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FCE III Year Two Annual Report For NSF Award Deb-1237517

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FCE III YEAR TWO ANNUAL REPORT
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FLORIDA COASTAL EVERGLADES LTER

Florida International University

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Major goals of the project

The goal of the Florida Coastal Everglades Long Term Ecological Research (FCE LTER) program is to conduct long-term studies to understand how climate change and resource management decisions interact with biological processes to modify coastal landscapes. Our focus is on the oligohaline ecotone of the Florida Everglades, at the intersection of marine and freshwater influences. Long-term data show that the ecotone is highly sensitive to the balance of marine pressures, driven over long and short time scales by sea level rise, and storms and tidal exchanges, respectively, and freshwater flow, controlled by climate variation and upstream allocation decisions. FCE is in its third phase of research (FCE III), focused on linking the long-term dynamics of the ecotones of two major drainages, Shark River Slough (SRS) and the Taylor Slough/Panhandle (TS/Ph), to the balance of these two primary water sources.

The overarching goals of this reporting year included: (1) continued collection and analysis of long-term datasets relative to programmatic goals, (2) improved understanding of the socioecological and hydrological politics of freshwater restoration in the face of sea level rise, (3) analysis of long-term dynamics of the Everglades ecotone relative to exposure to fresh and marine water supplies, (4) fully implemented design for benchtop, mesocosm and field-scale experiments manipulating salinity, phosphorus and inundation, (5) completed chapters for the FCE synthesis volume, (6) continued updates of FCE data to the Network Information System (PASTA), (7) integration of core findings through LTER network-wide collaborations (particularly focused on primary productivity), and (8) advancements in education (FCE Schoolyard) and outreach through expanded partnerships directed toward goals of the Strategic Implementation Plan for LTER.

FCE research is conducted within the context of four major working groups (WG): *Biogeochemical Cycling*, *Primary Production*, *Organic Matter (OM) Dynamics*, and *Trophic Dynamics*. Integration is accomplished through four Cross-Cutting Themes (CCT): *Hydrology and Water Policies*, *Carbon Cycling*, *Climate and Disturbance Legacies*, and *Modeling and Scenarios*. Further synthesis is being driven by our contributions to a holistic synthesis book to be completed in the coming months. Here we report progress integrating across each of these categories relative to the goals set in our proposal.

Accomplishments

Major Activities

A major emphasis of the FCE III program is on the tension between freshwater delivery and salinity intrusion, and feedbacks to the structure and function of the coastal Everglades and the ecosystem services supported. Activities have focused on analysis of long-term datasets to identify connections between water supply and ecosystem properties, design and implementation of experiments to tease apart effects of salt and nutrient exposure on ecotone communities, landscape-scale studies to understand long-term, large-spatial scale change, and integrative

modeling and scenario development to help understand forms of control and guide restoration decision-making.

We are using long-term datasets to address how the current and historical balance of fresh and marine water supplies regulates primary producer composition and productivity through interacting effects on phosphorus availability, salinity, and water residence time. Activities with long-term datasets in the past year are contributing to a greater understanding of: 1) marsh and mangrove ecosystem net primary production with climate and hydrologic drivers, 2) hydrology, salinity and phosphorous as drivers of *Cladium* biomass and periphyton dynamics and 3) coastal landscape patterns of marsh and mangrove communities as related to inter- and intra-annual salinity gradients. We are using these data to participate in an LTER network-wide analysis of the drivers and patterns of variability in net primary production across ecosystem types.

To understand mechanistic causes for changes observed in these datasets, we designed and implemented complex salinity and salinity × phosphorus mesocosm and field experiments in freshwater and oligohaline marshes. Experiments were modeled on prior experimental manipulations of these variables in mangrove peats (Chambers et al. 2014). Data from a 2013 experiment addressing biogeochemical consequences of phosphorus and disturbance to mangrove ecotone plant-soil systems have been analyzed and presented at a scientific conference. An REU student contributed to the development of mesocosm experiments and installation of field dosing chambers. Four FCE graduate students submitted related research proposals to the Everglades Foundation Fellowship Program.

The effects of changes in productivity and producer structure on long-term dynamics of soils and organic matter is a key component of our research. Long-term data suggesting that salt and nutrient exposure associated with sea level rise is rapidly depleting peat soils prompted the aforementioned experimental research to identify causal mechanisms. In addition, paleoecological investigations are determining dynamics of soils relative to historical salinity exposure. As part of an FCE-leveraged Water Sustainability and Climate grant, we measured soil accretion rates over the last 100 years in the mangrove forests to assess biogeochemical processes driving changes. We also are determining the fate of organic and inorganic particulate and dissolved carbon in the estuary using stable isotopes, optical properties and molecular characterizations.

We also expect that variability in freshwater inflows will interact with sea level rise to modify the consumer-mediated habitat links and the importance of detritus to food webs. We continue investigations of environmental drivers of spatiotemporal responses of ecotonal fish communities and movements, trophic interactions, and levels of individual specialization in upper trophic level consumers. We track these responses as a function of community patterns and individual responses. In marsh communities, we have designed an enclosure experiment with food-web fragments to evaluate the impact of wet-season water flow on nutrient loading in periphyton mats, its effect on mat algal composition, and that effect on consumers. We are conducting a controlled diet switching study on three species of consumers to document the turn-over time for fatty acid markers in their tissues. Finally, we used simulation models to evaluate a collection of future climate scenarios.

Integration of the interaction of water source changes and biological transformations is occurring partly through development of a dynamic carbon budget. In the past year, FCE has held several workshops to move this complex component of our research forward following the framework presented in Troxler et al. (2013). We began by collecting qualitative data for all carbon stocks and fluxes for freshwater, oligohaline and marine sites. This activity generated a matrix of parameters and sampling frequencies to conduct an uncertainty analysis. We set a timeline for populating this dataset with quantitative data that will result in a carbon balance for the three major FCE ecosystem types. This research is being coordinated with a network-level initiative to understand long-term dynamics of carbon across ecosystem types.

Underlying all FCE studies is the underlying hydrologic controls on the dynamics of water supply to the ecotone, which is highly driven by water management decisions. We continue hydrological and geochemical assessments using ground-based measurements and satellite observations, in addition to a leveraged project with the SFWMD to determine the effects of water management and sea level rise on the water quality in oligohaline lakes. A 3D underwater floc-tracking camera was tested to measure surface water flow velocity. Satellite imaging research continued in Shark Slough with an emphasis on measurement improvements. Ecopolitical research continued to explore the institutional process of Everglades restoration, entailing interviews with government agencies, the Miccosukee Indian Tribe and other stakeholder groups, conduct public interviews to examine the implementation of on-farm best management practices in the Everglades Agricultural Area, analyze ethnographic interviews exploring the environmental attitudes of residential homeowners in Miami-Dade county, and calibrate of an agent-based model of water demand linked to land use/cover changes in the south Florida urban gradient.

An important driver of integration in FCE is synthesis through modeling. A large and diverse set of models are being used to understand the effects of changing water source on the biogeochemical and ecological dynamics in the ecotone. Major efforts are underway to fully understand the chemistry, transport, and fate of phosphorus and carbon, with an emphasis on identifying the source of phosphorus supporting high primary productivity in the ecotone and the residence time of C passing through the ecotone. As a "clearinghouse" for modeling efforts, FCE is defining a scenarios framework to derive 3-4 plausible scenarios of climate, sea-level rise, ecosystem restoration (e.g., water delivery to Everglades), and regional water demand (e.g., demand for water that might otherwise be delivered to the Everglades). We are using a landscape-scale ecological model to visualize outcomes under plausible scenarios, with a dual emphasis on hypothesis testing and serving the needs of the regional planning and policy-making community.

Major progress has been made on the first FCE synthesis book volume. All chapters are expected to be completed by Fall 2014.

Specific Objectives

Specific objectives of this reporting year were to continue analysis of long-term datasets to identify connections between water supply and ecosystem properties, design and implement experiments to tease apart effects of salt and nutrient exposure on ecotone communities, conduct landscape-scale studies to understand long-term, large-spatial scale change, and develop a

scenario framework to guide modeling efforts to inform controls on ecosystem change and guide restoration decision-making.

Long-term collection of hydrological, biogeochemical, marsh and mangrove net ecosystem exchange and net primary production are fundamental components of our research framework that utilizes spatial and temporal trends to evaluate peaks in ecosystem productivity with shifting freshwater and saltwater gradients. To further develop our mechanistic research using manipulative experiments, we sought to establish an outdoor mesocosm experiment to evaluate the effects of salinity and phosphorus additions on freshwater marsh "monoliths". Furthermore, using leveraged funds, we also initiated the establishment of both field and outdoor mesoscosm experiments to determine the effects of increased salinity inundation on marsh ecosystem productivity and peat soil stability. Finally, we sought to relate coastal landscape patterns of vegetation with salinity, water level and inorganic nutrient concentrations using a combination of Digital Globe's WorldView-2 2x2 m pixel satellite imagery, data products to develop vegetation maps and strategic sampling of environmental parameters to help us to unravel vegetation-environment trends.

We sought to improve our understanding of the effects of water source and residence time on the contribution and quality of organic matter from marshes, mangroves, and the marine system to FCE estuaries by constraining models and proxies for the assessment of depth and hydroperiod in the freshwater marshes, measuring organic matter accretion in the estuarine zone as it relates to sea-level rise, and building upon the existing database on soil biogeochemistry with regards to better constrain organic and inorganic carbon interactions and relationships with phosphorus and nitrogen. We also sought to determine the relationship between particulate and dissolved organic matter dynamics in the mangrove estuary, and the continued characterization of organic matter to better understand its reactivity. A major goal of this reporting year was to begin development of integrated carbon budgets for the marsh, mangrove and marine systems, beginning with the characterization of qualitative information to evaluate sources of uncertainty.

Research on consumers sought to improve understanding on how the freshwater and estuarine fish community responds to hydroclimatic variation. Specifically, we wanted to document the response of the fish community to extreme climatic events (Boucek & Rehage 2014), specifically a cold front (2010) and a drought (2011). To obtain more extensive long-term data on fish response to hydroclimatic variation, we expanded a successful citizen science project. We sought to improve our ability to track trophic linkages mediated by large predator movements through tracking, and by improving techniques for food web analysis. We planned experimental studies to assess the role of freshwater flow changes in marsh community dynamics and the movement of alligators.

Hydroecological research underlying core FCE hypotheses focused on understanding how climate change and sea level rise interact with water management practices to control hydrologic conditions in the oligohaline ecotone, and how stakeholder uncertainties over SLR influence conflicts over Everglades restoration implementation and will affect freshwater delivery to the oligohaline ecotone. This research integrates closely with studies of landscape disturbance and ecosystem connectivity, so a major goal of this research year was to improve documentation of

the connections between legacies of land use and water delivery change and oligohaline ecosystem variability.

Modeling and synthesis efforts focused on developing a scenario framework for examining the future impact of climate change, sea level rise and freshwater restoration on the ecosystem. We have proceeded on three broad fronts: defining scenarios to constrain modeling efforts, informing model development with empirical data, and validating model approaches and application. Specifically, we are conducting laboratory experiments to better understand and constrain phosphorus budgets by better understanding the sorption/desorption of phosphorus from the underlying bedrock and soils, with a long-term goal of linking this better understanding to a model of groundwater discharge. We have also been using the Everglades Landscape Model to explore implications of alternative restoration scenarios on nutrient distribution and peat accumulation (or loss) across the landscape.

We planned to complete the chapters of our synthesis book during this reporting period.

Significant results

The FCE III research framework focused on the tension between marine and freshwater supplies has reshaped and improved our understanding of how the Everglades is responding and will change in the future in response to changing water management in the face of sea level rise. First, we have found that an acceleration in the rate of sea level rise, as predicted to result in increases of 0.5 m to 2 m from 2010 to 2100, can be determined with statistical significance by 2020 to 2030 (Haigh et al., 2014). Increases in marine exposure are increasing inundation times in the ecotone, and causing rapid changes in groundwater salinity (Zapata-Rios and Price 2012). Laboratory results suggest that phosphorus tends to adsorb to sediments in the presence of freshwater and desorb from sediments in the presence of native Florida Bay water, consistent with the findings of Price et al. (2010) and suggesting a trend toward phosphorus desorption under sea-level rise in the absence of additional freshwater inflows (Fig. 1). Therefore, increased marine exposure from groundwater sources is increasing salinity, inundation and phosphorus in the ecotone, confirming an appropriate context for conducting and interpreting our long-term and experimental research.

