the L-31 East Flow-way to recreate a natural flow of water through coastal mangroves, allowing for a comparison of MP concentrations in mangrove stands with and without water deliveries. Surficial water and sediment samples were taken from 3 “zones” (West to East): the L-31E canal (a potential MP source), dwarf mangroves, and fringe mangroves. Water samples will be filtered, and sediments will be dried, sieved, oxidized to remove organic matter, and separated from lighter plastics by density using sodium chloride (1.2 g/mL) followed by sodium bromide solution (1.4 g/mL). Samples will be stained with Nile Red, a lipophilic dye that fluoresces, and analyzed under blue light. Most plastics were recovered by count from spiked water samples (68.0 ± 34.6% - 100 ± 0%), whereas in sediments, recovery depended on polymer type (10.0 ± 24.5% - 100 ± 0%). Field samples have been collected and MP isolation is ongoing. It is expected that MP concentrations will be higher in areas with culverts compared to without, in sediments compared to water, and within dwarf mangroves compared to other zones. This experiment will fill critical knowledge gaps on MP occurrence and dynamics to generate management recommendations for reducing MPs entering the Bay.

USE OF REGIONAL SEDIMENT MANAGEMENT TO INCREASE COASTAL WETLAND RESILIENCE TO SEA LEVEL RISE

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Sea level rise (SLR) is expected to affect natural and urban areas by shifting habitats and inundating coastal developments in South Florida. Given this challenge of SLR, building resiliency within South Florida's natural communities is imperative, not only to protect an abundance of fish and wildlife species, including important recreational and commercial fisheries, but also as a means of reducing risk to the built environment from coastal storm surge and saltwater intrusion. For coastal wetlands to exist into the future, soil accretion must match or outpace SLR. Beneficial uses of dredged material, such as thin-layer placement (TLP) can enhance landscape resiliency by building soil elevation and improving soil aeration in the root zones. A proof-of-concept physical model will evaluate the ability of TLP to increase elevation and enhance net primary productivity within coastal wetlands of Miami-Dade County, Florida most vulnerable to SLR. Varying depths of beneficial use materials will be placed at selected sites to identify 1) whether TLP is a viable option to build elevation to increase the adaptive capacity of coastal wetlands to SLR, and 2) whether TLP can also promote internal mechanisms of peat accretion (*i.e.,* root growth, and carbon sequestration) within coastal wetlands, including mangrove communities. The results of this proof-of-concept physical model will also inform and direct the development of management measures, adaptive management, and monitoring options for the ongoing Biscayne Bay and Southeastern Everglades Restoration (BBSEER) Study, the only coastal component of the Comprehensive Everglades Restoration Plan (CERP). Results from this initiative will be applicable to areas throughout the Gulf, Atlantic, and Pacific coasts of the United States where direct preservation, enhancement, and restoration of mangrove and other vegetative communities, will build coastal resiliency, reduce storm surge damage, and create habitat for a variety of fish and wildlife species.

EVERGLADES HYDROLOGIC RESPONSE TO FUTURE CLIMATE CHANGE

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The freshwater resources are highly sensitive to climate change in South Florida. Climate model projection data and analyses suggest that extreme low and high flow periods, seasonal runoff regimes and other hydrologic characteristics could all be significantly affected by climate change over the course of coming decades. Climatic factors such as rainfall and evapotranspiration are the main hydrologic drivers of the Everglades freshwater ecosystem, and a small change in these factors is expected to have a large influence on the hydrology and species inhabiting this area. This study examined the short and long-term effects of future climate change on the hydrologic conditions of the Everglades. In this work, we used Localized Constructed Analogs (LOCA) statistically downscaled climate projections for key climatic variables such as precipitation and temperature from 27 Global Climate Models (GCMs) that participated in the Coupled Model Intercomparison Project Phase 5. We used an ensemble mean of 27 GCMs for rainfall and temperature data. Various combinations of regional climate models and GCMs were used for other climatic variables required to estimate evapotranspiration. The climate projection data were used in South Florida Water Management Model (SFWMM) to simulate the hydrologic response of the Everglades system. For hydrologic simulations, we considered two Representative Concentration Pathways, RCP4.5 and RCP8.5, for the historical baseline (1965-2005), near-term (2016-2056) and long-term (2059-2099) periods. We evaluated the relative differences in hydrologic variables (e.g., flows, stages) and water supply demands under the Existing Conditions Baseline (ECB) and the Comprehensive Everglades Restoration Plan (CERP0). Climate projection data in south Florida showed a strong spatial-temporal variability relative to the historic data and hydrologic simulations results demonstrated that there were significant impacts on the water budgets across different regions of the Everglades.

UNDERSTANDING THE IMPACTS OF FUTURE EXTREME RAINFALL AND COMPOUND FLOODING IN BROWARD AND NORTH MIAMI

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South Florida is vulnerable to pluvial, fluvial, coastal and groundwater flooding due to its unique hydrogeology, low-elevation topography, geographical location, climatology, and complex water management system. In addition, it is projected that this area will experience not just an increase in sea level rise but also higher frequency and magnitude of extreme rainfall events. Hydrological variations in a system with limited flexibility and storage capacity could overwhelm the canal system resulting in exacerbated flooding conditions and a lower level of protection to the population. One important step to properly estimate compound flood risks from coastal and inland hazard is to account for changing future extreme rainfall conditions. This presentation highlights the C-8 and C-9 basins in Miami-Dade and Broward Counties. These basins were selected to assess the impacts of extreme rainfall scenarios utilizing the Flood Protection Level Of Service (FPLOS) models (for the 3-day duration, 100-year recurrence event). The methodology is based on the South Florida Water Management District Technical Memorandum: Adoption of Future Extreme Rainfall Change Factors for Flood Resiliency Planning in South Florida. A sensitivity analysis was performed using a rainfall change factors threshold approach (20%, 30%, 40%, 50%, and 75% increase) and the runs were developed based on an integrated groundwater and surface water model (MIKE SHE and MIKE Hydro River). Two performance metrics from the FPLOS rating were selected, including the analysis of maximum discharge capacity through the canals (PM1) and depth of flooding (PM5). The results illustrate increasing flood risks in these basins, represented by up to a 1-ft increase in overland flow inundation resulting from these selected future rainfall scenarios. Understanding the impacts of future rainfall scenarios is critical to support resiliency planning efforts, and to properly account for rainfall driven flooding risks to develop more accurate local and regional flood vulnerability assessments.

DEVELOPMENT OF AN ENVIRONMENTAL DNA CRISPR BIOSENSOR FOR THE DETECTION OF INVASIVE BURMESE PYTHONS IN THE GREATER EVERGLADES

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The widespread inaccessibility of the vast Greater Everglades ecosystem and the cryptic nature of Burmese pythons (*Python bivittatus*) has resulted in low detection rates that hinder management efforts. Monitoring of Burmese python environmental DNA (eDNA) using traditional PCR-based techniques has considerably improved the detection rates of the large invasive reptiles; however, these methods require the use of expensive instruments, technical expertise, and the elimination of environmental inhibitors that could interfere with molecular amplification. As an alternative, we developed an onsite, inexpensive, qualitative CRISPR/Cas-based field biosensor assay to rapidly detect the presence of invasive Burmese python eDNA to aid early detection and rapid response activities. This novel method addresses the limitations of PCR-based eDNA assays by enabling accurate DNA-based Burmese python identification using a sensitive, portable platform that combines all necessary reagents for sample processing into two reagent tubes and can be used in the field without specialized technical knowledge. A rapid detection tool that can be used in the field can help to quickly identify Burmese python hot spots, allow for rapid assessments after eradication efforts, and conduct more expansive eDNA surveys. This simplified technology can be readily applied in alternative locations such as the Caribbean or Florida Keys. The assays can also be adapted to additional species and genetic targets with relative ease by replacing the DNA and RNA sequences specific to Burmese pythons with those from another organism or infectious disease agent of interest. This proof-of-concept work will set the foundation for adapting this portable assay for the detection of other invasive species.

MICROBIAL AND BIOGEOCHEMICAL CONTROLS ON MERCURY METHYLATION IN THE EVERGLADES

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Methylmercury (MeHg) is a highly neurotoxic contaminant found at high levels in Everglades aquatic food webs and is produced from inorganic divalent mercury ($Hg(II)_i$) by microbes carrying the *hgcAB* gene cluster. MeHg levels in the Everglades display a "Goldilocks curve" along a sulfate gradient, with low MeHg levels at high and low sulfate concentrations but elevated MeHg at the intermediate sulfate sites. While this has been hypothesized to be controlled by the competing effects of sulfate on (1) the bioavailability of $Hg(II)_i$ and (2) Hg-methylation capacity of the microbial community, the relative importance of these factors under environmentally relevant conditions and the underlying biogeochemical constraints has not been addressed directly. Here, we conducted a MeHg formation assay designed to isolate the relative effects of $Hg(II)_i$ bioavailability and the microbial Hg-methylation capacity from sites across a sulfate gradient in the Florida Everglades. First, an enriched $Hg(II)_i$ stable isotope tracer was pre-equilibrated with porewater from six different sites along the sulfate gradient in Water Conservation Area (WCA) 1-3, as well as three other "control solutions" to further test our hypotheses regarding biogeochemical controls on $Hg(II)_I$ bioavailability, and then injected into intact peat cores taken from the same sites using a full factorial experimental design. MeHg production was quantified in each of these peat core incubations. Comprehensive biogeochemical analyses of the porewater and shotgun metagenomic sequencing of the peat cores to identify *hgcA*-carrying microbes were also conducted. The experimental results identified the relative importance of the aqueous biogeochemistry and the microbial community on MeHg formation. At sulfate-rich sites in WCA-2A, porewater with high $SUVA_{254}$ DOM promoted the bioavailability of $Hg(II)_i$ yet the lack of *hgcA* genes at these sites limited overall MeHg production. Conversely, at the low sulfate WCA-3A sites, high *hgcA* gene content drove high microbial Hg-methylation capacity but overall MeHg production was limited by low $Hg(II)_i$ bioavailability. Only at sites with high $Hg(II)_i$ bioavailability and high Hg-methylation capacity were high MeHg levels observed. Notably, *hgcA* sequences were from diverse taxonomic microbial groups, none of which contained genes for dissimilatory sulfate reduction. This work demonstrates that either $Hg(II)_i$ bioavailability or microbial Hg-methylation capacity can limit MeHg production under environmentally relevant conditions. It greatly expands our understanding of the geochemical and microbial constraints on MeHg formation *in situ* and of the impact of sulfate pollution on MeHg production in the Florida Everglades. Further, it also provides an experimental framework for further mechanistic studies of MeHg production or other metal transformations.

MODELING TROPIC LINKAGES: DRY SEASON PREY CONCENTRATIONS OF AQUATIC FAUNA AND WADING BIRD NESTING

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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 2005-2022, 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 199,684 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 – 2022 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 effort for Great Egrets and White Ibis was positively associated with high foraging density in the month of April. This pattern supports the *Foraging Distribution Hypothesis*, which suggests that nest effort is related to factors that produce large foraging aggregations of birds rather than being a simple function of hydrologic conditions. Wood Stork nest effort was negatively associated with the number of days water rises during the dry season. This supports the *Progressive Drydown* Hypothesis, which predicts nesting effort is highest when water levels continuously drop throughout the breeding season exposing a large amount of foraging habitat. This first quantitative attempt to develop a wading bird food availability performance measure 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.

REAL-TIME MONITORING INDEX TO IDENTIFY CHANGING SALINITY CONDITIONS RELATED TO COASTAL ENVIRONMENT DISTURBANCE EVENTS

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The Coastal Salinity Index (CSI) is a long-term monitoring tool developed in 2017 to identify changes in coastal water environments due to extreme events such as drought and floods. The CSI classifies the salinity at a water-quality gage relative to historic measurements to indicate the changing severity of the saline (or freshwater) conditions at that location and can be calculated for various time intervals to evaluate short- and long-term conditions. The CSI can be used to characterize coastal drought, monitor changing salinity conditions, and improve understanding of the effects of those changes on fresh and saltwater ecosystems, fish habitat, and freshwater availability for municipal and industrial use. In 2019, the U.S. Geological Survey (USGS) published a website to disseminate real-time CSI results for 17 USGS South Atlantic Water Science Center salinity gages. Funding provided from the USGS Community for Data Integration in 2020 expanded the network to 130 gages located from Maine to Texas and Puerto Rico by including additional real-time salinity gages from the USGS, Everglades National Park, and the National Estuarine Research Reserve System. The real-time dissemination of this index provides a decision support tool that researchers and water-resource managers can apply to ecosystem monitoring, management, and restoration activities. This poster will describe the CSI website (https://www2.usgs.gov/water/southatlantic/projects/coastalsalinity), including the available mapping and graphing applications.

WHAT CAN THE TRENDS IN PERIPHYTON ENZYME ACTIVITY WITHIN THE STAS TELL US?

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The Everglades Stormwater Treatment Areas (STAs) play a critical role in Everglades Restoration by reducing phosphorus (P) from stormwater runoff before it enters the Everglades Protection Area. Nutrient cycling by periphyton may be a critical mechanism in achieving nutrient reduction, particularly in the lower reaches of the treatment cells or flow-ways where nutrients are primarily in the dissolved organic and particulate forms. Enzymes produced by the periphyton can liberate nitrogen (N) or P from the dissolved organic fraction, reducing nutrient limitation and potentially resulting in lower nutrient concentrations in the water column. To evaluate enzyme effects in the STAs, this study measured various enzymes from periphyton grown on artificial substrates within three STA cells (STA-2 Cells 1 and 3 and STA-3/4 Cell 3B). Enzyme activity for carbon (C), N, and P (B-glucosidase, leucine aminopeptidase, alkaline phosphatase, and bis-diesterase) were measured within the STA treatment cells at three locations, representing the inflow, mid and outflow transect locations. Because the STAs receive variable hydraulic loadings that can affect TP retention, the enzyme activity was analyzed under flow and no flow conditions. The potential influence these conditions have on nutrient-limiting conditions and dissolved organic nutrient cycling within the dominant vegetation communities (i.e., emergent or submerged aquatic vegetation, EAV and SAV, respectively) was evaluated. Enzyme activity was highly variable along the transect. During flow conditions, significantly different activity was observed at the inflow compared to the mid and outflow regions for all enzymes measured. During no flow, only P-enzyme activity differed significantly along the transect. Ratios of enzyme activity, used to evaluate N and P limiting conditions, were significantly different at the inflow compared to the other locations. These ratios indicated N-limiting conditions at the inflows and P-limiting conditions at the mid and outflow sites. These P limiting conditions were more pronounced for SAV periphyton compared to EAV. Enzyme activity differed among the STAs; STA-2 had higher N-enzyme activity and less P-enzyme activity compared to STA-3/4, suggesting increased P-limiting conditions exist within STA-3/4, and greater N-limited conditions are present at most locations within STA-2. These results indicate that flow affects enzyme activity, the STAs may be highly P-limited. However, the extent of P or N-limitation differs between the STAs, and that the activity between the EAV and SAV periphyton was similar at the outflow for all enzymes measured.

ASSESSMENT OF A PEROXIDE-BASED ALGAECIDE PRODUCT FOR POTENTIAL CONTROL OF CYANOBACTERIA IN LAKE OKEECHOBEE: A MESOCOSM STUDY

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The large-scale blooms that occur across Lake Okeechobee warrant effective control and mitigation strategies. To evaluate the effectiveness of a USEPA-registered peroxide-based algaecide (formulated as sodium carbonate peroxyhydrate) for controlling cyanobacteria in Lake Okeechobee waterways a three-day small-scale field study was conducted in the summer of 2019 in enclosed *in situ* mesocosms in Pahokee Marina. Mesocosms containing natural populations of cyanobacteria were deployed with either no algaecide or the maximum label rate of 10 mg $H_2O_2 \cdot L^{-1}$. A subset of algaecide treated mesocosms were then subjected to a sequential application of 5 mg $H_2O_2 \cdot L^{-1}$ at 48 h after initial treatment. Following applications, peroxide concentrations rapidly decreased and were non-detectable by 48 h. Within 10 mins of application, substantial pigment loss was visible. 24 h after treatment, significant decreases were observed in all biomass indicators compared to untreated mesocosms, including extracted chlorophyll *a*, cell counts (total phytoplankton and total cyanobacteria), and cyanobacteria-specific 16S rRNA gene copies by over 71%. Although peroxide treatment reduced cyanobacteria biomass, there was no change in overall community structure and the remaining population was still dominated by cyanobacteria (>90%) 72 h after treatment. By 48 h exposure, some biomass recovered in single application mesocosms resulting in only a 32–45% reduction in biomass, while repeated peroxide dosing resulted in the greatest efficacy, which had a sustained decrease (60–91%) in all biomass indicators for the 72 h study. This suggests that a sequential treatment is likely necessary to sustain efficacy when using this approach to manage cyanobacteria in the field. Results of this study support the evaluation of peroxide-based algaecides for rapid short-term relief from cyanobacterial harmful algal blooms in scalable field trials to assess its potential future utility for operational management programs in the Lake Okeechobee waterway. Future research is required to investigate and refine this technology under operational field settings. Work is also required to determine the sensitivity of various cyanobacteria species to avoid potentially more toxic succession events in mixed populations.

AN INVASIVE PREY PROVIDES LONG-LASTING SILVER SPOON EFFECTS FOR AN ENDANGERED PREDATOR

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Conditions during early development may influence key biological and behavioral processes that affect individual organisms over long time periods and can feedback to influence population dynamics. Silver spoon effects occur when an individual reared in favorable conditions incurs benefits, with outcomes that may influence survival, morphology, and fitness. For the critically endangered Snail Kite (*Rostrhamus sociabilis*), recently-observed increases in survival, reproduction, and population size have been linked to invasion of wetlands in the southeastern US by an exotic snail. Exotic snails increase food availability for Snail Kites and can affect habitat quality and individual quality. Using 17 years of data on 2,588 individuals across the entire US breeding range, we tested for silver spoon effects on survival and movement and whether the invasion of a non-native snail may alter outcomes. We modeled survival rates of Snail Kites using a multistate extension of the Cormack-Jolly-Seber model to account for imperfect detection. We found support for silver spoon effects on survival that operated through body condition at fledging, explained by hydrology in the natal wetland. When non-native snails were present at the natal site, kites were in better condition, individual condition was less sensitive to hydrology, and kites fledged across a wider range of hydrologic conditions, leading to higher survival that persisted for at least 10 years. Movement between wetlands was driven by the current (adult) environment, and birds born in both invaded and uninvaded wetlands preferred to occupy invaded wetlands post-fledging. These results illustrate that species invasions may profoundly impact the role of natal environments on native species and point to individual condition at fledging as a key indicator for habitat quality.

USING HERBICIDES TO CONTROL SALIX CAROLINIANA AND RESTORE MARSHES IN THE ST. JOHNS RIVER FLOODPLAIN

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Since the 1980s, there has been widespread shrubification of herbaceous marshes by Carolina willow (*Salix caroliniana*) in the upper St. Johns River basin (USJRB) in Florida. This primarily occurred due to lower frequency flooding and burning. Consequently, managers at the St. Johns River Water Management District have been actively investigating the use of herbicides to control Carolina willow where hydrology and fire has not been used effectively. We present the responses of willow communities to application of different herbicides (metsulfuron methyl, imazapyr, and glyphosate) and assess the impact on the willow canopy and understory plant communities. In both investigations, we found that willow canopy cover was significantly reduced by herbicide treatment for up to 5-6 years. However, we project that willow canopy will return to pre-treatment cover in about 14 years, requiring follow-up herbicide treatments and/or other interventions, such as mechanical removal, if feasible. Reduction in willow cover resulted in the increase of herbaceous ground cover, especially forbs and graminoids. In one study, there was sufficient herbaceous cover to carry a fire during a prescribed burn in the sixth-year post-treatment, which indicates that we can restore the pyric nature of herbaceous marshes using this type of approach. We demonstrated the successful use of herbicides to control willow in the short-term and suggest that restoration of appropriate hydrologic and fire regimes be implemented to prolong the treatment effect and to promote long-term sustainability of herbaceous wetlands. Because few herbicide studies monitor off-target effects and reinvasion for more than a couple of years, results from our continuing studies in the USJRB should offer much-needed information on managing willow and other invasive shrubs around the globe.

PHOSPHORUS RETENTION OF STA ECOTOPES

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The Everglades Stormwater Treatment Areas (STAs) are wetlands constructed to reduce total phosphorus (TP) concentrations from runoff prior to discharge to the Everglades Protection Area. Key factors in STA function are wetland plant communities that directly or indirectly remove phosphorus (P) from the water column. This study evaluates the effect of wetland ecotopes, i.e., contiguous homogenous vegetation communities, on TP concentrations in the water column. Research at the ecotope scale captures the influence of vegetation communities on water quality that are not observed at a landscape scale while keeping key ecological factors present in the STAs that are not included in finer scale mesocosm research. Four different ecotopes in the outflow regions of STA-3/4 Central Flow-way were monitored for water quality, physico-chemical properties, and soil characteristics for one year. Ecotope types included a dominant *Chara* spp. ecotope, a dominant *Typha domingensis* ecotope, a codominant *Najas guadalupensis* and *Typha domingensis* ecotope, and an open-water/bare ecotope. The *Chara* spp. ecotope had the lowest estimated annual TP flow weighted mean concentration (FWMC) of all ecotopes measured, followed by the *Typha domingensis* ecotope. Differences in ecotope annual FWMC were smaller than the effects from season, water depth, or flow. Although the effect of ecotope type only ranged up to 1 µg L^{-1} this could be a meaningful difference when ambient TP concentrations are only 10-15 µg L^{-1}. These findings are based on one flow-way where the great majority of flow occurred during the late wet season. Because the P retention rates of ecotopes changed differentially by season the distribution of flow throughout the year is key to determining which ecotope will retain the most P annually. Further research is ongoing to provide greater confidence in these findings and expand the study to additional STA flow-ways and ecotope types. This study should provide guidance to vegetation management decisions for optimizing P retention within the STAs giving them the best chance to meet TP discharge requirements.

HYDRAULIC CONDUCTIVITY OF EVERGLADES PEATS

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Hydraulic conductivity is defined as the ability of a porous medium to transmit water and is the foundation of determining groundwater flux. Along the coastal Everglades, peat soils overlie the more permeable limestone of the Biscayne Aquifer. The assumed lower hydraulic conductivity of the peat soils may inhibit water movement through them. The purpose of this investigation was to 1) determine the hydraulic conductivity of both sawgrass and mangrove peats within the Shark River region of Everglades National Park and 2) determine if the hydraulic conductivity of the peat changes upon short-term exposure to salt water. Triplicate soil cores were collected from three of the Florida Coastal Everglades-Long Term Ecological Research stations (SRS2, SRS4, SRS6) located in Shark Slough. Sawgrass peat was collected at sites SRS2 and SRS4, while mangrove peat was collected at sites SRS4 and SRS6. The soil cores extended from the ground surface to depths ranging from 50 to 87 cm. Vertical hydraulic conductivity of the peat cores was determined from falling head tests using surface water collected from each site with salinities ranging from 0.1 to 24.7 psu. Falling head tests were also conducted on the cores using surface water from SRS6 with a salinity of 30 psu. Specific yield, a value often equated with effective porosity, as well as bulk density of the peat were determined. Sawgrass peat was found to have a higher vertical hydraulic conductivity (1.35 x 10^{-3} cm/sec) compared to mangrove peat (2.7 x 10^{-4} cm/sec). Additionally, sawgrass peat was found to have higher specific yields (9-17%) compared to mangrove peats (5-7%). Exposure of the peat cores to water of higher salinity (30 psu) for about 2 weeks had no effect on the hydraulic conductivity. The results of this investigation can be applied to hydrologic models of groundwater and surface water interactions in the coastal Everglades. *This material is based upon work supported by the National Science Foundation through the Florida Coastal Everglades Long-Term Ecological Research program under Grant No. DEB-2025954 as well as the* Grant Nos. HRD-1547798 and HRD-2111661 awarded to Florida International University as part of the Centers of Research Excellence in Science and Technology Program.

