FCE III YEAR ONE ANNUAL REPORT

FOR NSF AWARD DEB-1237517

Florida Coastal Everglades LTER

Florida International University

Reporting Period: 12/01/2012 – 11/30/2013

Submitted September 16, 2013

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Table of Contents

Accomplishments

What are the 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 beginning 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 the first year of FCE III included: (1) updating working group and thematic research teams, goals and leadership, (2) integrating new collaborators through workshops and the 2013 All Scientist Meeting, (3) continuing oversight of measurements and studies directed at long-term programmatic goals, (4) expanding the spatial domain of FCE research into the South Florida Urban Gradient, (5) initiating mesocosm and field experimental research, (6) outlining the content of a synthesis book volume, (7) completing transfer of data to the Network Information System (PASTA), (8) continuing advancements in education (FCE Schoolyard) and outreach through expanded partnerships directed toward goals of the Strategic Implementation Plan for LTER, and (9) expanding collaborations across coastal LTER sites.

FCE research is conducted within the context of four major working groups (WG): *Biogeochemical Cycling*, *Primary Production*, *Organic Matter (OM) Dynamics*, and *Trophic Dynamics*. Intergration 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 stimulated in FCE III through the intended publication of a synthesis book volume. We report progress within each of these categories relative to the specific goals set forth in our renewal proposal.

What was accomplished under these goals?

Major Activities

General: Year 1 activities have included updating our membership and transitioning leadership to FCE III structure. Leaders presented progress and goals and new members were welcomed at the 2013 All Scientists Meeting. Working group activities are commencing through workshops, and long-term data collections continue without interruption. Synthesis has begun in earnest through three book-writing workshops. FCE data are now available through PASTA. Researchers and staff have been engaged in Network communications planning and implementation, while maintaining core and new public communications and partnerships in South Florida. FCE researchers have also been expanding collaborations across coastal LTER sites through proposals and contributions to the special coastal LTER issue of *Oceanography*.

Biogeochemical Cycling: This WG is testing hypotheses by combining analyses of long-term biogeochemical data with an intensive set of mesocosm experiments that will unravel ecosystem responses to sea-level rise and saltwater intrusion. Experiments were modeled after a 2011 experiment on SRS-6 mangrove soils. We submitted a manuscript for publication summarizing the results of the 2011 manipulation of inundation and salinity, and conceptualized a set of experiments for FCE III involving both soils and live plants. The first experiment using a live plant-soil system was completed summer 2013. This research team was just informed of funding from Florida Sea Grant to conduct field manipulations that complement the mesocosm experiments.

Primary Production: This WG has continued extensive monitoring and analysis of primary production and community dynamics in the FCE study area, including periphyton, freshwater marsh, mangrove, marine macroalgae and seagrass communities. Several major summary papers of long-term trends and changes in primary producers along the TS/Ph transect were published in a special 2013 FCE issue of *Wetlands*. Field studies are complemented by research in the experimental mesocosms (described above) to determine mechanisms of plant response to salinity, nutrient and inundation changes. Summer 2013 experiments measured responses of mangrove transpiration, root and leaf growth, and periphyton dynamics to manipulated phosphorus availability. We also expanded our remote sensing research toward understanding the variation and change in landscape patterns of these communities through access to newly available WorldView imagery.

Organic Matter Dynamics: This WG has continued measurements to determine the effects of water residence time and nutrient availability on DOM and POM source strength and export. A combination of excitation emission matrix fluorescence with parallel factor analysis (EEM-PARAFAC) and stable carbon isotope $d^{13}C$ analyses were used to characterize DOM and POM from Florida Bay and the ecotone of the Shark and Harney rivers. The WG is also using exploring the use of dissolved black carbon (DBC) as a conservative terrestrial tracer in estuarine systems. Samples along salinity transects were irradiated to test the potential photo-reactivity of DBC. Site-based work was coordinated with a large cross-site study to determine the proportion of DBC oxidation products, the benzenepolycarboxylic acids (BPCAs), from a variety of sites globally. We also examined long-term trends in porewater chemistry in mangrove sites along SRS and TS/Ph transects.

Trophic Dynamics: This WG is using biomarkers (fatty acids) to identify importance of detrital pathways in coastal food webs, examining prey pulses from the marsh to diets of estuarine predators (particularly snook and bull sharks), and is beginning new studies of trophic interactions of bottlenose dolphins. We continue to collect data on the spatial and temporal variation in the abundance and community composition of fishes and alligators from marshes to coastal estuaries (including investigations of individual specialization) and use electrofishing and trophic sampling to track spatiotemporal responses in ecotonal fish communities to seasonal hydrology and impacts of introduced fishes. The group also expanded movement work in relation to hydrological drivers by acoustically tracking common snook and largemouth bass and by deploying satellite transmitters on American alligators and crocodiles. We completed cross-site synthesis paper on drivers of top predator movements and consumer-mediated nutrient flow.

Hydrology and Water Policies: This CCT is continuing hydrological assessments through ground-based measurements, hydrological modeling, and satellite observations. We adopted 2 hydrological sites in the ecotone (SH-2, SH-3) previously operated by the USGS. Modeling efforts included simulating: 1) the effects of pulsed surface water flow on sediment transport, 2) variable density groundwater flow along the coastline, and 3) the effects of water mitigation in TS/Ph. Satellite imaging using Interferometric Synthetic Aperture Radar (InSAR) was used to detect tidal flow in SRS. Landsat imagery was used to estimate evapotranspiration across FCE and to correlate biophysical indices of mangroves with water chemistry in both SRS and TS/Ph. Progress toward understanding the role of political decisions in water availability in South Florida was made through new research activities that began with a guided tour of SFWMD operations. Collaborators also conducted interviews with tribal, regional, and county water mangers, environmental advocates, and community organizers in South Florida, with particular focus on issues related to Everglades restoration and sea level rise planning.

Carbon Dynamics: This CCT took a major step forward by contributing a manuscript to the *Oceanography* LTER special issue that outlines the steps necessary to produce an integrated carbon budget for FCE, and for making comparisons across other coastal wetlands (Troxler et al. 2013). Progress has been made in two of the key areas of uncertainty: long-term FCE POC and DOC data are being processed to estimate source strengths and C-export from SRS and soil C accumulation rates are being estimated through paleoecological investigations in the ecotone.

Climate and Disturbance Legacies: Activities have focused on compilation and initial analyses of times series data on water quality and quantity, as well as remote sensing land cover datasets in order to address proposed hypotheses linking land use/land cover (LULC) change in urban areas to changes in the oligohaline ecotone. Analyses included evaluation of the impacts of zoning on the rate and pattern of urbanization in FCE, characterization and classification of South Florida coastal and estuarine waters, assessing the relationship between water flow and nutrient concentrations in TS/Ph, and work on paleoenvironmental change and climate teleconnections in the greater Everglades.

Modeling and Scenarios: This CCT proceeded along three broad fronts: defining a scenarios framework to constrain modeling efforts, conducting analyses to support modeling efforts, and conducting modeling efforts. To best define a scenarios framework, we have been working with regional groups and attending workshops and meetings, and are finding consensus around a narrow range of plausible outcomes. Our analyses to support modeling efforts include literature reviews and laboratory analyses to better understand P dissolution/precipitation and desporption/adsorption to support a P-transport modeling effort, field analyses to better understand sheet flows to support a sediment-transport modeling effort, and remote-sensing analyses to better understand tidal propagation up sloughs and out into the vegetated fringes.

Ongoing modeling efforts include modeling the effects of potential sulfate loading on receiving waters in the greater Everglades and modeling LULC change in the metropolitan region.

Specific Objectives

General: The overarching objectives for Year 1 were to update the FCE membership and leadership according to the new FCE III structure through workshops and the 2013 All Scientist Meeting. We also planned to continue long-term measurements without interruption while expanding the FCE spatial domain into the South Florida Urban Gradient through involvement of new political ecologists and geographers. A new initiative in FCE III is integrating mesocosm and field experimental research with long-term measurements to address key FCE questions. We also planned to outline the content of a synthesis book. Much effort has been aimed at completing transfer of data to PASTA. We also planned to expand collaborations across coastal LTER sites through planning workshops, proposal activities and synthesis manuscripts.

Biogeochemical Cycling: Year 1 objectives were guided by proposed hypotheses: H1) The balance of fresh and marine water supplies influences microbially-mediated C and nutrient cycling in wetland soils through interacting effects on P availability, salinity, and water residence time, culminating in gains or losses in C storage, and H2) The balance of marine and freshwater supplies of dissolved organic carbon (DOC) to Everglades estuaries will determine bioavailability for bacterioplankton and the microbial loop. We planned a protocol for summer 2013 experiments in the mesocosm facility at the Florida Bay Interagency Science Center and hired an REU and RET student. Summer plans included a manipulation of phosphorus exposure to simulate delivery associated with sea water exposure to determine effects on production, respiration and dynamics of plants and soils.

Primary Production: Year 1 objectives were guided by proposed hypotheses: H1) The balance of fresh and marine water supplies regulates primary producer composition and productivity through interacting effects on P availability, salinity and water residence time, and H2) Landscape patterns of plant composition and production express legacies of fresh and marine water supplies to the ecotone. Specific plans included collaborating with the biogeochemical cycling WG in experimental manipulations in conjunction with continued long-term measurements of periphyton and plants along the marsh-mangrove transects. Marine macroalgae research included continued systematic monitoring of production, growth rates and nutrient content of calcareous green algae in the seagrass beds.

Organic Matter Dynamics: Year 1 objectives were guided by proposed hypotheses: H1) Water source and residence time influence the relative contribution and quality of OM from marshes, mangroves, and the marine system to FCE estuaries, and H2) Variability in water source and residence time control the rates of DOC, POC, and DIC transport in and export from water and soils.different sub-environments of the FCE region. Plans included expanding measurements of sources and fates of DOM and POM across the Everglades landscape and comparing them to measurements in other coastal ecosystems. We also included studies of black carbon as a potential source tracer.

Trophic Dynamics: Year 1 objectives were guided by proposed hypotheses: H1) Freshwater delivery influences the importance of detritus to freshwater marsh and mangrove estuary food webs, and H2) Variability in freshwater inflows will interact with SLR to modify the spatial scale of consumer-mediated habitat links. H1 objectives were to expand studies assessing the importance of detritus to aquatic food webs and determine connectivity between top and mesoconsumers by complementing our abundance and tracking research with analyses of stomach contents, stable isotopes, and fatty acids. H2 objectives included: (1) determining variability in contributions of top predators to community dynamics and nutrient cycling by maintaining quarterly sampling of bull shark abundance and bi-annual sampling of alligator abundance, diets, and body condition in the ecotone region in relation to continuous FCE biogeochemical data, (2) conducting trial deployments of satellite transmitters on American alligators, and (3) building a comparative approach to understand patterns of individual behavioral specialization through collaborations with other coastal LTER sites.

Hydrology and Water Policies: Year 1 objectives were guided by proposed hypotheses: 1) Variable inflows from upstream sources, SLR, and storm surge interact to alter surface water residence time, salinity, and groundwater intrusion in the oligohaline ecotone, and 2) Stakeholder uncertainties over SLR will increase conflicts over Everglades restoration implementation and will affect freshwater delivery to the oligohaline ecotone. Year 1 focused on water management practices, specifically understanding how water managers make decisions related to water delivery and how changes in water mitigation strategies affect water flow, quality and residence times in TS/Ph.

Carbon Dynamics: Year 1 objectives were guided by proposed hypotheses: 1) Temporal variability in C uptake, storage, and transport in the mangrove ecotone reflects the pulsed dynamics of marine water, nutrient, and sediment supplies driven by tides and storms, and freshwater supply driven by seasonal rainfall and water management, and 2) Landscape patterns in C fluxes reveal legacies of exposure of the marsh, mangrove, and seagrass ecosystems to long-term changes in the balance of fresh and marine water supplies. The Year 1 goal was to establish a pathway forward for creating dynamic carbon budgets for the FCE ecotone, culminating in the compilation of a manuscript that outlines the progress and remaining questions necessary to address to complete our overarching goals.

Climate and Disturbance Legacies: Year 1 objectives were guided by proposed hypotheses: 1) Changes in land-use and water allocation decisions in the South Florida Urban Gradient have hydrodynamic consequences in the Everglades landscape that explain observed changes in the oligohaline ecotone, and 2) Legacies of changing freshwater inflows to the oligohaline ecotone have influenced sensitivity to the balance of fresh and marine water supplies across the landscape. Year I objectives included the compilation, cross-linking and analyses of diverse data streams related to land use, water quantity and water quality throughout the greater FCE study area (including the FCE-LTER sampling sites, but extending further north to Lake Okeechobee to encompass the historical Everglades). Inherent to these goals and activities were analytical tasks building on and integrating data and insights from prior retrospective studies in FCE.

Modeling and Scenarios: Year 1 objectives were guided by proposed hypotheses: 1) Scenarios that maximize freshwater inflow to the Everglades will sustain distinctive biophysical features and dynamics of the oligohaline ecotone in the face of climate change, and 2) Scenarios that maximize the sustainability of ecosystem services provided by the marsh-mangrove ecotone will also improve freshwater sustainability to the South Florida Urban Gradient. Specifically we planned to: (1) work with regional groups to better define a scenarios framework to constrain modeling efforts, (2) constrain P budgets by measuring the liberation of P from the underlying bedrock and soils, and (3) improve predictions of sediment transport, especially as it relates to the maintenance of wetland surface topography. We planned further development of novel remote-sensing techniques to better understand tidal propagation to improve projections of the potential hydrologic effects of sea-level rise. The Everglades Landscape Model is being used to model the effects of sulfate loading on receiving waters in the greater Everglades. We are also using zoning data to model LULC change in inhabited areas adjacent to ENP.

Significant results

General: Working group leadership has transitioned smoothly, facilitated by the 2013 All Scientists Meeting. Working groups are meeting regularly and long-term datasets continue uninterrupted. New collaborators have expanded the spatial domain of our research into the urban areas of Miami-Dade County. Synthesis meetings were very successful and identified a pathway forward toward integrative book chapters. FCE data are available from PASTA, and FCE staff led the development of Network communications initiatives. Collaborators contributed three manuscripts in the special coastal LTER issue of *Oceanography*.

Biogeochemical Cycling: Experimental manipulation of salinity and inundation on peat soils showed that soil respiration is a major pathway of organic C loss (Fig. 1), and is accelerated by increased salinity and shortened inundation. Methanogenesis was minimal and increased under simulated SLR, while DOC production increased with inundation and may have contributed to a loss in surface soil bulk density. Porewater ammonium and soluble reactive phosphorus increased with combined salinity and inundation. Overall, saltwater intrusion and prolonged inundation slightly reduced soil organic C mineralization, but could increase the soil's susceptibility to peat collapse and accelerate nutrient export to adjacent Florida Bay. The subsequent (summer 2013) manipulation of phosphorus on the mangrove seedling-peat soil system is complete and samples are being analyzed in the laboratory (Fig. 2).

Primary Production: Analysis of long-term data on primary production through the FCE showed that variation and shifts in the abundance of dominant species illustrate not only legacies of hydrologic variation but also the influence of salinity and hydrologic dynamics in the coastal ecotone (Fig. 3). Methodological differences in periphyton production estimates show the importance of developing a periphyton C balance (Table 1). New research on root biomass and light-use efficiency in mangroves is contributing to our understanding of soil carbon balance and physiological drivers at the forest-scale. Long-term research in marine macroalgal communities is unraveling the contribution of $CaCO_3$ production to sediment C accumulation. This research provides the foundation for integrative carbon budget models across the terrestrial-coastal-oceanic gradient of the FCE LTER study area.