Initial experiments to determine the influence of elevated phosphorus and plant defoliation (simulating storm damage) on ecotone carbon exchange and stoichiometry was successful in addressing our key hypotheses. We found that phosphorus exposure to mangrove peat soils reduced N:P and C:P, increased net aquatic ecosystem productivity, reduced respiration and resulted in an overall increase in soil CO_2-C flux (Fig. 2-5). Mangrove defoliation reduced aquatic gross primary productivity and ecosystem respiration. Overall, added phosphorus increased soil organic C mineralization suggesting that increased phosphorus loading with sea level rise, together with elevated salinity (Chambers et al. 2014), may increase soil carbon losses. However, increased aquatic production may offset this influence on soils. Storms that deliver P-rich sediment to coastal wetlands may be important short-term drivers of longer-term increases in coastal net ecosystem production through enhanced terrestrial and aquatic gross primary production. These results set the stage for more extensive long-term experiments in the laboratory and field.

Our long-term research on marsh net ecosystem exchange has shown that both energy balance and CO_2 dynamics are closely linked to the hydrologic consequences of water source changes. We have identified site-specific seasonal patterns in CO_2 where at Taylor Slough net CO_2 uptake rates were higher in the dry season and at Shark River Slough greater rates of carbon sequestration occur during the wet season (Malone et al., 2014). Variations in both ENSO phase and annual net CO_2 exchange rates co-occurred with changes in wet and dry season length and intensity (Malone et al., in review). Trends in *Cladium* biomass illustrate a convergence trend that may coincide with recent water management shifts (Fig. 6). Models predicting periphyton abundance and qualities under different freshwater restoration scenarios were run using output from the Everglades Landscape Model (Fig. 7), suggesting that the deeper water and longer hydroperiods expected under all restoration scenarios will reduce periphyton abundance but increase nutrient uptake rates. We are particularly working with community-level responses that suggest beta diversity (turnover) in time and space is a strong metric of change in nutrient supply and hydrology (Bramburger et al. 2013; Lee et al. 2013; Gaiser et al. 2014; Gaiser et al. in press). Long-term observations of calcareous green macroalgae suggest that composition, distribution, and productivity of calcareous green algae are increasing with reduced freshwater supply to the estuary.

Paleoecological studies of plant biomarkers and accretion rates have confirmed this hydrological influence on productivity, suggesting that long-term reductions in delivery of freshwater to the Everglades ecotone have reduced water depths in marshes by about 15 cm since 1900 (Saunders et al., 2014; Fig. 8). Similarly, chronologies of cores from sites within 10 km of the coastline suggest accretion rates are matching or exceeding the rate of sea level rise over the last 100 years, indicating a positive influence of marine exposure on accretion at current rates (Smoak et al., 2013). However, we continue to explore the process of peat collapse observed in areas recently inundated for prolonged periods with sea water as a result of sea level rise. Insight into the variability in carbon stability will be gained from our characterization studies that show a decoupling between POC and DOC sources (Timko et al., 2014).

Our long-term data suggest that this hydrologic variability appears to interact with other climate disturbances to modify ecosystem processes and function. In particular, the 2010 cold snap (the most severe on record, Fig. 9) interacted with the 2011 drought (a decadal event) to modify consumer abundances throughout the estuary. Across species, the cold front reduced the abundance of tropical euryhaline fishes. Conversely, the 2011 drought reduced the abundance of temperate freshwater species (Fig. 10). Simulations of sea level rise projected for the next 35 years predicted that increased hydroperiod would increase aquatic consumer productivity. However, the brackish fish communities favored by such conditions sustain less biomass than the freshwater fish communities which could negatively affect the birds that rely on these small fish communities as a source of food.

Analysis of the obstacles to freshwater restoration have shown that the greatest impediment is its "savings clause" that prohibits any reduction of flood protection for existing "users," further complicated by the technical challenges of massive-scale flood control in southeast Florida, and the need to push water across a flat landscape inhabited by flow reducing vegetation (Schwartz 2014). On the other hand, the achievement of water quality targets has been aided by monitoring, research and training partnerships, and enforcement actions that have resulted in phosphorus

reductions from agricultural areas. Farmers have significantly shaped research on best management practices, and their crop choices play important roles in water chemistry. Ecosystem restoration may ultimately be impossible without challenging flood-protection entitlements or accounting for farmers' and residents' decision-making rationales and environmental attitudes (Polsky et al 2014; Groffman et al 2014). In addition, urban growth studies indicate that zoning has specific and quantifiable impacts (Onsted and Roy Chowdhury, 2014) that need to be included in forecasting future land use changes in the region. Conversion of agricultural lands to developed lands usually results in less water used while the conversion of row crops to nurseries results in more water used (Pokharel, 2014). We have found that these historical socio-economic development patterns will cause sea level rise adaptation to have strong social and environmental justice implications in South Florida (Craumer et al., 2014).

Our modeling efforts have focused on how water source changes in response to freshwater restoration and sea level rise influence landscape distribution of peat accretion (Fig. 11) and nutrient concentrations in the coastal Everglades (Briceño et al., 2013; Fig. 12). We expect to hold a workshop in September 2014 to better constrain scenarios for our integrative modeling and another in early 2015 to refine the scenarios developed in response to those consensus needs. Our synthesis efforts have resulted in the completion of the first draft of chapters for our integrative book "The Coastal Everglades: The Dynamics of Social-Ecological Transformation in the South Florida Landscape."

Key outcomes or Other achievements

Here we provide a bulleted list of some key achievements and discoveries for this year:

Achievements

- FCE III experimental studies to determine the influence of nutrients, salinity and inundation on the freshwater and oligohaline ecosystems have been designed and implemented at benchtop, mesocosm and field scales.
- Experimental manipulation of phosphorus and defoliation on live plant-soil experimental units from mangrove ecotone were completed.
- Integrated carbon budget research has resulted in a qualitative uncertainty analysis and a pathway toward a quantitative carbon balance for the three FCE ecosystem types.
- Molecular proxies to be applied in the assessment of hydrological change in the Everglades have been developed and validated.
- Two scenarios workshops have been planned with specific objectives for Fall 2014 and Spring 2015.
- Completed chapters for our synthesis book volume: "The Coastal Everglades: The Dynamics of Social-Ecological Transformation in the South Florida Landscape."

Discoveries

The changing balance of freshwater-marine supplies:

- Over the last 50 years, water management releases of fresh water to the upper reaches are insufficient to restore hydrological conditions in the oligohaline ecotone causing water levels in the oligohaline ecotone to increase in the past 50 years coincident with sea level rise.

- The greatest obstacle to implementation of Comprehensive Everglades Restoration Plan (CERP) and the delivery of additional fresh water to the oligohaline zone is a clause in CERP of providing flood protection for current "users". Land use policies, farmer decisions, soil geography and crop type play important roles in the achievement of CERP water quality goals.
- Historical socio-economic development patterns will cause sea level rise adaptation to have strong social and environmental justice implications in South Florida.

Effects of the changing balance of freshwater-marine supplies on ecosystems:

- Phosphorus adsorbs to sediments in the presence of freshwater and desorbs in the presence of salt water, suggesting a trend toward phosphorus desorption under sea-level rise in the absence of additional freshwater inflows.
- Added phosphorus increases soil organic carbon mineralization suggesting that increased phosphorus loading with sea level rise may increase soil carbon losses.
- Long-term research on marsh net ecosystem exchange has shown that both energy balance and CO_2 dynamics are closely linked to changes in hydrology.
- Hydrologic restoration in Taylor Slough caused convergence of aboveground *Cladium* biomass at freshwater marsh sites.
- Mean water depths in Everglades marshes were *ca.* 15 cm deeper before 1900 and accretion rates for sites within 10 km of the Gulf of Mexico seem to match or exceed SLR over the last 100 years.
- Freshwater delivery pulses interact with disturbance events to influence prey availability and capture by predators in estuaries.

Future consequences of the changing balance of freshwater-marine supplies on ecosystems:

- Modeling activities suggest that deeper water and longer hydroperiods expected under all restoration scenarios will reduce periphyton abundance but increase nutrient uptake rates.
- Simulations suggest that sea level rise could have negative impacts on wading bird populations by favoring lower-biomass brackish water communities.
- Proposed decompartmentalization as part of CERP scenarios leads to longer inundation durations in some locations and shorter inundation durations in other areas, with substantial positive peat accretion rates in the former and substantial negative peat accretion rates in the latter.

Opportunities for training and professional development

FCE LTER offered new training and professional development opportunities for both our graduate and undergraduate students in 2013-2014.

FCE Collaborator Dr. Stephen Davis and former U.S. Senator and Florida Governor Bob Graham held a workshop focused on empowering college students to become more actively engaged in promoting Everglades Restoration. The workshop, entitled "Everglades Service-to-Activism", was held at the Bob Graham Center for Public Service at the University of Florida and was modeled after Sen. Graham's recent book titled "America, The Owners Manual, Making Government Work For You".

FCE students Christine Beck (Rehage Lab) and Edward Linden (Price Lab) were two of the twenty-five graduate and undergraduate students with backgrounds in policy, science, and law that participated in the workshop. Experts from the Everglades Foundation, University of Florida, Florida International University, and U.S. Geological Survey provided presentations on Everglades ecology, restoration, climate change, litigation, and policy issues. Sen. Graham and Chris Hand, his co-author and former Chief of Staff, led an afternoon interactive session with students to illustrate the skills needed to communicate with decision-makers in both Tallahassee and Washington, D.C. Breakout groups also discussed strategies for developing fund-raising campaigns and advancing restoration of the greater Everglades ecosystem with uncertainties of climate change and sea level rise.
Graham and Davis were pleased with the turnout and content, but they are already looking for ways to improve the workshop. Both would like to repeat the workshop at Florida International University, where the FCE-LTER program provides an established research program in Everglades science and policy arena. A Miami workshop would more easily allow students from other universities across south Florida to attend.

Dr. Evelyn Gaiser collaborated with 15 scientists from seven LTER sites to offer the course "Cross-site graduate student workshop—Linking Biology and Geomorphology". The course was open to both LTER students and others interested in keeping up with LTER science and was designed as a distributed seminar across several LTER sites including FCE, GCE, JRN, MCR, PIE, SBC, and VCR. Participating students explored the link between wetland ecology and coastal geomorphology—two fields that were traditionally studied as independent disciplines.

The course provided a unique opportunity for students to learn from experts in the field distributed across multiple universities. Speakers discussed the topic from various perspectives, with some lectures generalizing the material beyond wetlands to other habitat types. Course content was delivered live over the internet, and the FIU/FCE group had independent readings and discussions following on the topic for each week.

FCE graduate student Christine Beck took a course on the Parasites of Marine Animals at the Gulf Coast Research Laboratory Summer Field Program, Ocean Springs, MI from June-July 2014 to support her Master's thesis research.

Communicating results to communities of interest

FCE reaches out to a range of individuals throughout the South Florida community and across communities of interest.

Public Understanding: Deering Estate Seafood Festival
The Deering Estate Seafood Festival is one of the largest community outreach events for FCE. Over 9,500 people attended the 2014 Seafood Festival and at least 2,500 participated in the educational programming. FCE LTER had four booths at this year's Festival including Dr. Ligia Collado's Marine Macroalgae Mobile Lab, the Coastal Angler Science Team (CAST) Mark-Recapture, Bioluminescence, and Geoluminescence activities.

Increasing Interest in Learning
In 2013-2014, FCE has continued to increase its presence and visibility through a variety of media outlets including social media networks, print and radio.