ASSESSING PLANT TAXONOMIC AND FUNCTIONAL DIVERSITY ALONG HYDROLOGIC GRADIENTS: AN INTEGRATED FIELD AND REMOTE SENSING APPROACH.

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Plant communities vary considerably in space and time and evaluating taxonomic and plant functional diversity across these communities along environmental gradients offers a better understanding of how species assemble. Plant functional traits, a measure of functional diversity, reflect differences in resource use patterns in plant communities along a resource gradient, ranging from fast-acquisitive to slow-conservative traits. As a feasible and non-intrusive option for monitoring in situ plant community characteristics, remotely sensed data combined with field observations offers an opportunity to evaluate the relationship between spectral variability and species diversity. WorldView-2 satellite imagery contains high-resolution imagery at local scales, covering large geographic extents, making it an effective remote sensing tool for monitoring plant communities at local and landscape scales. The Florida Everglades ecosystems has undergone large-scale drainage and restoration, altering freshwater plant communities throughout the region, particularly along the hydrological gradient present between the marl prairies and the ridge & sloughs. Along this gradient, plant diversity, aboveground functional traits, and soil characteristics are generally impacted by increasing wetness, and thus ideal for assessing variation in plant taxonomic and functional diversity along a hydrological gradient. Furthermore, WorldView-2 data is a reliable method for monitoring vegetation changes in Everglades communities, thus suitable for testing the relationship between spectral variability and fine-scale species diversity in wetland communities. Sampling was conducted at thirty-seven sites located in the Taylor Slough basin and eastern portion of the eastern prairies. At each site, plant species cover and aboveground functional traits (plant height, leaf mass area, specific leaf area, leaf nutrient) were recorded in 3 x 1 m^2 plots and used to calculate taxonomic and functional diversity. Furthermore, hydrological explanatory variables derived from monitoring network sites and used to calculate 4-year mean water depth, hydroperiod, and total number of wet/dry events. For the second part of our investigation, multispectral variables (normalized difference vegetation index and spectral heterogeneity) from WorldView-2 data were extracted from the sampling plots and used as explanatory variables. Functional traits expressed along the hydrological gradient are expected to represent fast-acquisitive traits along the wetter portions of the gradient, whereas slow- conservative traits are expected along the drier portions of the gradient. Conversely, spectral variability is expected to be greater in drier portions of the gradient than in wetter portions. In the context of Everglades restoration, it's extremely important to consider the changes in taxonomic and functional diversity of wetland plant communities and the effect restoration is having regionally.

INVASIVE SNAILS ALTER MULTIPLE ECOSYSTEM FUNCTIONS AND SERVICES IN SUBTROPICAL WETLANDS

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Invasive species that compromise ecosystem functioning through direct and indirect (or cascading) pathways are a rising global threat. Apple snails (*Pomacea* spp.) are semi-aquatic freshwater invaders that have exerted devastating ecological and economic impacts on agricultural wetlands and are emerging as a major threat to the structures and functions of natural wetlands. In this research, we conducted a field mesocosm experiment in subtropical wetlands in Florida, USA to investigate how *P. maculata* alter a suite of wetland vegetation, water, and soil processes and how these effects vary across wetlands under two different management intensities. Overall, we found that invasive snails substantially decreased aboveground biomass and vegetation cover and exhibited preferential feeding on wetland plant species. In addition, snails increased water nutrients (e.g., total carbon, nitrogen, phosphorous and dissolved solids), but showed minimal impacts on soil pools and processes. While most effects of invasive P. maculata were similar across wetland types, certain responses (e.g., algal biomass) were divergent. Our study provides holistic evidence on multiple direct and indirect consequences of invasive apple snails along the wetland plant-water-soil continuum. By altering plant assemblages and nutrient cycling (e.g., via consumption, egestion, and excretion), P. maculata invasion could hamper vital wetland services, which is concerning for these globally vulnerable ecosystems. Differential snail effects across management intensities further suggest the need for tailored actions to mitigate apple snail impacts and conserve wetland ecosystems.

CHARACTERIZATION OF CANAL AND MARSH CHEMICAL COMPOSITION WITHIN THE EVERGLADES BASIN

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Typically, phosphorus is present in small concentrations in natural ecosystems. However, anthropogenic influences such as agricultural practices can contribute phosphorus to downstream oligotrophic wetland systems causing eutrophication. Periods of elevated total phosphorus concentrations have been observed in discharge waters at the S333 structure near the northern border of Everglades National Park. High total phosphorus concentrations in discharge waters from the S333 structure may end up in northeast Shark Slough. The purpose of this study is to characterize canal and marsh floc and sediment chemical composition at and upstream of the S333 structure. The sampling sites cover the upstream area of L29, L67A, Miami canals and S333 structure as well as the adjacent wetland. Sediment and floc samples were fractioned based on particle sizes for silt (0.002-0.05mm), sand (0.05-2.0mm), and gravel (>2.0mm) with the dry-sieving method. The top two layers (0-5cm and 5-10cm) of sediment samples were analyzed. Various analyses, including total phosphorus, phosphorus fractionation, adsorption and desorption, and sediment particle analyses were conducted. Canal samples showed higher total phosphorus levels than marsh samples, and floc exhibited higher concentrations than sediments. Silts have higher total phosphorus concentrations than sand, and the 0-5cm layer showed a higher level than the 5-10cm layer. The canal samples had higher calcium and magnesium bound phosphorus, while the marsh samples had higher water soluble and exchangeable phosphorus. The fractionation analysis showed that phosphorus fractions were the same for floc and each layer of sediment. The canal and marsh samples showed similar adsorption capacity, but the floc had higher adsorption capacity than sediments. Higher total phosphorus concentrations in floc and 0-5cm samples also suggest that the top layer has a higher potential for exchange with water as compared to the deeper 5-10cm layer.

MANGROVE MORTALITY AND RESILIENCE FOLLOWING HURRICANE IAN IN SOUTHWEST FLORIDA

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Mangrove forests are damaged during hurricanes by high-speed winds and wave energy, but they can also face long-term stress and delayed mortality months after the hurricane from standing water and overwash sediment deposits that can suffocate tree roots. Mangrove forests recover from hurricane impacts at different rates, and those forests already stressed by altered hydrology from surrounding roads or impoundments may experience delayed recovery. Fifteen plots in eight mangrove forests across Charlotte Harbor and the Ten Thousand Islands were monitored following Hurricane Ian, which made landfall in Southwest Florida as a high-end Category 4 storm in September 2022. Permanent monitoring plots were established in the fringe and basin of the selected mangrove forests, which encompassed a spectrum of hydrologic conditions and hurricane impacts. Initial monitoring was conducted 3 – 4 months post-storm and included documentation of canopy cover, recent tree mortality, trunk impacts, branch loss, sapling and seedling density, thickness of the storm surge deposit, and soil shear strength. Water level loggers were also installed at selected sites. Across the eight Charlotte Harbor plots, recent tree mortality in each plot ranged from 0 to 80% and severe branch loss was observed in 5 to 69% of trees. The overwash sediment deposit thickness ranged from 0 to 10 cm, and seagrass wrack was found as high as 2.94 m above the forest floor. Monitoring will be conducted at 3 – 6 month intervals to document vegetation recovery, delayed mortality, and hydrologic conditions.

APPLICATION OF CFD TO RESTORATION HYDRAULICS IN EVERGLADES RESTORATION PROJECT

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S-333 along with the recently constructed S-333N spillways, located at the intersection of the L-67A Borrow Canal and the L-29 Canal in Miami-Dade County, control discharges from Water Conservation Area (WCA)-3A to the Everglades National Park (ENP) as a part of Comprehensive Everglades Restoration Plan (CERP). Frequent occurrences of high total phosphorus (TP) transport through the S-333/S-333N complex has long been a concern. As a complement to the sediment and TP transport studies conducted by the National Park Service (NPS) and U.S. Army Corps of Engineers (USACE), this study presents a hydrodynamic analysis of the local area around the S-333 complex to analyze the pertinent hydrodynamic features that can potentially induce sediment and TP transport through the structures. Instead of relying on physical models, a three-dimensional Computational Fluid Dynamics (CFD) modeling has been used to examine the local velocity fields under low and high-water depths at the spillways and within the canals and marsh areas in immediate proximity of the structures. Engineering measures for potentially reducing sediment and TP transport were also evaluated. This successful case study demonstrates that CFD modeling, utilized in conjunction with field monitoring and laboratory studies, is not only cost- and resource-effective but can also lead to better designed physical models and monitoring networks that are normal components of general hydraulic engineering applications.

RESTORATION IN THE CONTEXT OF CLIMATE CHANGE

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Climate change represents an existential threat to many aspects of the South Florida ecosystem and the people who value and rely on it. Several previous National Academies' biennial reviews of Everglades restoration progress have discussed the need to consider rise in sea level, change in precipitation patterns, and increasing temperature conditions. The 2022 report focuses on how climate change and variability can pose risks to the Central Everglades Restoration Plan (CERP) at various stages of its development and implementation. South Florida will experience increases in sea level and air temperature in the future and while changes in precipitation are uncertain, increased evapotranspiration will reduce runoff. A combination of SLR and reduced runoff could exacerbate peat collapse in areas such as that addressed by the Biscayne Bay Southern Everglades Ecosystem Restoration (BBSEER) project. The committee found that while there has been progress in integrating sea level rise considerations into project planning, lack of USACE guidance on the use of precipitation/temperature information in quantitative analysis is limiting the consideration of climate change overall. This can lead to the risk of advancing a project that is not viable under climate change. For projects like BBSEER, existing modeling tools constrain planning for SLR and climate change. Sea-level rise is presently treated as a step change between time slices, rather than a progressive driver of change. The planning process for future projects would also benefit from early development of scenarios of future precipitation and temperature change, and changing variability, and a strategy to use them. The committee discusses how some aspects of climate change can influence the operations of CERP projects, highlighting the Lake Okeechobee operations, and reviews the role of System Operating Manuals in efforts to adapt to climate change. Updates to operating rules provide an opportunity to incorporate the latest data and projections, enabling operation of the system to better incorporate understanding about changing climate and climate variability. To be successful, CERP cannot assume the future will be well represented by the past. Systemwide analysis of climate change on CERP performance is needed to assess the robustness of the restoration effort to possible futures, and support decision making. The ongoing CERP Update provides an opportunity for such analyses.

SEAGRASS SEASCAPE STATE, STABILITY, AND FUNCTION IN RELATION TO WATER QUALITY IN BISCAYNE BAY

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Biscayne Bay submerged aquatic vegetation (SAV) communities are composed mainly of seagrass species and provide many valuable ecosystem functions and services. These seagrass communities are dynamic, displaying spatiotemporal variation in the amount and configuration of seagrass seascapes but have been declining overtime. These seagrass seascapes have been shown to be influenced by freshwater inflows and proximity to freshwater canals, indicating that water quality likely plays a major role in the state, stability, and functioning of these important habitats. Proper management of seagrass ecosystems requires more information on the causes and impacts of shifts in seascape state, stability, and functioning. Water quality is increasingly becoming an issue in Biscayne Bay leading to problems for seagrass ecosystems and their biota. However, more information is needed to understand how water quality influences spatiotemporal patterns in the state, stability, and function of seagrass seascapes across Biscayne Bay. Here we present a new project that focusses on understanding the drivers of seagrass seascape state, stability, and functioning in Biscayne Bay. We will address three main objectives: 1) Quantify the spatiotemporal patterns of the state and stability of seagrass seascapes, 2) Quantify the relationship between seagrass seascape state and stability and seagrass function, and 3) Determine the relationship between water quality and seagrass seascape state, stability, and function. We will use a hypervolume approach that uses long-term seagrass monitoring and remote sensing to quantify the state and stability of seagrass seascapes, *E*-scapes to quantify the trophic functioning of seagrass seascapes, and boosted classification trees and generalized linear models to determine the relationship between water quality and seagrass seascape state, stability, and functioning. The outputs from this project will provide valuable information about spatiotemporal trends and how water quality influences seagrass seascape state, stability, and functioning that will better allow for the planning and prioritization of restoration and management actions for seagrass seascapes in Biscayne Bay.

TEMPERATURE AND FLOODING DURATION MEDIATE THE STRUCTURE OF A MARSH PREY SUBSIDY IN THE COASTAL EVERGLADES

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Riverine floodplains serve as an important link between terrestrial and aquatic systems, as the rising and falling of water drive spatial food web subsidies that are critical to the functioning and stability of riverine ecosystems. As these systems are increasingly impacted by hydrological alterations and climate change, it is important to understand how floodplain-associated spatial food web subsidies may respond to changing environmental conditions. Here, we examine the interannual variation in the structure of a sunfish (*Lepomis* spp.) prey subsidy from freshwater marshes into the mangrove-lined creeks of Rookery Branch in the Florida Coastal Everglades that occurs during seasonal dry downs and evaluate how it relates to prior temperature and hydrological regimes. We evaluate the dry season prey subsidy based on 16 years of electrofishing data and relate it to the duration and magnitude of flooding and low-temperature events. We found that interannual variation in the abundance and diversity of the sunfish prey subsidy was best explained by the minimum water temperature occurring within 90 days prior to peak abundance sampling periods, with lower minimum water temperatures associated with higher sunfish abundance and diversity. In contrast, interannual variations in the biomass of the sunfish prey subsidy were positively related to the duration of marsh flooding over 30 cm depth during the prior wet season. Multivariate analysis of community abundance and biomass composition revealed that minimum water temperatures played an important role in structuring the prey subsidy, while flooding duration had a weak effect. These results provide important insight into how floodplain prey subsidies may be altered under future climate and hydrological regimes and inform ecosystem-based water management decisions.

QUANTIFYING POST-HURRICANE REGENERATION OF MANGROVE SPECIES ALONG PHOSPHORUS FERTILITY GRADIENTS IN THE FLORIDA COASTAL EVERGLADES

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Mangrove wetlands are frequently impacted by hurricanes and have developed adaptations and intrinsic resilient traits to regenerate and cope with their destructive impacts. Yet, how species-specific variation in regeneration rates of early life stages interacts with environmental conditions following these recurring disturbances is poorly understood in neotropical mangroves. Here, we quantified how regeneration rates varied among three dominant species of mangrove seedlings and saplings (*Avicennia germinans, Laguncularia racemosa,* and *Rhizophora mangle*), along phosphorus (P) fertility gradients in Everglades National Park (ENP), south Florida, USA, following the passage of Hurricane Irma (September 2017). Through the support of the South Florida - Caribbean Cooperative Ecosystem Studies Unit, our project was able to build on long-term research on disturbance responses in coastal mangroves. We selected mangrove forests from midstream (lower P) and downstream (higher P) sites along the Shark, Harney, and Broad Rivers in southwestern ENP. From July 2020-July 2022, we measured seedling and sapling stem elongation (SE) growth biannually, porewater (PW) variables (salinity, sulfides, and inorganic nutrients) during the wet and dry seasons, and continuous measurements of light availability. Seedling and sapling SE rates varied across sites and among species. Overall, *L. racemosa* saplings showed the highest SE rate among all species across all sites (3.7 ± 0.4 cm mo^{-1}), followed by *R. mangle* (3.2 ± 0.1 cm mo^{-1}), and *A. germinans* (2.7 ± 0.2 cm mo^{-1}). Seedlings followed a similar trend with *L. racemosa* having the highest SE rate (0.9 ± 0.1 cm mo^{-1}), followed by *A. germinans* (0.7 ± 0.1 cm mo^{-1}), and *R. mangle* (0.7 ± 0.0 cm mo^{-1}). *L. racemosa* and *R. mangle* saplings showed the highest SE rates at the midstream site of Broad River, whereas *A. germinans* saplings had the highest rates at the midstream site of Harney River. For seedlings, *L. racemosa* and *R. mangle* had the highest growth rates at the downstream site of Shark River, and *A. germinans* had the highest SE rate at the midstream site of Harney River. Our results showed that mangrove regeneration rates vary among species within life stages and across mangrove forest sites but were not explained by P availability or PW variables. However, light availability within the forests accounted for 37-50% of the variability in SE rates of seedlings and saplings. To our knowledge, this is the first study that quantifies post-hurricane mangrove regeneration rates of seedlings and saplings for all three dominant mangrove species in the Everglades region. Given the increasing exposure of coastal mangroves to high-disturbance events such as hurricanes, particularly in neotropical northern latitudes, it is critical to quantify species recovery along environmental gradients to better understand how different mangrove ecotypes will respond to future ecological changes under a warming climate.

LANDWARD CREEK EXPANSION IN THE SOUTHERN EVERGLADES AND DISTRIBUTION OF HALOPHYTIC COMMUNITIES

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Sea-level rise induced landward expansion of creeks in coastal plains with low topographic relief, are expected to shift salinity gradients into freshwater marshes and to change plant community compositions. Increasing the connectivity of saline and brackish water flow into freshwater marshes is expected to increase encroachment of halophytic plants of coastal plant communities into freshwater communities. The objectives of this research were to quantify the spatiotemporal landward expansion of the Shark-Harney River creek system, and to understand the spatial relationship of the current spatial patterns in distribution of associated halophytic communities along the flow paths of the system. The geographic area of the study is the Shark-Harney River system located in the Western coastal plain of South Florida Everglades National Park. Tidal creek expansion was mapped by performing progressive segmentation of the current extent of the creek system, as referenced by historic aerial stereo photography, using the DAT/EM stereo plotter, at four intervals between 1952-2018. A spatial line density as a function of distance to the coast were modeled with generalized additive models for each time interval. Creek expansion was observed for localized areas at various distances from the coast. The preliminary results of tidal creek expansion showed that the total increase in length of the landward expansion of tidal creek system since 1960 was 17.9 kilometers. The average rate of expansion increased significantly from 476-1,047 meters per year, between 1960-1984. The results from the spatial line density analysis for segment increase between periods showed that the expansion of segments observed during the 1952-1960 and 1960-1973 time periods are evenly distributed between 16 to 25 km from the coast, whereas new creek segment development during the 1973-1984 and 1984-2018 time periods were denser at distances of approximately 20-25 kilometers from the coast. More importantly, the average range of the density values for each recorded time period shows progressive increase of values, with maximum values of less than 10 line segment per km2 between 1960-1973, to about 18-line segments per km2 for the years 1984 and 2018, respectively. As the process of tidal creek expansion constitutes a mechanism of saltwater intrusion, a bimodal distribution in the abundance of halophytic communities is expected to be observed, primarily at distances closest to the coast and secondarily in areas of high creek densities.

INCREASED PHOSPHOROUS AVAILABILITY IMPACTS SEAGRASSES IN BISCAYNE BAY, IMPLICATIONS FOR WATER QUALITY MANAGEMENT AND BISCAYNE BAY SOUTHEAST EVERGLADES RESTORATION (BBSEER) PROJECT

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Seagrasses provide essential fish habitat in the shallow underwater environments found throughout the estuaries of South Florida. Seagrasses only proliferate and survive in places with low nutrient availability. In Biscayne Bay, the availability of the nutrient phosphorus (P) controls the abundance, productivity and species composition of seagrasses. The nearshore region of Biscayne Bay existed for thousands of years in a nutrient-limited state. The addition of nutrients changes the balance and impairs the functioning of this ecosystem.

Much of the nutrient loading into southern Biscayne Bay is in the form of groundwater (Caccia and Boyer 2007, Brynes 1999). In central and northern Biscayne Bay surface water discharge, largely through canals, is the principal pathway for nutrient enrichment. Phosphorous delivered to Biscayne Bay via groundwater is likely to be absorbed by the sediments and the P-limited benthic ecological community before reaching bay surface waters (Byrne 1999). Seagrasses respond to higher levels of P in the sediment by increased uptake, through their roots. This in turn feeds a cascade of change in the composition of the benthic community and in the balance between slow-growing seagrasses and faster-growing algae (Fourqurean et al. 1992).

Recently analyzed data collected over a 20+ year period by Miami-Dade County reveal significant loss of the original benthic community. For example, a 16 percent loss of Thalassia cover and a 24 percent loss of total seagrass cover over a 20+ year period. At the same time there was a 23 percent increase in macroalgae cover from 1999-2021. Abnormally high P concentrations correlate with seagrass loss and shifts in nearshore ecology. In Biscayne Bay seagrass N:P ratios below 60 suggests that P availability is much higher than the historic ratio of 85. Continuous additions of P to this kind of system initially fertilizes seagrass beds, creating denser seagrass meadows, P accumulation is cumulative and permanent and so continued P loading leads to replacement of the seagrasses by macroalgae and ultimately a loss of all cover. Changes in the extent of seagrass beds and macroalgae accumulation in nearshore areas are consistent with this pattern of nutrient-driven habitat succession.

The state of Florida uses numeric nutrient criterion (NNC) that average surface water samples across a polygon (WIBID) that includes both offshore and nearshore areas that masks the P levels, which are higher in the nearshore and in groundwater. Biscayne Bay has never had a P violation; yet this is the limiting nutrient and is driving the seagrass loss across the bay. In addition the Everglades Restoration project, BBSEER focused on Biscayne Restoration does not consider reduction in nutrients as a goal, only a constraint. A greater focus must be paid to reducing and eliminating P inputs if we are to restore the benthic communities of Biscayne Bay.

HYDROLOGIC EFFECTS ON NET ECOSYSTEM EXCHANGE OF CO_2 IN THE SOUTHEASTERN SALINE EVERGLADES

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In the Florida Everglades changes in water level and salinity cause shifts in plant community composition. Given the varying carbon (C) sequestration capacities of Everglades wetland ecosystems, it is important to understand how saltwater intrusion alters C fluxes in transitioning ecosystems. The objective of this study is to understand the impact of changing hydrologic factors in oligohaline wetlands transitioning from a freshwater marl prairie to a brackish mangrove scrub. First, we quantified the impact of changing hydrology using surface water level and salinity data from the South Florida Water Management District's (SFWMD) public environmental monitoring database. Then we measured changes in net ecosystem exchange of CO2 (NEE) rates at an Ameriflux tower in the Southeastern Saline Everglades ecotone. Using generalized additive models (GAMs), we evaluated seasonal trends in water level and salinity and explored the relationship between salinity and water level at different locations in the coastal Everglades landscape. Next, we compared NEE rates under different water level conditions. We hypothesized that water level and salinity have increased over time and that water level and salinity relationships differed with distance from the coast. Increases in water level were expected to reduce salinity stress and thereby increase carbon uptake. This research will advance our understanding of sea level rise effects on C fluxes in coastal wetland ecosystems, underscoring the importance of restoration and managing ecosystems for C sequestration.

MULTI-SCALE HABITAT SELECTION OF SPOTTED SEATROUT IN AN AREA OF SEAGRASS RECOVERY

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A pressing need throughout South Florida, particularly in the coastal Everglades, is understanding the factors that promote sustainable ecosystem services. Of particular interest is the sustainability of recreational fisheries (one of the most economically and ecologically valuable ecosystem services provided by the Everglades) and the seagrass beds on which they rely. However, the seagrass and associated faunal communities have continuously experienced degradation over the past several decades. In particular, major reductions in freshwater inflows have led to 2 large-scale seagrass die-offs in Florida Bay, resulting in a reconfiguration of the seagrass seascape in the northcentral region. Using machine learning and resource selection functions, we investigated the habitat selection of Spotted Seatrout within this recovering northcentral region of Florida Bay at multiple scales within 2 Basins following different recovery trajectories. Preliminary results indicate that Spotted Seatrout prefer areas of high seascape complexity characterized by more edge habitat regardless of the within-patch characteristics of the SAV (Submerged Aquatic Vegetation). These results indicate that spatially-complex beds, a target of Everglades restoration, could have a positive influence on Spotted Seatrout occurrence in Florida Bay.