Organic Matter Dynamics: Measurements of DOC fluroescence and $\delta^{13}C$ show humic and protein-like signatures from upstream and downstream communities (Fig.4). POM contains higher protein-like fluorescence and microbially derived humic substances compared to DOM (Fig. 5). DBC molecular structure is more degraded at higher salinities suggesting that DBC is affected by photodegradation (Fig. 6). The BPCA signature of the Everglades was similar to that of other ecosystems characterized by frequent fires (Fig. 7). We identified a consistent seasonal pattern in porewater chemistry for mangrove sites from 2001-2013 driven by hydroperiod, with ecotone sites being influenced by delivery of marine nutrients from tropical storms (Fig. 8).

Trophic Dynamics: Our cross-site research is showing that individual specialization in top predator populations is widespread along the Atlantic coast and is important in shaping patterns of consumer-mediated nutrient flow at diverse scales. In the FCE, estuarine predators in the ecotone region receive an annual trophic subsidy when freshwater taxa enter mangrove-lined creeks as the marsh dries down. These temporally brief subsidies are important components of annual energy budgets. Our studies also show that extreme weather events (cold snaps, drought) have large impacts on population and community dynamics (Fig. 9). Scenario research has shown that climate change is likely to result in reduced fish biomass, decreasing prey for wading birds, and shifts in community composition. Movement studies show that American alligators move between the ecotone and the marsh more than previously documented potentially resulting in links from marshes to coastal marine waters. Individual alligators, however, vary in the extent of movements into marshes (Fig. 10).

Hydrology and Water Policies: Changes in water delivery from canal discharge to retention basins in northern TS/Ph resulted in enhanced groundwater seepage out of ENP and decreased surface water flow to the ecotone (Sullivan et al. 2013). With the decrease in surface water flow, ET and rainfall were the dominant variables affecting water residence time in TS/Ph ecotone, while water chemistry was influenced by ET, rainfall, inputs from Florida Bay and groundwater discharge (Sandoval, 2013). In the more tidally influenced SRS ecotone, water level changes were highest along tidal channels, with a tidal flushing zone extending 2-3 km from the sides and 3-4 km inland from the end of the channel (Wdowinski et al. 2013) (Fig. 11). Research on water management decision-making reveals that several factors are shaping the planning process: particularly stakeholder uncertainties over the impacts of SLR, the efficacy of restoration-related water deliveries in light of SLR, lack of funding and litigation delays (Garvoille 2013).

Carbon Dynamics: We published a manuscript that estimates the carbon balance across the marsh-mangrove ecotone (Table 2) and provides a pathway forward for integrative carbon cycling research (Fig. 12) (Troxler et al. 2013). One outcome was the need for further focus on DOC and POC lateral transport in the estuary (Fig. 13), and we are already making progress in this arena: A biomarker-based 3-end-member mixing model for POC in the SRS mixing zone resulted in estimates of relative contributions of fresh-water derived POC (1-8 %), mangrove-derived POC (70-90 %), and marine-derived POC (6-20 %). POC loss from mangrove estuary was estimated at 0.21-0.45x10^9 mg-C d^{-1} for SRS, which is similar to rates of mangrove-derived DOC flux. Contrary to POC flux estimates, the majority (*ca*. 80%) of DOC exported from SRS was derived from the freshwater end-member and only about 20% was mangrove-derived (Cawley et al. 2013).

Climate and Disturbance Legacies: Analysis of LULC trends indicate that zoning is a key driver of urban growth, but that impacts vary across the study region (Table 4; Fig. 14). For instance, restrictive zoning does control the rate and extent of urban expansion, but is less effective at stemming urbanization in areas experiencing high development pressure.

Biogeochemical segmentation of South Florida waters rendered forty-four distinct water bodies (Fig. 15). Analysis of the relationship between water flow and nutrient concentrations in TS/Ph revealed important thresholds and changes in nutrient concentrations along discharge gradients (Fig. 16). Analysis of long-term precipitation records shows a strong north–south gradient in the magnitude by which ENSO and the AMO regulate dry and wet season precipitation, respectively (Moses et al. 2012). Strong, positive teleconnections between these two climate drivers and South Florida hydrology have implications for future climate projections for the ecosystem.

Modeling and Scenarios: Though work is ongoing, there is consensus around a narrow range of plausible futures. Using 2060 as an event horizon, current estimates indicate a temperature change of 1.8-2.1 °C, a precipitation change of (-8)-5 cm, and a sea-level rise of 50 cm. Tides propagate rapidly up channels, then more slowly into adjacent and upgradient vegetation areas, with tide propagation extending 2-3 km laterally and 3-4 km upgradient of the channels (Wdowinski et al. 2013). Under some plausible scenarios, increased sulfate loading, which might occur as a consequence of proposed Aquifer Storage and Recovery efforts, does not result in ecologically significant increases in sulfate concentrations in the greater Everglades (Fig. 17).

Key outcomes or Other achievements

Here we provide a bulleted list of outcomes by working group/thematic areas for this year:

Biogeochemical Cycling

- Submitted a manuscript to *Hydrobiologia* from 2011 mesocosm experiment looking at effects of sea-level rise (i.e., increased inundation) and saltwater intrusion (i.e., increased salinity) on mangrove soil carbon dynamics.
- Completed a pilot experiment in summer 2013 with live plant-soil experimental units, and data are being analyzed. Subsequent experiments for 2014+ are being planned.
- Kominoski trained an REU (Julio Pachon) and RET (Lisa Giles) in summer 2013, and manuscripts are being authored by both the REU and RET following the summer 2013 pilot experiment.
- Submitted a collaborative proposal to Florida Sea Grant to fund complementary field manipulations to be carried out in conjunction with FCE III mesocosm experiments and identified candidate field sites in Everglades National Park showing evidence of peat collapse from saltwater intrusion. We have preliminary news that this proposal will be funded.
- Continued core long-term biogeochemical data collection and analysis of trends in a spatio-temporal GIS framework coordinated with the Legacies CCT.

Primary Production

- Completed an experimental manipulation of phosphorus in a mangrove-plant soil system and began the development of plant-soil systems to begin salinity manipulations in 2014.
- Completed a FCE synthesis paper on integrated primary production data (Troxler et al. 2013).
- Completed a special issue of *Wetlands* highlighting long-term trends in primary production in TS/Ph.

- Completed the development of a light use efficiency model relating tower-based information to remote sensing data. Collaborators Fuentes and Barr led two REU students who examined the effect of inundation level on the carbon assimilation rates by red mangroves.
- Continued our long-term core dataset collection for periphyton, freshwater marsh, mangrove, marine macroalgae and seagrass communities.

Organic Matter Dynamics

- Statistically differentiated the relative abundance of DBC oxidation products (BPCAs) across seasons and sites.
- Identified similar BPCA signatures among Florida Bay, Shark Bay (Australia), and some geographically remote sites (i.e. Alaska glacier-fed rivers, Antarctic lakes).
- Long-term data showed that porewater residence time is higher in TS/Ph than SRS, due to more stagnant conditions that drive dissolved inorganic nitrogen and sulfide accumulation, while depressing redox state.
- Showed enrichment of phosphorus in porewater at SRS-6 due to deposition of marine mud from Hurricane Wilma in 2005.

Trophic Dynamics

- Determined the effect of extreme climate/weather events on community and population structure in the marsh and ecotone region.
- Developed a model of marsh and ecotone community structure and population densities under multiple scenarios of climate change.
- Synthesized data on individual specialization and consumer-mediated nutrient flow across east coast LTER sites.
- Conducted considerable public and K-12 outreach and professional development based on LTER science.

Hydrology and Water Policies

- Current water restoration efforts in TS/Ph have not increased surface water flows to the ecotone.
- The tidal flushing zone in SRS extends 2-3 km on both sides of tidal channels and can extend 3-4 km inland from the end of the channel.
- Uncertainties related to SLR pose a significant political challenge to water deliveries goals for Everglades National Park.

Carbon Dynamics

- Created models of the carbon budget for the Everglades and determined research needs
- Examined available data relative to carbon budget models and determined that FCE mangrove marshes and seagrass communities bury more carbon than most tropical ecosystems.
- Much of the uncertainty in carbon budgets is due to poor estimates of carbon transport. New FCE research has provided values for DOC and POC fluxes from SRS, and shows that POC export is similar to DOC export, but that the former is dominated by mangrove-derived material and the latter to freshwater production.

Climate and Disturbance Legacies

- Evaluated long-term legacy data which indicates greater temporal richness than spatial. Spatially explicit data integration is critical to enable spatiotemporal analysis of disturbance and land use impacts on ecohydrodynamics in FCE.
- Analyzed land use data on urban form and growth it indicate that zoning is a key driver of urban growth, but that its impacts vary across the study region. For instance, restrictive zoning does control the rate and extent of urban expansion, but it is less effective at stemming urban development in areas experiencing high development pressure.
- Biogeochemical segmentation of South Florida coastal and estuarine waters rendered forty four biogeochemically distinct water bodies whose spatial distribution is closely linked to geomorphology, circulation, benthic community pattern, and to water management.
- Analyzed the relationships between water flow and nutrient concentrations in TS/Ph to reveal patterns, relationships, and change points in otherwise noisy water quality and hydrologic data. Our research found important thresholds and defined changes in nutrient concentrations along discharge gradients.
- Analyzed long-term precipitation records to show a strong north–south gradient in the magnitude by which ENSO and the AMO regulate dry and wet season precipitation, respectively (Moses et al. 2012). Strong, positive teleconnections between these two climate drivers and South Florida hydrology have implications for longer-term paleoecological interpretations and future climate projections for the Greater Everglades ecosystem.

Modeling and Scenarios

- Gathered collective knowledge about plausible climate-change futures for south Florida.
- Improved our understanding of P dissolution/precipitation and desorption/adsorption in the bedrock underlying the coastal Everglades.
- Furthered mechanistic understanding of the characteristics of tide propagation up channels and into the surrounding and upgradient vegetated areas.
- Improved planning-level understanding of the potential effects of sulfate loading on the greater Everglades under plausible management scenarios.
- Developed the relationship between zoning and development in south Florida, and a mechanism for applying it to model LULC change in the greater metropolitan area.

What opportunities for training and professional development has the project provided?

FCE researchers are active members of the LTER Education and Communication Committee developing, coordinating, and implementing programs through participating in the development of the LTER Education Digital Library (LEDL) and offering a cross-site course for coastal Atlantic LTER graduate students. FCE Research Experience Programs (REP) are used to advance environmental knowledge/learning and provide programs for underrepresented minorities through formal and informal research internships.

FCE Education & Outreach has continued to recruit underrepresented minorities in our Research Experience Programs (REP) and specifically for RET, RAHSS, and REU positions. A total of

11 different research labs provided 33 semester units of formal research internships to 40 undergraduates and 16 high school students. The REP consists of students distributed across 11 institutions and although the majority of students are based at Florida institutions, diversity increased in FY6 to include participants from Massachusetts, Virginia, Louisiana, New York, and Pennsylvania.

FCE research was presented to 1,325 students including: 580 K-12; 594 undergraduates; and 151 graduate students in courses taught by FCE scientists. These students are distributed in 30 courses at 7 institutions.

FCE scientists created communication working group sessions at the LTER Site Communicator Training workshop, June 2013 at LNO, UNM, sharing FCE communication strategies.

FCE LTER Education & Outreach strengthened and expanded partnerships. In collaboration with the Deering Estate, the partnership leveraged an additional $31,000 through the My Community, Our Earth (MyCOE) project. MyCOE resulted in 75 informal research experiences for students and 6 classroom teachers from Felix Varela Senior High School. Deering staff and MyCOE participants produced 65 projects focused on the themes of: Environment; Food Security; and Climate. The MyCOE project presented FCE results and related topics 6,884 contacts in the classroom and through community events at the Deering Estate.

FCE continues to collaborate with the Deering Estate in developing "The Everglades Experience" and is currently monitoring aspects of the Cutler Slough Rehydration Project through our RET, REU, and RAHSS program.

How have the results been disseminated to communities of interest?

The broader impacts of FCE Education & Outreach are accomplished by serving as panelists on governmental and non-governmental organizations, reports to managers/decision makers, speaking directly to the community, and through our partnerships. This year, FCE added a communications team to further address objectives in the LTER Strategic Communication Plan (2010). Combined, these efforts have been instrumental in developing network and site level strategies for improving communication with policy makers, key constituent groups, and the south Florida community.

FCE researchers have continued to provide research and results to decision makers for use in shaping policy as panelists for the Everglades Foundation and the Environmental Protection Agency and through reports to the South Florida Water Management District and the South Florida Ecosystem Restoration Task Force.

The FCE Citizen Science program consists of two major initiatives: Predator Tracker and CAST. Introduced in as part of the Living in the Everglades exhibit at the Ft. Lauderdale Museum of Discovery and Science, Predator Tracker allows museum patrons and website visitors to track Everglades predators such as alligators and bull sharks. In 2013, FCE added the CAST: Coastal Anglers Science Team program, which has been developed as a collaboration between anglers and researchers as a means for understanding how changes in the Everglades impact coastal fisheries.

FCE research has been highlighted through several media outlets including the Wall Street Journal, Miami Herald, Science, All Things Considered and Radiolab on National Public Radio, Florida Wildlife Corridor Expedition on Public Broadcasting in Jacksonville, West Palm Beach, and Miami along with an episode of Coastal Carnivores and the National Geographic Website. FCE is also currently collaborating with the Tropical Botanic Artists on a Diatom project and will be similar in nature to the previous Marine Macroalgae: Hidden Colors of the Sea exhibit. In 2013, FCE has also partnered with Eco Artist Xavier Cortada on the Reclamation Project and Native Flags. The Reclamation Project was exhibited at NSF as part of the Ecological Reflections.

FCE researchers delivered 84 presentations in the community and as invited classroom guests.

The FCE LTER Program also reaches out to the public is through our web site (http://fcelter.fiu.edu/) and our web statistics show a steadily growing number of new web clients since the inception of the web site in 2001, suggesting a strong positive trajectory for our web-based public outreach. We've had 148,146 'Data' page visits made in 2012, up from 141,129 visits in 2011. Additionally, visitors to the data section of our website downloaded 357 datasets from September 26, 2012 thru July 19, 2013.

What do you plan to do during the next reporting period to accomplish the goals?

Biogeochemical Cycling: We will complete analysis of summer 2013 pilot experiment data, present results at the FCE All-Scientists Meeting in spring 2014, and submit manuscripts for publication shortly thereafter. A graduate student (Shelby Servais) and REU Pachon will present papers at international meetings in spring 2014. We will also be working with members from the Primary Productivity and Organic Matter Dynamics working groups on completing planning of mesocosm experiments beginning in 2014. This will involve planting and establishing mangrove propagules in field-collected soils and maintained under consistent conditions of salinity and water depth. Our first experiment, a 6-month experiment on the influence of red mangroves and salinity on carbon cycling rates and pathways in freshwater marsh peat soils, will commence in fall 2013. Data analysis is planned for summer 2013-2014 in preparation for presentations at national meetings and publications. This WG is establishing a plan for finalizing the design of future experiments for FCE III, including those associated with the new Florida Sea Grant. Mangrove seedlings were collected and will be grown in field-collected soil. These will be tended in separate tanks adjacent to the Key Largo Mesocosm Facility and maintained with ambient water from Florida Bay.

Primary Production: A key goal of the primary production working group is to integrate and synthesize primary production data to not only deduce the role of each primary producer but also identify we are attempting to deduce the role of periphyton in carbon budgets along the freshwater-marine continuum. For instance, periphyton production is an order of magnitude different using different methodological approaches. One goal is to compare field-based estimates to those obtained in the experimental mesocosms to help resolve the relative contribution of periphyton to carbon cycling. We will also begin plant-soil experiments to test the interactive effects of phosphorus, salinity and inundation on aboveground and belowground contributions to community dynamics and carbon cycling. New underwater ecosystem metabolism work in seagrass meadows is also anticipated. To address our second hypothesis, we will work with the FIU GIS center to employ WorldView imagery data to map freshwater marsh and mangrove plant communities and test relationships with spatial variation in soil water and surface water salinity in test areas of the FCE study area.