FCE's "*Wading Through the Research*" Blog (http://floridacoastaleverglades.blogspot.com) is maintained by our graduate students with thoughtful and interesting posts such as: "*Toni the pollen-dependent Bee*" and "*My recapture story for the Everglades*". Boasting an impressive 67 total posts, 8 were added during 2013 and 7 thus far in 2014. Dr. Michael Heithaus' group also maintains the Heithaus Lab (http://heithauslab.blogspot.com) with 20 posts during 2013-2014 and includes engaging topics such as "*Dolphins in the coastal Everglades*" and "*Animal-borne video cameras reveal the secret lives of turtles*."

Social media continues to provide publicity through the FCE LTER YouTube increasing total offerings of 38 videos by adding 14 in 2013 and 24 in 2014.

Careers in Science: One Night in the Everglades/Una Noche en Los Everglades
The LTER Schoolyard Book Series continues to grow in the number of title offerings and the dual/multi-language editions. In 2014, FCE Education & Outreach placed a copy of both *One Night in the Everglades* and the Spanish Language version *Una Noche en Los Everglades* inside of every elementary and middle school library of the fourth largest school district in the nation, Miami Dade County Public Schools. Over 247,234 students across Miami Dade County now have access to *One Night/Una Noche* in 172 elementary, 55 middle, and 47 K-8 centers in South Florida and FCE is working with MDCPS to obtain annual circulation statistics.

In a donation by Dr. Rudolf Jaffe, 32 copies of *One Night/Una Noche* were part of 24,000 books that were distributed to 100 Caribbean schools through *Hands Across the Sea.* The mission of the *Hands* initiative is to improve literacy and assist schools in the Caribbean through their Caribbean Literacy and School Support (CLASS) program.

Technology: Media
Facebook continues to serve primarily as an internal means of social networking maintaining interactions between FCE members based at FIU and our collaborating and partner institutions.

In December 2013, Dr. Jeffrey Onstead was interviewed by WLRN Radio in the report "ENCORE: The sunshine economy on agriculture". FCE research was also discussed in 14 periodic articles and Dr. Henry Briceño's work was highlighted on the nbcnews.com webpage in the feature "Latino Scientists, City Managers Sound Alarm on Miami's Rising Seas."

In our third year of FCE III we further developed our outreach strategies through our newsletter "News From the Sloughs" by including accomplishments, activities and research findings from our both our own researchers, partners and collaborators.

We added a more developed structure to our quarterly newsletter to include contributions from each of our core areas of effort during the reporting period. This includes a new feature our quarterly address from our Lead P.I. "Take Me to Your LTER". Our new collaborator feature and student spotlights and highlights also have had positive feedback. Our FCE communications

team also concentrated effort in learning more effective science communication resulting in changes to the design, structure, and content of the newsletter to be more concise and consistent in content provided from one newsletter to the next. We also added hyperlinks for papers, reports and accomplishments. These newsletters are already proving useful to a variety of our audiences as a quick and valuable reference for Everglades research and researchers.

All of our current year and past three years of newsletters are available at http://fcelter.fiu.edu/about_us/news/.

David Green, Instructor at FGCU, STEM Education Instructional Designer, and long time FCE colleague, has been working with our communications coordinator and developed a model video short for the purpose of providing information richness to our webpages, specifically researcher profiles, but material that may also be used in other forms on our FCE webpages. David is developing modular video teaching units that use FCE research findings (Geoutours, are currently in-production for the Everglades.

Humanities: Tropical Botanic Artists—In Deep

FCE continues working with the Tropical Botanic Artists and over the last year Dr. Evelyn Gaiser has mentored the artists in capturing Everglades' diatoms in the watercolor exhibit *In Deep*. TBA spent several days in the Gaiser lab exploring the diatom database, learning about their ecology, and observing them under the microscope for the correctness of the species and specificity to South Florida. The artists were also provided with high resolution SEM images for reference.

The artists were given some liberties without restriction to traditional botanic watercolor style and were free to venture into graphite, colored pencil, pen, ink, and mixed media. The images were hung in a 12"x12" plain, wooden frame for a finished, comprehensive look. The final exhibit, *In Deep,* opened Saturday April 12, 2014 with a Curators Tour. This collaborative effort between the artists, scientists, and was curated by Kim Yantis-Strycharski, Exhibit Specialist at the Deering Estate, was on display as part of the *Deering Estate Festival of the Arts Exhibit* and ran from March 23 – April 23, 2014.

In May 2014, *In Deep*, traveled to KNZ LTER in Manhattan, KS for the LTER Science Council. Since then, *In Deep*, has also been booked in the Frost Art Museum (Feb 2015) with FCE Partner, Eco-Artist Xavier Cortada. We are also currently negotiating further exhibitions at the FIU Hubert Library and working with Scott Collins to arrange an exhibition in Arlington, VA at NSF for the Mini-symposium.

100th Anniversary of the Tamiami Trail

More recently, FCE and TBA are working on our 2015 exhibit that will celebrate the 100th Anniversary of the Tamiami Trail. Construction of the trail divided the northern and southern Everglades and is a major factor impacting FCE research and the Comprehensive Everglades Restoration Plan.

Plans to accomplish goals during the next reporting period

The effects of additional water restoration efforts on the water delivery to and quality in the mangrove ecotone of the FCE will continue to be investigated. Hydrological and geochemical monitoring will continue using ground-based measurements and interpreted relative to freshwater delivery and saltwater exposure. Qualitative as well as quantitative analyses will continue to address the social-political aspects of restoration, and link decision-making process and effectiveness to ecosystem transformation.

In the coming year, we will be devoting significant attention to benchtop, mesocosm-scale and field-scale manipulations of salinity, inundation and phosphorus in oligohaline and freshwater systems. We will complete analyses of the effects of salinity and disturbance exposure to mangrove soils and seedlings. We will continue our long-term evaluations of marsh and mangrove ecosystem primary production relative to hydrology, salinity and phosphorous in conjunction with these experimental findings. Field studies will be complemented by installation of a new eddy-flux tower at TS/Ph7, in a dwarf mangrove site. This long-term site-level and experimental research will be scaled up through remote sensing to characterize environmental patterns of vegetation in the freshwater-saline ecotone in the southeastern coastal Everglades. Vegetation class percent cover will be used to estimate biomass, relying on pre-existing and/or literature data for estimates of vegetation class biomass per unit area. For mangrove sites, we will analyze species-specific recovery rates to inform mangrove forest models, particularly along Shark River sites, to forecast changes in biomass and carbon allocation in these forested wetlands as result of future climate change and hydrological modifications in the upper watershed associated with the Everglades restoration program.

FCE assessments of organic matter accretion and quality will continue, particularly in the upper watershed in response to decompartmentalization and improved freshwater flows and in estuarine lagoons in response to changing water sources. This will include completions of the molecular characterization of dissolved organic matter in response to changing water source and the validation of compound-specific D/H as a proxy for water stress and thus hydrological change in the FCE. The importance of this detrital material to food webs will be studied through multiple exclosure and enclosure studies to determine the effects of increased freshwater flow on detrital delivery to marsh habitats and the strength of top-down processes including those initiated by alligators. We will continue studies to determine the influence of freshwater flow on the movements of large predators, and their importance in linking disparate habitats.

By early 2015, we will have fully defined climate and land/water use scenarios for guiding modeling efforts, especially those at the landscape scale. We plan to continue carbon transport modeling by processing additional remote-sensing and field-collected data to develop detailed maps of topography and water-level changes to serve as boundary conditions, reanalyzing SF6 tracer data previously collected and analyzed to better constrain longitudinal and lateral dispersion (Ho et al. 2009), and constructing an initial conservative mass-transport modeling using smooth particle hydrodynamics, a mesh-free Lagrangian method for simulating fluid flows. Landscape modeling efforts will increasingly focus on the ecotone, with the highest priority being to calibrate-validate hydrologic and salinity fluxes, incorporating historical tidal,

stage, and salinity data that has yet to be explicitly used in landscape modeling efforts within this subregion. Once complete, these models can be incorporated into our carbon budget efforts to create dynamic budgets under contrasting scenarios.

A major goal for 2015 will be completion of our synthesis book. We expect drafts of all chapters to be complete by Fall 2014 and submitted to the publisher in early 2015.

Figures and Tables

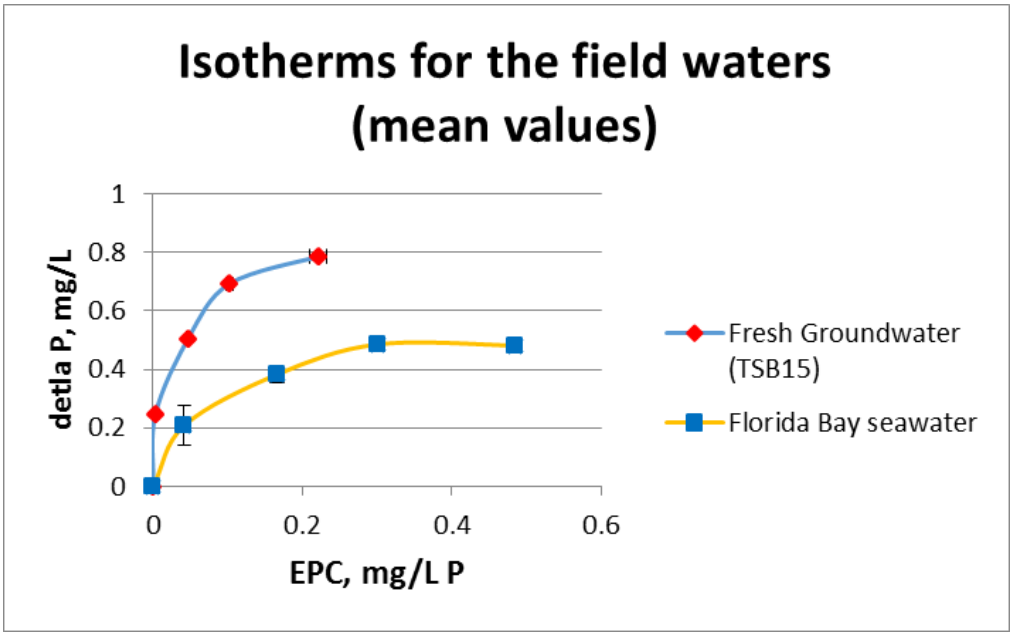


Figure 1. Isotherm showing that P tends to adsorb to sediments in the presence of native fresh water and desorb from sediments in the presence of native Florida Bay water.

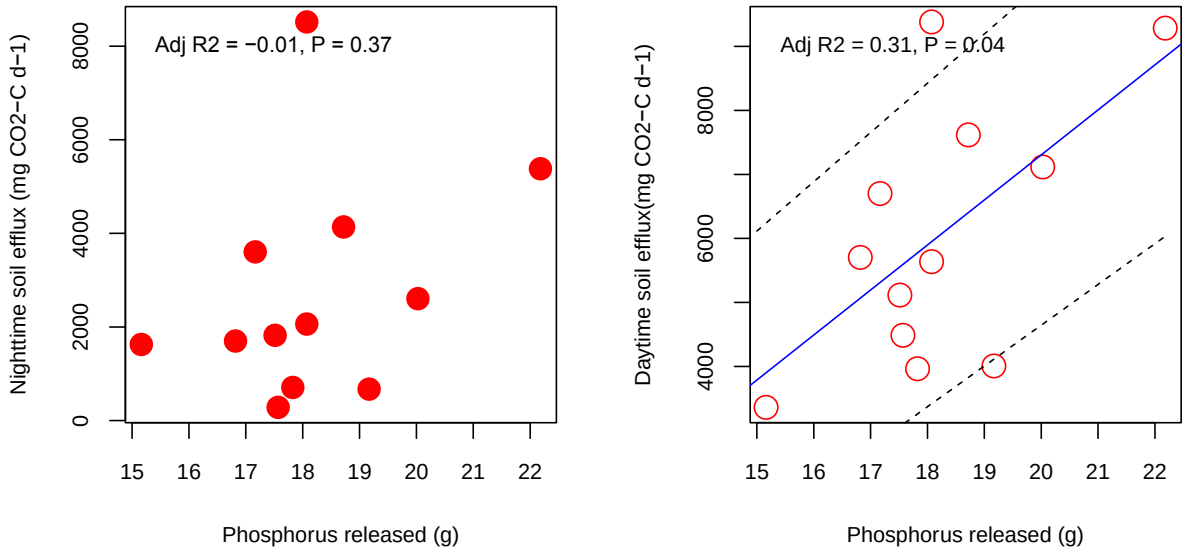


Figure 2. Nighttime and daytime CO_2-C flux along a gradient in phosphorus released from treated mangrove peat soils. Data indicate that phosphorus stimulated autotrophic release of C. This result was observed after 42 days and indicates an effect of phosphorus during storms on the mangrove soil carbon balance at FCE estuarine ecotone sites. Future experiments will address this further by conducting similar experiments with live plant-soil experimental units.