PREY SPECIES COMPOSITION, RICHNESS, AND DIVERSITY OF BURMESE PYTHON DIET IN FLORIDA

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Invasive species impacts are a high priority when planning the restoration and conservation of the Greater Everglades Ecosystem. Impacts have ranged from clogging waterways to altering food webs.
The Burmese python, an invasive predator that has invaded the region, consumes a diverse array of vertebrate prey across its range in southern Florida. Pythons have caused direct and indirect effects on trophic structure, the extent of which depends on how long the snakes have been present in a particular locale. There remain several unanswered questions about spatial, temporal, and/or size-related shifts in their prey species composition. Using more than 1700 necropsied pythons across south Florida, we assess how diet composition and prey richness are affected by python size and geographic region. Python diet data were subdivided into regions that reflect the expansion of the range from the southernmost Everglades, north to Water Conservation Area 3A, and west to Collier County. Since snake species often undergo ontogenetic shifts in diet related to gape limitations, we also defined six size classes. We estimated species richness through rarefaction-based species accumulation curves across the region. We used Bray-Curtis dissimilarity matrices to evaluate turnover and nestedness in the beta diversity of python diet among subregions and python size class. The estimated species accumulation curves did not reach an asymptote, suggesting that the number of prey species consumed by pythons will continue to increase, but this result may also be driven by data sparsity in prey types. Diet differed significantly across size classes, and both turnover and nestedness contributed to those differences. Continued efforts to characterize the python diet in the context of classic biodiversity measures (e.g., species richness and composition) can create food web networks to assess energy and biomass flows to inform ecosystem resilience in the Greater Everglades.

SEA LEVEL RISE IMPACTS ON PRIORITY HABITATS AND SPECIES

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Florida's low elevations and more than 13,500 km of coastline leave the state vulnerable to rising seas. With an estimated 350,000 people moving to Florida annually, unprotected ecosystems may be threatened by land use conversion for urban expansion. To examine the potential threats of sea level rise and urban conversion in 2040 and 2070, we developed six scenarios representing combinations of intermediate and high sea level rise paired with two types of urbanization, sprawling and compact. We focused on potential future threats in High Pine and Scrub, Coastal Uplands, and Freshwater Aquatics ecosystems throughout the state. We found projected decreases in spatial extent of these priority ecosystems into the future. The greatest projected losses were in Coastal Uplands with estimates of up to 47% reduction. In protected areas, the threat of urban expansion may only extend to the borders, but the impacts of sea level rise may be significant, particularly for coastal ecosystems. We conducted a more detailed examination of potential sea level rise effects on the endangered Cape Sable seaside sparrow (Ammospiza maritima mirabilis) which occurs on protected lands near the coast and is therefore likely vulnerable to sea level rise. Three of the sparrow's six subpopulation areas (A, B, and D) are proximate to the southern and western coasts of Florida. We used intermediate and high sea level rise projections and incorporated current Everglades water operations into our analysis. We used the EverSparrow model to estimate the predicted probability of sparrow presence for each of the three coastal subpopulations. Within approximately 50 years, probability of presence is expected to significantly decrease, with limited areas above 40% probability. Our results show projected losses in biodiversity, including for an endangered species; however, there are solutions for reducing these losses. Outside of protected areas, we found that Florida's current urbanization practices lead to projections indicating greater impact on priority ecosystems compared to practices that reduce urban sprawl. Although habitat for the Cape Sable seaside sparrow is protected from urbanization, sea level rise impacts have already been observed through shifts to more salt-tolerant vegetation. However, continued restoration of the Everglades has the potential to allow water releases at specific times of year to reduce impacts of salinity on the ecosystem.

DYNAMICS OF VEGETATION COMPOSITION AND DIVERSITY DURING COASTAL TRANSGRESSION IN THE C111 WATERSHED SINCE 1995

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While not locally rich in plant species, coastal wetland landscapes in the Everglades provide a diverse habitat mixture that supports robust faunal communities. During coastal retreat driven by sea-level rise, zonally arranged wetland communities may migrate inland. However, the transgression process must eventually be slowed or prevented by canals or roads, resulting in coastal wetland loss that may be preceded by a reduction in diversity. In this case study, we asked whether vegetation transgression over a 21-year period in a fixed band midway within the C111 basin resulted in reduced plant diversity at local or sub-regional scales. We sampled plant species composition and potential environmental drivers at 26 coastal wetland locations in 1995-96 and 2016-18, defined vegetation types by cluster analysis, and examined the trajectories of individual sites and 1995-defined types along environmental gradients in non-metric multidimensional scaling ordination space. α-diversity was assessed via the inverse Simpson metric, and β-diversity was determined during each sampling event as the total variance of the community matrices within 1995-defined types and across the study area. The application of a temporal beta diversity index allowed analysis of changes in among-site variation between surveys. Two broad vegetation types occupied the area – an open brackish scrub community dominated by the mangrove *Rhizophora mangle* closest to the coast, and an interior freshwater marsh in which sawgrass was the leading species. The vegetation ordination indicated a significant shift toward halophyte dominance over time, signaled also by a transformation of 5 of 12 marsh sites to mangrove scrub. Loss of salt-sensitive species caused α-diversity to decline slightly in scrub sites while remaining stable in the interior, where small decreases in freshwater-dependent taxa were matched by rapid mangrove colonization. Similarly, β-diversity was largely unchanged within types and across the study area over time. Our results suggest that sea-level rise-driven taxonomic homogenization in coastal wetland plant communities at sub-regional scales may be slow to develop, lagging niche-based changes in community structure and composition. Nevertheless, diversity metrics are fundamental for coastal restoration aimed at counteracting sea-level rise effects over the long term.

LOCAL AND SPATIAL VARIABILITY IN VEGETATION SPECIES COMPOSITION IN RELATION TO ENVIRONMENTAL HETEROGENEITY IN THE EVERGLADES ECOSYSTEM

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The ridge and slough (R&S) landscape in the Everglades ecosystem comprises a mosaic of flow-oriented sawgrass ridges, sloughs, and tree islands. The unique landscape patterning is crucial for ecosystem functioning and ecological, economic, recreational, and cultural habitat values. However, the ecosystem has been modified and is threatened by managed-induced changes in the hydrologic regime and other anthropogenic disturbances. Restoration efforts are underway with the general goal of reducing and reversing the degradation of the Everglades, including the R&S landscape. Past research in this ecosystem has evaluated the extent to which surface patterning is regulated and the factors associated with species composition dynamics. However, most works focus on a subset of the ecosystem, hindering our understanding of system-wide patterns and processes at local and landscape scales. In this study, our objectives were to assess the variation in microtopographic patterns, hydrologic conditions, and vegetation species composition and to evaluate how landscape patterning and species composition dynamics are associated with the hydrology, fire, and soil depth. We conducted our study over 11 years (2009-2020), and during those years, we sampled twice, 2009-2015 and 2015-2020. We recorded species cover, water depth, and soil depth in fifty-eight 2×5 km permanent sampling units (PSUs), each containing up to 135 1×1 m quadrat. We calculated fire frequency using the fire data obtained from Everglades National Park and Fish and Wildlife Conservation. We used model-based clustering techniques to examine the presence of bimodal distributions in elevation values as a proxy for conserved patterning. We analyzed data at local (primary sampling unit, PSU) and landscape (management blocks) levels to understand whether the association between landscape patterning, species composition dynamics, and environmental variables operate similarly or differently. Our results suggest variability in maintenance and loss of elevation bimodal distribution among PSUs across the landscape. Species composition dissimilarity strongly correlated with hydrology but varied among PSUs. Moreover, the relationship between species composition and environmental variables varied between management blocks. This study provides baseline measures related to the association between vegetation communities and microtopographic structures valuable for detecting changes/trends in the landscape system patterns due to water management operations and restoration initiatives.

A BAYESIAN NETWORK AS A DECISION SUPPORT TOOL FOR MANAGING THE CALOOSAHATCHEE RIVER ESTUARY

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Decision-making in water resource management has many dimensions including water supply, flood protection, and meeting ecological needs. It is therefore often complex, full of uncertainties, and contentious due to competing needs and distrust among stakeholders. It requires specialized tools for supporting the decision-making process and for communicating with stakeholders. This paper presents a Bayesian Network (BN) modeling framework for analyzing various management interventions regulating freshwater discharges to an estuary. This BN was constructed using empirical data from monitoring the Caloosahatchee River Estuary from 2008-2021 as a case study to illustrate the potential advantages of the BN approach. Results from three different management scenarios and their implications on down-estuary conditions as they affect eastern oysters (*Crassostrea virginica*) and seagrass (*Halodule wrightii*) are presented and discussed. Finally, the directions for future applications of the BN modeling framework to support management in similar systems are offered.

DIET ANALYSIS OF INVASIVE ARGENTINE BLACK AND WHITE TEGUS (SALVATOR MERIANAE) IN SOUTHERN FLORIDA

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Argentine black and white tegus (*Salvator merianae*) are large, omnivorous lizards native to South America. Tegus were introduced to southern Florida through the pet trade and have established populations in Miami-Dade, Hillsborough, Charlotte, and St. Lucie counties. Tegus are dietary generalists, with an affinity for consuming eggs, and predation of native wildlife and nests have been documented. Recent diet analysis of tegus in central Florida suggests predation of at-risk taxa and these findings are corroborated by historic diet data collected from tegus in southern Florida. We examined diet contents of tegus (n =294) captured in 2018 in southern Florida to document prey items and to identify potential impacts to native flora and fauna. We analyzed size, sex, and seasonal variables to infer ecological impacts. Our preliminary observations suggest that tegus are consuming various invertebrates, small mammals, and reptiles, with a primary focus on insects and fruits. Additionally, our preliminary observations indicate potential temporal variation of prey availability as we observed changes in tegu diet over time reflective of seasonal resource abundance.

LONG-TERM VEGETATION DYNAMICS IN CAPE SABLE SEASIDE SPARROW HABITAT: LESSONS LEARNED AND IMPLICATIONS FOR EVERGLADES RESTORATION

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Cape Sable seaside sparrow (CSSS), a federally endangered species, and its habitat, marl prairies, have been a pivot point for water management operations in Everglades for two decades, primarily due to a precipitous decline in sparrow populations during the early 1990s. The reasons for declines in sparrow numbers and deterioration of its habitat in four of six sub-populations (A-F) were attributed to management-induced changes in hydrologic regimes in the southern Everglades. Since the early 2000s, several restrictive measures as well as hydrologic restoration activities have been undertaken to ensure that there is no further damage to sparrow habitat, and to improve habitat conditions on both sides of Shark River Slough (SRS). The question is now how water management actions aimed at mitigating damage to Everglades' ecosystems caused by past management, including those associated with Comprehensive Everglades Restoration Plan (CERP), have affected CSSS habitat. With a goal of understanding the response of landscape-level processes to hydrological restoration, we studied spatio-temporal variation in vegetation structure and composition throughout the marl prairie landscape for 20 years (2003-2022). Our results show that marl prairie landscape vegetation change patterns over this period have varied spatially, primarily responding to hydrologic condition and its interaction with fire events. West of SRS, where sparrow habitat suitability has declined in 1990s, the vegetation in the northeastern part of sub-population A showed a drying trend or improvement in habitat quality, partly due to regulated water deliveries through the S12 structures implemented in 2002. In contrast, vegetation in the south and southwestern portion of sub-population A reflected wetter conditions in recent years than during the early 2000s. East of the SRS, vegetation in the southwestern portion of sub-population B and throughout sub-populations C, E and F was indicative of slightly wetter conditions in recent years. The vegetation shift in these sub-populations resulted from a broader restoration strategy, including the rehydration of the Rocky Glades and increased water deliveries through Northeast Shark River Slough (NESRS). Since the habitat deterioration in eastern sub-populations along the Everglades National Park boundary was considered to have resulted from over-drainage followed by frequent fire, only time will tell whether the recent vegetation shift towards a more mesic type will result in an improvement in habitat conditions. Our study has implications for Everglades restoration success in the marl prairie landscape where sparrow habitat conditions were damaged by past water management activities.

ESTIMATING WATER AND NUTRIENT RETENTION OF PAYMENT FOR WATER SERVICES PROJECTS ON SOUTH FLORIDA RANCHLANDS

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The Northern Everglades Payment for Environmental Services (NE-PES), a part of the South Florida Water Management District's Dispersed Water Management (DWM) program, commenced in 2011 as a multi-stakeholder solution to provide water retention and nutrient removal services in the Northern Everglades. In NE-PES water retention projects, water is held back on ranches by maintaining weirs at a predetermined height (termed as service elevation) in culverts on major drainage ditches and the resulting flooding decreases grazing areas for which ranchers are compensated. Nutrient retention projects under NE-PES involved pumping in water from regional canals into either reservoir where nutrients were taken up by soil and growing vegetation, or into fallow fields to grow forage grasses that are then harvested for winter cattle use. The objective of this talk is to provide a summary of the performance of water retention and nutrient removal projects over the last 11 years. This presentation details calculations and provides results of the amount of nutrients held back yearly by several projects. Water levels in the ditches are automatically monitored at a 15-minute resolution with respect to NGVD29 datum. The amount of water retained annually on individual ranch basins was equated to the sum of rainfall over the periods when the water level lies between the baseline and service elevations multiplied by basin area (acres) and divided by 12" to get volume in acre-ft. The baseline elevation is determined from the baseline storage volume (non-compensated) estimate related to the extent of wetlands and ditches in the basin. The amount thus calculated includes water that is lost due to evapotranspiration. For 4 representative water retention projects over 2011-2021, we estimated an average annual storage above baseline at 1.47 acre-feet/acre. For the nutrient removal projects, a wetland flow-through project retained on average 75% of the phosphorus and 47% of the nitrogen pumped in or received via rainfall (2011-2021). The forage harvest project annually removed around 3200 lbs. of phosphorus and 15000 lbs. of nitrogen from 188 acres (2018-2021). These results point to the efficacy of such approaches, which would need to be scaled up to cover wider areas across the Northern Everglades watershed and monitored to effectively address downstream water quantity and quality issues.

EFFECTS OF CYANOBACTERIA HARMFUL ALGAL BLOOMS ON MICROBIAL COMMUNITIES WITHIN LAKE OKEECHOBEE, FL, USA

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The Lake Okeechobee (Lake O) watershed is a Floridian freshwater ecosystem that has been affected by the increased frequency of harmful cyanobacterial bloom events occurring over recent decades. Lake O has several ecological and economic purposes such as providing habitats to various organisms, providing drinking water, and providing recreation to urban communities surrounding the lake. The toxic cyanobacterial bloom events are posing a threat to the ecosystem and economy of the lake due to the degradation of water quality. This study investigates how microbial community structure within Lake O is affected by annual cyanobacterial harmful algal blooms over several years. The objectives of this study were to assess the dominant taxa, temporal patterns, and spatial patterns within the microbial communities and to investigate the spatial and temporal scales at which cyanobacterial blooms affect these communities in Lake O. Filtered surface water samples were collected from 21 routinely monitored sites within and connecting to Lake O from March 2019 to October 2021. Corresponding environmental variables were also obtained from the South Florida Water Management District database, DBHYDRO. DNA extraction, purification, and polymerase chain reactions on the V4 region of the 16S rRNA gene were used to create amplicon libraries for high-throughput sequencing. A total of 541 samples were sequenced and underwent statistical analyses. After characterizing the dominant taxa within Lake O, the top five phyla include Proteobacteria, Bacteroidota, Cyanobacteria, Actinobacteriota, and Verrucomicrobiota. Significant differences were found between microbial communities based on temporal (year, month, and season) and spatial (ecological zone and station) scales—with spatial scale showing greater differences (ANOSIM, zone: $r=0.40$, $p=0.001$; station: $r=0.33$, $p=0.001$). Pearson's correlation test showed that there were significant negative correlations between alpha diversity indices, Shannon-Weiner, Inverse Simpson, and species evenness, to *Microcystis* relative abundance ($r = -0.38$, -0.29, and -0.76, respectively); while, a Mantel correlation test showed a significant positive correlation between beta diversity index, Bray-Curtis dissimilarity distances, and Chlorophyll *a* value (Mantel's $r = 0.26$, $p = 0.001$). These results suggest that there is a decrease in the alpha diversity and an increase in the beta diversity of the microbial communities of Lake O due to these blooms. No significant differences in microbial community alpha and beta diversity were found within the temporal and spatial scales of bloom occurrences (i.e., no bloom, before bloom, bloom, and one month after bloom). Yet, there were shifts in taxa abundance during these blooms. These observations from this study suggests that annual cyanobacterial harmful algal bloom events alter the microbial communities within Lake O and may help serve as indicators in the prediction of blooms.

BIG CYPRESS NATIONAL PRESERVE SCOUT SNAKE PROGRAM, WHERE WE'VE BEEN AND WHERE WE'RE GOING

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Management of the invasive Burmese python, *Python bivittatu*s, in the Greater Everglades ecosystem involves numerous partners implementing multiple control strategies. Big Cypress National Preserve (BICY) began radiotracking Burmese pythons in late 2017 and shortly after partnered with the U.S. Geological Survey (USGS), Fort Collins Science Center and the University of Florida. The resulting telemetry program, now called a scout snake program, focused on tracking adult male python breeding movements to locate and remove conspecific females from the Preserve. Over the past 5 years, the BICY scout program has expanded and in 2022 staff from the USGS Wetland and Aquatic Research Center joined the team. The BICY scout program collaborates with other scout programs managed by the U.S. Fish and Wildlife Service at Crocodile Lake National Wildlife Refuge, The Conservancy of Southwest Florida, and the South Florida Water Management District. The BICY scout python program has recently added females to the tracking program and collects important biological data on both sexes while continuing to remove associate pythons from the wild. Current research priorities for the BICY scout program include estimating vital rates of reproduction, survival, and individual growth rates, as well as studies of dispersal, habitat use, causes of mortality, and foraging behavior. The expansion of the scout program continues to improve our understanding of the biology and ecology of invasive pythons. Tracking pythons on a regular basis provides an opportunity to observe adult pythons in breeding season as they attract and locate one another, in nesting season as sites for oviposition are selected, and year-round as pythons move across the landscape and forage. We anticipate that scout python programs will continue to provide research opportunities and uncover novel insights into the impacts of pythons on the landscape with the goal of improving our ability to manage this invasive species in the Greater Everglades ecosystem.

SHIFT IN TROPHIC NICHE CHARACTERISTICS OF COMMON SNOOK AND ATLANTIC TARPON IN EVERGLADES COASTAL LAKES

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Freshwater inflows from terrestrial into coastal ecosystems are essential to many ecosystem processes. Freshwater inflows influence connectivity, salinity, nutrient fluxes, and physio-chemical regimes, leading to habitat quality and resource availability changes. Globally, anthropogenic land use, freshwater management, and climate change are altering the magnitude and connectivity of freshwater inflows into coastal ecosystems, especially in South Florida. Trophic interactions and food-web dynamics are important factors influencing the stability of aquatic communities; still, our understanding of the effects of altered freshwater inflows on ecological processes such as food web function and energy flow is limited. We assessed the trophic niche size and overlap of Common Snook and juvenile Atlantic Tarpon in two adjacent lake systems in the Coastal Everglades with different levels of freshwater inflow using stable isotope analysis, Bayesian mixing models, and a hypervolume analytical framework. In both systems, Snook had larger trophic niches than juvenile Tarpon. The trophic niche size was larger for Snook and juvenile Tarpon in the more disturbed, hydrologically disconnected eutrophic lake system than the mesotrophic system with more hydrologic connectivity. Trophic niche overlap between Snook and Tarpon was low in both systems suggesting limited resource competition between both mesoconsumers. Also, our results indicate that decreasing hydrologic connectivity through altered freshwater inflows increases the variability of resource use, likely due to the reduced ability of consumers to focus on preferred resources. Trophic niche dynamics (e.g., size and overlap changes) are responsive to changes in the environment and resource availability with possibly adverse or positive effects on mesoconsumer populations, thus, highlighting the need to incorporate trophic assessments into the coastal ecosystem monitoring and management efforts.

MODEL-BASED DESIGN RECOMMENDATIONS TO REDUCE CANAL FLOW IN THE BLUE SHANTY FLOWWAY

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To restore connectivity characteristic of the predrainage Everglades, the Central Everglades Planning Process-South (CEPP-S) project will build three new culverts in the L-67A levee and the north-south L-67D "Blue Shanty" levee bisecting WCA-3B. The project will also remove the L-67C levee between the L-67A and L-67D levees and reconnect WCA-3B to ENP by degrading the southern L-29 levee between the L-67A and L-67D. The resulting Blue Shanty Flowway (BSF) is intended to provide evenly distributed sheetflow from WCA-3B to ENP. In its current design, there are no canal plugs or backfill treatments proposed for the L-67C. However, the project is intended to incorporate findings from the DECOMP Physical Model (DPM), an Adaptive Management experiment evaluating benefits of restored sheetflow and canal backfill with levee removal. Conducted within the BSF footprint, DPM showed that without backfilling, natural sheetflow was re-routed through the L-67C canal, mobilizing P-enriched canal sediments, which subsequently caused eutrophication of marshes downstream of the levee gap. Extrapolated to the BSF, results suggest sheetflow will be re-routed by the L-67C canal, creating high canal flows and sediment mobilization, maximized at the southwestern terminus of the canal, nearest (~1.5 km north of) the BSF outflow boundary to ENP. These harmful impacts of canal flow, sediment mobilization, and concentration of flow (and P-loads) near ENP, however, could be alleviated with the inclusion of canal plugs or fill. Here we present a modeling approach used to identify the optimal design of canal plugs, fill, and levee modification to minimize canal flow and more evenly distribute sheetflow across the BSF. Flow fields and stages in the BSF are modeled using HECRAS 2D software. The model includes 14 vegetation classes which control flow resistance, and the simulation period covers October-December 2016 which includes sufficient variation in L-67A culvert discharges to evaluate low and high flow conditions. The model uses a variable mesh grid, with smaller grids for near-culvert marshes and within/adjacent to the L-67C, facilitating comparisons with observed data and evaluating flow targets. Simulations of current (pre-CEPP) conditions are checked for consistency with observed flows in DPM. Future conditions (completed CEPP-S) are simulated to evaluate 8-10 different (including no) canal and levee modification options. Boundary conditions (e.g., levee seepage and stages) were provided by simulating the Regional Simulation Model (RSM) for the same period for current and future scenarios. The RSM output also provides a means to check consistency of flow fields between RSM and BSF for interior marshes in WCA-3B. Results from current conditions and future scenarios will be presented, as available. Next steps and how this work fits into the CEPP-S project delivery schedule will also be discussed.

TWO DECADES OF RESTORATION SHAPE RARE PLANT COMMUNITIES ALONG AN ELEVATIONAL GRADIENT IN SOUTH FLORIDA

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Quantifying the response of plant diversity to large-scale restoration is essential for measuring management success. One of the world's largest restoration efforts began in 2000 in Everglades National Park through the Comprehensive Everglades Restoration Plan. This restoration effort, in coordination with ongoing fire management, aims to restore natural hydrologic and fire regimes in this dynamic ecosystem. Restored water and fire regimes in the Everglades interact along an elevational gradient between seasonally inundated marl prairie and frequently burned pine rockland in Long Pine Key. Long Pine Key is critical for management success because it holds the largest intact segment of the globally critically imperiled pine rockland ecosystem. To determine the effects of management on plant community richness and composition in Long Pine Key we resampled transects spanning the elevational gradient between marl prairie and pine rockland originally sampled prior to the implementation of current restoration efforts (c. 1997-1999). We measured precent plant cover and species presence/absence and developed two separate generalized linear mixed models to determine the effects of fire frequency, inundation, and elevation on plant species richness and composition across the two time periods. Additionally, we used species random effects to examine how individual species respond to each environmental variable. We failed to detect any systematic shifts in plant composition in response to updated fire and water management. However, we found that complex interactions between fire and water structure plant species richness and composition along the elevational gradient. Additionally, species-level random effects showed that species endemic to the system increased while invasive species decreased between the two time periods indicating effective management of these species groups. Overall, we find that the plant communities within Long Pine Key are highly resilient to an ecologically relevant range of fire and water management.

DISTRIBUTION, ABUNDANCE, AND COMMUNITY COMPOSITION OF AMPHIBIANS IN THE EVERGLADES ECOSYSTEM.