Trophic Dynamics: In 2013-2014 we will extend our long-term datasets on bull sharks, American alligators and consumer communities of the ecotone and marshes in order to understand the role of abiotic and biotic drivers in shaping these communities and the importance of acute environmental events and pulsed resources on food web and ecosystem dynamics. We will extend our use of satellite telemetry on American alligators and conduct trial deployments of animal-borne video units to better understand top-predator mediated linkages between the marsh and ecotone. Finally, we will identify locations and submit permit applications to initiate exclosure/enclosure studies.

Organic Matter Dynamics: The OM WG will continue studies of how surface water residence time influences DOM and POM transport and quality. We will collaborate with the biogeochemical cycling group on mesocosm studies to measure rates of peat collapse (or formation) under different salinity regimes, and their impact on changes in DOM and POM quality. We will continue to investigate the role of DBC in estuaries, particularly its use as a source tracer.

Hydrology and Water Policies: The effects of additional water restoration efforts on the water delivery to and the water quality in the mangrove ecotones of both SRS and TS/Ph will be investigated. We will combine ground based and satellite hydrological monitoring data with numerical hydrological models being developed for the ecotone. Ethnographic research on community understandings of climate change and the future of water will be analyzed to help us understand the politics of water management in our study site. PhD student, Suzana Mic, will complete her dissertation research that examines the ways South Florida water management agencies contend with conflicting forms of expertise related to climate change (academic science, techno-engineering, community activists).

Carbon Dynamics: We plan to continue collaborations to determine rates of DOC and POC transport so that estimates can be included in dynamic carbon budgets. We are improving our understanding of above- and below-ground contributions to production in both field and experimental settings. One of our major challenges has been understanding the importance of scale in carbon balance estimates. We are proceeding by developing large-scale estimates from by linking flux data to imagery. We are expanding our flux estimates by adding continuous measurements in Florida Bay and the TS/Ph ecotone. Funding is pending from a leveraged proposal for new towers in the SRS ecotone. Mechanistic experiments in the mesocosm facility and laboratory are helping to reveal sources contributions toward ecosystem metabolism at smaller scales.

Climate and Disturbance Legacies: We will continue the compilation of legacy biogeochemical and LULC datasets, and initiate trend analyses to identify key interactions. We hope to define critical tipping points or thresholds in relationships among land use and hydrological variables. These analyses will help identify the impacts of land use change and transitions on regional hydrology, characterize dominant causal processes behind long-term trends in water quantity and quality as a function of regional and local land use, and help inform integrated land use planning in the FCE.

Modeling and Scenarios: We will continue the development of the scenarios framework, P-transport modeling, and sediment-transport modeling while also adding new modeling efforts. We will begin the early stages of C-transport modeling by processing additional remote-sensing data to develop detailed maps of water level changes to serve as boundary conditions and to begin constructing the C-transport modeling using smooth particle hydrodynamics, a mesh-free Lagrangian method for simulating fluid flows. Our ELM modeling efforts will increasingly focus on the mangroves, with the highest priority being to calibrate-validate monthly- and seasonal-scale hydrologic and salinity fluxes, incorporating historical tidal, stage, and salinity data that has yet to be explicitly used in ELM within this subregion. Our LULC modeling will focus on expanding the LULC model of the Redlands to the entirely of the Miami-Dade County, and then linking modeled LULC change to projected water-use change.

Figures and Tables

Biogeochemical Cycling

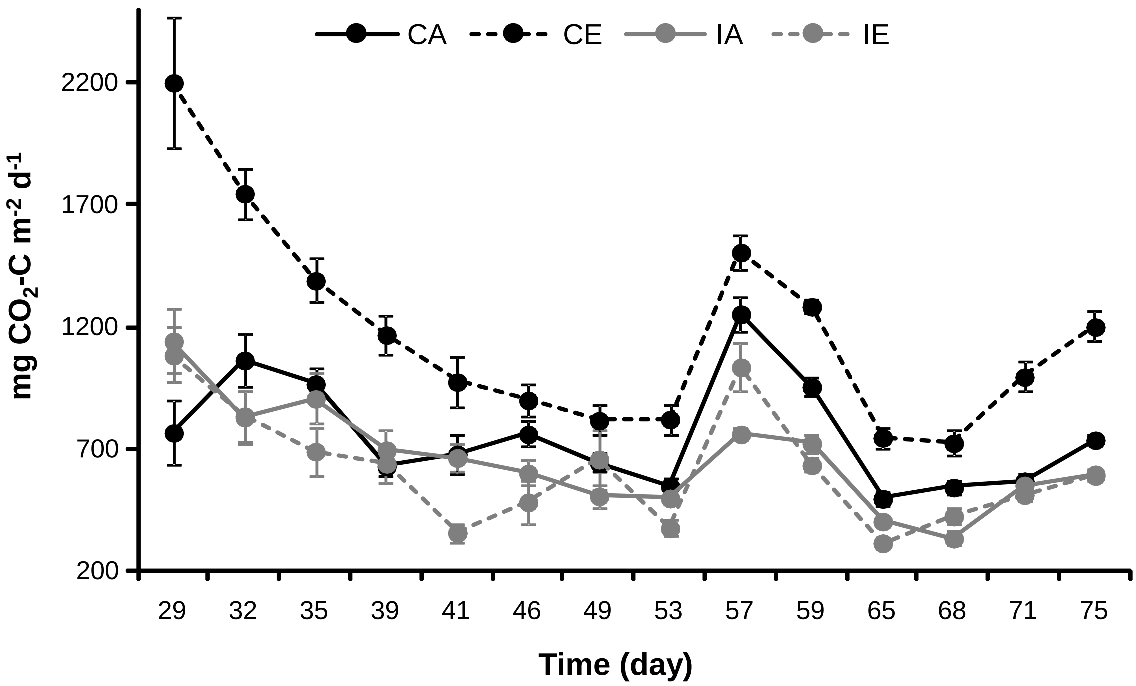

Figure 1: Data from experimental manipulation of salinity and inundation time on peat soil metabolism in the mesocosms at the Florida Bay Interagency Science Center. Daytime CO_2-C flux is depicted over time (days) according to treatment condition (C= control water level; I = inundated water level; A = ambient salinity (15-20 ppt); E = elevated salinity (30-35 ppt)). Points represent means and error bars represent standard error (n = 6 for each treatment combination). The data indicate that throughout a period of conditioning of soils under the same conditions (3 weeks) and ramping-up of salinity (1 week), there was a significant shift in CO_2 efflux from the control inundation, elevated salinity treatment (CE) relative to the other treatment combinations. This persisted for the duration of the experiment and indicates an effect of increasing salinity on the mangrove soil carbon balance at FCE estuarine ecotone sites.

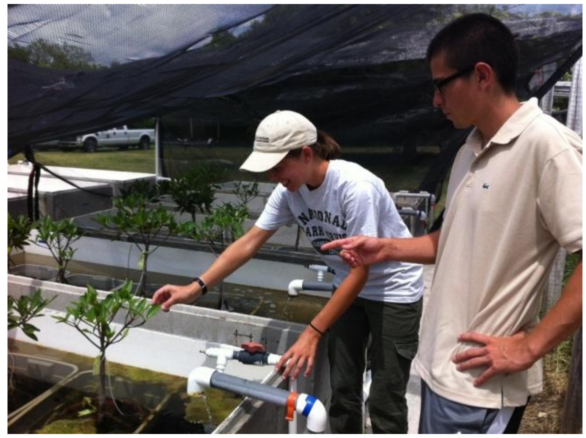

Figure 2: Left: Looking down one of the mesocosm tanks from the summer 2013 pilot experiment with live plant-soil experimental units. Note the presence of collars for CO_2 flux readings and sample tubes for porewater collection. Above: Graduate student Shelby Servais (left) and REU Julio Pachon (right) conducting their summer mesocosm research.

Primary Production

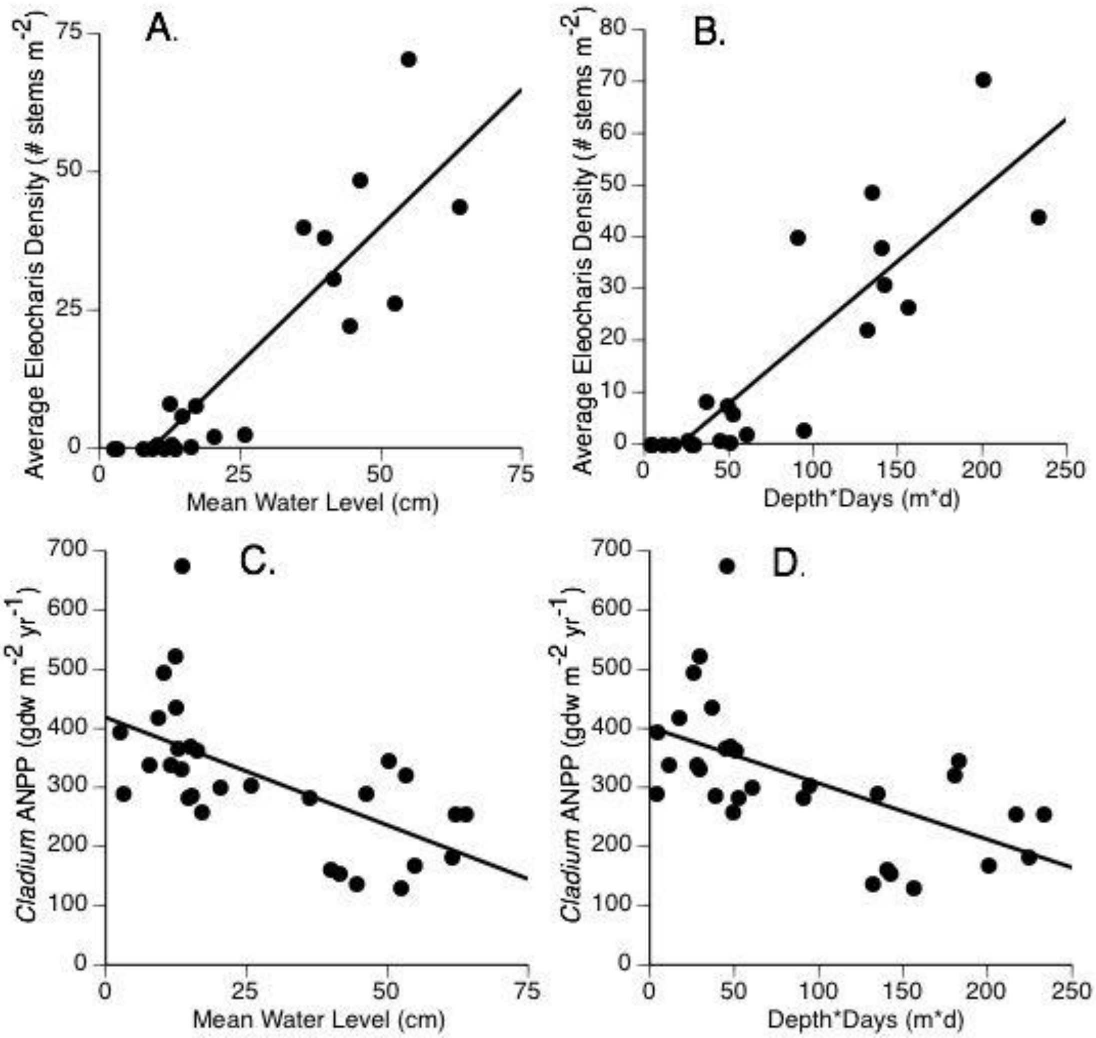

Figure 3: Synthesis of long-term macrophyte data in Taylor Slough resulted in several notable trends in two dominant species, *Cladium jamaicense* and *Eleocharis cellulose*, because of their relatively distinctive hydrologic tolerances. Regression models relating variation in (a) mean water level and (b) Depth*Days to *Eleocharis* stem density and (c) mean water level and (d) Depth*Days to *Cladium* ANPP. Spatial and temporal variability in primary production and species composition illustrate legacies of fresh and marine water supplies in the Taylor Slough watershed. We applied a best fit multivariate model which described 83% of the variation in a relationship of precipitation, freshwater discharge and number of high salinity days (>30ppt) on *Cladium* ANPP at TS/Ph 6 ecotone site. From Troxler et al. (2013, *Wetlands*).

Table 1: Periphyton biomass, accumulation rates on artificial substrates and metabolism values (Net Ecosystem Production (NEP), Ecosystem Respiration (ER), and Gross Primary Production (GPP)) in Shark River Slough (SRS) and Taylor Slough (TS) from long-term studies (means with standard deviation in parenthesis). If growth rates on artificial substrates are representative of natural mat accrual, extant periphyton mats represent from 3-16 years of accumulated organic carbon. In contrast, biological oxygen demand (BOD) methods suggest very high rates of NEP when expressed annually (270-780 g m^{-2} yr^{-1}), suggesting periphyton carbon turns over fully 3-5 times per year. Rates imply an autotrophic bias during the wet season capable of producing thick mat accumulations observed in flooded marsh (Troxler et al. 2013, *Oceanography*).

	Biomass Wet[a] (g C m^{-2})	Biomass Dry[a] (g C m^{-2})	Accumulation Rates[b] (g C m^{-2} yr^{-1})	Periphyton NEP[c] (g C m^{-2} yr^{-1})	Periphyton ER[c] (g C m^{-2} yr^{-1})	Periphyton GPP[c] (g C m^{-2} yr^{-1})
SRS	73 (21)	35 (10)	22 (11)	269 (212)	-106 (180)	375 (243)
TS	185 (22)	150 (59)	11 (7)	777 (423)	-103 (340)	881 (499)

[a] Calculated from 1-m^2 quadrats during annual visits to 40-70 sites during the wet season (Oct-Dec) and 4-26 sites during the dry season (Feb-Apr) from 2005-2011 (only sites >10 cm were sampled).
[b] Calculated from replicate sets of 20 glass slides incubated quarterly for 2 months in situ at LTER sites SRS 1-3 and TS/Ph 1-3 from 2001-2011.
[c] Calculated from wet season (Oct) periphyton accumulated after 2 months on glass slides and incubated for 4 hours in light and dark bottles from 2001-2011, using standard BOD methods for estimating aquatic C flux.

Organic Matter Dynamics

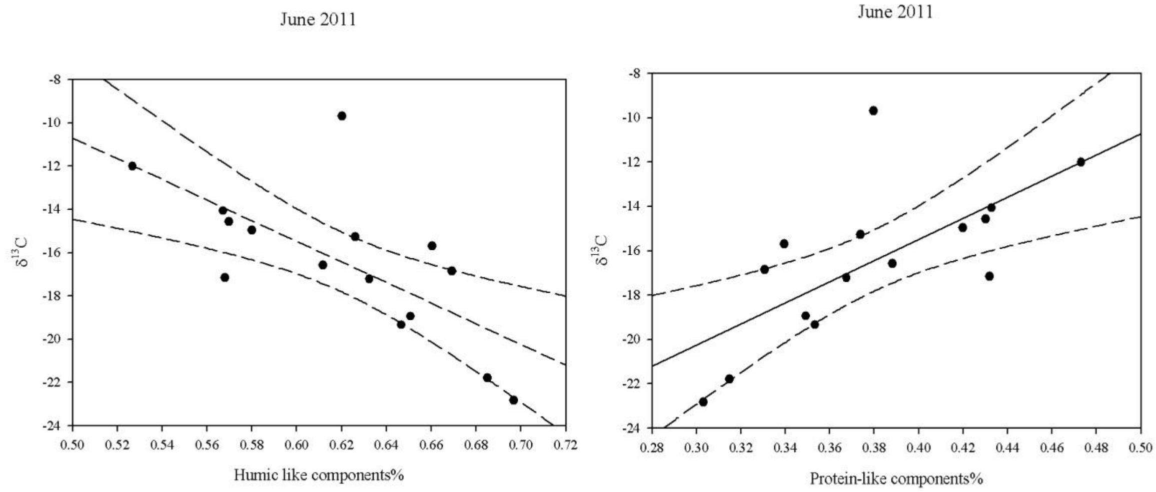

Figure 4: Significant negative correlations between humic-like components and $\delta^{13}C$ and positive correlations between protein-like fluorescence and $\delta^{13}C$ and ($p<0.5$), suggest that the former is derived from DOC exported from freshwater marshes and/or mangrove swamps (depleted isotopic signature), while the protein-like fluorescence is primarily derived from the seagrass communities (enriched isotopic signature).