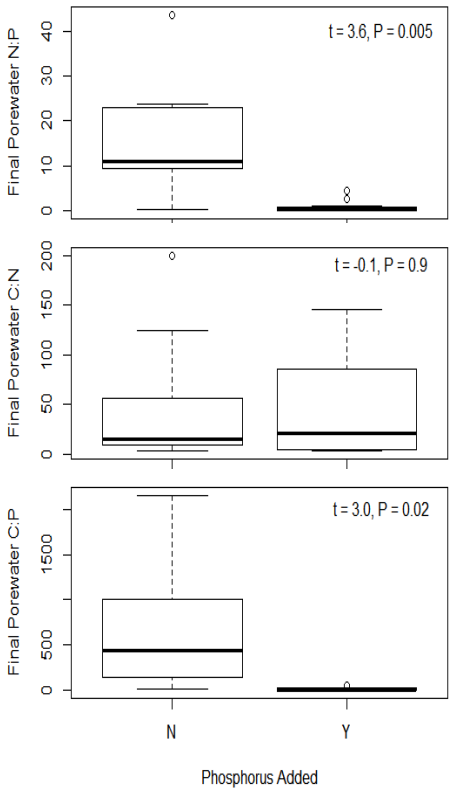


Figure 3. Porewater stoichiometry (N:P, C:P) was altered by added phosphorus.

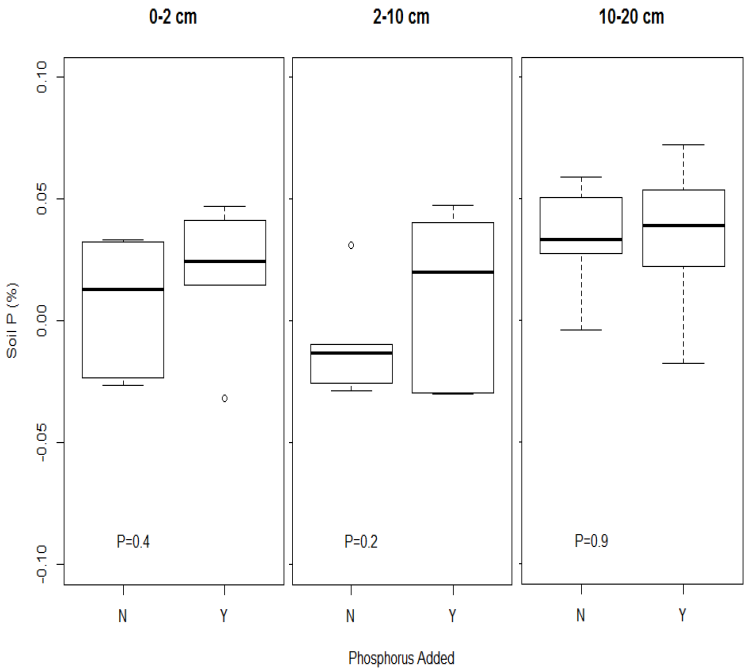


Figure 4. Added phosphorus did not affect soil %P.

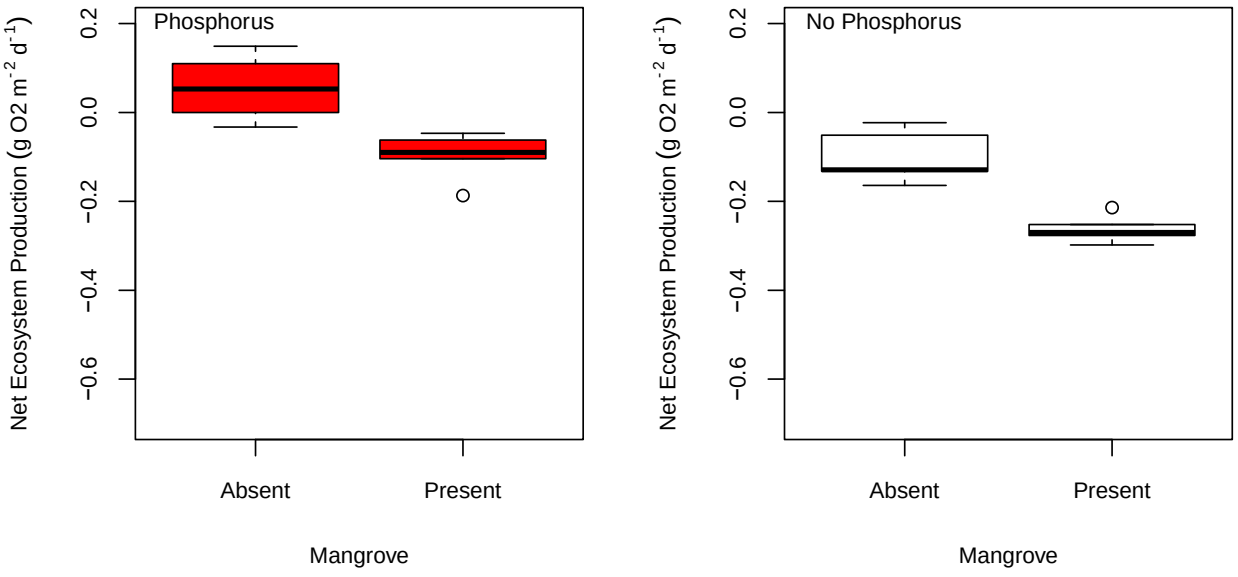


Figure 5. Increases in phosphorus enhance aquatic net ecosystem production (NEP) through increased gross primary production. Removing mangroves increases NEP by reducing respiration by soil heterotrophic communities.

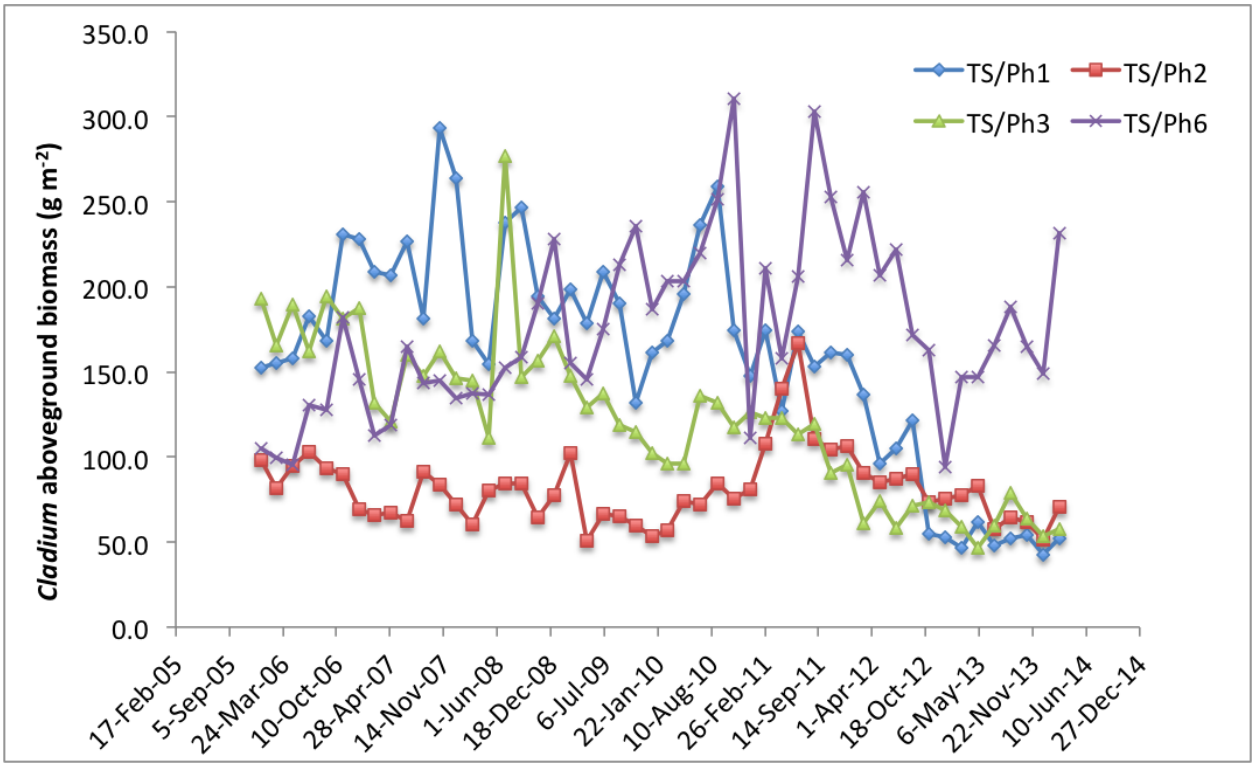
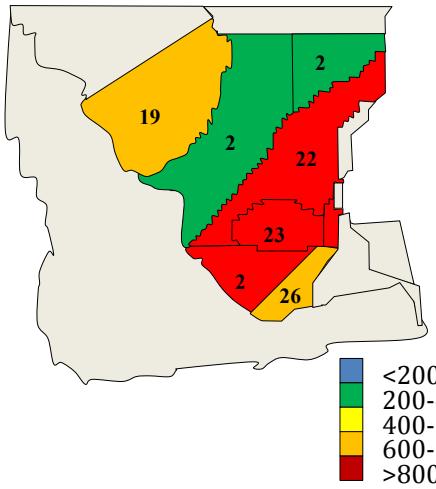


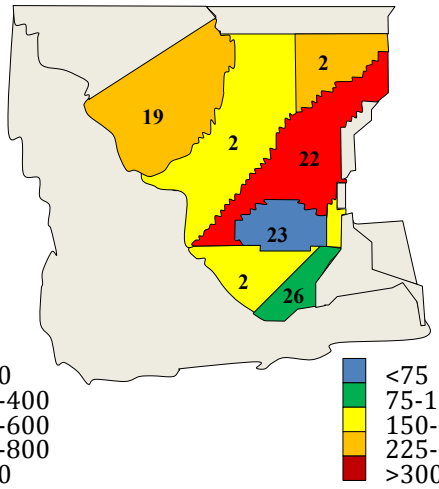
Figure 6. *Cladium* aboveground biomass (2005-2014) along the Taylor Slough transect.