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As amphibian populations around the globe continue to shrink and suffer enigmatic declines, it is critical to utilize systematic studies to isolate causes and provide target recommendations for key environmental variables. Unfortunately, our recent analysis of three long-term datasets collected between 1996-2019 that include nearly 13,000 individual amphibians from 87 sites dispersed across the Everglades shows that amphibian populations have declined dramatically, ranging from 66% - 88%, over the last 25 years. However, despite the inclusion of a large suite of abiotic (e.g., multiple hydrology variables, water temperature, dissolved oxygen) and biotic (e.g., native and non-native fish abundances) factors, we have been unable to currently identify any clear drivers of these declines. To further examine potential factors influencing the declines of amphibians in the Everglades, we sampled the amphibian community at 30 sites dispersed across the four main Water Management Areas (WMAs) of the Everglades, Florida, USA that covered the full range of observed values for potentially important environmental variables selected *a priori* to sampling. We utilized a series of passive and active collection techniques at each site and then used a suite of models to determine the factors important for amphibian abundance and structuring community composition. We collected 2,251 individuals of 10 amphibians species across the 30 sites as well as 102 reptiles, 253 macroinvertebrates, 150 native fish, and 174 non-native fish using our various survey methods. Our results show significant differences in both amphibian abundance and community composition across the four WMAs. Amphibian abundance in the Everglades is driven by native fish abundances, water temperature, distance to human disturbance, longitude, and latitude, while amphibian community composition is driven by invertebrate abundance, elevation, temperature, longitude, latitude, pH, soil nitrogen, water nitrate, and invasive fish abundance. Some species were entirely absent from the community and others were found in much lower abundances than anticipated. We detected zero aquatic amphibians within the Taylor Slough sub-region of Everglades National Park, likely a result of ecosystem collapse driven by invasive fish, especially the Asian Swamp Eel. Our results show that while some of the structuring of the amphibian community in the Everglades is due to inherent regional differences, anthropogenic changes and management strategies that have increased nutrient levels have likely impacted amphibian populations. Future management in the Everglades should focus of mitigating the impact of invasive fish, limiting future human disturbance, and preventing future increases in water temperature and pH.

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SETTING THE FOUNDATIONS FOR A CERP SCIENCE MODULE IN THE SOUTHWESTERN MARGINS OF THE EVERGLADES.

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The Comprehensive Everglades Restoration Plan (CERP) is the largest ecosystem restoration program in the world. Authorized by Congress in the year 2000, this plan is designed to restore, preserve, and protect water resources in central and southern Florida, with goals to strengthen ecosystems and enhance the human environment. Several CERP projects and their components have objectives related to hydrologic restoration to the inland and coastal Everglades with objectives to establish the timing, quantity, quality, and distribution of freshwater throughout the whole south Florida system. RECOVER (REstoration COordination VERification) is a multi-agency and interdisciplinary team of scientists, modelers and specialists operating in a collaborative mode to ensure that the implementation of CERP is guided by the best available science for successful ecosystem restoration. RECOVER implements a system-wide perspective by organizing, applying, and communicating scientific and technical information to CERP decision makers. The CERP footprint is sub-divided into similar landscapes and system characteristics that represent RECOVER modules where monitoring is applied with the goals to address uncertainties and inform progress toward achieving CERP goals and objectives. Historically, RECOVER's evaluations, assessments and planning approaches have focused on the eastern regions of the system such as Lake Okeechobee, the Greater Everglades and Florida Bay, and this past year, RECOVER has expanded its area of focus with the purpose to link Everglades restoration to the freshwater wetlands and coastal estuaries of southwestern Florida. This new CERP science module, The Southwest Florida Module, aims to assess impacts of the Picayune Strand and Western Everglades Restoration Project throughout the Greater Big Cypress Basin and the southwestern coastal mangrove estuaries. The Southwest Module footprint encompasses a network of sub-tropical freshwater wetlands and estuarine ecosystems. These forested wetlands evolved in the context of an intricate relationship between fire and water, and although this region of the Everglades system has not been significantly developed, it has experienced a drying trend over the last 50 years producing undesirable hydrologic and ecologic effects. CERP projects aim to re-hydrate key regions of the southwest and getting the water right can result in more natural downstream flows to the Tribal Reservations, Everglades National Park, Big Cypress National Preserve, and the western Marl Prairies and produce favorable estuarine conditions along the upper southwest coast in the Ten Thousand Islands, Rookery Bay, Broad River and Lostmans Slough. Such regional and system-wide expected changes, produces the requirement to implement RECOVER's programmatic evaluation and assessment framework. The application of the CERP Science framework in this region will be highlighted, including the groundwork in setting a boundary for this new CERP zone, the development of Conceptual Ecological Models used to determine the ecological premise and hypotheses clusters, and the preliminary design of a monitoring strategy to set baseline conditions and track restoration responses over-time.

MODELING FRESHWATER INFLOWS IN THE LOXAHATCHEE RIVER AND ESTUARY WATERSHED

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The Loxahatchee River and Estuary provides habitats supporting a variety of ecological resources and contains a federally designated Wild and Scenic River system. During the past several decades, the natural hydrologic regime of the Loxahatchee River watershed has been altered by population growth, land use changes and drainage activities associated with urban and agricultural development. These anthropogenic alterations have resulted in significant encroachment of saltwater-tolerant, mangrove-dominated communities into the freshwater, bald cypress-dominated floodplain. Most of the watershed is drained by the Northwest Fork of the Loxahatchee River. Development of models capable of predicting long-term freshwater inflow and salinity in the river and estuary is critical for the formulation and evaluation of the restoration plan for the Northwest Fork. Freshwater inflows from major tributaries of the Northwest Fork are simulated using a watershed hydrologic and water quality model (WaSh). The WaSh model was developed based on restructuring a Hydrologic Simulation Program – Fortran (HSPF, Donigian et al., 1984) into a cell-based system with the addition of a groundwater model and a full dynamic channel routing model (Wan et al., 2003). The WaSh model is capable of simulating hydrology in watersheds with high groundwater tables and dense drainage canal networks, which is typical in South Florida. The model consists of four basic components: (1) a cell-based representation of the watershed basin land surface, (2) a groundwater component that is consistent with the basin cell structure, (3) a surface water drainage system, and (4) water management practices. Water level data were collected at two groundwater wells. The WaSh model was calibrated and validated using long-term flow data collected at Lainhart Dam, S-46, Hobe Grove Ditch, Cypress Creek, and Kitching Creek. The model simulates daily flow reasonably well which was verified with the coefficient of determination (R^2) and Nash-Sutcliffe coefficient (NS) values of most of the stations above 0.5 for both calibration and validation period. The WaSh model-simulated daily flow outputs providing freshwater inflows for ungauged sub-basins. These results inform flow restoration scenarios of the Northwest Fork ecosystem restoration, re-evaluation of minimum flows and minimum water levels (MFLs), and assessment of climate and land use change impacts on this coastal ecosystem.

WATER QUALITY DYNAMICS AT S12A DISCHARGE STRUCTURE ON THE WESTERN EDGE OF EVERGLADES NATIONAL PARK

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S12A water discharge structure is located on the north-western edge of Everglades National Park on L29-west canal. This canal is the major operationally controlled waterway conveying water to the Park through gated structures (S12A-D). The canal also contributes flows to S333 structures which discharge water to L29-east canal flowing to Park under culverts and the bridges. Park managers are actively monitoring water quality in discharges through L29 canal to evaluate potential impacts to the Park. S12A structure has a known water quality issue of showing high phosphorus concentrations. This presentation examines spatiotemporal conditions that influence phosphorus observed at S12A and how phosphorus at S12A may be impacted by implementation of the Comprehensive Everglades Restoration and Western Everglades Restoration Plans. S12A receives waters from a combination of Water Conservation Area 3A runoff and L29 canal. Total phosphorus concentrations at S12A have been high since the 1970s (as high as 246 mg/L in May 1985). Autosampler data for S12A since 2008 also show high phosphorus concentrations in recent years (as high as 110 mg/L in June 2021). Flows through S12A are usually lowest as S12A is generally closed from October 1 through July 14 to provide suitable hydrologic conditions in Cape Sable Seaside Sparrow habitat downstream. Since 2010, the average flows out of L29-west discharges have been: S12A- 9%, S12B- 12%, S12C- 31%, and S12D- 49%. Lower discharges from S12A reduces phosphorus going from S12A directly into the Park to some extent. However, since all the stations along L29 canal are hydraulically connected, this raises concern of high phosphorus migration from S12A to S12B-D. Investigation of landscape hydrologic features indicates inputs to the western boundary of Water Conservation Area 3A marsh is a plausible source for transporting high phosphorus levels to S12A. Additionally, examination of data in upstream watersheds suggests runoff from the northern basins may also be contributing to these higher concentrations at S12A. Here we explore the potential drivers of elevated levels of phosphorus observed at the S12A structure.

CARBON CYCLING RESEARCH WITH DIGITAL IMAGERY IN GREATER EVERGLADES FORESTED WETLANDS

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Forested wetland ecosystems within the greater Everglades are threatened by changes in land-use, altered hydrology, and climate change such as rainfall patterns, increased drought frequency, wildfire intensity, and sea-level rise. Long-term measurements of ecosystem gas exchanges (water vapor, carbon dioxide and methane), vegetation and soil characteristics, and surface-energy cycling are indicators of the dynamic conditions of these ecosystems. Every additional year of data collection furthers our understanding of ecosystem function and response such as peat loss and accumulation to regional and global stresses. Unmanned Aircraft Systems or drones, with a mounted camera were flown over a pine upland ecosystem before and after habitat-affecting burn events and hurricanes. Flight patterns are precise enough to allow overlaying of georeferenced aerial mosaics for viewing time series images and performing forested and understory vegetation change analyses. Additional video and high-resolution images captured with CCFC-field observation digital cameras were used for quarterly comparisons of vegetation change within forested ecosystems from controlled burns and weather events such as, flooding and hurricanes. Individual spectral bands were used to calculate parameters such as percent green index or normalized difference vegetation index (NDVI). Results from these efforts document trends in processes that shape wetland habitats.

FROM THE EVERGLADES TO THE CITIES: TRADE-OFFS TO URBAN NESTING IN WHITE IBISES (*EUDOCIMUS ALBUS*)

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Land-use changes such as urbanization and agriculture have caused many wildlife species to decline, yet some species benefit from novel resources offered by human-altered habitats. The White Ibis (*Eudocimus albus*) is an increasingly urbanized wading bird in Florida that has been showing shifts in landscape use, diet, and movement patterns and only recently began to nest in urban areas. Ultimately, survival and reproductive success are the two key factors to determining the potential for urbanization to impart population-level impacts to urbanized species. We aimed to investigate the productivity of an urban colony of White Ibises in south Florida. We investigated productivity, nestling growth and diet, and *Salmonella* and avian influenza virus (AIV) dynamics of one urban and two natural ibis colonies in south Florida. A total of 64 and 67 nests were monitored until fledging via weekly nest checks in 2020 and 2021, respectively. Results were analyzed using the Mayfield survival method and compared with data collected in the Everglades during the same period. The urban colony showed high nest success in 2020 (70.8%) and 2021 (76.4%). Additionally, a total of 77 urban and 39 natural nestlings were handled weekly from hatch until fledging to take measurements and collect biological samples. We failed to detect differences in the growth rates and body condition of urban and natural nestlings. Urban chicks consumed a mixture of anthropogenic (e.g., bread) and natural (e.g., invertebrates, fish) food as determined by stable isotope analysis, suggesting that urban nestlings are provided with the necessary nutrients and calories to grow and fledge. However, urban nestlings shed *Salmonella* at a much higher prevalence (52%, N=209 samples) than natural chicks (13%, N=60 samples). Seroprevalence against AIV was detected at ~99% and 89% at the urban and natural rookeries, respectively, which waned over time, indicating maternal transfer. In 2020, urban nestlings died suddenly, and 3/4 were diagnosed with West Nile virus (WNV) based on histopathology, immunohistochemistry, virus isolation, and PCR. Sera collected from 4/36 (11%) urban chicks in 2020 had anti-WNV antibodies, which were all likely maternally derived. Our results suggest that urban environments are suitable habitats for ibis breeding but with important impacts to nestling health. This study also highlights potential trade-offs for other urban-nesting species and encourages a holistic approach to investigate source-sink relationships of urban breeding.

MODELING SLOUGH CRAYFISH POPULATIONS IN RESPONSE TO HYDROLOGIC VARIABILITY

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Understanding and predicting densities of aquatic fauna as a function of hydrological variation is critical for management and restoration of freshwater ecosystems. Restoring trophic functions of these systems require development of expectations for small prey production that will provision wading birds and other wildlife. Crayfish are important prey taxa for the most abundant wading bird in the Florida Everglades, the White Ibis, but models have not been developed to predict their densities across the ecosystem. This study attempts to model the relationship between slough crayfish (*Procambarus fallax*) populations and hydrologic conditions throughout the Everglades using the Modified Water Deliveries monitoring dataset from Everglades National Park and Water Conservation Area 3. Hydrologic terms reflecting dry disturbances were included because low water (dry events) indirectly improve densities through seasonal reductions of predatory fishes, but new hydrologic terms were explored as well. We first used linear mixed-effects models to identify useful hydrologic terms from a larger set of covariates and then applied model selection, plus classification and regression trees (CART), and random forest (RF) algorithms to explore general interpretations and stronger predictive capacity. Comparisons between models aided the development of ecological insights that were evident in certain models. The RF model demonstrated the greatest predictive ability ($R^2 = 0.55$) among all approaches followed by linear mixed-effect models ($R^2 = 0.43$) and the CART ($R^2 = 0.28$). In the RF model, we observed that lower average depths over year prior to the sample, in conjunction with intermediate shallow recent depths (peaking at approximately 40-50 cm average over the last 30 days), were associated with greater crayfish densities. Lower annual averages and recent intermediate depths were ecologically interpretable based on prior studies. Low antecedent water reduces predators and improves recruitment success, while the phenomenon of higher densities at intermediate recent depths likely reflects dispersal/concentrations along topographic gradients plus the effects of depth-limited foraging by birds, burrowing behavior under shallower depths, and possibly a failure to reproduce at yet lower depths. Incorporating interactions between the same hydrologic variables and seasonality significantly improved performance of the linear-mixed effects models. The highest predicted densities generally occurred in the months of February or April, and densities were lower in more recent years. The results illustrate general agreement between traditional linear modeling and machine learning methods, a consistent understanding of crayfish eco-hydrologic relations, and provide a set of parameters and methods to be used as predictive modeling tools for natural resource management and evaluation of restoration scenarios.

HYDROLOGIC MODELING IN BROWARD COUNTY: PLANNING FOR RESILIENCE

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Broward County has a long history of utilizing advanced hydrologic models (MIKE SHE/MIKE11, MODFLOW, SEAWAT/MT3DMS) to guide resilient water resources planning and management policy needed to address changing water demands and availability due to land use, population, and climate changes. Highly complex stormwater drainage system along with a tightly coupled groundwater-surface water continuum requires an integrated modeling approach that can adequately simulate a variety of drainage infrastructure and structural operational rules. Over the past twenty years, several regional and County scale MIKE SHE/MIKE 11 models have been developed for different purposes including the development of County-wide Integrated Water Resources Plan (IWRP), future 100-yr flood maps and most recently an ongoing development of County-wide resilience plan. Based on the modeling results, the IWRP employs an adaptive management process that addresses the unique topographic, hydrologic and climatic conditions in the County as well as the regional policies (Comprehensive Everglades Restoration Plan, CERP). The future 100-yr flood map as adopted in 2017, is aimed to Improve the resiliency standards for flood protection by serving as a regulatory tool for establishing finish floor elevations for new buildings and major redevelopments. The existing version of the MIKE SHE model is currently being refined to develop future resilient adaptation and mitigation strategies at local level (50 acre) across the entire County to address the future conditions including changes in rainfall, sea levels and land use. To address, subsurface storage and drainage issues that routinely cause flooding in several areas of the County, MODFLOW family of models along with different surface water flow/routing packages have been utilized to develop future conditions groundwater maps as a regulatory tool to assist in surface water permitting for new drainage and water management infrastructure development projects. Saltwater intrusion is a worsening problem for the public water supply system in the County given that several wellfields are located near the coast. The County has developed regional and County scale variable density models (SEAWAT) to develop a better understanding of saltwater intrusion under current and future conditions of sea level rise and water demand changes. These models have been used to simulate several adaptation and mitigation strategies including redistribution of pumping, relocation of wellfields and alternatives water supplies to help guide future management and policy. Broward County is currently pursuing the development of an updated MODFLOW6 based variable density model that would be used for finer spatial scale simulations in several critical areas such as wellfields and coastal areas. Hydrologic modeling is likely to continue playing an important role in understanding the effects of land use and climate change at local as well as regional scale to help guide the development of resilient management and policy in the County.

ADAPTIVE FOUNDATIONAL RESILIENCE (AFR): A PERFORMANCE MEASURE TO ASSESS THE ABILITY OF NATIVE, ENDEMIC VEGETATION TO ADAPT TO SEA LEVEL RISE IN SOUTHEASTERN FLORIDA

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Sea level rise (SLR) and changes in storm and rainfall patterns associated with climate change could have a dramatic impact on the remaining natural areas in South Florida. Due to its low elevation and proximity to the coast, the natural vegetation of the coastal wetland community is extremely vulnerable to SLR. Mangrove forests and coastal marshes within the Everglades ecosystem rely on external inorganic sediment input and autochthonous organic matter generated to maintain and build vertical soil elevation that have allowed them to keep pace with SLR for the last 500 years. The resilience of the coastal mangrove ecosystems to continue to keep pace with SLR and migrate upstream into brackish and freshwater habitats will depend upon the ability of the CERP Projects to (1) mitigate for saltwater intrusion, (2) improve the hydrodynamics (i.e., increased flow and hydroperiods) and (3) increase the ecological connectivity (i.e., canal and levee removal) to foster soil accretion and marsh transformation. These three factors have been built into Adaptive Foundational Resilience (AFR); the first CERP Performance Measure (PM) that allows for coastal structural adaptations in respond to SLR. By adaptive we mean that this PM captures the ability of the coastal wetland to adapt to rising sea levels via enhanced soil elevation change. By foundational, we mean a species that has a strong role in structuring a community. The activities of foundation species physically modify the environment and produce and maintain habitats that benefit other organisms. By resilience we mean the ability of the foundational communities to shift rates of productivity, community structure and spatial extent, in the face of SLR, to minimize wetland conversion to open water habitats and maximize shoreline retention. This AFR PM will use depth-duration, sheetflow volume and porewater salinity to predict the rates of peat accumulation across transects and nodes within the RSM-GL hydrodynamic model, used to evaluate CERP restoration alternatives. The derivative of each non-linear peat accumulation metric (i.e., depth-durations, sheetflow and porewater), as a function of alterative-based estimates of hydrology and salinity, are calculated annually and summed over the entire POR to estimate accretion rates. The target is an annual accretion rate of 4 mm/yr and 8 mm/yr for all freshwater wetland and all saltwater wetlands, respectively. The target for the combined integration of all three non-linear AFR metrics is to keep up with SLR while allowing for freshwater wetlands to transition to mangrove ecosystems with minimal transition to open water due to either peat collapse or saltwater inundation.

HOW MANY ARE REALLY DOWN THERE? EVALUATING ELECTROFISHING CATCHABILITY RATES FOR BIOSURVEILLANCE OF NON-NATIVE FRESHWATER FISHES.

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We developed a mark-recapture protocol and model to determine boat electrofishing efficiency, estimate abundance, and evaluate the effects of boat electrofishing on recapture rate for important non-native and native fish species. We completed a pilot study at two locations in the Picayune Strand State Forest (PSSF) in southwest Florida, and the L-31W canal that borders Everglades National Park in southeast Florida. These locations were chosen to represent some of the different habitats that are found in the south Florida canal systems (e.g., vegetated vs unvegetated littoral zones). In the PSSF, we sampled three isolated segments from the degraded Merritt Canal, and three segments from the southern "T" canal that were isolated using block nets. In the L-31W, we sampled three segments that were isolated using block nets and existing canal plugs. To collect fish data, we performed boat electrofishing following standard Florida Fish and Wildlife Conservation Commission protocols to ensure results would be compatible with existing surveillance sampling. Captured fish were separated by species in aerated live-wells until the entire shoreline of each segment was sampled, and then each adult fish was inspected, marked with a fin clip that indicated day of capture, and released back into the same segment. At 24-hour intervals, we repeated electrofishing of each canal segment for a total of three capture events, again marking each fish to indicate the day of capture. We employed a Bayesian multinomial N-mixture model to estimate the capture probability and abundance of each focal fish taxon at each location. We also incorporated a "trap effect" to determine if fish recapture rates changed over the course of the sampling events due to behavioral or physiological effects from the shocking or handling. Mean catch rate was 16 percent for non-native fishes compared to 52 percent for native species, indicating that population sizes of non-native fishes may be larger than previously thought. Abundance of non-native fishes was highest in the remnant Merritt Canal segments of the PSSF, while abundance of native species was more similar between the Merritt segments and the L-31W canal segments. The PSSF "T" canal segments had the lowest density of all focal taxa. Knowledge of catch rates across varying habitat types can inform the design of detection strategies to ensure sufficient power to detect species with low electrofishing catchability. The ability to interpret electrofishing catch in terms of abundance, as opposed to catch per unit effort, will give a more accurate picture of fish community structure, allowing managers to make informed decisions for meeting restoration targets or managing non-native freshwater fish in south Florida canals.

SPECIES STATUS ASSESSMENT REPORT FOR THE EVERGLADE SNAIL KITE (*ROSTRHAMUS SOCIABILIS PLUMBEUS)*

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The Everglade snail kite (*Rostrhamus sociabilis plumbeus*) is a medium-sized raptor whose prey consists almost entirely of freshwater apple snails (*Pomacea spp*.) and which was listed as endangered pursuant to the Endangered Species Conservation Act in March of 1967 due degradation, fragmentation, and direct loss of habitat from urban development and agricultural activities. Ongoing influences also include hydrological changes due to increased variation in annual precipitation patterns coupled with conflicting anthropogenic water management demands. In 2022, we composed a Species Status Assessment (SSA) for the snail kite to conduct an in-depth review of the subspecies' biology and threats, evaluate its biological status, and assess the resources and conditions needed to maintain long-term viability. Using the SSA framework, we considered what the snail kite needs to maintain viability by characterizing its status in terms of its resiliency, redundancy, and representation (together, the 3 Rs). We compiled available information from the literature and species experts about the subspecies' biology and needs and assessed the 3 Rs under current conditions and multiple plausible future scenarios. For this assessment, we divided the snail kite population into the following six Analysis Units (AUs), which coincide with the vast majority of current nesting efforts: Paynes Prairie (PP), Kissimmee River Valley (KRV), St. Johns Marsh (SJM), Lake Okeechobee (OKEE), Southeastern Florida (EAST), and Everglades (EVER). We relied on the average 3-year population growth rate within each AU to characterize AU condition and combined these with total population size to understand current population resiliency. Based on this information, current resiliency is considered Low. We developed four scenarios that characterize how future management and restoration could change future condition under three plausible future climate projections. We relied on a population viability analysis (PVA) which provided projections of changes in AU population growth and total population size from 2020 to 2050. Based on the PVA results, snail kite population resiliency is predicted to be Very Low under three of the four future scenarios for all future climate projections. Under our High Conservation (best case) scenario, population resiliency is predicted to be Low regardless of climate change pathways. The highest population size (>5,000 birds) and Moderate population resiliency were only predicted under High Conservation with no change in precipitation patterns, which is unlikely because at least some change in the climate will likely occur. Future condition of the snail kite population in Florida is likely to be Low or Very Low given expected changes to precipitation patterns.

USING CAMERA TRAPS TO ESTIMATE OCCUPANCY OF INVASIVE TEGUS (*SALVATOR MERIANAE*) IN SOUTH FLORIDA

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The introduction of nonnative species is a leading cause of biodiversity loss. South Florida is home to several ecologically sensitive areas and ecosystems susceptible to the proliferation of nonnative species. Given the risks associated with the establishment of invasive species, the ability to detect and remove invasive species is of high importance to natural resource managers. However, many invasive species are cryptic or elusive in nature and therefore often evade detection. One technique employed in the detection of cryptic species is the use of camera traps, which can be utilized to measure occupancy. Occupancy estimates are used to determine the proportion of a group of sites that are occupied by a target species, while also accounting for imperfect detection of the target species. Occupancy modeling can reveal the presence and spread of invasive species over time and allows for assessment of factors affecting occupancy and detection, and therefore has important management implications. Over the course of a four-year study (2016-2020), we used camera traps to detect the presence of invasive Argentine Black and White Tegus (*Salvator merianae*) at sites throughout southern Florida in Miami-Dade County. Our preliminary results from a dynamic multi-season occupancy model revealed that Julian date is the best predictor of detection, while occupancy is influenced by distance to certain landscape features, notably, the distance to an intersection of two linear habitats where relative abundance of tegus is thought to be high. Understanding these factors affecting occupancy and detection probability can inform surveillance, removal efforts and management strategies.