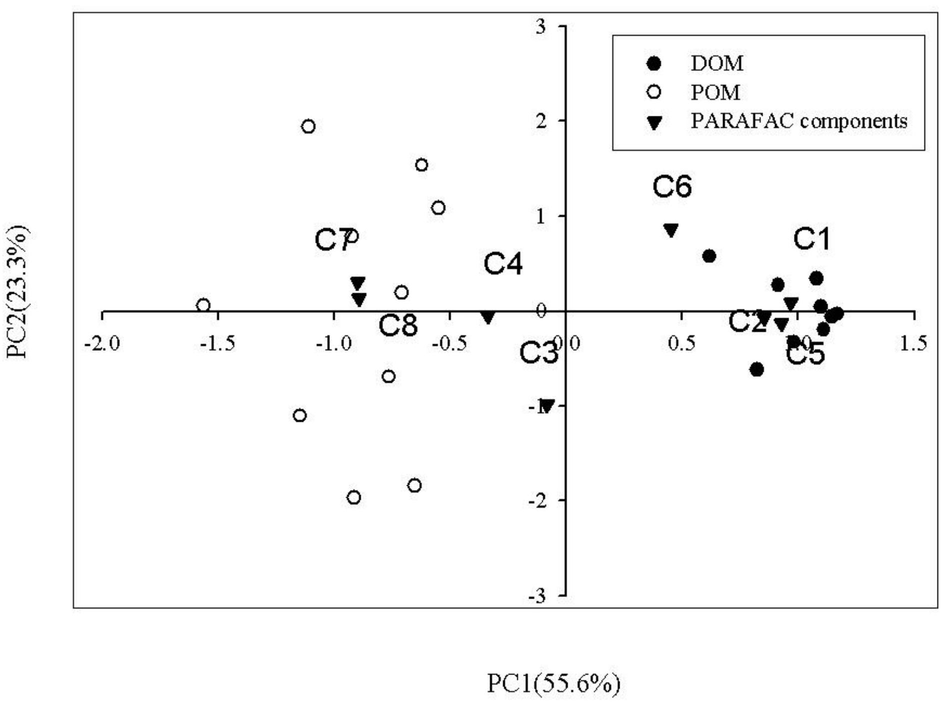

Figure 5: PCA plot of EEM-PARAFAC data for comparison between DOM and POM fluorescence in the Shark River estuary. Numbers indicate PARAFAC component loadings, where protein-like fluorescence (C7 and C8) and microbial humic-like fluorescence (C4) are enriched in the POM, while humic-like fluorescence (C1, C2, C5 and C6) is enriched in the DOM.

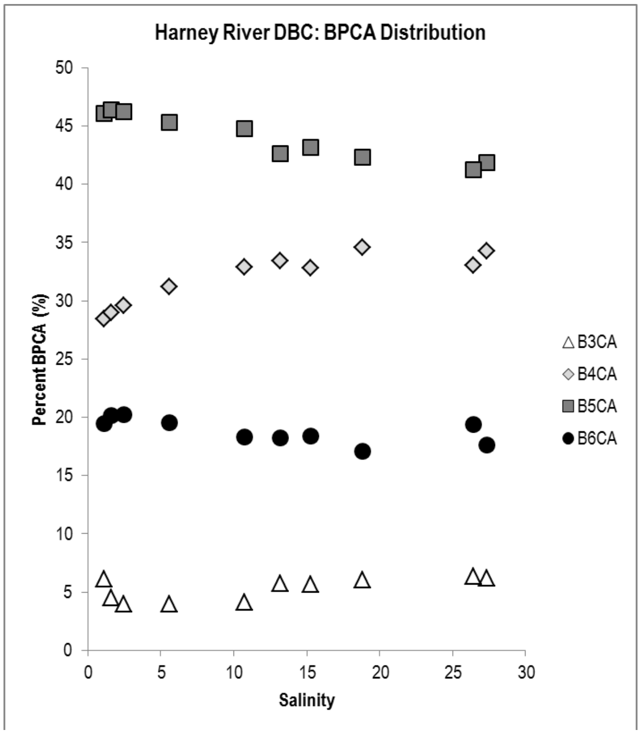

Figure 6: Dissolved black carbon (DBC) mixes more conservatively than bulk DOC within the Harney River estuary. The DBC molecular structure is more degraded at higher salinities suggesting that DBC is affected by photodegradative processes.

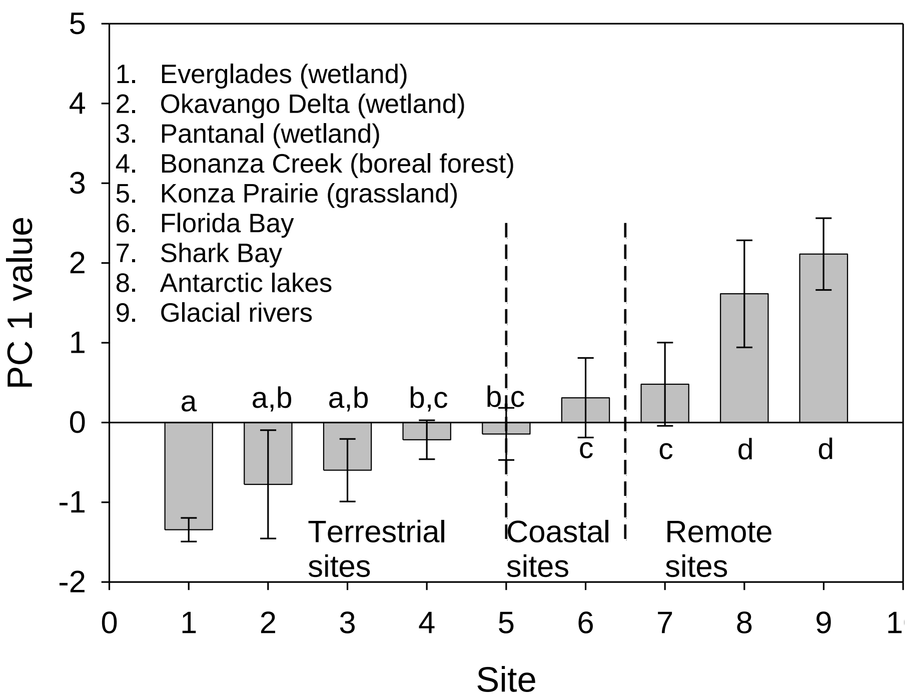

Figure 7: The average principal component 1 (PC1) values of samples from different environmental types. The error bar represents the standard deviation of PC1 values. Based on one-way ANOVA analysis ($\alpha = 0.05$).

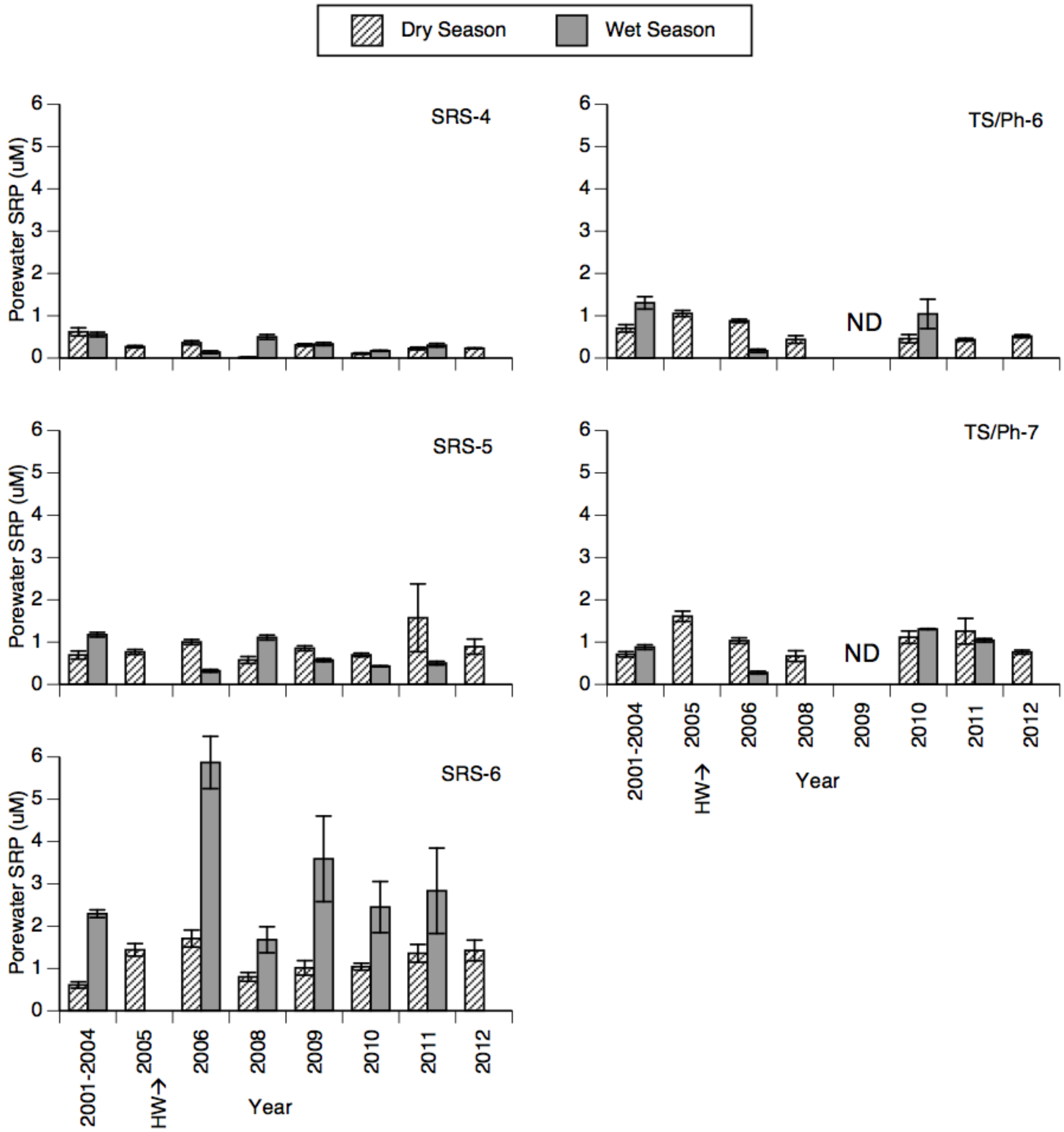

Figure 8: Spatial and seasonal variation in soluble reactive phosphorus (SRP) concentrations measured in mangrove sites of the Florida Coastal Everglades during the period 2001-2013 (ND = porewater analysis was not conducted, HW = Hurricane Wilma). Note that data are pooled for 2001-2004 prior to Hurricane Wilma. Notably, SRS-6 porewaters were relatively SRP enriched compared to all other sites and the marked increase in SRP concentration at SRS-6 in 2006 attributed to Hurricane Wilma.

Trophic Dynamics

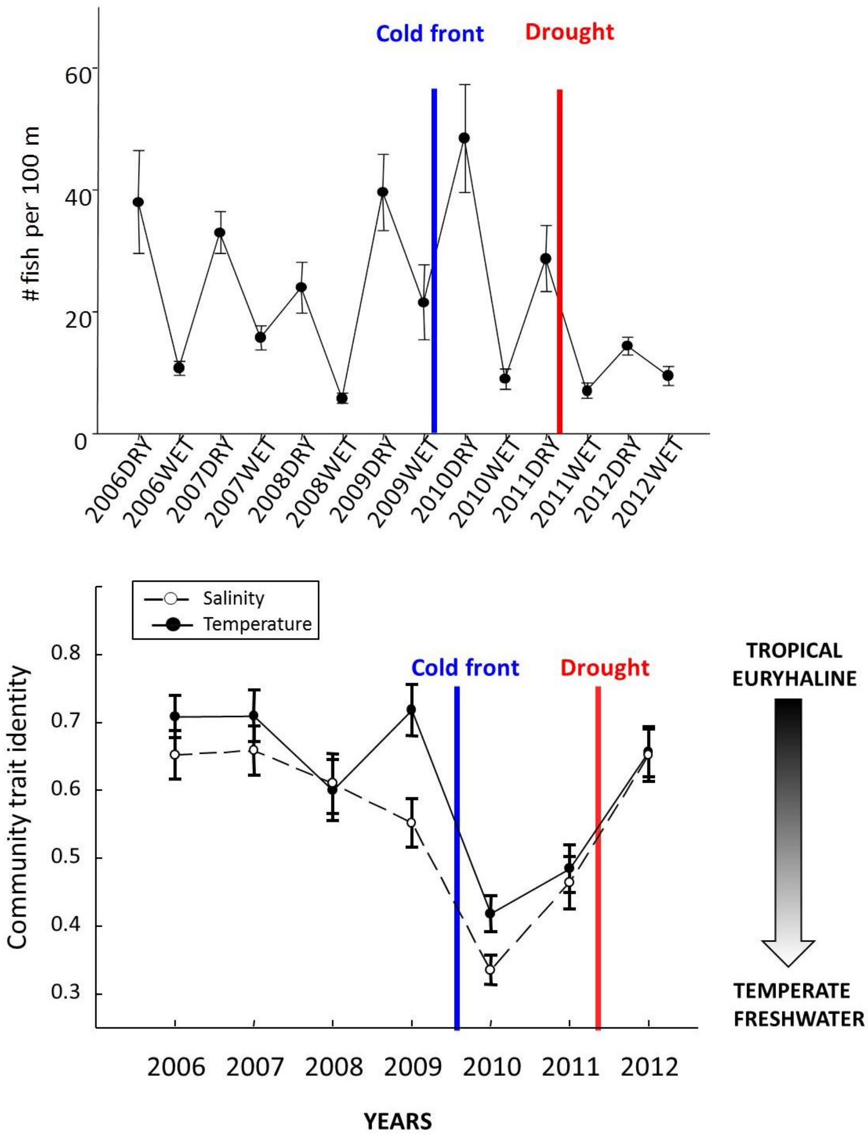

Figure 9: Patterns of ecotone fish abundance across years and seasons (combined early dry and late dry samples), and patterns of salinity and temperature trait identity across years, showing the effects of the 2010 cold front and the 2011 drought. The severe 2010 cold front had no major effect on total fish abundance, due to compensatory changes in composition, while the 2011 drought reduced fish abundance by over 60%. However, the cold front reduced the abundance of tropical euryhaline fishes, and shifted trait dominance of the community towards temperate freshwater species. Conversely, the 2011 drought reduced the abundance of temperate freshwater species, particularly the larger-body consumers, increasing the dominance of tropical euryhaline species, previously impacted and recovering from the cold front. This reorganization of the community resulting from both disturbances points to the importance of interspecific variation in functional traits, such as salinity and temperature tolerances, in driving responses to extreme events.