Periphyton Biomass (g m^{-}

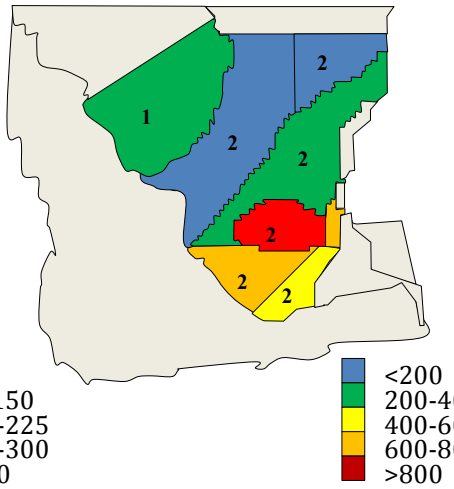
ECB



Difference

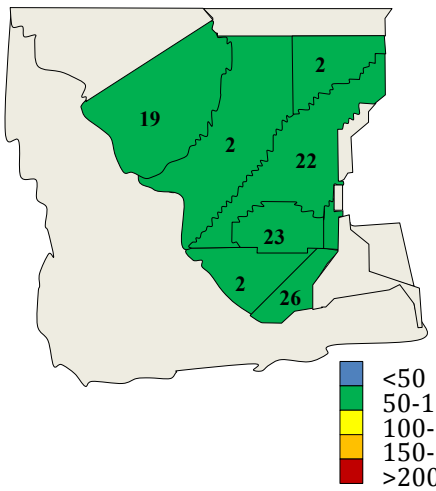


CERP 0



Periphyton TP (ug g^{-}

ECB



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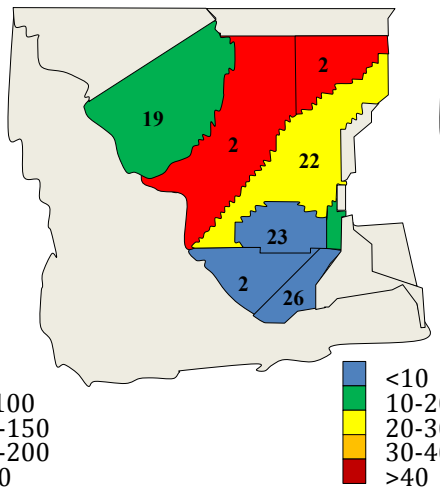
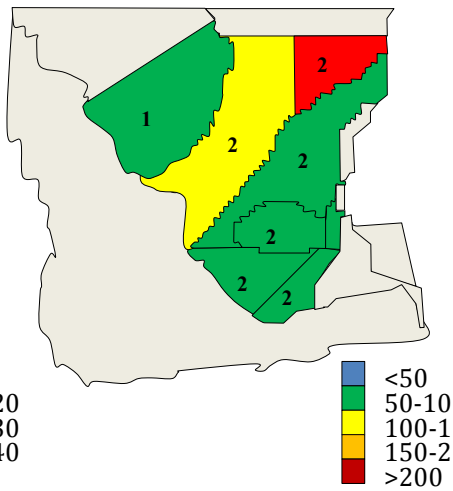
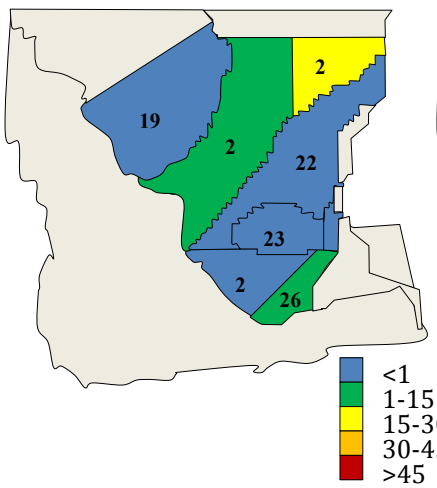


CERP 0



Edibility (%)

ECB



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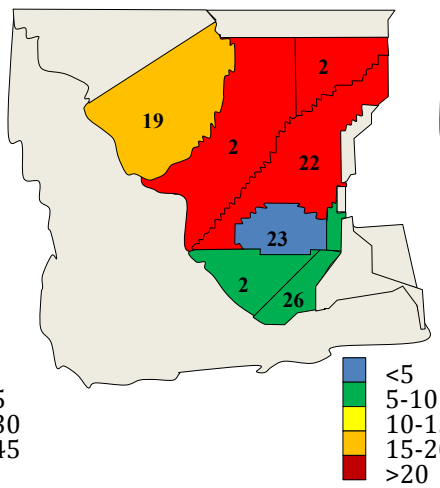
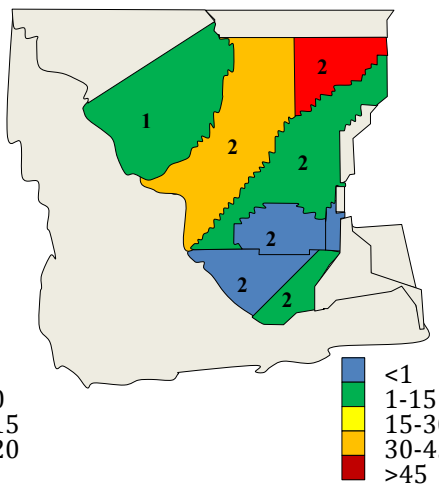


CERP 0



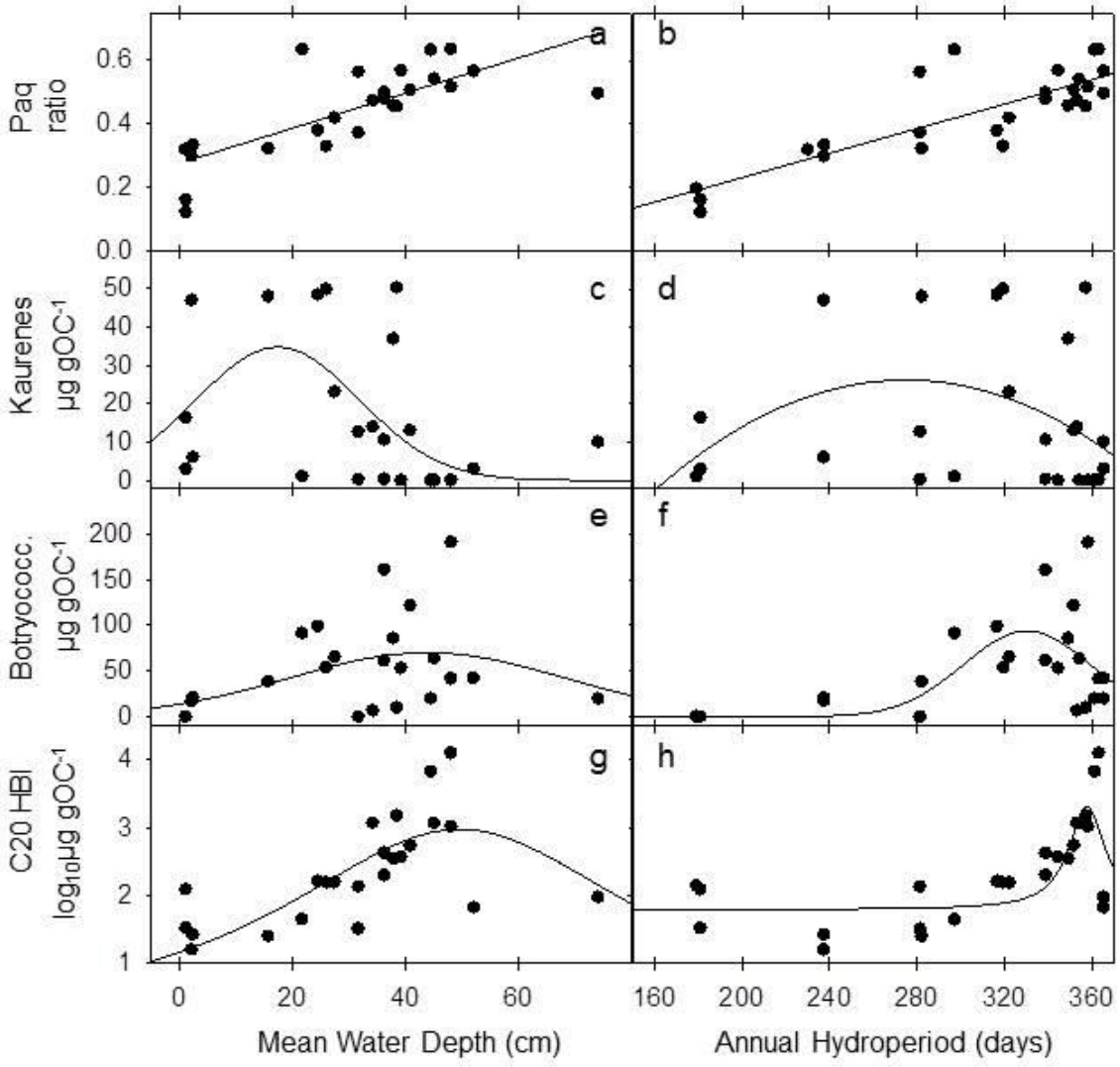


Figure 7. Results for periphyton biomass, phosphorus content and edibility driven by water depth and soil total phosphorus outputs from the Everglades Landscape Model (ELM) run under Existing Condition Baseline (ECB) and full Comprehensive Everglades Restoration Plan (CERP 0) inputs. The ELM model was run using a 36-year rainfall record and assuming functional Stormwater Treatment Areas that maintain phosphorus outputs to below the water quality criterion.

Figure 8. Distribution of different molecular markers with respect to mean water depth and annual hydroperiod (from Saunders et al., 2014)

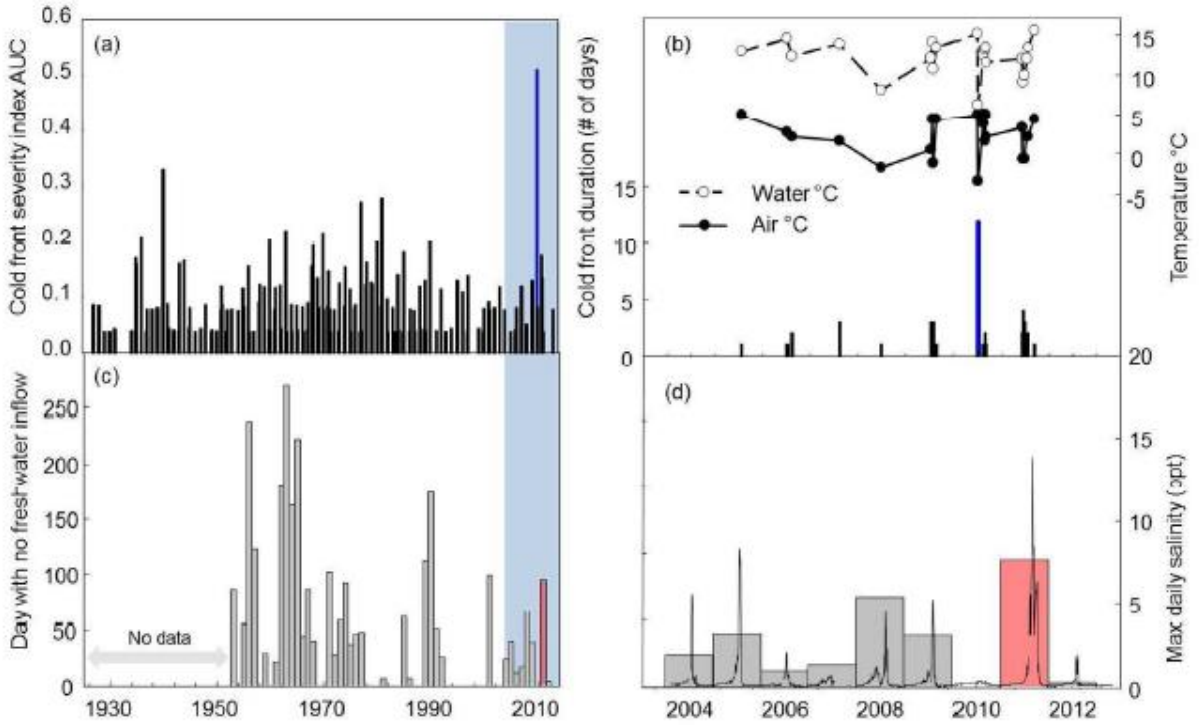


Figure 9. Area under the severity index curves (AUC) for all 319 cold fronts identified between 1927 and 2012. b) Minimum air temperature (black line), minimum water temperature (dashed line), and duration (in # of days, vertical bars) for each cold front during the study, 2004–2012, blue lines in panels (a) and (b) highlight the 2010 cold front. c) The number of days per year with no freshwater flow into the estuary for the longest period of record in ENP, 1955 2012. d) The number of days the estuary experienced no freshwater flow during the study, 2004-2012 (bars, red highlights the 2011 drought), and the accompanying maximum daily salinity values (solid line).