PAST AND PRESENT ACCRETION, ACCUMULATION, AND ELEVATION AS KEY TO THE FUTURE OF MANGROVE ECOSYSTEMS IN SOUTHWESTERN FLORIDA

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Over the past several millennia, coastal wetlands have expanded vertically and laterally under relatively stable sea-level conditions, however, as the rate of sea-level rise accelerates the future of coastal wetlands is uncertain. Coastal wetlands exist within the tidal range therefore as sea level changes, to continue their existence, these wetlands either shift laterally or the substrate elevation changes to maintain their position within the tidal range. Lateral migrations landward are often limited by accommodation space while substrate elevation increases are limited by the capacity of the system to produce, collect, and retain material. Lacking a significant terrigenous sediment supply, coastal wetlands in southwestern Florida are theoretically particularly vulnerable to sea level rise and mostly maintain soil elevation via the production and storage of organic matter. Conversely, loss in elevation occurs through compaction, shrinking, erosion, and degradation of organic matter. Here historical vertical accretion and mass accumulation rates along with recent surface elevation changes are used to explore the potential for mangrove ecosystems in southwest Florida to keep pace with sea-level rise. Many investigations find that, at a given location, these rates often vary depending on the time scale examined and the method utilized. Variation in rates should not be surprising as systems such as these do vary across time scales and the methods are not always measuring the same thing despite producing results with similar units. In addition to the somewhat steady press of sea-level rise, mangrove ecosystems are vulnerable to tropical cyclones which are low-frequency, high-impact pulse disturbance events, and it is important to consider the impact of these pulse events in the context of the broader press of accelerating sea-level rise. Whereas these events temporarily raise the water level, the loss of vegetation and the addition of storm deposit material may have longer-lasting consequences. Storm deposits along with an observed acceleration in organic matter accumulation rates enhance the substrate elevation, however, there are limitations, and future sea-level rise will exceed those limitations resulting in the loss of coastal wetlands in places where they exist today. These and other factors related to the future of southwest Florida mangrove ecosystems will be explored in this presentation.

DRY-OUT IN STAS: AN STA-5/6 CASE STUDY

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Stormwater Treatment Areas (STAs) are a major component of the Everglades restoration effort built and operated to reduce total phosphorus (TP) concentrations in surface runoff from agricultural and urban areas prior to discharge to the Everglades Protection Area (EPA). Phosphorus (P) retention within STA cells can be influenced by weather, soil type, cell topography, vegetation condition, fauna activities, nutrient and hydraulic loading, hydroperiod, water levels and regional flood control operations, either individually, or by a combination of these factors. Periodic dry-out during the dry season in South Florida (October - May) occur in portions of or entire STA cells, particularly during prolonged dry periods. High concentration of P following rehydration affects P retention and reduces the potential for the STA to achieve required annual discharge limits. One of the most effective means to reduce dry-out and sustain hydration is to bring supplemental water from available sources by hydraulically connecting the waterbodies. The dry-out of STA-5/6, a 15,944-acre STA located in eastern Hendry County is presented as a case study. A project is under development that will establish a hydraulic connection between the STA and Lake Okeechobee, the largest freshwater lake in the southeastern US. This proposed 9-mile-long project will improve existing structures, levees, and canals and construct a new permanent pump station. This project will enable delivery of up to 300 cubic feet per second of lake water, if available, when STA cells are experiencing dry conditions. The project also will provide an additional route for the delivery of Lake Okeechobee regulatory releases south. Using this new route, lake water could be sent first to the C-139 FEB and then to STA-5/6 for treatment, or directly to STA-5/6 to avoid dry-out. The delivery of lake water will be consistent with the flood control and water supply operations along Miami Canal and will not impact other regional water users.

SYSTEM-WIDE SHIFTS IN STANDING STOCK COMPOSITIONS RESPOND TO SYSTEM-WIDE DRYING PATTERNS

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The Comprehensive Everglades Restoration Plan (CERP) Monitoring Assessment Plan (MAP) is a spatially comprehensive monitoring program quantifying aquatic fauna and periphyton as they respond to hydrologic variation and other environmental factors. Small fish and macroinvertebrates, as well as periphyton, are collected with throw traps from 146 sites across the Greater Everglades during peak water depths in the wet season. The project has completed 17 years of data collection and this talk focuses on the small animal responses. In this talk I will report on recent biomass patterns, describe system-wide shifts in composition with drying and detail some uncertainties about site-level drying related to the EDEN model. In 2020-2021 the densities of fish and crayfish were statistically average or below average and no regions have recently produced high wet season standing stocks. To assess how system-wide drying impacts the composition of aquatic standing stocks, we utilize the Everglades Depth Estimation Network (EDEN) to obtain daily depths for all PSUs (Principle Sampling Unit) within the EDEN footprint. We correct the EDEN depth values with local site and date specific depths at time of sampling to create accurate hydrographs. We calculated a drying index by quantifying PSUs that dried when surface water depth reaches ≤ 5 cm anytime in the 365 days preceding wet season sampling. Over the 17 years an average of 60% of the sites dried to ≤ 5cm each year, but the drying index ranged annually from 16% - 94%. The relative abundance of crayfish was positively correlated with the drying index for the year prior to the wet season sampling, while the fish relative abundance was negatively correlated with drying. The relative abundance patterns were driven primarily by changes in the absolute densities and biomass of crayfish, while fish and shrimp density and biomass were not linearly related to the drying index. The system-wide increases in crayfish were evident over the full 17 years ($R^2 = 0.22$ and $\beta = 0.22$), but the most recent years (2017-2021) have weakened the relationship because the first 12 years had a stronger pattern (2005-2016: $R^2 = 0.55$ and $\beta = 0.32$). The causes of the weakening relationship will need to be carefully considered. The system-wide drying index and other covariates being used for modeling fish and crayfish responses requires that our hydrographs, based on the EDEN model, be sensitive to recession at low depths (< 10 cm) across the MAP landscape so that we can properly assess drying (0-5 cm depths). Initial exploration of the hydrographs for a few of our PSUs indicated potential error in identifying times when surface waters receded below 5 cm. This effect biases our depth estimates and drying indices. Some of the PSUs in Southwest Everglades National Park also fall outside the EDEN grid and therefore dry season hydrologic conditions are difficult to assess.

MAPPING KISSIMMEE RIVER FLOODPLAIN VEGETATION: A NEW APPROACH USING MACHINE LEARNING ALGORITHMS

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Machine learning (ML) algorithms combined with Object-based Image Analysis (OBIA) methods are being applied to the mapping of wetland vegetation as part of the Kissimmee River Restoration Project. Construction for this project, which involved backfilling parts of a large flood control canal and re-opening flow to stagnant river channels and a wide floodplain, was started in 1999 and completed in 2020. The only restoration component remaining is a change in the regulation schedule for the Headwaters Lakes called the Headwaters Revitalization Schedule (HRS). HRS will change the hydrology of lakes upstream and of the river itself to allow more water storage in the lakes which will provide improved continuous and variable flow to the downstream river. This change will be implemented in a phased process over several years and marks the final stages of the river restoration. To track wetland community response to restoration, vegetation maps produced through photo interpretation of aerial photo surveys have been generated periodically since 1996. The resulting maps have been used to measure the distributions and relative abundances of wetland vegetation types of interest. Comparisons are made to *a priori* expectations based on a pre-regulation reference vegetation map to determine if ecological restoration is proceeding according to plan. In 2022 a mapping effort based on 2020 imagery was completed using a workflow combining ML and OBIA algorithms developed through both commercial and open-source software products. The benefit of using these methods is a quick turnaround and lower funding requirements, compared to traditional methods using private mapping contractors. Results from the most recent imagery shows that the restoration is proceeding, but with mixed results. Wetland vegetation comprises about 82% of the Kissimmee Floodplain in the Phase I area (the oldest of four restoration phases) which meets one of the restoration expectations. However, specific expectations related to native wetland vegetation are not being met. Native wetlands appear to be under pressure from exotic and invasive wetland species including West Indian marsh grass and Carolina willow. The current mapping results seem to bear this out as both Broadleaf Marsh (BLM), a deep-water wetland class and one of our focal native wetland types, and native wet prairie (WP) grass species in this map have reduced areal coverage, while invasives have expanded, when compared to the most recent past map of floodplain vegetation. It is expected that once the HRS is on-line, native floodplain habitats will be favored by more prolonged floodplain inundation. Vegetation management options including the use of fire, herbicides and other measures are currently being used on the floodplain. This presentation will provide further details on mapping processes, along with a discussion of the mapping results and management options for dealing with current issues for vegetation recovery.

MARSH TRANSFORMATION INDEX TO INFORM COASTAL RESTORATION PLANNING

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Success for the Everglades Restoration program is tracked through an array of performance metrics. These include specific hydrologic outcomes of projects, the ecological responses of the natural system, and even the more administrative metric of percent completion and implementation of the constructed project features. Underlying these performance metrics are critical assumptions about how we define restoration – assumptions of stationarity are being challenged by our evolving understanding of how climate change impacts the range of resilient and sustainable outcomes. In the coastal environment, the influence of ocean transgression into the freshwater marsh adds a degree of uncertainty in our long-term planning. Still, new projects are being developed and new operational plans are being implemented that will alter conditions of these regions. To assist in understanding recent and current changes impacting the landscape and hydrology, we have previously developed the marsh to ocean index (MOI), an empirical tool to detect the changing influence of the coastal ocean on the inland freshwater system. Presented is a study on the application of the MOI to the process of defining useful performance metrics in coastal systems and using those metrics for the selection of Everglades Restoration project alternatives and ultimately the evaluation of project results. The MOI elucidates the relative similarity of water level time series data by comparison with two reference time series that represent the marsh and the oceanic end members of a transition zone. The extensive dataset of water levels throughout South Florida, due to investments made in the Comprehensive Everglades Restoration Program, provides a data-rich environment for the application of this approach. In this presentation, we will provide an analysis of available data within the Biscayne Bay and Southeastern Everglades Ecosystem Restoration (BBSEER) project footprint and a discussion on the potential application of this analysis to the development of performance metrics. Further, we will present an evaluation of the capacity to project MOI changes based on modeled influences on water levels in the marsh reference time series. These changes will be cast in the context of projected sea level rise to create a more robust prediction of project influences on the landscape.

RESILIENCY OF MANGROVES AND COASTLINES IN A CHANGING CLIMATE

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In the coastal and island environments of south Florida, mangroves play an important role in preserving the shoreline by acting as a natural buffer to storms. Red mangroves (*Rhizophora mangle*) build land area vertically and laterally due to their extensive root development, allowing sediment to accumulate as the rooting area expands in spatial coverage. Mangrove root systems provide additional ecosystem services by acting as a nursery for many species of fish and invertebrates. Climate model predictions for the next century suggest that temperatures will increase, sea level will rise, and storms will increase in intensity and frequency. It is critical for resource managers to understand how the south Florida coastline and islands are likely to be affected by these environmental changes and their resilience to such changes. To address these questions, we are monitoring mangrove response to perturbations and changes in surface elevation of a mangrove-ringed Florida Bay island in Everglades National Park, Jim Foot Key. This island was heavily impacted by high winds and storm surge from Hurricane Irma in September 2017. USGS researchers have been observing Jim Foot Key since 2010, and when fieldwork was conducted in January of 2018, storm impacts from Hurricane Irma were apparent. The eastern berm suffered significant mangrove loss and die-off and a narrowing of the berm itself. The black mangroves (*Avicennia germinans*) on the southeastern corner of the island were mostly denuded in the immediate aftermath of the storm, and in the years since then, we have observed extensive mangrove die-off over large areas of the island. Two mangrove monitoring plots were recently established on Jim Foot Key to assess mangrove post-Irma die-off, recruitment, and growth. Plot A, on the eastern berm, was established in September 2021, and plot B was established further inland and on the southeast corner of the island in March 2022. By assessing mangrove species, recruitment, growth rates, density, and die-off over time in these designated areas, we aim to quantify mangrove loss and gain on Jim Foot Key. In order to measure elevation change and understand where sediment is accumulating versus eroding, we installed eight surface elevation tables (SETs) on Jim Foot Key, four on the eastern side and four on the southeastern corner of the island, in February 2022. Each SET plot has 3 feldspar marker horizon pads to measure accretion. In addition, we have deployed a time-lapse camera, which photographs the eastern berm from the interior of Jim Foot Key every 4 hours during daylight (3 photographs per day) to observe how the water level changes on a daily basis and to record the impacts of storms. With the combination of these monitoring devices, we hope to gain a better understanding of the long-term impacts on the mangrove coastal ecosystem and how storms and sea level affect their resiliency.

STORMWATER TREATMENT AREA WATER QUALITY AND COMPREHENSIVE EVERGLADES RESTORATION PLAN PROGRESS

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There are currently more than 57,000 acres of stormwater treatment areas (STAs) in operation that are designed to remove nutrients, specifically total phosphorus (TP), before entering the Everglades Protection Area. In 2010, an Amended Determination by the US EPA directed the Florida Department of Environmental Protection to correct deficiencies in meeting water quality criteria, which resulted in the establishment of a water quality-based effluent limit (WQBEL). In this presentation, we discuss 1) STA performance; 2) the progress being made to achieve the water quality standards; and 3) recommendations to support the state's ongoing efforts to meet the WQBEL. The STAs can be categorized based on their geographic location (flowpath): eastern (STA-1E, STA-1W, and STA-2); central (STA-3/4), and western (STA-5/6). Performance, based on reductions of flow-weighted mean TP concentrations from 2017 to 2022 water years, varies across individual STAs: STAs 2 and 3/4 are functioning effectively and are close to or meeting the WQBEL; however, the other STAs have TP concentrations that exceed the 13 ppb WQBEL standard, with mean exceedances ranging from 10 ppb (STA-1E) to 37 ppb (STA-5/6). Poor performing STAs tend to have high P loading rates, high inflow TP concentrations, and high or low hydraulic loading rates (too high flow minimizes P contact time with substrates; too low can result in desiccation and subsequent oxidation and release of P from sediment). The state has initiated several actions to improve P retention performance, including the construction of flow equalization basins to limit extremes in discharge and projects associated with a restoration science plan to better understand STA functionality. Committee recommendations include: cell-by-cell monitoring within the STAs to develop detailed P budgets; understanding interactions of nitrogen and phosphorus within STAs to assess nutrient limitation; field research to examine P saturation of soils and biota; continued refinement of hydrologic and biogeochemical models; and an independent, external STA advisory committee to assist the SFWMD in evaluation of STA performance and identification of areas of concern and promising strategies.

ENDOPHYTIC FUNGI CAN INHIBIT THE GROWTH OF THE CAUSATIVE AGENT OF SEAGRASS-WASTING DISEASE, *LABYRINTHULA* SP

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The protistan endophytic pathogen *Labyrinthula zosterae* (Protista, Labyrinthulomycetes) is responsible for seagrass-wasting disease that presumably played a significant role in the decimation of large areas of seagrass meadows in the Florida Keys between 1987 and 1991. Recent studies have shown that the pathogen is still present in the majority of plants in Turtle grass meadows in the Florida Keys, but no major damages due to its presence have been reported recently. Here we studied possible interactions of *Labyrinthula* sp. with other endophytic fungi that they might encounter in the tissue of Turtle grass. We established culture collections of potentially pathogenic and non-pathogenic strains of *Labyrinthula* as well as of endophytic fungi. Using bioassays on agar plates, we could show that Turtle grasses in Florida host several culturable endophytic fungi that can produce bioactive molecules that inhibit the growth of the pathogen. One of the antagonistic endophytic fungi was identified as *Trichoderma* sp. and the bioactive molecule could be identified as Cytosporone B using LC-HRMS after extraction of organic compounds in spent media. Further studies in vivo will be necessary to better understand the interactions between host, *Labyrinthula* pathogens and fungal endophytes, but our study indicates that endophytic fungi might be an important factor in the development of this devastating disease.

FLOODING AND PLANTING DENSITY SHAPE FORESTS IN AN EXPERIMENTAL EVERGLADES LANDSCAPE: LESSONS FOR FOREST RESTORATION

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Tree islands are patches of forest scattered throughout a contrasting matrix of herbaceous marsh, present in wetland landscapes worldwide. They are a key habitat in the Everglades ecosystem where they have developed over millennia as elevated, relatively well drained features above the wetland surface. Their cultural importance to Native Americans and critical function as plant and animal refugia are well recognized. Unfortunately, much of the Everglades tree island habitat has been lost or severely degraded due to scarce or excessive water levels and has prompted the need for tree island rehabilitation or reconstruction. Since the early 2000s, researchers at the Loxahatchee Impoundment Landscape Assessment (LILA) platform in the Loxahatchee National Wildlife Refuge in southern Palm Beach County have gained experience in tree island creation and subsequent dynamics. At LILA, control of hydrology and replication of landform structure allow investigators to precisely assess ecosystem responses to important physical or biological drivers. Tree islands were created as part of a field-scale experiment to examine the effects of flooding, planting density, and neighbor size and proximity on the performance of native tree species. Results 7-8 years after initial planting show that flooding reduced survival and mean tree size, while planting seedlings at spacings as close as 1m apart resulted in higher total biomass, with no significant cost in tree survival. Flood tolerant species increased in relative abundance during the study period along the entire hydrologic gradient, while flood intolerant species were able to survive only at the highest elevations. Crowding effects within neighborhoods varied across the flooding gradient. Growth and survival increased or remained stable with increased crowding in high flooding zones but declined sharply with crowding under low flooding conditions. These data suggest that tree island restoration can benefit from targeted mixed species plantings at variable densities, as the compositional and structural heterogeneity promoted by these measures may increase adaptability and resilience to future uncertainties.

EVALUATING THE EFFECTS OF HABITAT STRATIFICATION ON SAMPLING BIAS FOR ESTIMATIONS OF AQUATIC ANIMAL POPULATIONS

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Accurately estimating the size of animal populations is important for determining the progress of restoration programs and avoiding the loss of vulnerable ecological communities. Many factors can influence the results from field data collection, but a proper sample design can help manage bias in sampling data. Monitoring programs supporting the Comprehensive Everglades Restoration Plan (CERP) use a Generalized Random Tessellation Stratified (GRTS) sampling design to optimize sampling efforts by creating randomized spatially balanced sample plots across sampling regions. Although an effective tool, the GRTS sample design alone does not account for the potential bias that is created from the heterogeneous landscape of the Florida Everglades. As a part of the CERP Monitoring and Assessment Plan (MAP), field surveys of aquatic animals and periphyton are directed to areas with relatively low to medium emergent plant stem density, termed “sampleable” areas. This leaves some of the ecosystem unsampled, either because it has vegetation that is too dense for sample collection methods or are non-aquatic habitats that are inhospitable for aquatic animals. The CERP MAP for aquatic animals and periphyton was designed to statistically accommodate the dichotomy of sampleable and non-sampleable habitats. However, sampling efforts currently only take place in favorable habitat conditions (sampleable habitat), leaving animals in unsampleable aquatic habitats neglected from ecosystem assessments. In this study, we evaluate the effects of using habitat stratification data to create a weighting scheme (inclusion probability) to adjust data for bias. We simulated a range of bias estimates to existing CERP MAP samples to explore if sampling bias has ecologically important effects on population estimates. We report calculations that correct for spatial bias in data collection based on a new vegetation mapping effort for the 146 primary sampling units (PSUs) of the CERP monitoring program using Worldview 2 multispectral satellite imagery data. PSUs in this project are 800m^2 grid cells established over the entire Greater Everglades ecosystem. From the vegetation maps that were generated, we found that among all actual sample sites the relative habitat composition was 55% sampleable, 36% unsampleable, and 9% non-aquatic habitat. The weighting scheme was applied to biomass estimates of different species from a 15-year fish sampling data set (2006-2021). By comparing the corrected and uncorrected datasets, we discovered that in some regions we could be underestimating fish populations as much as 33% and overestimating it in other areas by as much as 23%. The magnitude and direction of bias varied across regions of the ecosystem based on the relative coverage of unsampleable habitat and estimates of the density of fish in those unsampled areas. Failing to account for unsampleable habitat assumes that it has the same density as sampled habitats, which is known to be incorrect. This study illustrates the benefits of identifying and accounting for sampling and spatial bias in estimations of population data. The support from the South Florida Caribbean Cooperative Ecosystem Studies Unit (SFC-CESU) allows students to conduct research like this and provide essential opportunities to share their knowledge and perspectives on ways to improve restoration for the Everglades ecosystem.

FORECASTING CYANOBACTERIA BLOOMS IN LAKE OKEECHOBEE

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Lake Okeechobee has experienced blooms of cyanobacteria for several decades. These blooms often produce toxins, as well as ecological and economic impacts. The blooms vary in size and duration and are transported around the lake in response to largely wind-induced currents. Since 2016, we have used the ocean land colour instrument (OLCI) on Sentinel-3 to monitor the surface concentration of these blooms in the lake. To develop a comprehensive time series, we have combined OLCI with its predecessor, the European MERIS (2002-2012), and filled the 2012-2016 gap with MODIS. This combination has allowed us to examine the inter- and intra-annual variability of the blooms from 2000 to the present. Cyanobacterial surface concentrations and the formation of scums on the lake are strongly dependent on wind speed in a way that can be estimated. Satellite data can be used to initialize and validate the transport pathways of the blooms with a coupled numerical model. The 20+ year time series provides data suitable for evaluating factors that lead to differences in the size and persistence of the blooms between years. This capability may allow us to assess the risks of these harmful blooms to the Lake and adjacent waters.

BIOAVAILABILITY OF DISSOLVED ORGANIC PHOSPHORUS VARIES WITH INFLOW SOURCE AND VEGETATION TYPE IN THE EVERGLADES STORMWATER TREATMENT AREAS

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The bioavailability of dissolved organic phosphorus (DOP) is central to our understanding of P recycling and retention in the Everglades Stormwater Treatment Areas (STAs), wetlands constructed to remove P in runoff prior to discharge to the Everglades. Despite this, little is known regarding microbial processes determining the transformation and fate of DOP in these systems. Here, we compared microbial respiration, growth, and fractions of enzymatically hydrolyzable DOP (<0.2 µm) in four source waters of the STAs. These source waters [outflow from Lake Okeechobee (S354), inflow to STA-2 (S6), inflow to STA-3/4 (G370), and inflow to the L-8 flow equalization basin (FEB) (G538)] represent varying composition from lake, urban and agricultural areas. Despite no significant differences in respiration rates between source waters, microbial characteristics (e.g., cell size/shape and production) differed, indicating variabilities in microbial responses. For example, microbial cell volume at the L-8 FEB source water was higher than at STA-2 source water. Bioavailability of the DOP also differed among source waters, where results showed that alkaline phosphatase hydrolyzable P fraction was a small component of DOP (<4% of TDP). In contrast, phosphodiester hydrolyzable P was the dominant component of the < 0.2 µm DOP fraction DOP, ranging from 78-97% of source water TDP. Phosphodiester hydrolyzable DOP for STA-2 source water (24 $\mu g\ L^{-1}$) was approximately 3, 2.9, and 2-fold higher than that of the L-8 FEB, STA-3/4, and Lake Okeechobee outflows, respectively. Low levels of bioavailable monoester P and high diester P in 0.2 µm filtered water samples indicate the recycling of P through biota. The role of vegetation in DOP sources was further evaluated using <0.45 µm filtered dissolved organic matter (DOM) leachates from litters of emergent and submerged aquatic STA vegetation. Preliminary evaluation of the <0.45 µm fraction of the leachates suggested a DOP hydrolysis pattern similar to the source waters (<0.2 µm), but in the leachates the proportion of diester-hydrolyzable P was much lower, representing only about 10% of the DOP (8$\mu g\ L^{-1}$ from emergent and 7$\mu g\ L^{-1}$ from submerged vegetation). Most DOP (<0.45 µm) being unavailable for hydrolysis by P-enzymes highlights the potential difficulty in lowering phosphorus concentration in STA waters through biotic conversion. Future studies should explore other enzyme processes such as (C-N-P) synergism and enzyme complexation with DOM to better understand biotic processing of DOP in the STAs.