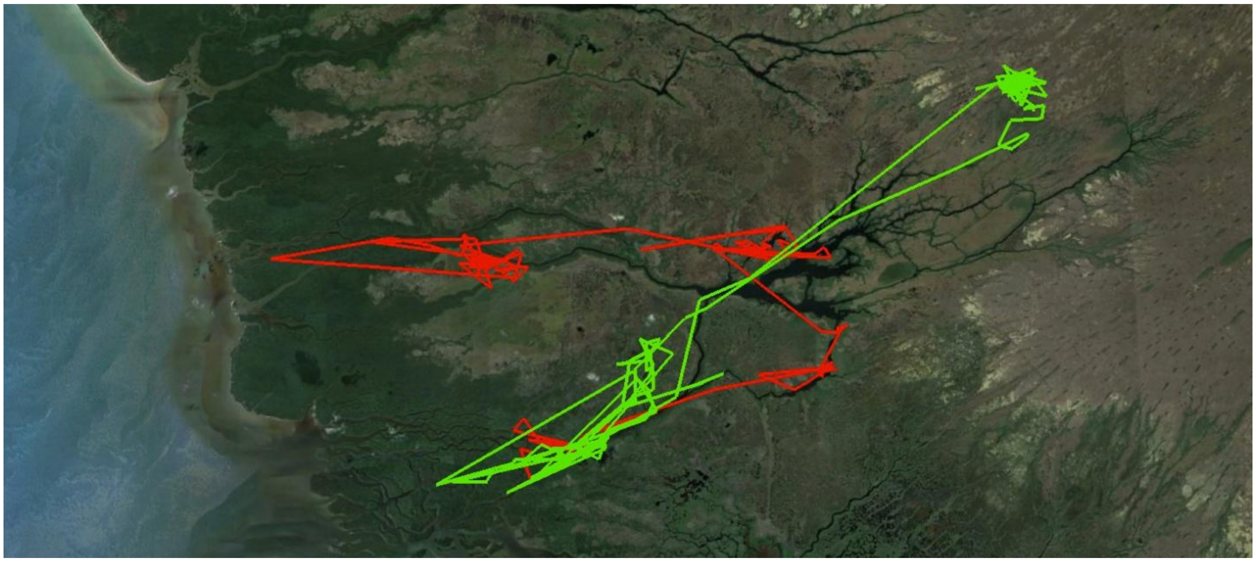

Figure 10: Studies of alligators have revealed that the level of individual specialization in trophic interactions varies among populations, with those in lakes displaying lower levels of specialization than those in estuarine systems. In the FCE, new tracking technologies have revealed even more axes of specialization in movements with some individuals commuting between marshes and the estuary more than previously documented. This figure shows movements of two American alligators based on satellite telemetry. Note one individual made extensive use of marsh habitats while the other remained largely in channels and estuarine waters.

Hydrology and Water Policies

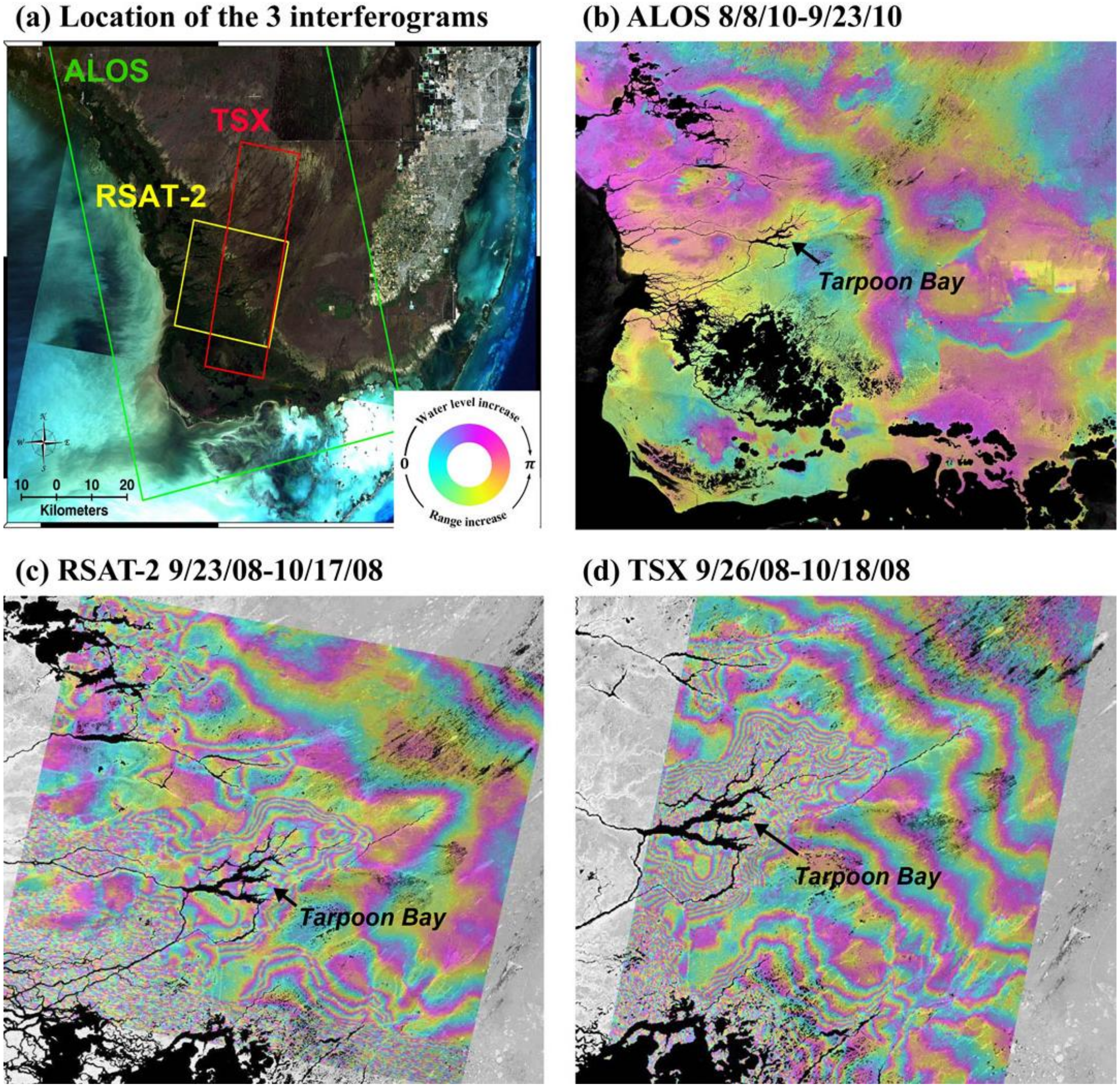

Figure 11: Satellite InSAR (Interferometric Synthetic Aperture Radar) data shows that the highest level of water level changes in Shark Slough occurs along tidal channels, reflecting a high velocity gradient between fast horizontal flow in the channel and the slow flow propagation through the vegetation. (a) Google earth's satellite image showing the location of the three satellite derived interferograms used in study area. (b) ALOS interferogram image showing a coherent fringe along the transition between fresh- and salt-water vegetation and partial fringe along the tidal channels. (c) Radarsat-2 interferogram showing short wavelength fringes surrounding tidal channels in the mangrove forest area. (d) TerraSAR-X interferogram showing a similar fringe patterns around the tidal channels. The different number of fringes in each interferogram reflects the sensitivity of each sensor to detect changes in surface water levels. Each ALOS (L-band) fringe reflects 15 cm of water level change, Radarsat-2 (C-band) 4 cm, and TerraSAR-X (X-band) 2 cm. From Wdowinski et al. (2013).

Carbon Cycling

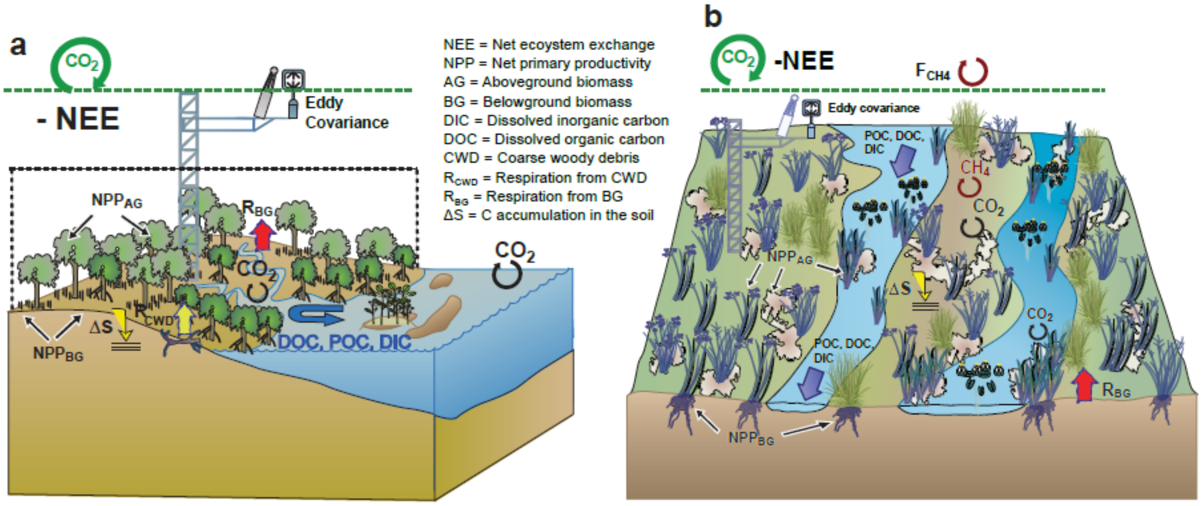

Figure 12: Balancing coastal Everglades ecosystem C budgets. Schematics showing CO2 uptake, transport, and storage (S) components and land-water-atmospheric fluxes that will be used to balance the FCE LTER site C budget. Existing eddy covariance towers in the Shark River Slough (SRS) riverine mangroves (A) and SRS and Taylor Slough/Panhandle (TS/Ph) marsh (B) will be supplemented by new towers in the TS/Ph dwarf mangroves and Florida Bay. Aboveground and belowground net primary production and ecosystem R are measured at all sites, and C flux research is being expanded to quantify lateral transport of DIC , DOC, and POC in Taylor and Shark Rivers. Storage is estimated using sediment elevation tables and dated sediment cores. By quantifying these parameters across a spatio-temporally variable template of fresh and marine water delivery, we can create dynamic C budgets to determine how changes in water supply influence the balance of C uptake, storage, and transport. Figure created by J. Barr in Troxler et al. (2013).

Table 2. Values for annual net ecosystem carbon balance (NECB), net ecosystem exchange (NEE), and derived aquatic carbon export calculated from FCE datasets. From Troxler et al. (2013).

		g C m^{-2} yr^{-1}					
Ecosystem	**Site**	**NECB**	**−NEE**	**Soil**	**AG**	**BG**	**Aq C Export**
Marsh	SRS	621 ± 59	−45 ± 16	90	291 ± 35	240 ± 48	666 ± 61
	TS	457 ± 61	50 ± 15	90	122 ± 12	245 ± 60	407 ± 63
Mangrove[¥]	SRS	1,038 ± 88	1,170 ± 127	194	638 ±36	206 ± 80	−131 ± 155
Seagrass	FL Bay				75 ± 40		

[¥] Mangrove root production estimates for size classes < 2 mm to 20 mm in diameter (to a depth of 90 cm).
AG = aboveground. BG = belowground. SRS = Shark River Slough. TS = Taylor Slough.

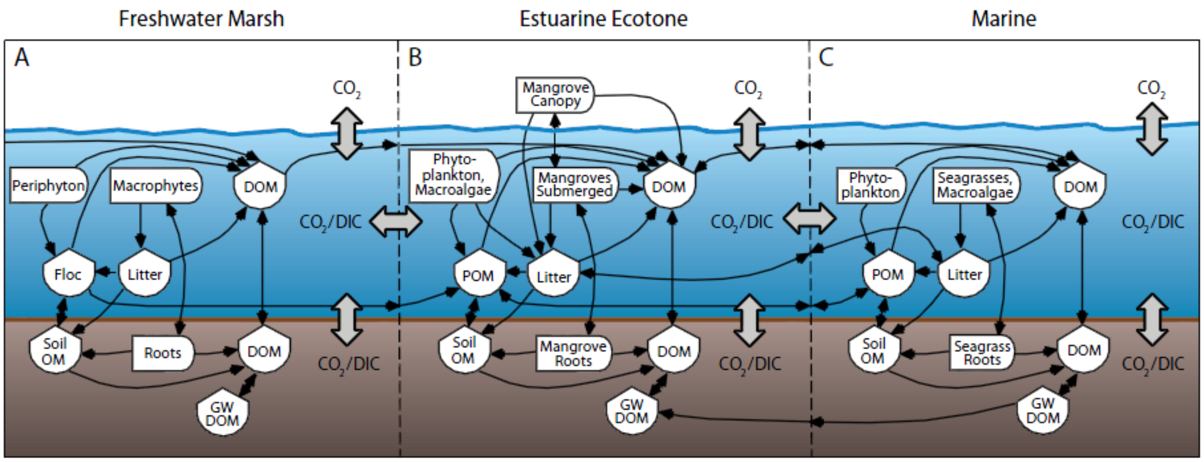

Figure 13: Conceptual model of organic matter (OM) compartments and fluxes, based on research conducted by the FCE. Both particulate organic matter (POM, as floc) and dissolved organic matter (DOM, derived from freshwater plant production) are delivered to the estuarine ecotone from upstream. Seagrass-derived litter, POM, and DOM are delivered to the ecotone from downstream. Hydrology and biogeochemical processing control the degradation and residence times of these C pools, and are not fully understood. Thus, whether these allochthonous sources of OM help to fuel the estuarine productivity peak remains to be determined. Although we have made great strides in understanding OM dynamics in the FCE, there are still many OM pools and pathways to investigate in the context of a dynamic south Florida hydroscape. Figure created by R. Chambers, R. Jaffe, and V. Rivera-Monroy in Troxler et al. (2013).

Climate and Disturbance Legacies

Table 4: Available land and actual urban growth under each zoning designation in Redland, 2001 to 2011. Zoning is a good predictor of LULC over a decadal time scale and therefore can be used to model short-term LULC change (Onsted and Chowdhury, in review).

	Developed (ha)	Available (ha)	Avg. Annual Growth Rate (% change)
All Redland	1,825	15,730	1.23
Lands zoned for Development	338	757	5.74
Lands zoned as Interim	677	6,342	1.12
Lands zoned for Agriculture	810	8,631	0.98

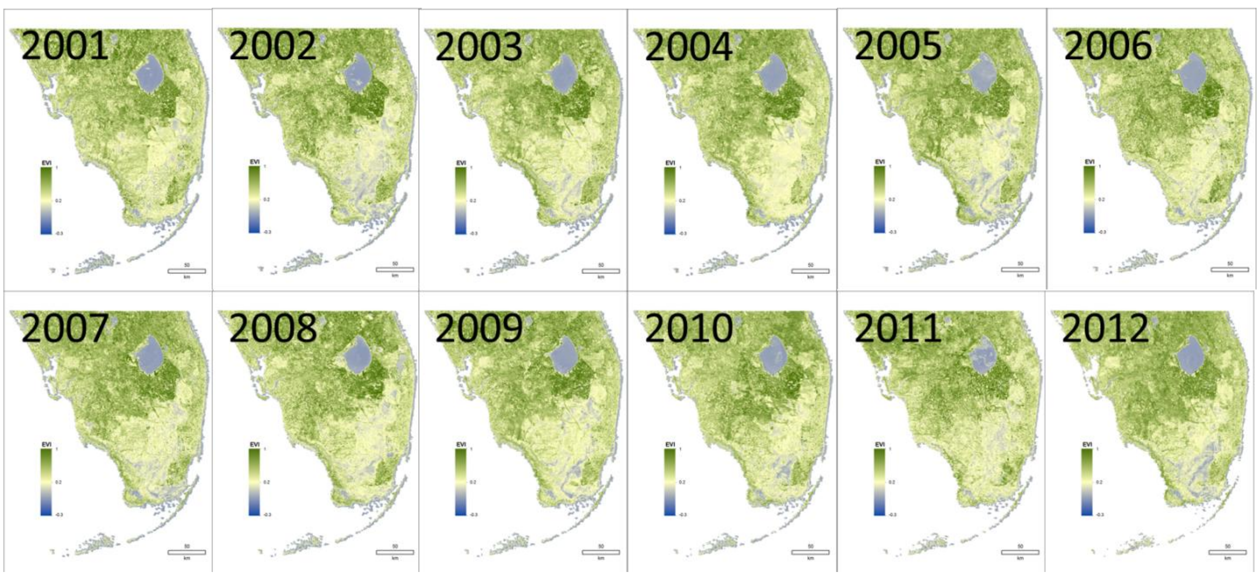

Figure 14: Coarse resolution MODIS derived Enhanced Vegetation Index, July 2001-2012 for the greater Everglades –South Florida land use gradient. This imagery reveals interannual changes in relative greenness over 2001-2012. Research on land use changes and urbanization indicates that land use zoning matters for urban development outcomes in FCE. For instance, zoning in 2001 is key to predicting current 2011 development patterns in the formerly agricultural Redlands community adjoining the FCE in southern Miami-Dade County. The effects of zoning are not spatially uniform, however, and vary by zone of development pressures. For instance, restrictively zoned lands (Agricultural and Interim zoning) within high growth pressure areas grew at a higher rate (50 to over 200%) than the same zoning categories in the overall Redlands region.