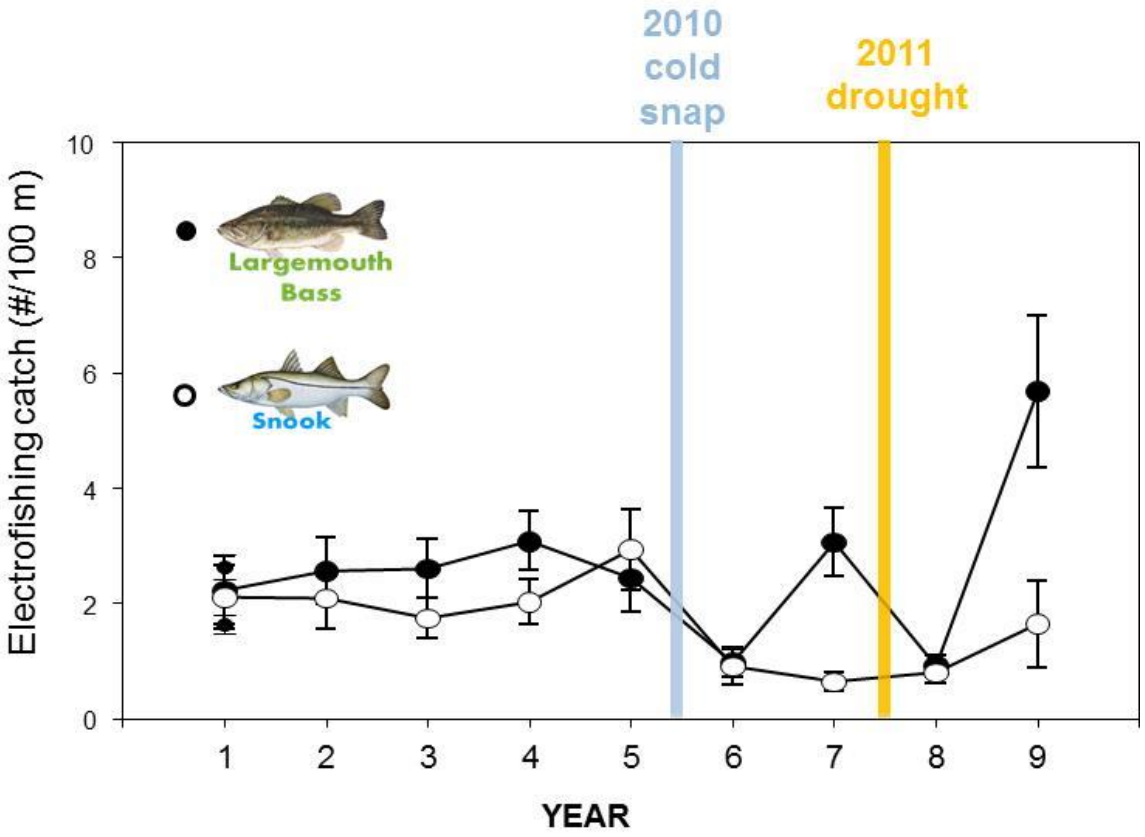


Figure 10. Estimates of abundance (electrofishing catch, # of fish per 100 m of shoreline) for recreational fisheries (Florida Largemouth Bass and Common Snook) in the upper SRE for 2004-2013. Shown are the timing of two climate extremes, the 2010 cold snap, and a 2011 drought.

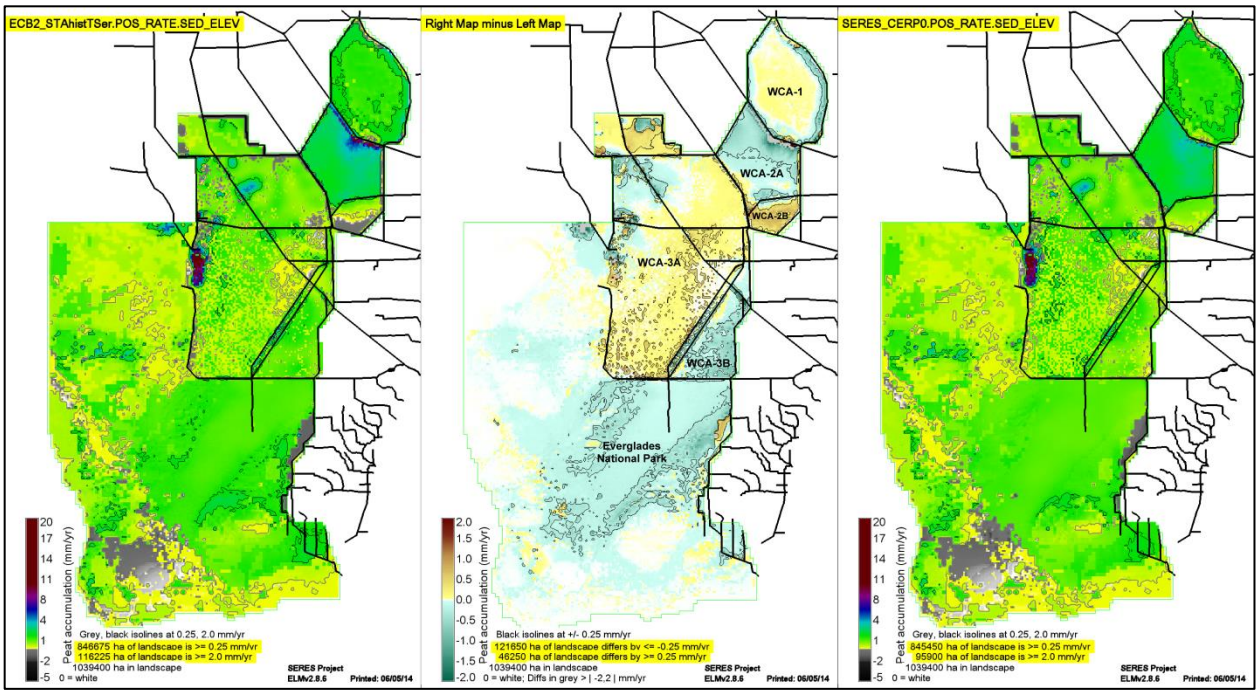


Figure 11. Peat accretion (mm/yr) under the Existing Condition Base (ECB, left map), the latest update to the CERP (CERP0, right map), and the differences between the two (CERP0 - ECB, middle map). Note that CERP0 has significant levee removal, and these levees are shown for CERP0 are for reference only.

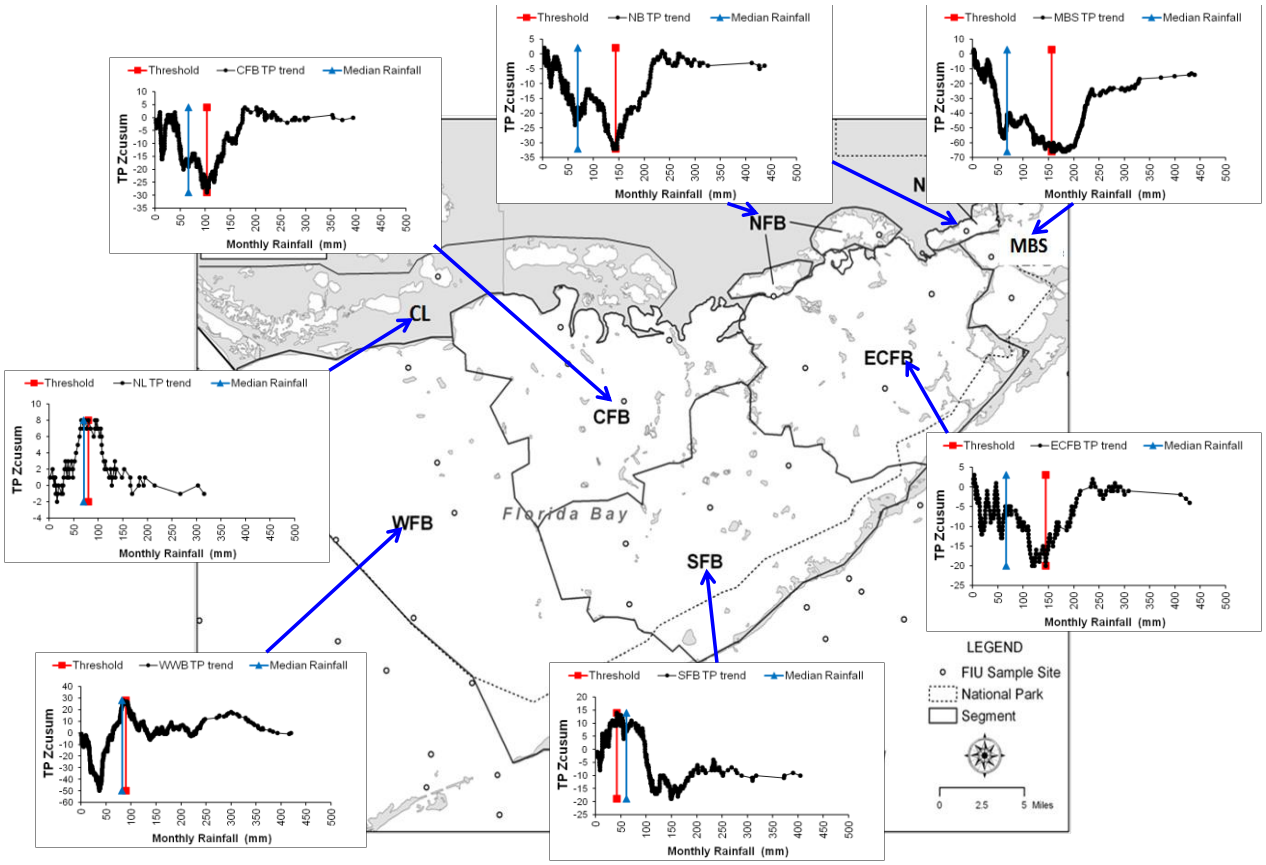


Figure 12: Tendency of TP as a function of rainfall. TP increases with rainfall in Central, North, and East-Central Florida Bay, and in Manatee-Barnes Sound. Red bar in those areas is rain threshold for onset of higher-than average TP

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Book Chapters

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Gaiser, E.E. (In Press). Long-term environmental research. *Long-Term Environmental Research: Changing the Nature of Scientists* Willig, M., L. Walker. Oxford Press.

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Conference Papers and Presentations

Barr, J.G., M.S. DeLonge, and J.D. Fuentes (2014). *Controls on evapotranspiration across the mangrove ecotone in Everglades National Park*. International Symposium Evapotranspiration: Challenges in Measurement and Modeling from Leaf to the Landscape Scale and Beyond. Raleigh, North Carolina.

Boucek, R. and J.S. Rehage (2014). *Multiple year legacy of a climate episode on a trophic subsidy*. Ecological Society of America 99th Annual Meeting. Sacramento, California.

Blanchard, J.R., V. Trujillo, and J.S. Rehage (2014). *Shifting metacommunity assembly rules: how do nonnative fishes affect metacommunity assembly in ephemeral wetland habitats?*. Ecological Society of America 99th Annual Meeting. Sacramento, California.

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Chambers, L.G., R. Guevara, T. Troxler, J.N. Boyer, and S.E. Davis (2014). *Microbial Community Response to Simulated Sea Level Rise in a Mangrove Soil (Everglades, USA)*. 2014 Joint Aquatic Sciences Meeting. Portland, Oregon.

Chuc-Contreras, A., I. Ortegon-Aznar, M.E. Fuenmayor, A. Perez, and L. Collado-Vides (2014). *Perspectivas de la produccion de Carbono organico y CaCO3 de las algas calcareas de los generos Halimeda y Penicillus (Bryopsidales, Chlorophyta) en Yucatan Mexico y el sur de la Florida, EUA: Una colaboracion promovida por el LTER*. V Simposio Internacional del Carbono en Mexico. Merida Yucatan, Mexico.

Craumer, P.R., H. Gladwin, and S. Mic (2014). *The sea in the 'hood: spatio-temporal modeling of water level and settlement in Miami-Dade County, Florida*. Annual Meeting of the Association of American Geographers. Tampa, Florida.

Gaiser, E.E., S.S. Lee, and J.C. Trexler (2014). *Establishing Ecological Targets in Ecosystems with Cascading Threshold Responses to Nutrient Pollution*. 2014 Joint Aquatic Sciences Meeting. Portland, Oregon.

Gaiser, E.E. (2014). *How is LTER advancing our understanding of the dynamics and controls of primary productivity in a changing world?*. LTER Network Science Council Meeting. Manhattan, Kansas.