FRESHWATER MANAGEMENT STRATEGIES FOR POTENTIAL ALGAL BLOOM IN THE ST. LUCIE ESTUARY, PERSPECTIVE FROM A SIMPLE BOX MODEL THEORY

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Under the guidance of a simple box model theory (Sun et al., 2022, submitted), a quantitative analysis was performed to evaluate the impact of freshwater discharges on potential algal blooms in the St. Lucie Estuary. Results suggest that an algal bloom may occur if the net growth rate of phytoplankton in the estuary (k) is greater than the flushing rate (f). The flushing rate is dependent on both freshwater inflow and tide. The low end of flushing (f_s) is estimated to be approximately 0.05/day corresponding to residence time of 20 days when there is no freshwater discharge. Estimation of k is more complex due to high uncertainty associated with each of the three terms (gross production, respiration, and predation) needed for k. When the net growth rate k is lower than f_s , there would be low risk of an algal bloom developing locally in the estuary. However, when $k > f_s$, freshwater discharges are needed to prevent an algal bloom from developing locally. As k increases, so too does the need for the discharge quantity. Thus freshwater discharge can be a useful management tool to prevent local development of algal blooms. However, the box model theory also suggests if upstream waters are experiencing an algal bloom or containing higher algal biomass than the estuary, increased freshwater discharge will increase algal biomass and the risk of bloom related impact in the estuary. Therefore, different freshwater management strategy is needed for different sources of algal bloom in the estuary.

PROGRAMMATICALLY ESTIMATING VOLUMETRIC FLOW IN THE EVERGLADES DEPTH ESTIMATION NETWORK (EDEN)

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The U.S. Geological Survey (USGS) measures water-level data which, along with data from Everglades National Park, Big Cypress National Preserve, and the South Florida Water Management District, is used to calculate water level and depth grids spanning the Greater Everglades. The gridded data are available on the Everglades Depth Estimation Network (EDEN) website (https://sofia.usgs.gov/eden/models/watersurfacemod.php). Using the Python programming language, a script was developed to calculate grids of volumetric flow vectors from the water-level grids, providing deeper insight into the current state of the wetlands. The script began as a basic calculation of the X and Y components of the flow vectors and functionality was added to plot the vectors on a map. Code was then added to retrieve water-level and depth data from the USGS EDEN Thematic Real-time Environmental Distributed Data Services (THREDDS) server (https://sflthredds.er.usgs.gov/) using command-line arguments, allowing a user to specify a date or date range without having to manually download data or modify the script. Lastly, the constants in the flow vector formula were calibrated by comparing calculated flow vector magnitudes to measured river outflows. The final script, for each date requested by the user, generates and saves a plot of the grid of vectors, as well as a file containing the vector positions, components, and magnitudes. Optionally, the user also can specify regions in the grid in which to sum vector magnitudes, generating an additional file containing daily magnitude sums for each region. This script will provide engineers, water-resource managers, researchers, and others with a new decision-support tool for observing the state of the Everglades in regard to flow and discharge.

REFINEMENTS AND ADVANCEMENTS: 17 YEARS OF THE EVERGLADES DEPTH ESTIMATION NETWORK (EDEN)

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The Everglades Depth Estimation Network (EDEN) was implemented in 2005 to provide scientists, water managers, and other users with daily-averaged water-levels and depths across the Greater Everglades. Since that time, EDEN has expanded to include ecological models, rainfall and evapotranspiration data, coastal salinity indices, and wetland flow estimation. EDEN utilizes feedback from users to improve output and address additional needs, such as the representation of below-ground water levels, higher resolution water-level grids, and wetland flow vectors computed from the water-level map. EDEN utilizes over 250 field stations operated by the U.S. Geological Survey, Big Cypress National Preserve, Everglades National Park, and the South Florida Water Management District to develop daily average water-level surface representations on a 400-meter grid for the Greater Everglades. The water-level surface and a digital land-elevation model are used to calculate daily water-depth information essential to determining the suitability of various ecological habitats. EDEN currently supports the Wading Birds Depth Viewer, which assesses current hydrologic conditions for wading birds in the Everglades, and the Cape Sable Seaside Sparrow Viewer, which evaluates conditions for nesting success in designated Cape Sable Seaside Sparrow habitats. Available online, these ecological tools have proven valuable in water management decision-making and in assessing the ecological health of the Everglades system. Although the water-level network does not extend to the coast, EDEN does provide essential information at the coastal fringe in the form of salinity indices, which utilize salinity data to characterize saline (drought) and freshwater (wet) conditions for the coastal Everglades and other regions. Besides these fully implemented ecological and salinity tools, additional improvements and tools are currently being developed. Higher-resolution digital elevation models allow for EDEN grid spacing down to 50 meters to resolve smaller areas of inundation. Users will be able to select specific regions of interest within the EDEN domain to implement a finer grid. Another EDEN tool under development uses the daily-average maps of water levels to compute gradients and flow volumes, calibrated to known flows at coastal rivers. The resulting map of flow vectors provides the path and destination of water in the Greater Everglades and quantifies the effect of water releases from control structures. Although EDEN began as an integrated water-level network, since 2005 it has expanded to include multiple ecological tools, a monitoring tool for changing coastal salinity conditions, a method to represent wetland flows, and it serves as a clearinghouse for Greater Everglades data from multiple agencies. Feedback from EDEN users have been invaluable in the developmental process and will continue to guide EDEN advancements in the years to come.

POPULATION TRENDS OF THE CAPE SABLE SEASIDE SPARROW OVER DECADES OF MONITORING IN THE EVERGLADES

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Demographic knowledge is critical to the conservation of endangered species. The Cape Sable Seaside Sparrow (CSSS; *Ammospiza maritima mirabilis*) is a federally endangered species endemic to the freshwater prairies of Everglades National Park and Big Cypress National Preserve. The maintenance of marl prairie habitat and prescribed environmental conditions is critical to the species' recovery and is both an important goal and measure of Everglades restoration success. Yet evaluating population-level responses to environmental conditions and restoration scenarios is a fundamental challenge for restoration planners who often must consider the impacts of water management projects to the CSSS. While field research on the CSSS spans over four decades, a statistically robust analysis of demographic parameters in response to altered hydrologic and environmental conditions of the Everglades has yet to be performed. Therefore, our objectives are to quantify the effects of hydrologic and environmental factors on three key demographic parameters and quantify the relative importance of these demographic parameters on population change. We compiled data from range-wide helicopter surveys, mark-recapture and resights, and nest surveys to jointly estimate population size, individual survival, and daily nest survival within a Bayesian framework. We test how these demographic parameters change in response to hydrology, vegetation, and individual-level attributes, and identify which demographic parameters most impact population change. Current estimates of the CSSS population indicate a 63% decline since 1981 across its fragmented range which is delineated by six small subpopulations (A-F). Between 1994 and 2021, 1,126 active CSSS nests were monitored with varying levels of effort across the six subpopulations (A = 111 nests; B = 416; C = 71; D = 106; E = 418; F = 4) and of those nests, 573 (51%) fledged and 553 (49%) failed. The percentage of fledged nests is highest in subpopulation D (64%) where numbers of birds have increased in recent years, and lowest in subpopulation A (33%) where numbers of birds have not recovered to pre-1990 levels and have been extremely low in recent years. Examining how short- and long-term changes in hydrology and vegetation impact individual survival, nest success and growth of each subpopulation provides a more accurate status assessment of the CSSS population and sheds light on the viability of subpopulations considering potential future conditions. Furthermore, these results will provide insight into the causes of declines in the CSSS population and support species recovery planning and water management actions for Everglades ecosystem restoration.

CONSIDERATIONS FOR USING DRONE TECHNOLOGY FOR ESTUARINE HARMFUL ALGAL BLOOM (HAB) MONITORING

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Drones are a relatively new technology that have been utilized more recently for environmental monitoring. They offer a unique perspective and can be used to supplement large scale remote sensing and in situ field monitoring efforts. The South Florida Water Management District (SFWMD) initiated a drone program in 2020 to take advantage of this new technology and enhance our monitoring capabilities. A variety of challenges were addressed during program initiation that included requirements and constraints for governmental agencies using drones, changes in federal aviation regulations, and hazards associated with flying drones within estuarine environments. With the new drone program at the SFWMD, future efforts to monitor and track harmful algal blooms will be more cost effective and allow for a more rapid response.

EVALUATING FIELD SCALE HYDROLOGIC AND CROP SIMULATION MODELS IN SOUTH FLORIDA

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Understanding field-scale hydrological processes is critical to developing efficient water resources management practices and hydrological and crop simulation modeling frameworks that promote crop water productivity and environmental sustainability. However, the availability of quality data at spatial and temporal scales is challenging. A precision irrigation field experiment was conducted at the Tropical Research and Education Center (TREC), the University of Florida under a linear move variable rate irrigation system. Data collection included major hydrological components (e.g., soil moisture, evapotranspiration) and crop growth and yield components. Lysimeters and soil moisture sensors were installed in each plot. In addition, micro-climate conditions were measured using a weather station on site. The performance of different hydrological and crop growth simulation models such as DSSAT and APEX in simulating field scale rootzone moisture and evapotranspiration dynamics and crop growth processes was evaluated. In this presentation, we will discuss results from hydrologic and crop simulation modeling work based on data from a two-year study in South Florida.

DISCERNING THE RELATIONSHIPS BETWEEN WATER LEVELS, CRAYFISH POPULATIONS, AND WHITE IBIS IN THE WESTERN EVERGLADES.

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Restoring the super-colonies of wading birds in the southern coastal Everglades is an important indicator for Everglades restoration success. Until recently it was unknown how the Everglades' wetlands and estuaries produced prey for super-colonies, as nesting irruptions had not occurred in recent history. In 2018 and again in 2021, White Ibis (*Eudocimus albus*) nesting numbers were >24,000 nests across all coastal colonies and represented the highest nesting activity since the early 1940s, giving us an opportunity to understand the relationships between hydrology, prey production, and prey availability. The ibis that nested in 2018 fed their chicks crayfish (mostly *Procambarus alleni* during nest initiation) which are produced in the short hydroperiod western marl prairies of Everglades National Park and Big Cypress. To begin to understand the relationship between ibis nesting effort, hydrologic variation, and the availability of crayfish in the marl prairies, we reconstructed hydrographs for the CERP MAP sample sites stratified across the marl prairies and western ENP over a 16-year period and summarized the wet season crayfish biomass data collected in September to October of the same years. The hydrographs were created using depth data from the Everglades Depth Estimation Network (EDEN) daily average depths across the marl prairies and western Shark Slough using CERP-MAP sampling areas from the) 2006-2021 water years (May 15-May 14). Depths were corrected for elevation of the sampling sites by using our *in situ* depth measurements. Water levels in the two high nesting years were characterized by the highest November water depths in the marl prairies. Depths were 55-60 cm across the marl prairies in November, making them >20 cm deeper than the wettest year without high nesting effort, and >30 cm deeper than the average of all other years. 2018 and 2021 were not the only years with water available for foraging in February, suggesting that foraging habitat availability alone could not explain the years of high nesting effort. Wet season mean crayfish biomass in sixteen sites west of Shark Slough ranged from 0-20.62 g/m^2, but we found no correlation between wet season crayfish biomass in the marl prairies (Sept-Oct) and ibis nesting effort the following dry season. These findings suggest that the high water, after the annual CERP MAP wet season sampling, was functionally important for producing high crayfish availability in the dry season. We propose multiple hypotheses that could explain a link between *P. alleni* availability in the marl prairies and deep water at the end of the wet season. Hypotheses about hydrologic limitation of crayfish in the marl prairies are being addressed, in part, by expanding CERP MAP sampling into the early dry season plus complementary studies of *P. alleni* in short hydroperiod wetlands in southern Big Cypress (i.e., near Loop Rd) to examine reproduction, growth and recruitment.

MONITORING INLAND LAKES FOR CYANOHABS THROUGH THE USE OF SATELLITE REMOTE SENSING

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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 microcystin toxins. *Microcystis* blooms have been a recurring problem in Lake Okeechobee and adjacent estuaries 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. Other water bodies within the Everglades ecosystem experience cyanobacterial blooms. Understanding the presence, timing, and magnitude of dense blooms in Lake Okeechobee is important to examine the potential impact on the St. Lucie and Caloosahatchee Rivers, both of which may receive water from the lake when lake levels are high. Routine satellite monitoring provides 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, and is applicable to lakes across the country, including those in Florida. The algorithm, Cyanobacteria Index (CI), provides an estimate of the near-surface chlorophyll concentration found within cyanobacteria and does not depend on the occurrence of scum for detection. This method was developed for the European Space Agency's 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 program Sentinel-3 (S3) satellites first launched in 2016. OLCI provides 300 m resolution data with almost daily repeat coverage with two satellites (Sentinel 3a and b). However, OLCI has more limited use for smaller lakes and 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 with 20 m data every five days. In addition, by monitoring the wind speed prior to the imagery, we can provide a more accurate interpretation of individual images for bloom intensity.

WHAT ROLE CAN UAS PLAY IN THE EFFORT TO DETECT, MONITOR, AND PREVENT HARMFUL ALGAL BLOOMS: INTEGRATING UAS INTO THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT'S CURRENT PROGRAM

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The UAS program at the South Florida Water Management District began in 2019. Until that point, the use of UAS was primarily in the Survey Section for creating orthoimages and obtaining topographic data. In the Spring of 2021, there was a localized HAB at the Pahokee Marina on the shore of Lake Okeechobee and another along the L10 Canal. The UAS Team was called upon to help in the effort to monitor the HABs. This presentation will address the challenges faced, the benefits realized, and the lessons learned to improve future efforts.

IMPACT OF FLOATING AQUATIC VEGETATION IN DRAINAGE CANALS AND FARM PHOSPHORUS DISCHARGES

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Floating aquatic vegetation (FAV), proliferate in farm drainage canals at the Everglades Agricultural Area (EAA), in southern Florida. FAVs produce detritus material that accumulates on canal sediments and contribute to the farm phosphorus (P) discharges. Control of FAVs in farm canals not only improves drainage water conveyance and irrigation water throughout the farm, but also may lead to further reductions in farm P load. In this study, farm drainage discharges were monitored between 2011-2020 from eight participating commercial farms. FAV coverage was evaluated biweekly and canal sediment was collected twice annually for evaluating P content. Multivariate statistical analysis techniques including Spearman correlations, Stepwise regression, and Principal Component Analysis (PCA) were performed to assess the relationship between FAV coverage and canal sediment properties, with canal drainage water P concentration and loads. Drainage water total dissolved P (TDP) and particulate P (PP) concentrations had a significant positive correlation with FAV coverage, and sediment total P (TP) concentration had a significant positive correlation with drainage water PP concentration. This shows that both FAVs and canal sediment can act as sources of P and contribute to the drainage water P loads. Controlling FAVs and sediment removal in agricultural canals could reduce the risk of P loading from agricultural drainage.

ILLUSTRATING IMPACTS OF THE BOOM-AND-BUST DYNAMICS OF AFRICAN JEWELFISH IN THE SHARK RIVER SLOUGH

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Boom-and-bust population dynamics have been a long-recognized phenomenon during species invasions. However, few studies document the impact and recovery from these temporary changes in a dominant species. The Everglades ecosystem of southern Florida is the largest wetland in the United States, is undergoing a multi-decade hydro- restoration effort, and has been invaded by several freshwater fishes. We used a 25-year dataset of fishes and decapods in Everglades National Park (ENP) to assess potential effects of African Jewelfish (*Hemichromis letourneuxi*) invasion (boom-bust dynamics; 2012–2021) on native species. After accounting for effects of hydrologic variation (e.g., dry disturbances) several native species were reduced by jewelfish; both higher jewelfish abundance and jewelfish presence were associated with low densities of four common small-fish species (declines up to 50%). Following the bust in jewelfish populations, densities of most prey species recovered to match predictions based on hydrologic models. To illustrate the impact of African Jewelfish boom, we estimated their impact on Eastern Mosquitofish (*Gambusia holbrooki*) by estimating the spatial range of the invasion and their area-weighted density using data from CERP MAP, and their per-capita impact on Eastern Mosquitofish from the long-term data. At their peak abundance, approximately 50% of Eastern Mosquitofish in Shark River Slough were replaced by African Jewelfish. Eastern Mosquitofish are historically among the most abundant species in the Everglades, and Florida freshwaters generally. They are considered aggressive predators of invertebrates, eggs and larvae of amphibians, and eggs, larvae, and juveniles of fishes; they are linked to extinction of native species when introduced outside their native range. The functional ecological role of Eastern Mosquitofish in the Everglades is not well delineated but is assumed to be significant, and their replacement by African Jewelfish may have dramatic impacts on energy flow and food-web function. We documented recovery and resiliency in native species following the population bust of African Jewelfish. Our findings for jewelfish were consistent with some, but not all, findings from experimental mesocosm studies. Long-term and spatially extensive monitoring data provide an opportunity to probe for novel population-level impacts at field scales. Future work should delineate the implications of biological invasions on Everglades ecological functions such as providing critical prey resources for apex predators like wading birds during the nesting season.

INVESTIGATING ADAPTIVE CAPACITY OF SALINIZING COASTAL WETLANDS IN NATURAL AND URBAN ENVIRONMENTS

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Coastal wetlands are exposed to a unique combination of stressful environmental conditions, including subtropical wet-dry season extremes, periodic salt exposure, occasional extreme temperatures, and an underlying rapid change in climate (e.g. sea-level rise, SLR) and disturbance (e.g., coastal storms) regimes that regulate biological structure and function. Wetland plant species have important foundational roles in maintaining and enhancing ecosystem resilience to disturbance by stabilizing and building soil and retaining nutrients. In our experimental work on coastal peat marshes in the Everglades, we have found that increased salinity reduces plant productivity, and availability of the limiting nutrient, phosphorus, offsets the stressful impacts of salinity on a moderately salt-tolerant freshwater species, sawgrass (*Cladium jamaicense*). Our long-term monitoring data have also shown that sawgrass can persist in continuously saline conditions at higher marsh elevations. In order for the coastal wetland landscape to adapt to the impacts of increasing salinity and inundation with increasing SLR (in the absence of restored freshwater flows), marsh and mangrove species must maintain productivity levels that enable the rate of soil elevation change to increase at a greater rate than SL (e.g., wetland adaptive capacity). Adaptive capacity is an informative tool for predicting ecosystem trajectories. We are exploring dynamics in vegetation and geomorphic gradients to test the overarching hypothesis that productivity and sediment availability modulate adaptive capacity in Everglades coastal marshes and urban mangroves. We are conducting long-term monitoring of vegetation, sediment elevation change, and hydrology at six sites in Everglades coastal marsh and two sites in urban mangroves. Our work to date illustrates broad variation among marsh and urban mangrove sites, ranging from 0.5 – 5.5 mm/yr in peat marshes to 6.6 – 7.6 mm/yr in urban mangrove sites. New experimental work will investigate phosphorus availability and sediment elevation as drivers of adaptive capacity in a marl-forming coastal marsh. To improve coastal wetland ecosystem function degraded by saltwater intrusion, this program of work in natural and urban environments will help elucidate environmental factors limiting positive wetland soil elevation change and illuminate optimum approaches for enhancing ecological resilience of Southeast Florida coastal wetlands. These collected datasets also facilitate parametrization of advanced models to simulate wetlands elevation change and ecosystem trajectories in the face of accelerated SLR.

EXPLORING THE EFFECTS OF WATER-TABLE ELEVATION CHANGES IN PEAT SOILS ACROSS A SALINITY GRADIENT

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The phenomenon of peat collapse is an important contributor to soil loss in coastal wetlands that will likely accelerate with sea level rise. Recent studies have investigated several aspects related to peat collapse, including conceptual models describing drivers and mechanisms. However, few datasets can be found in the literature to support these models, particularly given the difficulty of monitoring soil dynamics at the matrix level. The purpose of this study is to improve the mechanistic understanding of the phenomenon of peat collapse by using an array of state-of-the-art sensors (including ground-penetrating radar, GPR) to explore how the process of peat collapse may be affected by changes in water table elevation. A set of peat soil monoliths (30cm x 30cm x 25cm) was collected across a salinity gradient located between the Big Cypress and the Fakahatchee Strand Preserves. They were subject to changes in water-table elevation to explore how physical properties of the peat soils (e.g., porosity, moisture content, biogenic gas content and dynamics, etc.) were affected differently by positioning in reference to the salinity gradient (i.e., saltwater vs. freshwater vs. brackish conditions). Measurements at the laboratory scale included the use of GPR to infer in-situ gas content, elevation rods to infer soil surface deformation, and gas chromatography to infer gas composition. Results show that: 1) changes in surface elevation during increases and decreases in water-table elevation were more pronounced in freshwater soils; and 2) biogenic gas dynamics, including methane concentration, were also more pronounced in freshwater soils and seem to directly correspond to water-table elevation, i.e., increased activity at higher water-table elevation. These results have implications for better understanding how seasonality may mechanistically affect the peat soil matrix (and thus potentially the process of peat collapse) across soils affected by different water salinities.

HARMFUL ALGAL BLOOM PREDICTION USING HYDROGEN PEROXIDE MONITORING

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Lake Okeechobee is the largest lake in the southeastern United States (1,900 km^2) and serves as a hub for its downstream waterways, the St. Lucie River to the East and the Caloosahatchee River to the West. These warm tropical/subtropical waters undergo harmful algal blooms (HAB), with occurrence and severity increasing in recent decades. *Microcystis aeruginosa* is the most frequent and persistent toxic cyanobacterium and the mitigation of this species has become a greater focus for water managers of the region. Predicting HABs and detecting early accumulation of cyanobacterial biomass towards a bloom would allow water managers to rapidly respond with treatments to mitigate HAB impact at a more manageable stage. We hypothesized that the measurements of hydrogen peroxide dynamics in freshwater environments could be a mirror of algal community dynamics and used to forecast HAB events. To better understand cyanobacterial HAB ecology and associated hydrogen peroxide dynamics, we performed in-depth monitoring at Franklin Lock and Dam in the Caloosahatchee River from February 2019 through January 2022. Our 2021 data exhibit that environmental hydrogen peroxide in the Caloosahatchee River greatly increased before and during increases in bloom forming *Microcystis* biomass. We observed the same phenomenon in our 2019 weekly monitoring. A similar hydrogen peroxide peak was previously documented from Lake Erie right before the massive *Microcystis* bloom formation. We observed a correlation between algal colony numbers, which are mainly associated with *M. aeruginosa* abundance, and hydrogen peroxide concentrations. During our 2021 biweekly monitoring, two weeks before the spring bloom, hydrogen peroxide increased greatly and was maintained until the bloom dissipated. During the brief 2021 December bloom, there was a smaller but detectable increase in hydrogen peroxide levels along with an increase in the abundance of *M. aeruginosa*. The hydrogen peroxide concentration in 2021 fluctuated greatly and ranged between 41 nM to 1582 nM. The baseline concentration was around 50 nM in this study. The average concentration was 390 nM and the median was 273 nM. It should be noted that the baseline hydrogen peroxide concentration differs in every aquatic environment. Based on 2021 monitoring, and inputs from two previous year reports and others, we tentatively set a warning threshold value as 500 nM. If the concentration of hydrogen peroxide exceeds this number, we should prepare for HABs.