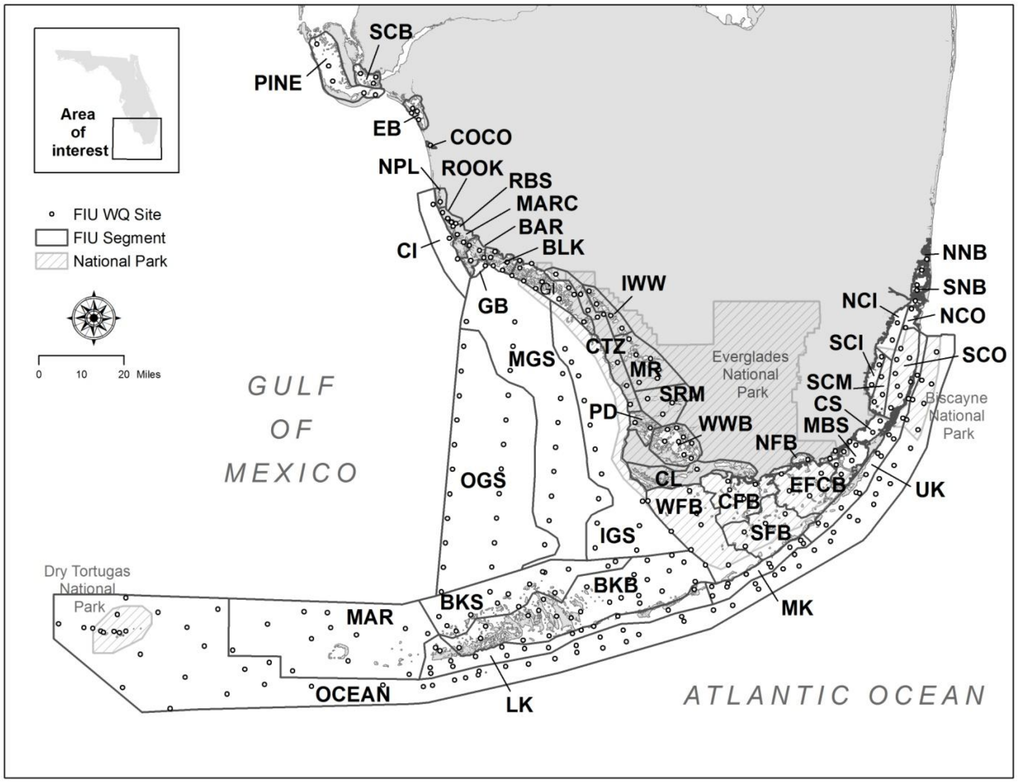

Figure 15: Biogeochemical segmentation of South Florida coastal and estuarine waters rendered forty four distinct water bodies whose spatial distribution is closely linked to geomorphology, circulation, benthic community pattern, and to water management. This segmentation has been adopted with minor changes by federal and state environmental agencies to derive numeric nutrient criteria. From Briceño et al. (2013).

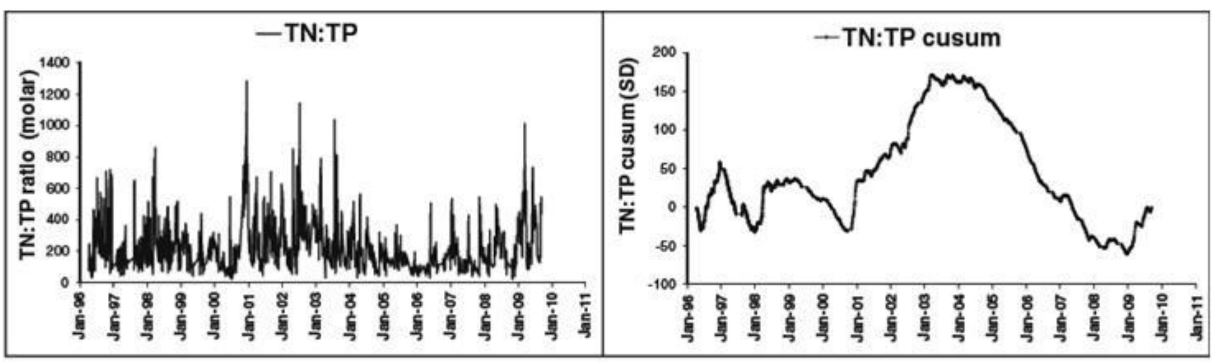

Figure 16: Time series and standardized cusum chart for the TN:TP ratio at the Taylor River mouth station. The dome-shaped line-plot indicates declining secular trend around 2004-2005 associated with strong hurricane seasons. Years with higher salinities were associated with higher TP concentrations. From Briceño et al. (2013).

Modeling and Scenarios

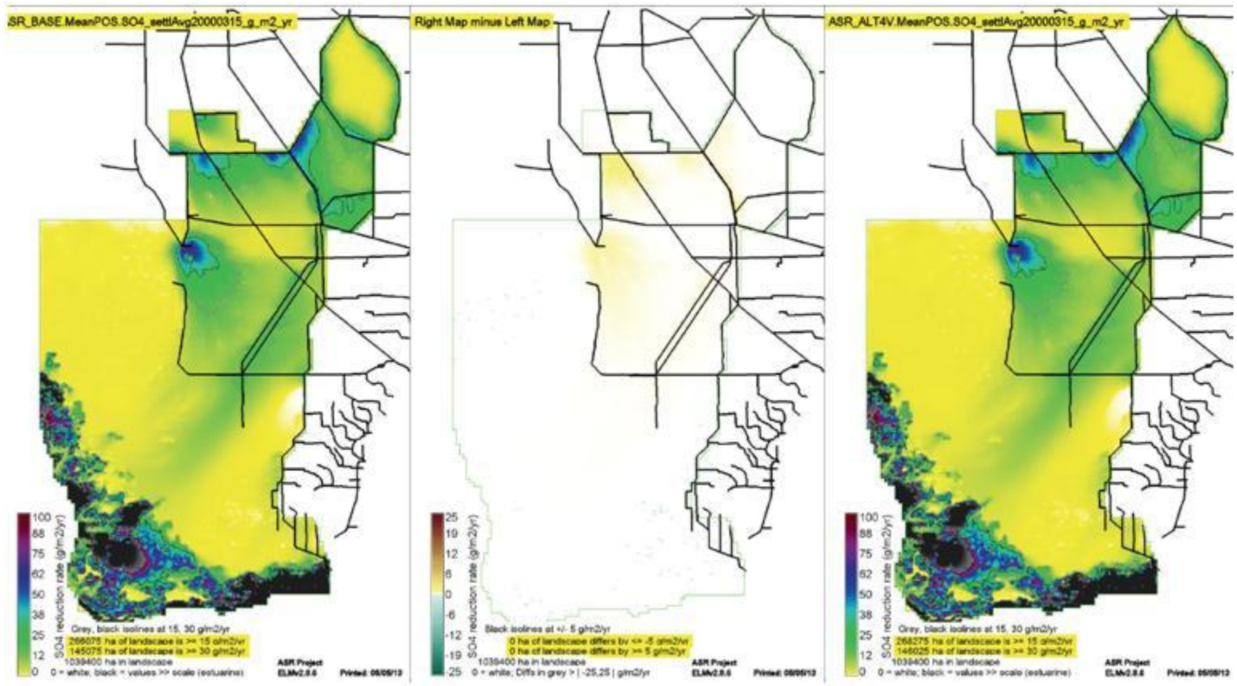

Figure 17: Sulfate concentrations in the greater Everglades for the baseline (left), a scenario (right), and the difference between the two (middle).

Products

Publications

Journal

Abbey-Lee, R., E.E. Gaiser, J.C. Trexler. 2013. Relative roles of dispersal dynamics and competition in determining the isotopic niche breadth of a wetland fish. Freshwater Biology 58: 780-792. DOI: 10.1111/fwb.12084

Aldwaik, S., R. G. Pontius, Jr., and J. Onsted. In Review. Sequential Land Category Aggregations to Maintain Maximum Change Over Time. Environmental Modeling and Software.

Anderson, W., E.E. Gaiser. 2013. Paleoenvironmental change in wetlands of the Florida Everglades, southeast USA. Journal of Paleolimnology 49(1): 1-3. DOI: 10.1007/s10933-012-9665-7

Apodaca, J.J., J.C. Trexler, N. Jue, M. Schrader, J. Travis. 2013. Large-scale natural disturbance alters genetic population structure of the sailfin molly, Poecilia latipinna. The American Naturalist 181: 254-263. DOI: 10.1086/668831

Barr, J.G., J.D. Fuentes, M.S. DeLonge, T.L. O'Halloran, D. Barr, J.C. Zieman. 2013. Summertime influences of tidal energy advection on the surface energy balance in a mangrove forest. Biogeosciences 10: 501-511. DOI: 10.5194/bgd-10-501-2013

Barr, J.G., V. Engel, J.D. Fuentes, D. Fuller, H.-H. Kwon. 2013. Modeling light use efficiency in a subtropical mangrove forest equipped with CO2 eddy covariance. Biogeosciences 10: 2145-2158. DOI: 10.5194/bg-10-2145-2013

Boucek, R., J.S. Rehage. 2013. No free lunch: displaced marsh consumers regulate a prey subsidy to an estuarine consumer. Oikos Early View: DOI: 10.1111/j.1600-0706.2013.20994.x.

Boucek, R., J.S. Rehage. 2013 (In Press). A tale of two fish: using recreational angler records to examine the link between fish catches and freshwater inflows in a subtropical mangrove estuary. Estuaries and Coasts

Bramburger, A., J. Munyon, E.E. Gaiser. 2013. Water Quality and Wet Season Diatom Assemblage Characteristics from the Tamiami Trail Pilot Swales Sites (Everglades National Park, Florida, USA). Phytotaxa 127: 163-182. DOI: 10.11646/phytotaxa.127.1.16

Briceno, H.O., G. Miller, S.E. Davis. 2013. Relating freshwater flow with estuarine water quality in the southern Everglades mangrove ecotone. Wetlands DOI: 10.1007/s13157-013-0430-0

Briceno, H.O., J.N. Boyer, J. Castro, P. Harlem. 2013 (In Press). Biogeochemical Classification of South Florida's Estuarine and Coastal Waters. Marine Pollution Bulletin DOI: 10.1016/j.marpolbul.2013.07.034

Campbell, J.E., J.W. Fourqurean. 2013. Effects of in situ CO2 enrichment on the structural and chemical characteristics of the seagrass Thalassia testudinum . Marine Biology 160(6): 1465-1475. DOI: 10.1007/s00227-013-2199-3

Cardona-Olarte, P., K.W. Krauss, R.R. Twilley. 2013. Leaf Gas Exchange and Nutrient Use Efficiency Help Explain the Distribution of Two Neotropical Mangroves under Contrasting Flooding and Salinity. International Journal of Forestry Research 2013: 524625. DOI: 10.1155/2013/524625

Castaneda-Moya, E., R.R. Twilley, V.H. Rivera-Monroy. 2013. Allocation of biomass and net primary productivity of mangrove forests along environmental gradients in the Florida Coastal Everglades, USA. Forest Ecology and Management 307: 226-241. DOI: 10.1016/j.foreco.2013.07.011

Cawley, K., Y. Yamashita, N. Maie, R. Jaffe. 2013. Using Optical Properties to Quantify Fringe Mangrove Inputs to the Dissolved Organic Matter (DOM) Pool in a Subtropical Estuary. Estuaries and Coasts DOI: 10.1007/s12237-013-9681-5

Chen, M., N. Maie, K. Parish, R. Jaffe. 2013. Spatial and temporal variability of dissolved organic matter quantity and composition in an oilgotrophic subtropical coastal wetland. Biogeochemistry DOI: 10.1007/s10533-013-9826-4

Ding, Y., Y. Yamashita, W. Dodds, R. Jaffe. 2013. Dissolved black carbon in grassland streams: Is there an effect of recent fire history? Chemosphere 90: 2557-2562. DOI: 10.1016/j.chemosphere.2012.10.098

Gaiser, E.E., P. Sullivan, F. Tobias, A. Bramburger, J.C. Trexler. 2013. Boundary effects on benthic microbial phosphorus concentrations and diatom beta diversity in a hydrologically-modified, nutrient-limited wetland. Wetlands DOI: 10.1007/s13157-013-0379-z

Giacomini, H.C., D.L. DeAngelis, J.C. Trexler, M. PetrereJr.. 2013. Trait contributions to fish community assembly emerge from trophic interactions in an individual-based model. Ecological Modelling 251: 32-43. DOI: 10.1016/j.ecolmodel.2012.12.003

Giblin, A.E., C.R. Tobias, B. Song, N. Weston, G.T. Banta, V.H. Rivera-Monroy. 2013. The importance of dissimilatory nitrate reduction to ammonium (DNRA) in the nitrogen cycle of coastal ecosystems. Oceanography 26: 124-131. DOI: 10.5670/oceanog.2013.54

Goss, C., W.F. Loftus, J.C. Trexler. 2013. Seasonal Fish Dispersal in Ephemeral Wetlands of the Florida Everglades. Wetlands DOI: 10.1007/s13157-013-0375-3

Green, T.W., D.H. Slone, E. Swain, M.S. Cherkiss, M. Lohmann, F.J. Mazzotti, K.G. Rice. 2013. Evaluating effects of Everglades restoration on American Crocodile populations in South Florida using a spatially-explicit, stage-based population model. Wetlands DOI: 10.1007/s13157-012-0370-0

Groffman, P.M., J.M. Cavender-Bares, N. Bettez, J.M. Grove, S.J. Hall, J. Heffernan, S.E. Hobbie, K. Larson, J.M. Morse, C. Neill, K.C. Nelson, J. O'Neil-Dunne, L.A. Ogden, D.E. Pataki, C. Polsky, R. Roy Chowdhury. 2013 (In Press). Ecological Homogenization of Urban America. Frontiers in Ecology and the Environment

Harrison, E., J. Lorenz, J.C. Trexler. 2013. Per Capita Effects of Non-native Mayan Cichlids (Cichlasoma urophthalmus; Gunther) on Native Fish in the Estuarine Southern Everglades. Copeia 2013: 80-96. DOI: 10.1643/CE-11-182

Jaffe, R., Y. Ding, J. Niggemann, A. Vahatalo, A. Stubbins, R.G.M. Spencer, J.L. Campbell, T. Dittmar. 2013. Global Charcoal Mobilization from Soils via Dissolution and Riverine Transport to the Oceans. Science 340: 345-347. DOI: 10.1126/science.1231476

Kline, J., W.F. Loftus, K. Kotun, J.C. Trexler, J.S. Rehage, J.J. Lorenz, M. Robinson. 2013. Recent Fish Introductions Into Everglades National Park: An Unforeseen Consequence of Water Management? Wetlands DOI: 10.1007/s13157-012-0362-0

Koch, G., S.E. Hagerthey, D.L. Childers, E.E. Gaiser. 2013. Examining seasonally pulsed detrital transport in the coastal Everglades using a sediment tracking technique. Wetlands DOI: 10.1007/s13157-013-0388-y

Kotun, K., A. Renshaw. 2013. Taylor Slough Hydrology, Fifty years of water management 1961-2010. Wetlands DOI: 10.1007/s13157-013-0441-x