Heithaus, M.R. (2014). *The ecological consequences of marine predator declines*. Gordon Research Conference. Ventura, California.

Heithaus, M.R. (2014). *The importance of large predators in tropical and subtropical marine ecosystems*. Fairchild Tropical Biology Symposium. Miami, Florida.

Kominoski, J., J.T. Brock, and C. McVoy (2014). *Aquatic Ecosystem Metabolism in Ridge and Slough Wetlands of the Everglades: Characterizing Spatiotemporal Variation in Water Column Heterotrophy*. 2014 Joint Aquatic Sciences Meeting. Portland, Oregon.

Lee, J., J.S. Rehage, and M.V. Lauretta (2014). *Population dynamics in drying times: How does seasonality affect apparent survival of resident versus transient mesoconsumer fishes in an estuarine environment?*. Ecological Society of America 99th Annual Meeting. Sacramento, California.

Lee, S.S., E.E. Gaiser, E.R. Sokol, A. Bramburger, and J.C. Trexler (2014). *Benthic Diatom Metacommunity Spatial and Temporal Beta Diversity are Related to Habitat Availability in a Hydrologically-managed Wetland*. 2014 Joint Aquatic Sciences Meeting. Portland, Oregon.

Onsted, J. (2014). *Wide open places and cramped little spaces: techniques for examining land use policy over a heterogeneous gov-scape*. Annual Meeting of the Association of American Geographers. Tampa, Florida.

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Pachon, J.C., J. Kominoski, S. Servais, S.E. Davis, E.E. Gaiser, and T. Troxler (2014). *Predicting Storm-driven Impacts of Phosphorus Loading and Terrestrial Carbon Loss on Coastal Aquatic Ecosystem Metabolism*. 2014 Joint Aquatic Sciences Meeting. Portland, Oregon.

Rehage, J.S. (2014). *Hydrological disturbance and the changing quality of refuge habitats for displaced fishes: Coastal natural vs. wetland artificial?*. Ecological Society of America 99th Annual Meeting. Sacramento, California.

Schwartz, K.Z.S. (2014). *Everglades Restoration and Climate Change Advocacy: Bridging the Divide?*. 29th Annual Everglades Coalition Conference. Naples, Florida.

Schwartz, K.Z.S. (2014). *Gridlock in the Everglades: Large-Scale Ecosystem Restoration and the Politics of the Anthropocene*. Association of Environmental Studies and Sciences. New York, New York.

Schwartz, K.Z.S. (2014). *Restoring the Everglades in the Anthropocene*. Tampa, Florida. Tampa, Florida.

Schwartz, K.Z.S. (2014). *The Transnational Politics of Environmental Change in the Florida Everglades*. "Cities, Rivers, and Cultures of Change: Rethinking and Restoring the Environments of the Global American South," 2014 Global American South Conference. University of North Carolina at Chapel Hill.

Schwartz, K.Z.S. (2014). *The anti-politics of biopolitical disaster on Florida's coasts*. Western Political Science Association. Seattle, Washington.

Servais, S., J. Kominoski, J.C. Pachon, S.E. Davis, E.E. Gaiser, and T. Troxler (2014). *Short-term Effects of Phosphorus Loading and Plant Defoliation on Plant-Soil Carbon Processes in Coastal Ecosystems*. 2014 Joint Aquatic Sciences Meeting. Portland, Oregon.

Troxler, T. and E.E. Gaiser (2014). *Understanding an iconic landscape through comparative international long-term ecological research*. Ecological Society of America 99th Annual Meeting. Sacramento, California.

Wagner, S., T. Dittmar, and R. Jaffe (2014). *Molecular Characterization of Dissolved Black Nitrogen*. 2014 Joint Aquatic Sciences Meeting. Portland, Oregon.

Thesis/Dissertation

Pokharel, Shiva. *Analysis of Land Use Change as a Method of Predicting Water Demands in an Urbanizing Environment: Redland, Miami-Dade County, Florida*. (2014). Florida International University.

Harrison, Elizabeth. *Analyzing invasion success of the Mayan Cichlid (Cichlasoma urophthalmus) in southern Florida*. (2014). Florida International University.

Lagomasino, David. *Ecohydrology, evapotranspiration and hydrogeochemistry of carbonate mangrove wetlands*. (2014). Florida International University.

Kotkowski, Rachel. *Environmental Influences on Bacterio-phytoplanktonic Coupling and Bacterial Growth Efficiency in a Sub-tropical Estuary*. (2014). Florida International University.

Matich, Philip. *Environmental and individual factors shaping the habitat use and trophic interactions of juvenile bull sharks (Carcharhinus leucas) in a subtropical estuary*. (2014). Florida International University.

Malone, Sparkle. *Hydrology drives Everglades ecosystem function: implications for ecosystem vulnerability to drought, energy balance, climate teleconnections and climate change*. (2014). University of Alabama.

Lee, Sylvia. *Mechanisms of Diatom Assembly in a Hydrologically-Managed Subtropical Wetland*. (2014). Florida International University.

Dewsbury, Bryan M.. *The Ecology and Economics of Seagrass Community Structure*. (2014). Florida International University.

Websites

Florida Coastal Everglades LTER Program Website
http://fcelter.fiu.edu/
The Florida Coastal Everglades LTER Program Website provides information about FCE research, data, publications, personnel, education & outreach activities, and the FCE Student Organization.

Coastal Angler Science Team (CAST) Website
http://cast.fiu.edu/
The Coastal Angler Science Team (CAST) Website, created by FCE graduate student Jessica Lee, provides information about how researchers and anglers are working together to collect data on important recreational fish species in Rookery Branch and Tarpon Bay in the Everglades and invites anglers to participate in this project.

Predator Tracker
http://tracking.fiu.edu/
The Predator Tracker website has information about the Predator Tracker application and a link to download the application. Predator Tracker is a stand alone application based on a kiosk at the Museum of Discovery and Science in Ft. Lauderdale. The application allows one to learn how researchers at Florida International University track and study big predators in the Shark River Estuary in Everglades National Park and explore their predator tracking data.

Wading Through Research
http://floridacoastaleverglades.blogspot.com/
A blog created by FCE graduate students which focuses on the experiences of graduate students conducting research in the Everglades.

Other products

(such as data or databases, physical collections, audio or video products, software or NetWare, models, educational aids or curricula, instruments, or equipment)

Databases
Description: The FCE Information Management System contains 138 datasets, of which a total of 128 are also publicly available online athttp://fcelter.fiu.edu/data/FCE/. Datasets include climate, consumer, primary production, water quality, soils, and microbial data as well as other types of data.

Audio or Video Products
Dr. Jennifer Rehage's lab Rehage lab is working with Encounters in Excellence to produce a film on their research in the Everglades, http://www.odysseyearth.com/videos/electrofishing-and-citizen-science/ . The film will be used in Miami-Dade Public Schools.

Participants & Other Collaborating Organizations

Participants*

*People who worked at least 1 person month on the project

Name	Most Senior Project Role
Gaiser, Evelyn	PD/PI
Heithaus, Michael	Co PD/PI
Jaffe, Rudolf	Co PD/PI
Ogden, Laura	Co PD/PI
Price, Rene	Co PD/PI
Kominoski, John	Co-Investigator
Briceno, Henry	Faculty
Childers, Daniel	Faculty
Collado-Vides, Ligia	Faculty
Fuentes, Jose	Faculty
Oberbauer, Steve	Faculty
Onsted, Jeff	Faculty
Rains, Mark	Faculty
Rehage, Jennifer	Faculty
Rivera-Monroy, Victor	Faculty

Name	Most Senior Project Role
Roy Chowdhury, Rinku	Faculty
Schwartz, Katrina	Faculty
Smoak, Joseph	Faculty
Starr, Gregory	Faculty
Troxler, Tiffany	Faculty
Wdowinski, Shimon	Faculty
Barr, Jordan	Staff Scientist (doctoral level)
Davis, Stephen	Staff Scientist (doctoral level)
Fitz, Carl	Staff Scientist (doctoral level)
Frankovich, Tom	Staff Scientist (doctoral level)
Whelan, Kevin	Staff Scientist (doctoral level)
Oehm, Nick	K-12 Teacher
Dailey, Susan	Other Professional
Powell, Linda	Other Professional
Rugge, Michael	Other Professional
Castaneda, Edward	Postdoctoral (scholar, fellow or other postdoctoral position)
Cummings, Justin	Postdoctoral (scholar, fellow or other postdoctoral position)

Name	Most Senior Project Role
Romera-Castillo, Cristina	Postdoctoral (scholar, fellow or other postdoctoral position)
Hines, Adam	Technician
Sanchez, Olga	Technician
Tobias, Franco	Technician
Travieso, Rafael	Technician
Boucek, Ross	Graduate Student (research assistant)
Danielson, Tess	Graduate Student (research assistant)
Feliciano, Emanuelle	Graduate Student (research assistant)
He, Ding	Graduate Student (research assistant)
Lee, Jessica	Graduate Student (research assistant)
Lee, Sylvia	Graduate Student (research assistant)
Malone, Sparkle	Graduate Student (research assistant)
Mic, Dumitrita	Graduate Student (research assistant)
Nodine, Emily	Graduate Student (research assistant)
Regier, Peter	Graduate Student (research assistant)
Seal, Matthew	Graduate Student (research assistant)
Wagner, Sasha	Graduate Student (research assistant)

Name	Most Senior Project Role
Williams, Asher	Graduate Student (research assistant)
Ya, Chao	Graduate Student (research assistant)
Cortez, Nicole	Research Experience for Undergraduates (REU) Participant
Johnson, Rachael	Research Experience for Undergraduates (REU) Participant
Fuenmayor, Maria	Undergraduate Student
Soto, Stephanie	Undergraduate Student

Partner Organizations

Name	Location
College of William & Mary	Williamsburg, Virginia
Dartmouth College	Hanover, NH
Everglades Foundation	Palmetto Bay, Florida
Everglades National Park	Homestead, Florida
Florida Atlantic University	Boca Raton, Florida
Florida Gulf Coast University	Fort Meyers, Florida
Florida State University	Tallahassee, Florida
Indiana University	Bloomington, Indiana

Name	Location
Louisiana State University	Baton Rouge, Louisiana
Miami-Dade County Public Schools	Miami-Dade County, Florida
National Aeronautics and Space Administration	Pasadena, California
National Audubon Society - Tavernier Science Center	Tavernier, Florida
National Oceanic and Atmospheric Administration - AOML	Miami, Florida
National Park Service - South Florida/Caribbean Network	Palmetto Bay, Florida
Pacific Northwest National Laboratory	Richland, WA
Plymouth State University	Plymouth, New Hampshire
Saint Louis University	St. Louis, MO
Sam Houston State University	Huntsville, Texas
South Florida Water Management District	West Palm Beach, Florida
Encounters in Excellence, Inc.	Miami, Florida
Texas A&M University at Galveston	Galveston, Texas
The Pennsylvania State University	University Park, Pennsylvania
USGS	Reston, Virginia
University of Alabama	Tuscaloosa, Alabama
University of California, Berkeley	Berkeley, California

Name	Location
University of California, Los Angeles	Los Angeles, California
University of Florida	Gainesville, Florida
University of Georgia	Athens, Georgia
University of Hawaii at Manoa	Honolulu, HI
University of Miami	Coral Gables, Florida
University of South Florida	Tampa, Florida
University of South Florida St. Petersburg	St. Petersburg, Florida
Yale University	New Haven, CT

Impact

Impact on the development of the principal discipline(s)

Evelyn Gaiser served as an Advisory Committee Member for the International Association of Diatom Research (2012-2015) and a Steering Committee Member for the Global Lake Ecological Observatory Network (2009-2015). She served as an Associate Editor for Wetlands and Frontiers in Ecology and Evolution. She also served as Co-Editor for special issues focused on FCE LTER in the Journal of Paleolimnology and Wetlands. She served as Co-Editor for a special issue focused on FCE LTER and International LTER in Ecosphere.

The work Jeff Onsted and Rinku Roy Chowdhury are doing to associate other impacts (water demand, etc.) with land use change is a crucial step for geography. Landscape and Urban Planning, a top-ranked geography and environmental science journal, has published their article (Onsted and Roy Chowdhury, 2014) and it has been downloaded over 1300 times so far.