ROOTED VEGETATION MOBILIZES PHOSPHORUS FROM MUCK SOILS: RESULTS FROM MESOCOSM STUDIES

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The Stormwater Treatment Area (STA) wetlands south of Lake Okeechobee were constructed to remove total phosphorus (TP) from runoff prior to discharge to the Everglades Protection Area. Phosphorus (P) loading rates can, in certain circumstances, be a key variable that affects TP removal performance in these STAs. However, in the low-P domain (<~20 µg/L), which is characteristic of STA outflow regions, processes such as internal loading may also affect outflow P at the lowest limits of STA performance. Rooted macrophytes are one potential P loading pathway. They have been found to play a role in “mining” P from sediments in shallow lakes. Because P-rich soils occur in most of the STAs, and rooted vegetation can be found throughout the outflow regions of the STAs, internal loading of soil P through plant mining could be a potential process inhibiting P removal. This process was investigated in several studies. In one flow-through mesocosm study, a limerock gravel layer was added over STA muck soils to test the P removal performance with or without macrophytes. The macrophyte treatments resulted in higher water P concentrations, compared to the no macrophyte treatments. The plant-available soil P pool was reduced in the macrophyte treatments compared to no macrophyte treatments, indicating that the plants rooted through the limerock layer and mined P out of the underlying STA muck soil. Further, macrophyte treatments accrued more P in newly generated sediments (2.0 ± 0.2 g P/m^2) than the total external P load added via inflow waters (1.2 g P/m^2). This indicates that plant mining of buried soil P was a substantial addition of P to the surface systems. A separate microcosm study found elevated *Chara* spp. and *Potamogeton* spp. tissue P contents when grown on muck, but not when grown on limerock, indicating that muck was the principal source of P that accumulated in plant tissues during the 84-day incubation. In another study, flow through mesocosms with mixed submerged aquatic vegetation species on muck soils showed higher *Potamogeton illinoensis* biomass relative to *Chara* biomass, when limerock was added onto the muck soil. *Potamogeton* roots penetrated through the limerock to access nutrients in the underlying muck, which the macroalga *Chara* could not have done. These projects are among several studies on STA function that have shaped the current understanding of internal P loading to the water column through plant mining of soil P.

INITIAL RECOVERY OF GROUNDCOVER PLANT COMMUNITIES AS THE PICAYUNE STRAND RESTORATION PROJECT PROGRESSES

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The goal of ecological restoration is to return an altered landscape to its pre-disturbance ecological functioning, reestablishing balance between abiotic and biotic ecosystems elements. In the Picayune Strand, the backfilling of canals and degrading of logging trams and roads is restoring hydroperiods and sheetflow. Hydrologic restoration changes the vegetation community from assemblages of upland and facultative species and increases the number of obligate wet species. In 2016, a permanent subset of 27 transects was chosen to capture vegetation changes within the major habitats, wet prairies, cypress, and pinelands. Eighteen transects are in portions of Picayune we consider to be or very close to being fully hydrologically restored as of June 2015. Nine transects serve as reference transects within the three major habitats outside of the PSRP. The subset of transects were field sampled in 2005, 2016, 2018, and 2021. Each recorded plant species is assigned a wetland affinity score reflecting its defined wetland habitat preference. Combining wetland affinity scores and adjusting for species frequency produces a wetland affinity index (WAI) for each sample point and time.

Positive responses in plant community composition within wet prairie and pinelands are defined as moving to a higher WAI and increasing in native plant species richness. In cypress habitat, however, as WAI increases with response to rehydration and longer hydroperiods, species richness is expected to decrease.

Non-metric multidimensional scaling was applied to principal component analysis to display the dissimilarities between groundcover plant communities at different sites and different sampling events. Fire history (fire intervals), species richness (count of native species within quadrat data), precipitation (average of yearly totals), drainage category as proxy for restoration efforts, and frequency-adjusted WAI were used as environmental variables to interpret the spatial distribution. Observed shifts in vegetation communities between sampling periods are partially explained by WAI and reduction in drainage along one axis as fire frequency and species richness move the distribution along a second axis. Wet prairie and cypress habitats are experiencing the greatest shifts in groundcover community composition in response to hydrologic restoration.

Although the PSRP is showing positive response to the restoration efforts in the PSRP, distinct challenges remain. Primarily, exotic nuisance plants thrive in disturbed habitats and must be kept in check while restoring the landscape.

SOURCES AND TEMPORAL TRENDS OF SULFATE IN THE FRESHWATER EVERGLADES

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Water flowing from Lake Okeechobee through the Everglades Agricultural Area (EAA) is enriched in nutrients through the runoff of agricultural amendments. Previous studies have found elevated surface-water sulfate concentrations in the canals that run through the EAA, far above the estimated background concentration of less than 1 mg/L in the freshwater Everglades wetlands. Sulfate can have numerous deleterious effects to the aquatic ecosystem, including stimulating microbial methylation of mercury. Over the last 25 years, changes in agricultural practices and the construction of stormwater treatment areas have successfully reduced phosphorus discharge downstream, however, elevated sulfate levels persist throughout the system. To assess if the current management practices are influencing sulfate concentrations, trend analysis was conducted on sulfate data from 40 U.S. Geological Survey and South Florida Water Management District (SFWMD) surface-water sampling locations from 1996-2019. Sampling locations included Lake Okeechobee, major canals in the EAA and Everglades Protection Area, and a marsh site in Everglades National Park. Sulfate concentrations were highest in the EAA canals with a median site-mean concentration of 60.5 mg/L, and lower concentrations in Lake Okeechobee (30.6 mg/L) and downstream of the EAA (15.6 mg/L). Overall, sulfate concentrations are highest in the wet season. For example, sulfate measurements at SFWMD site S7 on the New North River Canal near the southern extent of the EAA were 44 mg/L and 38 mg/L in the wet and dry seasons, respectively. Analysis of sulfate concentrations with cumulative precipitation prior to sampling indicates mostly steady sulfate concentrations during the wet season while sulfate concentrations spike during runoff events in the dry season. These trends are most pronounced in the canals within the EAA. Sulfate concentrations in Lake Okeechobee and at the canal intakes show a significant decreasing trend, possibly due to reduced back pumping from the canals to the lake over the study period. Most sites in the Everglades Protection Area show no significant increasing or decreasing trend in sulfate concentration across the study period. While current management practices have had little effect on sulfate concentrations in the system, long-term monitoring sites will continue to play an important role in assessing the effects of water management changes.

TWO DECADES OF CHANGE IN WCA-3 TREE ISLANDS: EFFECTS OF HYDROLOGY AND NATURAL DISTURBANCE

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Changes in tree island structure and composition have been noted in many regions of the Everglades, most frequently attributable to hydrologic influences. However, less attention has been paid to other ecosystem drivers affecting forest structure. Although seasonal hydrologic variation overlain by modified hydropatterns are chronic/continued influences that can shape island ecology thunderstorms, hurricanes, freezing and fires represent stochastic impacts that can also affect these islands. Both these types of ecosystem drivers synergistically interact to shape the long-term trajectory of changes in forest structure and composition. The purpose of this research was to understand how tree islands were changing over time across a range of hydrologic gradients with landscape-scale stochastic impacts, and the implications for long-term persistence of these key habitats within the Everglades landscape. To determine how tree islands have changed over time in WCA-3A and -3B, several islands were monitored over two survey periods (2001-2005, 2021/2022). All tree islands were dominated by flood-tolerant species such as *Annona glabra* (pond apple), *Salix caroliniana* (Carolina willow), *Ilex cassine* (dahoon holly), *Magnolia virginiana* (sweet bay), and *Chrysobalanus icaco* (cocoplum). A total of 11 woody tree species encountered on these islands and the species dominance within the islands did not shift over the two decades. Tree basal area and height were consistently higher on tree island heads relative to the near tail areas during both survey periods. Tree stem density patterns were also similar during both time intervals, with the near tail having greater density than the head for most of the islands. However, there was a significant decline in basal area and complexity on some of the tree islands between the two surveys; this was accompanied by an increase in smaller diameter stems and loss of some larger trees. These changes in species composition and forest structure in islands across the landscape seem to be related not only to differences in hydropattern, but also to natural disturbances such as hurricanes (e.g., Hurricanes Wilma and Irma). Since hurricanes disproportionately affect larger trees on these islands and can generate openings in the canopy when larger trees die, they create forest gaps conducive for natural recruitment. Data synthesis from surveys two decades apart indicate that the tree islands in this study are self-sustaining within the hydrologically managed WCA-3 landscape, with notable changes in forest structure appearing to be partially driven by stochastic events such as hurricanes. Consequently, studies of tree islands as regional-scale indicators of the health of the Everglades landscape should also consider the impacts of storms, fires and freezes. With future climate change scenarios for more intense hurricanes, the role of large storms in shaping the tree island communities should be considered in restoration and planning efforts.

UPDATING METHODS TO ESTIMATE FLORIDA BAY SALINITY FOR THE RECOVER SOUTHERN COASTAL SYSTEMS

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The Comprehensive Everglades Restoration Plan (CERP) aims to improve ecosystem health by providing for more natural flow characteristics of water through the Everglades while supporting other water-related needs in south Florida. RECOVER (REstoration COordination & VERification) is a multi-agency and multi-disciplinary team that serves as the scientific and technical arm of CERP. RECOVER supports CERP goals and objectives by maintaining a system-wide perspective for evaluations and assessments to inform managers, decision-makers, and the public. Due to the extensive area and diverse landscape of CERP, RECOVER is arranged into modules representing similar ecosystems for identification of threats and restoration options. Within the Southern Coastal Systems Module (SCS), RECOVER monitors and evaluates ecological conditions in Florida Bay, Biscayne Bay, and the southwest coast. Altered freshwater delivery to Florida Bay produces recurring hypersalinity events resulting in seagrass die-offs, algal blooms, and sediment destabilization. As a result, CERP restoration strategies for Florida Bay aim to reduce the intensity, frequency, duration, and spatial extent of these hypersaline events and establish a persistent and resilient estuarine zone capable of supporting extensive and diverse seagrass beds and habitat. Florida Bay also has many shallow basins that influence water circulation patterns and produce varying salinity levels throughout the bay. Therefore, the SCS team developed the Florida Bay Salinity Performance Measure (PM) in 2012 as a tool to assist in CERP project planning, evaluation, and module goals. This PM uses salinity data collected from 17 monitoring stations throughout the bay and multilinear regression (MLR) statistical models to estimate salinity responses and compare these to paleo-adjusted salinity targets derived from the Natural Systems Model. The PM was updated in 2019 to (1) expand the spatial extent of salinity data collection in the lower southwest Florida coast, (2) update the MLR for northeast Florida Bay to better assess project effects, and (3) use the Regional Simulation Model output to evaluate future conditions. Although the 2019 updates benefited CERP project planning, limitations still existed in future usability of the PM as new models became available. Renewed efforts began in 2021 to further update the PM and address challenges associated with the MLRs by investigating the use of the Environmental Fluid Dynamics Code model (EFDC) for salinity estimates. Transitioning to the EFDC enables (1) salinity to be estimated across the entirety of Florida Bay, which can then be used to better inform other SCS PMs (e.g., American Crocodile Growth and Survival and Juvenile Spotted Seatrout Habitat Quality), study planning and updates, and operational plan development and (2) the use of regional models, which would extend the period of record for measured salinity input to 2016.

LEAF FUNCTIONAL TRAIT VARIATION IN RED MANGROVES OF NEIGHBORING COASTAL ENVIRONMENTS

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Within the Everglades, a gradient of increasing water salinity faces transgressive vegetation replacement of freshwater marsh by shrublands (hereafter referred to as scrub) dominated by the facultative halophyte *Rhizophora mangle* L. (red mangrove). Adjacent to these shrublands, red mangrove is also found growing within tree islands containing mesophytic tropical hardwood species (hereafter referred to as tree islands) with relatively higher soil phosphorus than the surrounding plant matrix. This landscape setting is ideal for quantifying trait variation in red mangrove in relation to its wide spatial range in the area, and whether these traits are distinct between the two plant matrices. In the southeastern Everglades, eight leaf traits *of R. mangle* were measured in coastal tree islands and adjacent scrub mangrove habitats. Traits were compared across three zones of porewater salinity (ranging 1-19 parts per thousand) with increasing salinity toward the third zone, and in both scrub and in tree islands (ranging in soil phosphorus from 315.21-2910.83 ug cm^{-2}) with highest soil phosphorus concentrations in tree islands. We asked whether variation in leaf traits of *R. mangle* was present in accordance with the leaf economic spectrum, which describes the trade-offs leading to slow-return and quick-return on investments of nutrients and biomass. Leaf area, specific leaf area, stomatal density, stomatal size, leaf total nitrogen, total phosphorus, carbon isotope ratio, and leaf total phenolic concentration were measured. Traits were expected to trend toward slow-return with lower stomatal density or area in the low nutrient and high salinity plots relative to the higher nutrient lower salinity plots. Among tree island plots, specific leaf area, leaf total phosphorus, and carbon isotope ratio were found to significantly differ between the lowest and highest salinity zone. In some scrub plots, *R. mangle* traits did demonstrate slow-return traits relative to tree island plots, but individual traits in scrub habitat did not differ as much by zone. Therefore, the hypothesis of slow-return traits at higher salinity was only partially supported. Stomatal density was highest in scrub plots of the higher salinity zones contrary to expectations of a decrease with typically lower plant transpiration at higher salinities, while leaf area, stomatal size, and total phenolic concentration did not significantly differ across the study site. A gradient of high carbon isotope ratio and stomatal density on one end, and high leaf specific leaf area, total phosphorus, and total nitrogen on the other was represented by the first principal component of the leaf traits. This reflected a gradient of low to high resource availability between scrub and tree island plots along which the effect of salinity zone meant tree islands of higher salinity had scores closer to that of scrub plots.

A CHOMP AND A SLITHER: THE IMPLICATIONS OF THE INVASIVE BURMESE PYTHON ON AMERICAN ALLIGATOR

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The establishment of the invasive Burmese python has greatly devastated mammal communities across the Greater Everglades ecosystem, making the management of these invasive snakes a priority for restoration success. Burmese pythons are also known to depredate American alligators; however, little is known about the effects of this predation on alligator populations and whether pythons take primarily juvenile or adult alligators. The American alligator is an integral and symbolic species of the Everglades serving as ecosystem engineers and ecological indicators for restoration progress. In this study, we analyzed the gut contents from over 1500 pythons collected throughout Southern Florida. We focused on prey items that contained morphological traits such as scales, skin, and bones that were identified as alligator. Samples were then compared to alligator specimens housed at the Florida Museum of Natural History to characterize and create a size-class distribution that can be used to assess the percentage of alligator biomass consumed by pythons. The results of this study will provide insight to the Everglades food web and potential conservation concerns regarding the American alligator.

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TIGHT LINES AND SURVEY DESIGNS: ESTIMATING THE RECREATIONAL ECONOMIC VALUE OF LAKE OKEECHOBEE

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Ecosystem service valuation is an effective tool for justifying and advocating for continued Everglades restoration efforts. While previous valuation studies have targeted areas such as Everglades National Park and Florida Bay, few current studies have targeted the hydrological heart of the Everglades ecosystem: Lake Okeechobee. With ongoing Lake Okeechobee System Operating Manual (LOSOM) negotiations, greater understanding of the complex relationships between human populations and the Lake is critical. Lake Okeechobee is the future source of water for Everglades restoration as well as a premier bass fishery, complete with complex stakeholder dynamics, a variety of user groups, and fierce competitors for water allocation. This study aims to estimate Florida residents' and Florida anglers' willingness to pay for improving Lake Okeechobee management through an attribute choice survey. Additionally, traditional attribute choice surveys do not gather essential contextual information about respondents beyond demographics or provide insight into values associated with sociocultural ecosystem services. This study deploys analytical hierarchy process and environmental attitude metrics in tandem with willingness to pay to understand potential motivations behind willingness to pay results as well as sociocultural values of both residents and anglers. This study aims to combine social science, ecological economics, and environmental psychology to understand the economic and sociocultural values of Lake Okeechobee, while also contributing to ongoing ecosystem service valuation efforts in the Greater Everglades ecosystem.

USING WATER SURFACES AND FUEL TYPES TO AUTOMATE DAILY FIRE RISK MAPS IN SOUTH FLORIDA

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Mapping fire risk at a landscape scale in South Florida depends on spatially varying water levels, fuel characteristics, and topography. When surface and near-surface water levels recede below the lowest topographic features (strands, marshes, etc.), the ecosystem loses its natural, wetted fire breaks. However, with fine-scale changes in elevation, a point-based hydrologic monitoring system, and a heterogeneous fuels matrix, it is difficult to know when vegetation communities are drying, and wetted fire breaks begin to disappear. We developed a data-driven spatial method to generate daily, categorical fire risk maps; the maps visualize low-to-high risk areas based on available moisture and enable fire managers to both execute prescribed burns, as well as efficiently staff the landscape during high fire risk. This work is the next iteration of the open-source R package, FireHydro, with four specific parameter advancements 1) the daily maps expanded to include Big Cypress Preserve in addition to Everglades National Park, 2) the Digital Elevation Model resolution decreased from 400-meters to 5-meters, 3) a new fuels data layer was incorporated, which improved the resolution to 30-meters and was reclassified to better represent priority fuel types, and 4) Energy Release Component was incorporated to capture recent weather and fuel moisture. In addition to modifying the input spatial layers, fire risk is now assigned based on historic water surface variability within a given 100-m pixel and is spatially dependent on the fuel type and fire management unit. Defining spatially variable risk relationships for each pixel avoids a systematic over- or under-assigning of fire risk that can occur when applying landscape-level "average" water-fuel-topography relationships. Our data-driven approach enables the relationships between these variables to be quantified and visualized at a management-relevant, fine spatial resolution. These modifications will be incorporated into an updated, publicly available release of FireHydro.

2.5 YEARS OF EXPANDED HAB MONITORING ON LAKE OKEECHOBEE – WHAT DID WE LEARN?

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Phytoplankton play a critical role in primary production, nutrient cycling, and food web dynamics in all lacustrine ecosystems. They are sensitive indicators of environmental change and spatiotemporal changes in their biomass and community structure reflect the complex and highly dynamic nature of lacustrine systems, where waters are influenced by connectivity to land. Monitoring phytoplankton communities and associated water quality over large spatial and temporal scales can help isolate the effects of climate change on these ecosystems from other, more localized stressors such as pollution or nutrient loading and is essential to achieve improved understanding and management of these ecosystems. To better understand how harmful cyanobacterial blooms form as well as their temporal and spatial dynamics within the lake, bi-weekly water samples were collected from 32 stations during the 2020, 2021, and 2022 wet seasons (May-October). The same parameters were sampled monthly from 9 stations during the dry seasons (November-April). These samples were used for phytoplankton taxonomic analysis, chlorophyll *a*, physicochemical water quality, and cyanotoxin analyses. This monitoring effort revealed that different factors drove phytoplankton community composition, biomass, and toxin concentrations across the lake during this 2.5-year period. During the summers, the most detected toxins in the water were microcystins. Overall, microcystins were detected most frequently in the 2021 wet season while the 2022 wet season had the fewest detections (microcystins toxins were detected in 59% of the samples in 2021 vs. 50% in 2020 and 15% in 2022). The highest toxin concentration (760 µg/L) was detected at station L004 in the northeastern part of the lake in June 2020, followed by 440 µg/L at station PALMOUT3 in the southwestern part of the lake in May 2021. The highest microcystin concentrations were detected early in the wet seasons (May and June) and they decreased towards the end of the seasons. Chlorophyll *a* concentrations indicated that the lake had high to moderate bloom conditions during the three bloom/summer seasons (with concentrations often exceeding 100 µg/L early in the summer) and the blooms were dominated or co-dominated by *Microcystis aeruginosa*, *Cylindrospermopsis raciborskii*, and *Dolichospermum circinale*. Diversity and abundance of cyanobacterial communities was greater in the shallow nearshore areas of the northern part of the lake near major inflows, compared to deeper offshore areas in the central and south-central parts of the lake. The nearshore regions were characterized by higher water temperature, transparency, chlorophyll *a*, and nitrogen concentrations compared to the deeper regions.

EVERGLADES AGRICULTURAL AREA PHOSPHORUS SOURCE CONTROL PROGRAM BASIN MONITORING AND PERFORMANCE ASSESSMENT

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This presentation will describe the Everglades Forever Act (EFA) mandated regulatory source control program to reduce total phosphorus (TP) discharges from the Everglades Agricultural Area (EAA) Basin. The EAA Basin, located south of Lake Okeechobee, is the largest tributary of TP load to the Everglades. The basin encompasses approximately 474,000 acres of highly productive agricultural land, mostly in sugar cane with other crops including winter vegetables, sod, and rice making up the remainder. The EFA mandated regulatory program requires the implementation of agricultural best management practices (BMPs) and the annual reduction by at least 25 percent of TP load discharged from the EAA Basin compared to a pre-BMP program baseline period. Compliance with the TP load reduction requirement is based on a statistically sound methodology (outlined in Chapter 40E-63, Florida Administrative Code) that assesses the EAA Basin performance, incorporating target and limit TP loads calculated from samples collected at the inflow and outflow boundaries of the four major EAA subbasins (S-5A, S-6, S-7, and S-8). The EAA Basin flow and water quality data, including S-351, S-352, S-354, S-5A, S-6, G-370, G-372, G-434, and G-435, is publicly available on the South Florida Water Management District's DBHYDRO database. The program has achieved significant success since the first compliance determination in 1996, as the EAA Basin has remained in compliance with the program's TP load reduction requirements, and a total of 4,431 metric tons of TP load discharged from the basin has been prevented.

WILDLIFE UTILIZATION OF TREE ISLANDS IN EVERGLADES AND FRANCIS S. TAYLOR WILDLIFE MANAGEMENT AREA

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Tree island habitat represents a relatively small portion of the spatial area within the Florida Everglades, but this habitat is essential to the functional integrity of the entire Everglades ecosystem. Anthropogenic manipulation within the Everglades, which began over 100 years ago, contributed to the degradation of many tree islands via inconsistent hydrology, wildfires, and natural disasters. Since the early 1990's, the Florida Fish and Wildlife Conservation Commission has been working to restore tree islands, including removing invasive exotic vegetation (e.g., primarily Brazilian pepper [*Schinus terebinthifolius*]), planting native trees and shrubs, and collecting associated survivorship data in the Everglades Complex of Wildlife Management Areas. Although survival rates vary by species and by individual islands, the importance of promotion of plant diversity and subsequent benefits for wildlife, such as food and cover, cannot be underestimated. Monocultures of non-native plants significantly reduce diversity and available food resources in these areas. Species typically planted include cocoplum (*Chrysobalanus icaco*), elderberry (*Sambucus nigra*), red maple (*Acer rubrum*), firebush (*Hamelia patens var. patens*), dahoon holly (*Ilex cassine*), hackberry (*Celtis occidentalis*), myrsine (*Myrsine cubana*), pop ash (*Fraxinus caroliniana*), strangler fig (*Ficus aurea*), sweet bay (*Laurus nobilis*), and pond apple (*Annona glabra*). Other restoration tools include using prescribed fire to reduce fuel loading in the sawgrass marsh surrounding restoration tree islands to protect tree islands from wildfires. The Everglades is a fire-adapted ecosystem, and regular fire return intervals enhance wildlife habitat, promote diversity, and reduce the likelihood of catastrophic wildfires that would negatively impact wildlife. Tree islands support wildlife species such white-tailed deer (*Odocoileus virginianus*), the Florida panther (*Puma concolor coryi*), black bears (*Ursus americanus floridanus*), black (*Laterallus jamaicensis jamaicensis*) and king rails (*Rallus elegans*), amphibians and reptiles, as well as a variety of wading birds, marsh birds, and songbirds. During high water conditions, tree islands provide dry areas for terrestrial wildlife to take refuge and forage. Wildlife surveys on tree islands include year-round remote motion-sensor camera trapping and browse surveys during high water conditions. Since 2006, over 88 tree islands have been monitored with remote cameras, with over 40 wildlife species detected. Monitoring tree islands helps guide management and restoration efforts throughout the Everglades.