Lee, S.S., E.E. Gaiser, J.C. Trexler. 2013. Diatom-based models for inferring hydrology and periphyton abundance in a subtropical karstic wetland: Implications for ecosystem-scale bioassessment. Wetlands 33: 157-173. DOI: 10.1007/s13157-012-0363-z

Lee, S.S., F. Tobias, B. Van de Vijver. 2013. Envekadea metzeltinii sp nov., a new diatom (Bacillariophyta) species from the subtropical karstic wetlands of the Florida Everglades, USA. Phytotaxa 115: 15-24. DOI: 10.11646/phytotaxa.115.1.2

Liu, K., H. Li, S.E. Davis. 2013. Benthic Exchange of C, N, and P Along the Estuarine Ecotone of Lower Taylor Slough, Florida (USA): Effect of Seasonal Flows and Phosphorus Availability. Wetlands DOI: 10.1007/s13157-013-0431-z

Lorenz, J.J.. 2013. A Review of the Effects of Altered Hydrology and Salinity on Vertebrate Fauna and Their Habitats in Northeastern Florida Bay. Wetlands DOI: 10.1007/s13157-013-0377-1

Lorenz, J.J.. 2013. The Relationship Between Water Level, Prey Availability and Reproductive Success in Roseate Spoonbills Foraging in a Seasonally-Flooded Wetland While Nesting in Florida Bay. Wetlands DOI: 10.1007/s13157-012-0364-y

Lu, Y., J.E. Bauer, E.A. Canuel, R.M. Chambers, R. Jaffe. 2013. Photochemical and microbial alteration of dissolved organic matter in temperate headwater streams associated with different land use. Journal of Geophysical Research 118(2): 566-580. DOI: 10.1002/jgrg.20048

Malone, S.L., G. Starr, C. Staudhammer, M.G. Ryan. 2013. Effects of simulated drought on the carbon balance of Everglades short-hydroperiod marsh. Global Change Biology 19: 2511-2523. DOI: 10.1111/gcb.12211

Matich, P., M.R. Heithaus. 2013. Multi-tissue stable isotope analysis and acoustic telemetry reveal seasonal variability in the trophic interactions of juvenile bull sharks in a coastal estuary. Journal of Animal Ecology DOI: 10.1111/1365-2656.12106

Moses, C., W.T. Anderson, C.J. Saunders, F.H. Sklar. 2013. Regional climate gradients in precipitation and temperature in response to climate teleconnections in the Greater Everglades ecosystem of South Florida. Journal of Paleolimnology 49(1): 5-14. DOI: 10.1007/s10933-012-9635-0

Ogden, L.A., N. Heynen, U. Oslender, P. West, K. Kassam, P. Robbins. 2013 (In Press). Place, Equity and Earth Stewardship in the Anthropocene. Frontiers in Ecology and the Environment

Onsted, J., and R. Roy Chowdhury. In Review. Does zoning matter? A comparative analysis of landscape change in Redland, Florida using the SLEUTH model. Landscape and Urban Planning.

Osborne, T.Z., K.R. Reddy, L.R. Ellis, N. Aumen, D.D. Surratt, M.S. Zimmerman, J. Sadle. 2013. Evidence of Recent Phosphorus Enrichment in Surface Soils of Taylor Slough and Northeast Everglades National Park. Wetlands DOI: 10.1007/s13157-013-0381-5

Pearce, C., H. Cremer, E. Lammertsma, F. Wagner-Cremer. 2013. A 2,500-year record of environmental change in Highland Hammock State Park (Central Florida, U.S.A.) inferred from siliceous microfossils. Journal of Paleolimnology 49(1): 31-43. DOI: 10.1007/s10933-011-9557-2

Pickett, S.T.A., C.G. Boone, B.P. McGrath, M.L. Cadenasso, D.L. Childers, L.A. Ogden, M. McHale, J.M. Grove. 2013 (In Press). Ecological Science and Transformation to the Sustainable City. Cities DOI: 10.1016/j.cities.2013.02.008

Pisani, O., William J. Louda, R. Jaffe. 2013. Biomarker assessment of spatial and temporal changes in the composition of flocculent material (floc) in the subtropical wetland of the Florida Coastal Everglades. Environmental Chemistry DOI: 10.1071/EN13062

Platt, S.G., R.M. Elsey, H. Liu, T.R. Rainwater, J. Nifong, A.E. Rosenblatt, M.R. Heithaus, F.J. Mazzotti. 2013. Frugivory and seed dispersal by crocodilians: an overlooked form of saurochory? Journal of Zoology DOI: 10.1111/jzo.12052

Quillen, A., E.E. Gaiser, E. Grimm. 2013. Diatom-based paleolimnological reconstruction of regional climate and local land-use change from a protected sinkhole lake in southern Florida, U.S.A. . Journal of Paleolimnology 49(1): 15-30. DOI: 10.1007/s10933-011-9558-1

Rehage, J.S., R. Boucek, E. Cline, M.I. Cook, R.M. Kobza, A.K. Saha. 2013. Turning passive detection systems into field experiments: an application using wetland fishes and enclosures to track fine-scale movement and habitat choice. Acta Ethologica DOI: 10.1007/s10211-013-0154-4

Rehage, J.S., S.E. Liston, K.J. Dunker, W.F. Loftus. 2013. Fish Community Responses to the Combined Effects of Decreased Hydroperiod and Nonnative Fish Invasions in a Karst Wetland: Are Everglades Solution Holes Sinks for Native Fishes? Wetlands DOI: 10.1007/s13157-012-0361-1

Robertson, B.A., J.S. Rehage, A. Sih. 2013. Ecological novelty and the emergence of evolutionary traps. Trends in Ecology & Evolution DOI: 10.1016/j.tree.2013.04.004

Rosenblatt, A.E., M.R. Heithaus. 2013. Slow isotope turnover rates and low discrimination values for three tissues in the American alligator: implications for interpretation of ectotherm stable isotope data. Physiological and Biochemical Zoology 86: 137-148. DOI: 10.1086/668295

Rosenblatt, A.E., M.R. Heithaus, M.E. Mather, P. Matich, J. Nifong, W.J. Ripple, B. Silliman. 2013. The roles of large top predators in coastal ecosystems: New insights from long term ecological research. Oceanography 26: 156-167. DOI: 10.5670/oceanog.2013.59

Ross, M.S., J.P. Sah, J.F. Meeder, P.L. Ruiz, G.J. Telesnicki. 2013. Compositional Effects of Sea-Level Rise in a Patchy Landscape: The Dynamics of Tree Islands in the Southeastern Coastal Everglades. Wetlands DOI: 10.1007/s13157-013-0376-2

Ruehl, C., J.C. Trexler. 2013. A suite of prey traits determine predator and nutrient enrichment effects in a tri-trophic food web. Ecosphere 4: 75. DOI: 10.1890/ES13-00065.1

Sah, J.P., M.S. Ross, S. Saha, P.R. Minchin, J. Sadle. 2013. Trajectories of Vegetation Response to Water Management in Taylor Slough, Everglades National Park, Florida. Wetlands DOI: 10.1007/s13157-013-0390-4

Sanchez, C., E.E. Gaiser, C.J. Saunders, A. Wachnicka, N. Oehm. 2013. Challenges in using siliceous subfossils as a tool for inferring past water level and hydroperiod in Everglades marshes. Journal of Paleolimnology 49(1): 45-66. DOI: 10.1007/s10933-012-9624-3

Smoak, J.M., J.L. Breithaupt, T.J. Smith, C.J. Sanders. 2013. Sediment accretion and organic carbon burial relative to sea-level rise and storm events in two mangrove forests in Everglades National Park. Catena104: 58-66. DOI: 10.1016/j.catena.2012.10.009

Sokol, E.R., J.M. Hoch, E.E. Gaiser, J.C. Trexler. 2013. Metacommunity structure along resource and disturbance gradients in Everglades wetlands. Wetlands DOI: 10.1007/s13157-013-0413-1

Suarez-Abelenda, M., T. O Ferreira, M. Camps-Arbestain, V.H. Rivera-Monroy, F. Macias, G.N. Nobrega, X.L. Otero. 2012 (In Press). The impact of shrimp farm effluents on the soil carbon storage and the geochemistry of mangrove soils under semi-arid climate conditions in northern Brazil. Geoderma

Sullivan, P., R.M. Price, F. Miralles-Wilhelm, M.S. Ross, L.J. Scinto, T.W. Dreschel, F.H. Sklar, E. Cline. 2012 (In Press). The role of recharge and evapotranspiration as hydraulic drivers of ion concentrations in shallow groundwater on Everglades tree islands, Florida (USA). Hydrological Processes DOI: 10.1002/hyp.9575

Sullivan, P., R.M. Price, J. Schedlbauer, A.K. Saha, E.E. Gaiser. 2013. The influence of hydrologic restoration on groundwater-surface water interactions in a karst wetland, the Everglades (FL, USA). Wetlands DOI: 10.1007/s13157-013-0451-8

Sullivan, P., V. Engel, M.S. Ross, R.M. Price. 2013. The influence of vegetation on the hydrodynamics and geomorphology of a tree island in Everglades National Park (Florida, United States). Ecohydrology. DOI: 10.1002/eco.1394

Troxler, T., D.L. Childers, C.J. Madden. 2013. Drivers of Decadal-Scale Change in Southern Everglades Wetland Macrophyte Communities of the Coastal Ecotone. Wetlands DOI: 10.1007/s13157-013-0446-5

Troxler, T., E.E. Gaiser, J.G. Barr, J.D. Fuentes, R. Jaffe, D.L. Childers, L. Collado-Vides, V.H. Rivera-Monroy, E. Castaneda-Moya, W.T. Anderson, R.M. Chambers, M. Chen, C. Coronado-Molina, S.E. Davis, V. Engel, C. Fitz, J.W. Fourqurean, T.A. Frankovich, J. Kominoski, C.J. Madden, S.L. Malone, S. Oberbauer, P.C. Olivas, J.H. Richards, C.J. Saunders, J. Schedlbauer, L.J. Scinto, F.H. Sklar, T.J. Smith, J.M. Smoak, G. Starr, R.R. Twilley, K.R.T. Whelan. 2013. Integrated carbon budget models for the Everglades terrestrial-coastal-oceanic gradient: current status and needs for inter-site comparisons. Oceanography 26: 98-107. DOI: 10.5670/oceanog.2013.51

Varela-Margolles, A. and J. Onsted. In Review. Do Incentives work? Analysis of Solar Energy Adoption in Miami-Dade County. Southeastern Geographer.

Wachnicka, A., E.E. Gaiser, L. Collins. 2013. Correspondence of historic salinity fluctuations in Florida Bay, USA, to atmospheric variability and anthropogenic changes . Journal of Paleolimnology 49(1): 103-115. DOI: 10.1007/s10933-011-9534-9

Wachnicka, A., E.E. Gaiser, L. Wingard, H.O. Briceno, P. Harlem. 2013. Impact of late Holocene climate variability and anthropogenic activities on Biscayne Bay (Florida, U.S.A): evidence from diatoms. Palaeogeography, Palaeoclimatology, Palaeoecology 371: 80-92. DOI: 10.1016/j.palaeo.2012.12.020

Wachnicka, A., L. Collins, E.E. Gaiser. 2013. Response of diatom assemblages to 130 years of environmental change in Florida Bay (USA) . Journal of Paleolimnology 49(1): 83-101. DOI: 10.1007/s10933-011-9556-3

Waters, M.N., J.M. Smoak, C.J. Saunders. 2013. Historic primary producer communities linked to water quality and hydrologic changes in the northern Everglades. Journal of Paleolimnology 49(1): 67-81. DOI: 10.1007/s10933-011-9569-y

Wdowinski, S., S.-H. Hong, A. Mulcan, B. Brisco. 2013. Remote-Sensing Monitoring of Tide Propagation Through Coastal Wetlands. Oceanography 26: 64-69. DOI: 10.5670/oceanog.2013.46

Yamashita, Y., J.N. Boyer, R. Jaffe. 2013 (In Press). Evaluating the distribution of terrestrial dissolved organic matter in a complex coastal ecosystem using fluorescence spectroscopy. Continental Shelf Research DOI: 10.1016/j.csr.2013.06.010

Yurek, S., D.L. DeAngelis, J.C. Trexler, F. Jopp, D.D. Donalson. 2013. Simulating mechanisms for dispersal, production and stranding of small forage fish in temporary wetland habitats. Ecological Modelling 250: 391-401. DOI: 10.1016/j.ecolmodel.2012.11.001

Book Chapters

Rivera-Monroy, V.H., E. Castaneda-Moya, J.G. Barr, V. Engel, J.D. Fuentes, T. Troxler, R.R. Twilley, S. Bouillon, T.J. Smith, T.L. O'Halloran. 2013. Current Methods to Evaluate Net Primary Production and Carbon Budgets in Mangrove Forests . In Delaune, R.D., K.R. Reddy, P. Megonigal, C. Richardson (eds.) Methods in Biogeochemistry of Wetlands. Soil Science Society of America Book Series.

Conference Papers and Presentations

Boucek, R. and J.S. Rehage (2013). The power of the 1%: interactive impacts of extreme and episodic disturbances drive unexpected changes to mangrove fish communities. 33rd Annual Meeting of the Florida Chapter American Fisheries Society. Altoona, Florida.

Bush, M.R. and J.C. Trexler (2013). Variation in movement strategies of small fishes in a dynamic wetland. Ecological Society of America 98th Annual Meeting. Minneapolis, Minnesota.

Briceno, H.O. and J.N. Boyer (2013). Derivation of Protective Numeric Nutrient Criteria for Biscayne Bay Waters. Biscayne National Park Science Symposium. Biscayne National Park. Status = PUBLISHED; Acknowledgement of Federal Support = No

Cattelino, J. (2013). Ecosystems Services Valuation and the Measurement of Nature's Value. Conference on Global Ecologies: Nature/Narrative/Neoliberalism. UCLA, Los Angeles, California.

Collado-Vides, L., A. Perez, and J.W. Fourqurean (2013). Halimeda dynamics relative to nutrients availability in the Florida keys and Florida bay: a good indicator of C production. 36th Conference of the Association of Marine Laboratories of the Caribbean. Discovery Bay, Jamaica.

Gaiser, E.E. (2013). Commonalities in the diatom flora and benthic habitat structure of Caribbean karst and Canadian alvar wetlands. North American Diatom Symposium. Bar Harbor, Maine.

Gaiser, E.E., A. Quillen, and H. Swain (2013). Combining long-term observational and paleolimnological records to distinguish climate from local land use signals in a reference watershed. ASLO 2013 Aquatic Sciences Meeting. New Orleans, Louisiana.

Gandy, D.A. and J.S. Rehage (2013). Nonnative Fishes in Freshwater Canals of the Florida Everglades: Implications for Better Management. 33rd Annual Meeting of the Florida Chapter American Fisheries Society. Altoona, Florida.

Gehring, J. and S. Koptur (2013). Effects of Fragmentation, Fire Regime, and Landscape Position on the Vegetation and Insect Metacommunity Dynamics of Pine Rockland Sub-Tropical Forests. Botany 2013. New Orleans, Louisiana.

Harrison, E., J.C. Trexler, and T.M. Collins (2013). Introduction sources and population genetics of Cichlasoma urophthalmus (Mayan cichlids) in South Florida. Ecological Society of America 98th Annual Meeting. Minneapolis, Minnesota.

He, D., R.N. Mead, L. Belicka, and R. Jaffe (2013). Assessing Particulate Organic Matter Dynamics in a Subtropical Estuary: A Biomarker Approach. ASLO 2013 Aquatic Sciences Meeting. New Orleans, Louisiana.

Jaffe, R., K. Cawley, and Y. Yamashita (2013). Determining Optical Properties to Quantify CDOM and FDOM Contributions from Fringe Mangroves in a Sub-Tropical Estuary. ASLO 2013 Aquatic Sciences Meeting. New Orleans, Louisiana.

Jones, I. (2013). Temporal and developmental changes in extrafloral nectar production in Senna mexicana var. chapmanii: is extrafloral nectar an inducible defense?. Botany 2013. New Orleans, Louisiana.