Impact on other disciplines

Evelyn Gaiser served as an Advisor for the Nutrient Criteria for Wadeable Waters, U.S. Environmental Protection Agency; Contributor for Indicators of Everglades Restoration, South

Florida Ecosystem Restoration Task Force; and Collaborator for the Synthesis of Everglades Research and Ecosystem Services, Everglades Foundation.

Jennifer Rehage compiled and wrote a section of the 2014 System Status Report (SSR) for the USACOE. Research by J.S. Rehage is featured in the key findings section of the 2014 SSR. The SSR reports progress on Everglades restoration to federal agencies, including Congress. She also attended meetings of the Southern Coastal Estuaries module of RECOVER in January and June 2014.

Impact on the development of human resources

FCE LTER provided opportunities for research, teaching and mentoring in science and engineering through 56 semester units (SU) of undergraduate internships, 21 SU of internships with high school students, and at least 388 students received LTER as part of instruction in courses taught by FCE LTER scientists. Intensive, in-depth mentoring continues through our Research Experience Programs (REP) including REUs divide among three undergraduates and a single RET.

Research Experience for Undergraduates
In 2013-2014, FCE has began working to increase the participation of undergraduates from a broader range of institutions. Dr. John Kominoski hosted Julio Pachon of Cornell University and Shelby Servais.

Stephen Kelly and Alan Downey-Wall of the South Florida Water Management District and Everglades National Park (ENP) provided additional support in coordinating the establishment of the mesocosms and researchers Vicki McGee-Absten, Jeff Absten, and Nathan Lehmkuhl provided on-site support and mentoring throughout the project. Olga Sanchez, Rafael Travieso, and Franco Tobias worked with Julio in providing logistical and equipment support/training.

In August 2013, Julio summarized his work in a presentation entitled "*Analyzing carbon loss effects of phosphorus and defoliation on Florida's coastal R. mangle histosols."* (http://prezi.com/zzstdyngl9c3/untitled-prezi/?utm_campaign=share&utm_medium=copy) at both the Florida Bay Interagency Science Center and at the ENP—Krome Center.

Rachel Johnson was mentored by Dr. Tiffany Troxler in evaluating the potential mechanisms for peat collapse and soil dispersion. Three short-term experimental setups were used to observe whether or not elevated salinity alone would have an effect on the structure of the peat. Rachel is currently analyzing these results and plans to present a poster at the annual All Scientists Meeting.

Nicole Cortez has worked with the FCE-LTER since Fall 2013. She was trained to sample soil elevation tables (SET), which monitor the change in soil elevation over time and determine if soil production (elevation gain) can keep pace with sea level rise. After migrating historic SET data into a new soil elevation database, Nicole sampled SET sites to determine relative nutrient load. Processing her samples in Dr. Jayachandran's lab, she investigated total carbon, nitrogen, phosphorous, soluble reactive phosphorous and a variety of physical parameters. Nicole

produced a Standard Operating Procedure for SET data entry, a report investigating the relative soil nutrient load at the SET sites and presented the results to her Environmental Studies Senior Seminar class.

RAHSS—Improving access and retention in research

RAHSS Sara Osorio presented the results of her research with Dr. Evelyn Gaiser in a collaborative project with our partners at the Deering Estate that will be used as a baseline for monitoring within the Cutler Slough Rehydration Project. Sara described her work in a poster entitled *Changes in Diatom Assemblages along a Salinity Gradient in a Restored Mangrove Forest* and presented the poster at the 2014 South Florida Regional Science and Engineering Fair of Florida (SFRSEF). Sara's poster was given the highest rating of "*superior"* and also received: the *Genius Olympiad* prize; Stockholm Junior Water Prize; and was selected as a finalist for the State Science and Engineering Fair of Florida. In addition, Sara received *Third Place* in Environmental Science at the State Science and Engineering Fair of Florida.

Felipe Tamayo worked in Dr. Jennifer Rehage's Lab and was mentored by Ross Boucek. On January 11, 2014, Felipe gave the talk *"Factors affecting the fitness of invasive and native fish in South Florida"* and Sara presented her diatom research in Keller Science Theater at the Ft. Lauderdale Museum of Discovery and Science as part of the museum's *Everglades Days* program.

Research Experience for Teachers

Teresa Casal is working with Nicholas Oehm, FCE Education & Outreach Coordinator, to improve the performance, skills, or attitudes of members of underrepresented groups that will improve their access to or retention in research, teaching, or other related professions for students in the Global Studies Magnet at Felix Varela Senior High School. In September 2013, Teresa traveled with Nicholas to the Jornada (JRN) LTER for assistance in developing and implementing a DataJam at FCE. Stephanie Bestlemeyer (JRN LTER) has been an invaluable resource throughout the process of developing the FCE-Deering EvergladesDataJam. Teresa is working with former RETs, Catherine Laroche, Jennifer Gambale, and Terri Reyes Felix Varela, and Jennifer Tisthammer, Director of the Deering Estate towards holding a the DataJam on the Estate during the 2013-2014 school year.

Undergraduate Internships

Dr. Jennifer Richards mentored Morgan Wilson (MSc student in Urban Planning, Texas A&M University) as an FCE-LTER intern in the FIU GIS/RS Center for the summer, 2014. Morgan helped with image processing and vegetation classification using WorldView-2 remotely-sensed data, as well as exploratory data analysis with long-term nutrient and salinity data from the area being mapped.

Tech Camp Scholarships—Applying science and technology to issues of climate change

FCE LTER continues working with the Association of American Geographers (AAG) Global Connections & Exchange (GCE) Program and the US Department of State. The 2014 GCE consisted of three, 10 day, summer TechCamps in Bolivia, South Africa, and Panama. Students received scholarships to participate in one of the camps which focused on the use of GeoTechnologies in studying Climate Change and the Environment. A total of 120 High school

students were competitively selected from the United States , Bolivia, Panama, and South Africa from hundreds of applicants.

TechCampers self-organized on cross-cultural teams to create youth-led local projects. Each received academic preparation, orientation, mentoring and training in the use of GeoTechnologies, i.e. online mapping, community GIS, mobile GPS, crowd mapping, and participated in cultural exchanges.

FCE hosted the Bolivia Tech Camp Orientation in June 2014 at Florida International University and our partners at the Deering Estate. Felipe Tamayo, Christopher Naranjo, and Alexander Waller represented FCE along with 7 students representing other US locations.

During the orientation, participants learned about issues of climate change and the environment in the Florida Coastal Everglades. RET Jennifer Gambale demonstrated historic water flow patterns using 25'x50' map of South Florida. Afterwards, former FCE RAHSS/REU, Christopher Sanchez led them on a hike of the Cutler Slough Rehydration Project at the Deering Estate. Students returned from their hike to hear presentations by FCE RAHSS recipient, Sara Osorio, who discussed the results of her diatom work with Dr. Evelyn Gaiser and Felipe presented the results of his RAHSS work with Dr. Jennifer Rehage and Ross Boucek on Invasive Fish in South Florida.

TechCampers also heard Adrian Elkind, Christopher Naranjo, and Alexander Waller give presentations on Hurricane Impacts, Mangrove Ecology, and Game Species.

Christopher Sanchez and Christopher Naranjo co-led a tour through the mangroves on the Estate where they further discussed ecological processes from the classroom lecture.

On Sunday, June 30, TechCampers departed for a 10 day trip to La Paz, Bolivia, where climate change is increasing the frequency of landslides and discussed parallels with hurricane frequency and will continue to work through online collaboration next fall to finish their projects.

High Impact Leadership Trip (HILT)
In February 2014, FCE hosted 20 undergraduates from Concordia College through High Impact Leadership Trip (HILT). Students learned about anthropogenic and climatic stressors on water management issues. Led by Ross Boucek, the FCE student group hosted a mini-symposium featuring related FCE research and was broadcast via USTREAM.

Impact on information resources that form infrastructure

The major focus of the FCE Information Management (IM) team (L. Powell and M. Rugge) has been completing the implementation phase for a FCE IMS physical hardware restructure and improving its network-wide standardization to facilitate increasing use of site data in synthesis projects. The following contributions were made to the LTER network by the FCE IMS information manager: 1) member of the LTER Network Information Management Advisory Committee (NISAC) thru Spring 2014, 2) Chair of the LTER IM Unit Registry working group, 3) member of the IM Data Package Reporting working group, 4) attendance at the 2014

Information Management Committee annual meeting in Frisco, Colorado and 5) FCE IMS data contributions to ClimDB, SiteDB, All Site Bibliography, PersonnelDB, Metacat XML database and LTER PASTA system.

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The FCE LTER program continues to support and contribute to its information management system (IMS) during the third year of FCE III:

- Completed changes to the Oracle 11g database tables to reflect recent 'versioning' procedural changes to the FCE data archives.
- Submitted ALL FCE program data, with the exception of 15 dissertation research datasets, into the LTER PASTA and Metacat systems.
- Collaborated on a custom iOS application to facilitate exploration, manipulation, and annotation of long-term ecological data signals on a mobile platform. A web-based version of the application was completed and is in the process of being integrated with the FCE website thus allowing users to easily graph existing FCE research data from their browser.

IT Infrastructure

The FCE information management system (IMS) Web server and Oracle 11g database is now housed on five (5) virtual servers housed on Florida International University Division of Information Technology's (UTS) equipment. The FCE III Disaster Recovery Plan is currently being upgraded to where the program's data and information are not only backed up offsite at the Northwest Florida Regional Data Center (NWRDC) located on the campus of Florida State University in Tallahassee but also a 'trigger' is being set up that allows the FCE website and Oracle 11g Database to be continually available throughout disaster events such as hardware failures and hurricanes.

FCE III Website and Data Archives

The FCE web site provides outstanding support for site and network science. The site's home page (http://fcelter.fiu.edu/) design provides a simple, user-friendly gateway to a wide variety of information ranging from the FCE LTER project overview to links to additional research-related websites and online data downloads. The FCE IM team has incorporated several LTER working group initiatives to improve standardization of data search and access across LTER sites through adoption of controlled vocabularies and common interface features. A nearly completed (Winter 2014) web-based data processing visualization tool will allow researchers to rapidly visualize complex data streams and to efficiently process and annotate data. A new quarterly researcher newsletter called "News from the Sloughs" (http://fcelter.fiu.edu/about_us/news/) has been added to the FCE website, bringing interesting research articles and FCE highlights to the FCE group.

All of the FCE LTER core data and metadata files from individual research studies are stored in a hierarchical flat file directory system. FCE project information and minimal research data metadata are stored in an Oracle11g database that drives the FCE web site. This hybrid system (flat file and database) gives FCE researchers, network scientists and the general public an option to download complete original data files submitted by individual FCE scientists in addition to downloading queried data from the Oracle11g database. Core data are made available to the

public within two years of data collection and are accessible on-line in accordance with the FCE Data Management Policy.
The FCE IM team lends its expertise to site and network researchers when necessary by providing application support (Excel2EML), assistance with metadata entry, data submissions, individual project database design, collaborations on GIS work and research graphics**.**

Key Outcomes
The FCE LTER program is now in full compliance with the LTER PASTA system as all FCE program data, with the exception of 'restricted' dissertation research data, have been uploaded into LTER Network PASTA system. The FCE IMS contains 143 datasets, of which a total of 125 are also publicly available online at http://fcelter.fiu.edu/data/FCE/ .

Goals
Continue work on website redesign of the FCE Data section that will include a web version of the FCE data-processing visualization tool (graphing of FCE data via the web).
Process and archive all incoming FCE III research data that are ready for public release.
Continue support for site and network science by providing application support (Excel2EML), assistance with metadata entry, data submissions to both the local FCE III IMS and the LTER Network PASTA system, individual project database design and collaborations of GIS work.

Impact on technology transfer
Jordan Barr has discussed distribution of the Everglades National Park hydrologic monitoring station network to FCE LTER researchers and other Everglades researchers. This transfer is currently in process. The goal is for Everglades National Park staff to not become the bottleneck for data transfer outside of the National Park System.