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SCIENCE PLAN TO SUPPORT RESTORATION OF THE SOUTH FLORIDA ECOSYSTEM

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There is an increasing need for science to support decision making as the Everglades restoration program pivots from a focus on planning and advancing individual projects toward operations and adaptive management of the partially restored system, in parallel with ongoing planning for the remaining CERP projects. The Everglades restoration science enterprise, including work by local, state, and federal agencies, academia, Tribal nations, and nongovernmental organizations, has made tremendous advances over the past two decades, providing a firm foundation for the extensive planning to date. But as projects come online and the ecosystem begins to respond, the effort cannot afford to lose opportunities for learning from both CERP and non-CERP projects, requiring additional support for monitoring, modeling, and synthesis efforts. The accelerating pace of restoration decision making increases demands for science support at all scales of activity, from project-scale planning and adaptive management of operations (e.g., a greater understanding of the drivers of peat accretion and loss under different flow and water quality conditions and refinement of modeling tools) to the programmatic scale (e.g., the advancement, prioritization, and coordination of major projects and the refinement of goals). These science needs will be numerous and beyond the capacity of any single organization to meet; without a synthetic effort to determine which gaps are critical to the restoration effort and then characterize, compile, organize, and sequence them, the restoration is at significant risk of not addressing key impediments to restoration in a timely fashion. Therefore, the Everglades science enterprise should develop a science plan to advance and implement essential science actions that directly support restoration decision making. This effort will require intense multi-agency and stakeholder coordination. An Everglades Restoration Science Plan could serve as a central document that highlights and communicates priority science needs and management linkages to a broad audience of potential funders. The plan would guide the CERP program, other restoration initiatives, and individual funding agencies in their science investments and should be updated regularly with the engagement of a diverse range of stakeholders to respond to changing needs. Examples from other large coastal restoration efforts may be useful in designing a relevant Everglades Restoration Science Plan and the committee suggests that the Science Coordination Group is best positioned to lead an updated multi-agency assessment of priority science needs and gaps at a programmatic level to develop the plan.

DEVELOPMENT OF PAYMENT FOR WATER SERVICES IN THE NORTHERN EVERGLADES

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As a result of human growth, ecosystems have experienced changes to native communities from alteration of natural water flows, changes in water quality, and invasion of non-native species. In the Northern Everglades, ecosystem changes are due to a combination of actions, including hydrologic alterations from a government designed and built drainage system and urban and agricultural development. Historically, government agencies have led efforts to identify and implement activities as components of watershed management programs to protect and restore ecosystems. The activities primarily have consisted of regulatory, best management practice programs and public investment in regional reservoirs, stormwater treatment areas and technologies. Field testing innovative approaches is essential to the identification of the more environmentally, socially, and financially effective program components. In 2005, the Florida Ranchlands Environmental Services Project, an innovative water management environmental services pilot, was initiated through a multi-stakeholder collaboration. This market-like environmental services approach proposed a program that would provide financial incentives to landowners for implementation of water management activities on portions of their ranches that cumulatively would lead to watershed scale improvements. The water management activities were being implemented to provide the services of water retention or nutrient reduction. Market-like program development concepts include: (1) identify the environmental services and the service buyers; (2) evaluate and document performance of the activities that provide the service; (3) streamline processes e.g., regulatory that are critical to participation; and (4) negotiate the terms and conditions of the payment for environmental services contract including the service payment between buyers and sellers. After years of planning, design, testing and pilot implementation, managed through a collaborative multi-stakeholder process, the South Florida Water Management District (SFWMD) in 2011 issued the first solicitation under its Dispersed Water Management – Northern Everglades Payment for Environmental Services (NE-PES) Program. NE-PES converted the theory of water services into an operational program. Utilizing a collaborative multi-stakeholder development approach offers the opportunity to build credibility and trust across landowners, agencies and environmental groups. What can be achieved through a multi-stakeholder approach is an expanded brain trust of engaged partners. A collaborative services program process addresses all parties' concerns as well as new issues that arise. In addition, sources of funding are expanded because of the wide-spread support for the program. Ecosystem services programs developed collaboratively, provide the most sustainable opportunity to achieve watershed program goals by creating an atmosphere where innovative, timely solutions are most probable.

THE FUTURE IS BEHIND US!

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Ecosystems evolve and change over centennial to millennial timescales, often driven by changes in climate, sea level, and geologic events related to shifting plates. Biota respond to these drivers by adapting and evolving, migrating, or going extinct. The geologic and paleontologic record of the Earth contains many examples of how ecosystems and organisms have responded to these past perturbations. This record of change provides valuable information as we face rapidly changing global conditions today and is particularly relevant to restoration. For restoration of the Greater Everglades Ecosystem, we are focused on targets and performance measures related to hydrology and species distributions, but how do we establish baselines and goals when the system was already highly altered prior to the start of any systematic monitoring efforts? The answer is by looking to the past – the record of change preserved in the sediments of south Florida. These past records of change record the natural trajectory of the ecosystem and its biota, prior to significant human alteration. The goal of restoration should not be to return to some past condition, but rather to restore the system and/or species to their natural trajectory of change. Restoration targets can be set at an intercept point with this natural trajectory in the future thereby getting the system back on track following anthropogenic disturbance. This approach is more attainable and sustainable than the concept of returning to some past condition, and it is the paleontologic and geologic records that provide this essential information. The past is the key to the future!

LINKING MODERN AND SEDIMENT CORE DATA TO IDENTIFY POTENTIAL INDICATOR SPECIES FOR RESTORATION PERFORMANCE MEASURES

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Managed hydrology and urban development significantly altered the environments of south Florida throughout the 20th century. The impact of these changes on the natural landscape, and on the fauna and flora of the region, led to the development of the Comprehensive Everglades Restoration Plan (CERP). A primary goal of CERP is to restore freshwater flow to the wetlands, estuaries, and coastal ecosystems of south Florida, with the hope that restoration of natural hydrologic patterns would then lead to reestablishment of historic biodiversity and biomass. However, two key questions emerge regarding the biota: 1) What species were present in the past and what was their distribution? 2) How can we determine what species are good indicators of restoration success? Linking data on past species distributions to distributions over the last few decades can help address these questions. Mollusks and other benthic invertebrate remains have been examined from 10 cores (with age control) collected over the last three decades by the USGS in the nearshore areas of south Florida. The lower portion of these cores record conditions prior to hydrologic alteration and are dominated by species that are relatively rare today. When these species are found in the modern environment, they are often farther inland than their past distributions, which indicates upstream migration of the freshwater/saltwater boundary. In order to test estimates of salinity preferences in fossil taxa, we conduct modern sampling of live mollusks, recording salinity and other environmental variables at collection sites. Since 1994 we have established 231 sites in the estuaries of south Florida, that have been sampled over 988 times. We've recorded 220 molluscan taxa and 68 taxa with at least one occurrence in nearshore oligohaline to mesohaline salinities (<18 psu). In addition to providing insight on interpretations of the cores, these data can also be used to establish a suite of indicator taxa to test whether restoration goals are being met in the nearshore estuarine zones. Analyses of the presence/absence data identified a group of four molluscan taxa with inner quartile ranges <25 psu, and median salinities ranging from 0.4 to 21.7 psu: *Cyrenoida floridana*, hydrobiids, *Polymesoda caroliniana*, and *Crassostrea virginica*. Although we do not have enough observations to be confident the salinity data reflect their true range, seven additional taxa have medians < 18 psu, which suggests they also are good indicators of lower salinity. We propose this suite of molluscan taxa be used as indicators for restoration of the nearshore zones. Because they were present prior to hydrologic alteration of south Florida, their return would represent a re-establishment of historic distribution patterns of mollusks in the nearshore and could positively impact restoration of groups that utilize mollusks as food.

INTERNAL OXYGEN DYNAMICS AND RHIZOSPHERE OXIDATION IN TROPICAL SEAGRASS, *THALASSIA TESTUDINUM*

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Seagrass meadows are experiencing a rapid decline worldwide, threatening the stability of coastal ecosystems. In Florida Bay, large scale seagrass mortality events have been linked to internal hypoxia triggered by synergetic stressors such as elevated water temperatures, hypersalinity, water column hypoxia, and high concentrations of porewater sulfide (H_2S). Radial oxygen loss (ROL) into the rhizosphere or region surrounding roots has been shown in wetland species to create oxidized microenvironments to facilitate aerobic metabolism and serve as a barrier to H_2S intrusion. In the present study, *Thalassia testudinum* belowground tissue oxidation dynamics were examined in Florida Bay sediments using 2-D planar optode sensors and microsensors. We examined (1) O_2 concentration around *T. testudinum* roots and rhizomes, (2) established O_2 dynamics in belowground tissues and associated rhizosphere, and (3) compared O_2 and H_2S dynamics in belowground tissues, associated rhizosphere, and sediment. Microsensors were also used to establish concentration profiles through the water column, sediment, rhizosphere, and belowground tissues. Planar optode experiments showed no evidence of ROL from *T. testudinum* roots into surrounding rhizospheres. Florida Bay sediments were anoxic 2 mm below the surface water sediment interface and possessed a high O_2 consumption rate within the region of belowground tissues (~1.7 ± 0.9 kPa h^{-1}). Discrete microsensor measurements showed pO_2 in belowground tissues exceeded air saturation (23-38 kPa) in the light, while the associated sediment and rhizosphere remained anoxic with high H_2S concentrations (239 ± 39 μM). H_2S intruded into root tissues only when the pO_2 in roots dropped below 3 kPa. Our microsensor and optode results lead us to suggest that *T. testudinum* maintains a strong barrier to gas diffusion along its roots to maintain a high internal pO_2 to the root tips supporting aerobic root metabolism and oxidation of H_2S at the root tip-sediment interface.

EVALUATING THE USE OF REMOVAL AND ABUNDANCE MODELS TO INFORM INVASIVE BURMESE PYTHON MANAGEMENT

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Monitoring changes in abundance of wildlife populations is essential for effective management of invasive species, but it can be difficult and costly to obtain accurate estimates, particularly for cryptic species such as the Burmese python. In south Florida invasive pythons are removed through several state and federal programs. Ideally, removal efforts for invasive species should create data streams that contribute information on population structure, detectability, distribution, growth rate, and abundance to improve management decisions. Utilizing such a structured approach for data collection, estimation, and decision making remains largely underutilized, but two recently developed approaches provide new opportunities for invasive species monitoring efforts. The robust design removal model (RDRM) improves on traditional removal models by allowing invasive species removal over relevant time scales (multiple years) and direct estimation of abundance and population growth. The RDRM model accounts for population change and movement between removal events and has been used to inform removal efforts of invasive chameleons in Florida and Maui. Recently developed Close-Kin Mark-Recapture (CKMR) models infer population demographics by modeling the relationship between close-kin pairs (e.g., parent-offspring, half siblings) from genetic samples and population demographic parameters. The CKMR model has been used successfully to infer population size using relatedness of various fish species in both fresh- and saltwater systems. We are in the initial stages of assessing these two approaches to support science-based management decisions relative to Burmese python management.

REMOTE SENSING OF VEGETATION BIOMASS TO PREDICT CHANGING FLOW RESISTANCE FOR IMPROVED HYDROLOGICAL MODELING

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Frictional resistance associated with drag on vegetation stems is a critical parameter in building surface water flow models for the Everglades. We hypothesized that rather than relying on field-based calibration, the flow resistance parameters required for hydrologic modeling could be estimated using a remotely sensed Normalized Difference Vegetation Index (NDVI) derived from satellite images. The objectives of our work were to 1) identify ridge and slough NDVI signatures and estimate spatial variance characteristics at point, neighborhood, and regional scales; 2) examine how seasonal phenology and water depth influence NDVI and potentially confound estimation of biomass; and 3) develop statistical models relating measured vegetation biomass to NDVI values. Field campaigns were conducted in the summer or fall from 2010 to 2014 in the Decomp Physical Model (DPM) area, a basin enclosed by the L-67A and L-67C levees between water conservation areas 3A and 3B in the central Everglades. Biomass samples were obtained from ridge and slough vegetation communities at ten locations (55 biomass samples in total), with most sites revisited annually both prior to and after a natural fire event. We quantified NDVI using high-resolution, multispectral WorldView-2 satellite images that covered the DPM during this four-year period. Images were atmospherically corrected, and the resulting Top-of-Atmospheric (TOA) reflectance used to calculate NDVI. We first examined spatial and temporal variations of NDVI for ridge and slough from a cloud-free image on November 9, 2010. Calculating the spatial variance served to quantify how NDVI values changed when extracted at the point, ridge or slough pure-pixel neighborhood, or regional scale and could provide a scaling factor for hydrologic models. The point scale refers to extracting individual pixel values using the coordinates of a field sample. Neighborhood scale describes pure pixels identified by overlay of a published vegetation map falling within a certain radius (20 m) of a field site. To avoid mixed pixels, we included only “pure pixels,'' defined as those at least 1.85 m (i.e., one WorldView-2 pixel) from a patch edge, which produced a pure-pixel neighborhood of approximately 200 pixels for ridge and 184 pixels for slough. In comparison, the regional scale analysis was based on a 3-km × 7.5-km regional vegetation map produced from a 2010 image from the National Agriculture Imagery Program (NAIP) to aid in ridge and slough patch identification. The regional scale includes over 4.6 million pure pixels for ridge and 0.5 million for slough. Preliminary results indicated that ridge and slough with and without periphyton mats have three distinct spectral signatures. All had high reflection in the near infrared band and a low reflection in the visible red band. The degree of reflection differed considerably among the three vegetation types. Ridge reflection in red and NIR band is larger than slough without periphyton, whereas slough with periphyton had the largest reflection in both red and near-infrared, implying that NDVI differs among vegetation communities. The variation in bands resulted in different NDVIs for ridge and slough, with a mean ridge NDVI of 0.108 ± 0.015 (mean ± standard deviation) and a much lower but more variable slough NDVI of 0.023 ± 0.027. Sloughs with periphyton had a higher NDVI (0.055 ± 0.022) compared to sloughs without periphyton (0.012 ± 0.019). Regarding spatial variance, the regional scale variation of ridge NDVI (0.016) was approximately 50% larger than the neighborhood scale variation (0.011). Slough NDVI was more variable than ridge, with standard deviations of 0.034 and 0.014 for the regional and neighborhood scales, respectively. Overall, these early results are encouraging for the next steps to build year-by-year statistical relationships between measured biomass and remotely sensed NDVI that will permit biomass and frictional resistance parameters to be predicted over large areas, and to be updated as needed as vegetation resistance changes, in order to provide the best possible inputs for hydrologic models.

OPTIMAL FORAGING MODELS OF WADING BIRDS IN SEASONALLY-PULSED EVERGLADES WETLANDS

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Tactile-feeding wading birds, such as wood storks and roseate spoonbills, require high densities of fish and invertebrate prey to support themselves and their offspring during the breeding season. Prey availability in the Everglades is generally determined by seasonal pulsing of wetland hydrology, where prey become concentrated in high density patches as ponds and sloughs dry out locally. Our objective is to compare two optimal foraging strategies for wading birds, one threshold-based and the other memory-based, using mathematical modeling. In the first strategy, wading birds sample prey patches without a priori knowledge of the energetic content of the patches, moving from patch to patch while briefly estimating prey density at each, until they encounter one with a predetermined satisfactory threshold, where they stop to feed for longer bouts. The decision variable is the "giving up" density threshold. In the second strategy, the wading bird samples a fixed number of patches, then uses memory to return to the highest quality patch. Here, the decision variable is total patches in the itinerary. Performance of each strategy is compared by computing expected mean prey intake over a day, for different levels of the decision variables, and for varying spatial conditions of prey concentration. This addresses a broader conservation goal of better understanding how decision making of wading birds interacts with spatially and temporally dynamic prey landscapes, which is a key structural uncertainty in managing the Everglades ecosystem. Spatial heterogeneity of prey availability across the landscape is represented by probability functions, where changes in distribution parameters produce various conditions of prey "clumping" on the landscape. Perhaps surprisingly, foraging using memory does not necessarily lead to higher prey intake than simple foraging based on a prey density threshold. This research contributes to understanding wading bird foraging ecology and supports management of wetland hydrology for wading bird conservation.

APPLICATION OF 2D HEC-RAS MODEL TO KISSIMMEE RIVER RESTORATION PROJECT

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Construction for the Kissimmee River Restoration Project (KRRP) has been completed since 2022. In this project, nearly 20,000 acres of wetlands and 44 miles of historic river channel are being restored. The project aims to restore the Kissimmee River from flood control-oriented channelization to a more natural meandered river-floodplain ecosystem. This study presents two case studies involving the applications of 2D HEC-RAS modeling needed to address challenges in the KRRP. The first case study focuses on a hydraulic evaluation of the S69 weir and C38 canal backfill designs, where the flow field and sedimentation potential in the vicinity of S69 are evaluated. Impact of a feeder canal on the discharge capacity of the weir also assessed. The second case study presents the application of a 2D HEC-RAS model to re-evaluation of the S65A spillway and auxiliary structure capacities with respect to KRRP requirements. The results of these two case studies demonstrate the flexibility and effectiveness of 2D HEC-RAS modeling. It also reveals that this model application can supplement traditional laboratory and field studies, that are typically performed in support of hydraulic engineering applications.

QUANTIFYING VEGETATION AND WILDLIFE RESPONSE TO MECHANICAL REMOVAL OF NATIVE WETLAND SHRUBS

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Altered hydrology and reduced fire frequency is encouraging the spread of shrubs across herbaceous wetlands in Florida, successional change that reduces wildlife habitat, increases water loss through increased evapotranspiration, and prohibits effective use of prescribed fire as a land management tool. Over the past ten years, Audubon has refined methods to mechanically remove shrubs (mulching), restore herbaceous plant communities, and reintroduce fire to Corkscrew Swamp Sanctuary. An ecological monitoring program was launched in 2021 to document progress and evaluate restoration outcomes in wetland soils, vegetation, and wildlife. Preliminary observations suggest mulched woody debris from mechanical shredding breaks down quickly in the years following mulching, with little course woody material seen in soil samples only a few years after mulching. Herbaceous plant communities reestablish quickly in the months following mechanical removal of shrubs and re-inundation of marshes, with near elimination of woody vegetation (e.g., *Salix caroliniana*, *Acer rubrum*), increased coverage of pyrophytic herbaceous vegetation (e.g., *Pontedaria cordata*, *Spartina bakeri)*, and predominance of non-native species. Ongoing surveys are documenting increased use of restored habitat by wading and marsh birds and mammals, with Black-bellied Whistling Ducks, Limpkins, Wood Storks, white-tailed deer, and Florida black bear using sites within weeks of re-inundation. We provide an overview of how UAVs are being employed to map restoration progress and document changes in vegetation coverage, both qualitatively (photo points) and quantitatively by extracting data from multispectral images. We also discuss preliminary methodology for measuring changes in wading bird foraging with reduction of woody vegetation and discuss the importance of using monitoring data to inform restoration progress and evaluate outcomes of management activities, even with smaller-scale habitat improvement and restoration efforts.

APPLYING MACHINE LEARNING TO MAP GREENHOUSE GASES AND ET IN THE EVERGLADES WETLANDS

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Quantification of air-land fluxes like CO_2, CH_4, and evapotranspiration (ET) in the wetland ecosystems is critical to understand the cycling of carbon, water and energy, and their couplings in the Earth System under the climate warming scenario. We linked field and eddy covariance tower flux measurements collected from representative wetland ecosystems in the Everglades with satellite products and environmental variables via machine learning modeling techniques. We mapped seasonal CO_2 flux across the Big Cypress National Preserve and Everglades National Park, CH_4 across the Water Conservation Areas, and evapotranspiration (ET) across the Big Cypress National Preserve. It is concluded that machine learning is powerful to upscale flux measurements using large scale satellite observations in wetlands. The generated flux maps are the first type of flux products at the regional scale for wetlands.

HEC-RAS 2D ANALYSIS FOR IMPACTS OF L-28S CULVERTS IN WERP REGION 4

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High water levels in Water Conservation Area 3A (WCA-3A) frequently lead to complaints from key stakeholders located immediately south along the Tamiami Trail. Unseasonably high-water elevations in WCA-3A can also negatively impact the habitat of the endangered Cape Sable Seaside Sparrow (CSSS) population in the northern Everglades National Park (ENP). To mediate the negative impacts of the high WCA-3A water levels, three gated culverts are proposed to be installed on the L-28S Levee at select locations. These three culverts, along with the proposed modification to the L-28S Canal, L-28 Tieback Levee degrade, Tamiami Trail Plug, and additional conveyance structures along Loop Road and Tamiami Trail west of Forth Mile Bend, are features of the Western Everglades Restoration Project (WERP), a component of the Comprehensive Everglades Restoration Plan (CERP). By allowing more water to flow west into the Big Cypress National Preserve (BCNP), the proposed L-28S Culverts will help mediate high water levels in WCA-3A. Reduced water levels in WCA-3A will also reduce the volume of water flowing south into ENP, lessening negative impacts on the CSSS population. To quantitatively assess the impacts of the proposed modifications, a two-dimensional HEC-RAS model was developed to simulate existing and with-project conditions in the study area. An extensive survey, including vicinity roads, levees, canals, and culverts, was conducted in 2021 to capture the details of the existing infrastructure. The collected information was incorporated into the most recent terrain data and applied in the model. The impacts of the proposed modifications were identified by comparing the simulation results from the with- and without-project conditions during selected storm events.

VEGETATIVE FLOW SIMULATION IN WATER CONSERVATION AREA-3A AND FLOW UNIFORMITY EVALUATION

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A 2D hydrodynamic (HEC-RAS) model has been developed to simulate flow along the L-4 spreader canal into the wetlands of Water Conservation Area (WCA)-3A. The model calibration was performed by linking with Parameter Estimation Tool (PEST), a model-independent auto-calibration software to calibrate the Manning's roughness coefficients for different land covers through historical matching. According to a success criteria matrix developed by the ecological team of the United States Army Corps of Engineers (USACE) and South Florida Water Management District (SFWMD), the uniformity of flow distribution was evaluated for the vegetative flow in WCA-3A. The 3D histograms of velocities, water depths, and variations were analyzed for the most concerned region near the L-4 spreader canal. In this study, three flow conditions including high flow, normal flow, and low flow were simulated and evaluated for water supply and flood control. The outcome of this study suggests that a HEC-RAS model coupled with PEST is a useful approach to automatic model calibration and uncertainty analyzes if needed. This approach is good at fitting the model parameters more efficiently to observed data than manual calibration for large scale and complicated models. The proposed approach can be applied to other vegetative water areas as well.

FLOW RESTORATION IN A COMPLEX LANDSCAPE

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The Decomp Physical Model (DPM) was an adaptive management project aimed at understanding how ecological and biogeochemical processes are affected when flow is restored to the Everglades landscape. DPM has been functioning since 2013 and has provided information that challenges our basic understanding of the Everglades landscape. The typical 'cartoon' of the historic Everglades—water spilling over the banks of Lake Okeechobee and moving slowly as sheetflow to Florida Bay—has been useful in the past, but the generalities of this view tend to dominate while the specifics of Everglades landscape dynamics are now critically important as major restoration projects are being built.

Unexpected lessons learned in DPM, some as early as the first day of flow, have contributed to a deeper understanding of the details of the historic Everglades, particularly flow distribution, flow heterogeneity, and plant and phosphorus dynamics. Historic flow speeds of 2-5 cm/sec cause clearing of submerged aquatic vegetation (SAV) and periphyton in sloughs. The SAV/periphyton complex is one of the three key elements to the maintenance of the Everglades ridge and slough landscape (RSL): sediment, plants, and flow. There is a feedback loop between sediments and plants, and plants create sediment that are differentially distributed by flow to create a patterned system. Due to the relatively fast turnover of slough SAV (weeks) compared to emergent vegetation (months/years), the lack of SAV would substantially limit sediment production system-wide and could create a sediment-starved system, so the DPM results caused us to reconsider what a fully restored Everglades flow heterogeneity and distribution might look like. The DPM was also constrained to flow only when phosphorus levels were 10 ppb or less, but enrichment of sediments above oligotrophic levels, and the accompanying spread of cattail, has been observed within the DPM footprint. If the historic Everglades functioned similar to the DPM, how did the system maintain its characteristic oligotrophic nutrient status? To address these uncertainties, we are creating a spatial cellular automaton model of plant growth, seasonality, and flow effects (P loading and mechanical flow effects), but first present a deep dive into our updated understanding of the historic Everglades dynamics and their relevance to current restoration efforts.

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