Lagomasino, D. and R.M. Price (2013). Tracing coastal and estuarine groundwater discharge sources in a complex faulted and fractured karst aquifer system. American Geophysical Union Meeting of the Americas. Cancun, Mexico.

Lee, J. and J.S. Rehage (2013). Using mark-recapture techniques to evaluate recreational fisheries across hydrological seasons. 33rd Annual Meeting of the Florida Chapter American Fisheries Society. Altoona, Florida.

Lee, S.S. and E.E. Gaiser (2013). Morphology and typification of Mastogloia smithii and M. lacustris with the description of two new species from the Florida Everglades and the Caribbean Region. North American Diatom Symposium. Bar Harbor, Maine.

Lee, S.S. and E.E. Gaiser (2013). Envekadea metzeltinii sp. nov. from karstic wetlands of the Florida Everglades and the Yucatan, Mexico. North American Diatom Symposium. Bar Harbor, Maine.

Lee, S.S., E.E. Gaiser, and J.C. Trexler (2013). Diatom-Based Models for Inferring Hydrology and Periphyton Abundance in a Subtropical Freshwater Marsh: Implications for Ecosystem-Scale Bioassessment. Society for Freshwater Science 2013 Annual Meeting. Jacksonville, Florida.

Mayo, M., J.M. Smoak, C.G. Smith, T.J. Smith, and K. Fanning (2013). A Comparison of Uranium Budgets for Estuarine Wetlands of the Everglades National Park, Florida and Mobile Bay, Alabama. ASLO 2013 Aquatic Sciences Meeting. New Orleans, Louisiana.

Nodine, E. and E.E. Gaiser (2013). Diatom community assemblage changes following Tropical Storm Debby in a southwest Florida watershed: applications to understanding long-term tropical cyclone dynamics. North American Diatom Symposium. Bar Harbor, Maine.

Perez, A., G. Puig-Santana, J.W. Fourqurean, and L. Collado-Vides (2013). Evaluating Temporal Dynamics of Carbon Production for the Genus Halimeda in a Karstic System. 42nd Benthic Ecology Meeting. Savannah, Georgia.

Price, R.M., X. Zapata-Rios, and G. Koch (2013). Groundwater-surface water interactions and their effects on ecosystem metabolism in a coastal wetland: example from the Florida Everglades. American Geophysical Union Meeting of the Americas. Cancun, Mexico.

Rehage, J.S. (2013). Seasonal reassembly: disentangling the effects of hydrological disturbance vs. local conditions in an ecotonal fish metacommunity. 33rd Annual Meeting of the Florida Chapter American Fisheries Society. Altoona, Florida.

Richards, J.H., P.C. Olivas, and J. Hernandez (2013). Variations in Cladium jamaicense (sawgrass) morphology and growth in Everglades marl and peat soils. Botany 2013. New Orleans, Louisiana.

Roy Chowdhury, R., M. Simard, T.E. Fatoyinbo, E. Espinoza, and V.H. Rivera-Monroy (2013). Landscape and Anthropogenic Contexts of Mangrove Structure, Pattern and Change in the Yucatan Peninsula, Mexico. Annual Meeting of the Association of American Geographers. Los Angeles, California.

Sandoval, E., R.M. Price, A. Melesse, and D. Whitman (2013). Effects of Hydrologic Restoration on the Residence Times and Water Quality of of a Coastal Wetland in the Florida Everglades. American Geophysical Union Meeting of the Americas. Cancun, Mexico.

Simard, M., T.E. Fatoyinbo, V.H. Rivera-Monroy, and R. Roy Chowdhury (2013). Mapping height, biomass and vulnerability of all mangrove forest of the Americas. Annual Meeting of the Association of American Geographers. Los Angeles, California.

Soula, M., R. Boucek, J.S. Rehage, and S. Santos (2013). Healthy snack or junk food? Examining the nutritional quality of freshwater and estuarine prey in the Southwest Everglades Estuary. 33rd Annual Meeting of the Florida Chapter American Fisheries Society. Altoona, Florida.

Stroud, J. and G. Gillespie (2013). Habitat niche partitioning in two tropical leaf-litter lizards (Scincidae). American Society for Ichthyology and Herpetology Annual Conference. Albuquerque, New Mexico.
Status = PUBLISHED; Acknowledgement of Federal Support = No

Sweatman, J. and J.W. Fourqurean (2013). Relationship between light availability and benthic community structure in the Florida Keys. Ecological Society of America 98th Annual Meeting. Minneapolis, Minnesota.

Trexler, J.C. (2013). Emergent Effects of Disturbance Frequency and Return Time on a Wetland Metacommunity. American Society of Ichthyologists and Herpetologists. Albuquerque, New Mexico.

Trexler, J.C. (2013). Monitoring Fish and Macroinvertebrates for Everglades Management. 33rd Annual Meeting of the Florida Chapter American Fisheries Society. Altoona, Florida.

Trujillo, V. and J.S. Rehage (2013). Stress Effects of Non-Native Fish on Native Fish. 33rd Annual Meeting of the Florida Chapter American Fisheries Society. Altoona, Florida.

Ya, C., W.T. Anderson, and R. Jaffe (2013). Application of Stable Carbon Isotopes and Optical Properties in the Assessment of Dissolved Organic Matter Sources in a Subtropical Estuary. ASLO 2013 Aquatic Sciences Meeting. New Orleans, Louisiana.

Thesis/Dissertation

Sandoval, Estefania. Ten Year Study on Water Flushing Times and Water Quality in Southern Taylor Slough, Everglades National Park, FL.. (2013). Florida International University.

Ding, Yan. Environmental Dynamics of Dissolved Black Carbon in Aquatic Ecosystems. (2013). Florida International University.

Garvoille, Rebecca. Sociocultural Complexities of Ecosystem Restoration: Remaking Identity, Landscape and Belonging in the Florida Everglades. (2013). Florida International University.

Rosenblatt, Adam. Factors Influencing Movements and Foraging Ecology of American Alligators (Alligator mississippiensis) in a Dynamic Subtropical Coastal Ecosystem. (2013). Florida International University.

Other Publications
Nothing to report

Technologies or techniques
Nothing to report

Inventions, patent applications, and/or licenses
Nothing to report

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)

Product type: 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.

Participants & Other Collaborating Organizations

What individuals have worked on the project?

Name	Most Senior Project Role
Evelyn E Gaiser	PD/PI
Michael Heithaus	Co PD/PI
Rudolf Jaffe	Co PD/PI
Laura A Ogden	Co PD/PI
Rene M Price	Co PD/PI
Henry Briceno	Faculty
Daniel Childers	Faculty
Jose D. Fuentes	Faculty
John Stephen Kominoski	Faculty
Steve Oberbauer	Faculty
Jeff Onsted	Faculty
Mark Rains	Faculty

Name	Most Senior Project Role
Jennifer H. Richards	Faculty
Jennifer Rehage	Faculty
Victor H. Rivera-Monroy	Faculty
Rinku Roy Chowdhury	Faculty
Katrina Schwartz	Faculty
Joseph Smoak	Faculty
Gregory Starr	Faculty
Serge Thomas	Faculty
Joel Trexler	Faculty
Robert Twilley	Faculty
Shimon Wdowinski	Faculty
Tiffany Troxler	Faculty
Jordan Barr	Staff Scientist (doctoral level)
Stephen Davis	Staff Scientist (doctoral level)
Tom Frankovich	Staff Scientist (doctoral level)
Kevin Whelan	Staff Scientist (doctoral level)
Edward Castaneda	Postdoctoral (scholar, fellow or other postdoctoral position)
Cristina Romera-Castillo	Postdoctoral (scholar, fellow or other postdoctoral

Name	Most Senior Project Role
	position)
Ross Boucek	Graduate Student (research assistant)
Yan Ding	Graduate Student (research assistant)
Ding He	Graduate Student (research assistant)
David Lagomasino	Graduate Student (research assistant)
Jessica Lee	Graduate Student (research assistant)
Sylvia Lee	Graduate Student (research assistant)
Philip Matich	Graduate Student (research assistant)
Emily Nodine	Graduate Student (research assistant)
Estelle Robicheaux	Graduate Student (research assistant)
Estefania Sandoval	Graduate Student (research assistant)
Sasha Wagner	Graduate Student (research assistant)
Chao Ya	Graduate Student (research assistant)
Nicole Cortez	Research Experience for Undergraduates (REU) Participant
Julio Pachon	Research Experience for Undergraduates (REU) Participant
Martin Noguera	Undergraduate Student
Israel Salazar	Undergraduate Student

Name	Most Senior Project Role
Teresa Casal	K-12 Teacher
Lisa Giles	K-12 Teacher
Catherine Laroche	K-12 Teacher
Nick Oehm	K-12 Teacher
Susan Dailey	Other Professional
Linda Powell	Other Professional
Michael Rugge	Other Professional
Adam Hines	Technician
Franco Tobias	Technician
Olga Sanchez	Technician
Rafael Travieso	Technician
Abram DaSilva	Non-Student Research Assistant

What other organizations have been involved as partners?

Name	Location
College of William & Mary	Williamsburg, Virginia
Duke University	Durham, North Carolina
Ecology and Environment, Inc.	West Palm Beach, Florida
Encounters in Excellence, Inc.	Miami, Florida

Name	Location
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
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
Plymouth State University	Plymouth, New Hampshire
Portland State University	Portland, Oregon
Sam Houston State University	Huntsville, Texas
South Florida Water Management District	West Palm Beach, Florida
Texas A&M University at Galveston	Galveston, Texas
The Pennsylvania State University	University Park, Pennsylvania

Name	Location
USGS	Reston, Virginia
University of Alabama	Tuscaloosa, Alabama
University of California, Berkeley	Berkeley, California
University of California, Los Angeles	Los Angeles, California
University of Florida	Gainesville, Florida
University of Georgia	Athens, Georgia
University of Miami	Coral Gables, Florida
University of South Florida	Tampa, Florida
University of South Florida St. Petersburg	St. Petersburg, Florida

Have other collaborators or contacts been involved?
Yes

Impact

Impact on the development of the principal discipline(s)

Collaborator Tiffany Troxler presented a talk: "*A Focus on Tropical Systems: ILTER Research Highlights from the Florida Coastal Everglades"* at the NSF Forum/ LTER MiniSymposium "*The Globalization of Long Term Ecological Research*" at NSF headquarters in February 2013.

Evelyn Gaiser presented a talk: "*Understanding an iconic landscape through comparative international long-term ecological research*" at the LTER Science Council meeting in Albuquerque, NM in May, 2013.

Impact on other disciplines

Evelyn Gaiser serves 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 also served as an Associate Editor for Wetlands and a Special Issue Editor focused on FCE LTER for the Journal of Paleolimnology and Wetlands.

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.

Collaborator Ligia Collado-Vides has been working on an algal bloom in Biscayne Bay. She received $10,000 to evaluate the nutrient status of the bloom. She will continue working in this bloom at different levels including the taxonomic study of a potential new species, as well as the understanding of potential triggers of the bloom.

Ligia Collado-Vides has produced three internal reports to the Biscayne Bay Aquatic preserve, and advised them in algal related issues.

Collaborator J.S. Rehage contributed to the 2012 System Status Report (SSR) for the USACOE. 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 2013.

Collaborator J.S. Rehage Scientific evaluation of Central Everglades Planning Project (CEPP) restoration alternatives for Comprehensive Everglades Restoration Plan (CERP), January 2013. http://www.evergladesplan.org/pm/projects/proj_51_cepp.aspx

Impact on the development of human resources

Professional Service Teachers: FCE LTER is working with both professional and pre-service teachers in programs that provide the knowledge, skills and materials needed for taking advantage of LTER resources by working directly with LTER scientists. In 2013, we mentored three teachers (Teresa Casal, Catherine Laroche, and Lisa Giles) through our RET program. Catherine Laroche and Teresa Casal have been working with Dr. Victor Rivera-Monroy on a project studying the relationship between salinity and its effects on the establishment and productivity of mangroves. They're implementing a small research project at the Deering Estate as part of the Cutler Slough Rehydration Project where high school students can learn about how mangrove productivity relates to water quality parameters. Lisa Giles, mentored by Dr. John Kominoski, is assisting with field and laboratory needs for the wetland carbon project at the Florida Bay Interagency Science Center and working with the REU and graduate students to develop a teaching module associated with sea level rise implications for coastal wetlands.

Undergraduate Students: FCE is currently hosting 40 undergraduates in our labs. Two FCE REUs (Julio Pachon and Nicole Cortez) were funded with Year 1 FCE III funds. Julio Pachon designed and executed a short-term experiment using a live plant-soil system under the supervision of Dr. John Kominoski at the mesocosm facility at the Florida Bay Interagency

Science Center. Nicole Cortez is working with Dr. Kevin Whelan to establish long term SRS ecotone monitoring and to help support Soil Surface Elevation Table (SET) monitoring along SRS.

Mentoring High School Students: FCE continues to work with K-12 students through a near peer mentoring in our Research Experience for Secondary Students (RESSt) and Research Assistantships for High School Students (RAHSS) programs. Over the last year, FCE scientists have provided internship opportunities for 16 high school students. These internships promote collaboration and integrate curricula across biophysical and social science disciplines. RAHSS intern Jamie Odzer won a $2000 award for the Best Overall Project in Ocean Science/Marine Geoscience from the Consortium for Ocean Leadership at the 2013 International Science and Engineering Fair, where she presented her FCE research "The Effect of Fire on the Community Structure of Macro-Invertebrates in a Compartmentalized Wetlands Ecosystem: Will wetlands restoration efforts reduce the anthropogenic intensification of environmental damage from natural disturbances?"

In collaboration with the Deering Estate, FCE leveraged an additional $31,000 through the My Community, Our Earth (MyCOE) project. MyCOE resulted in 75 informal research experiences for students and 6 classroom teachers from Felix Varela Senior High School. Deering staff and MyCOE participants produced 65 projects focused on the themes of: Environment; Food Security; and Climate. The MyCOE project presented FCE results and related topics 6,884 contacts in the classroom and through community events at the Deering Estate.

Impact on physical resources that form infrastructure

Nothing to report

Impact on institutional resources that form infrastructure

Nothing to report

Impact on information resources that form infrastructure

The major focus of the FCE Information Management (IM) team (L. Powell and M. Rugge) has been 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), 2) Chair of the LTER IM Unit Registry working group, 3) member of the IM Data Package Reporting working group, 4) attendance at the 2013 Information Management Committee annual meeting in Fairbanks, Alaska and 5) FCE IMS data contributions to ClimDB, SiteDB, All Site Bibliography, PersonnelDB, Metacat XML database and LTER PASTA system.

The FCE LTER program had made both systematic and procedural changes to its information management system (IMS) during the first year of FCEIII:

- Completed major information migration of the FCE program's project and research data from FCE physical servers located in the FCE office to five (5) virtual servers housed on the Florida International University Division of Information Technology's (UTS) equipment.

- Upgraded the FCE Oracle 10g database to Oracle 11g Enterprise version.
- Upgraded FCE website content to reflect FCE III research and changes made to the FCE Information Management System.
- Upgraded FCE Excel2EML metadata tool and template.
- Converted ALL existing FCE Ecological Metadata Language (EML) 2.0 metadata to EML 2.1 and enhanced metadata content by implementing the LTER controlled vocabulary list.
- Made a procedural change in the FCE IMS whereby the practice of data 'versioning' was discontinued to better follow the LTER community practices and to facilitate data submissions into the LTER PASTA system.
- Re-packaged 525 original FCE datasets that included versions into 138 'primary' datasets.
- Working on changes to the Oracle 11g database tables to reflect recent changes to the FCE data archives.
- Submitted ALL FCE program data, with the exception of 10 dissertation research datasets, into the LTER PASTA system and made appropriate changes in the LTER Metacat database to match the FCE 're-packaged' data.
- 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.

Impact on technology transfer

Nothing to report

Impact on society beyond science and technology

Nothing to report