



FCE II FINAL REPORT
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FLORIDA COASTAL EVERGLADES LTER
Florida International University

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Principal Investigators

Evelyn Gaiser
Michael Heithaus
Rudolf Jaffé
Laura Ogden
René Price

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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. The FCE program completed its second phase in 2013, and here we report activities and findings from the no-cost extension (NCE) period between Dec 1, 2012-Nov 30, 2013.

The overarching goal of the no cost extension period was to: (1) complete working group activities related to the FCE II project goals, (2) integrate past activities with new objectives of the FCE III program, (3) complete the transfer of data to the Network Information System (PASTA), and (4) complete FCE Schoolyard activities relevant to FCE II project objectives. FCE research is conducted within the context of four major working groups (WG): Biogeochemical Cycling, Primary Production, Organic Matter (OM) Dynamics, and Trophic Dynamics. Integration is accomplished through four Cross-Cutting Themes (CCT): Hydrology, Human Dimensions, Climate and Disturbance, and Modeling and Synthesis. We report activities completed across these categories during this NCE period relative to the specific goals set forth in the FCE II proposal.

What was accomplished under these goals?

Major Activities

One of the main goals of the FCE II program was to determine hydrologic controls on ecosystem processes in the oligohaline ecotone under conditions of changing surface water inflows from the Everglades. To that end, during the NCE period, we continued to collect hydrological data including precipitation, groundwater levels, groundwater and surface water temperature, and surface water levels and flows and to extend long-term datasets of groundwater and surface water chemistry. We completed several models that describe controls on evapotranspiration, and spectral signatures of water availability and water chemistry in the mangrove ecotone. A major effort to determine the relationship between surface water flushing times and water chemistry in Taylor Slough was completed that is informing restoration initiatives in this area.

Determining the relationship between water source and quality and productivity in the ecotone depends on continued long term biogeochemical and productivity measurements throughout the freshwater-mangrove-estuary gradient. We extended these measurements and completed a thorough analysis of the causes for long-term changes in productivity in Taylor Slough subsequent to management activities to improve water flow along the eastern Everglades boundary. We also continued routine measurements of microbial dynamics along the gradient and completed studies to quantify bacterial growth efficiency along the “upside-down” nutrient

gradient within Florida Bay in comparison to Biscayne Bay. In preparation for FCE III research we completed the development of an alternative to oxygen consumption-based dark bottle incubations, using a ^{13}C tracer method to directly measure bacterial respiration of carbon. We also combined multiple data sets from multi-agency projects (NOAA/AOML, FIU/SERC) to prepare for studies of bacterio-phytoplanktonic coupling in Florida Bay, a goal for the FCE III program.

The effects of changing water source and quality on organic matter quality were explored through extended long-term measurements of DOC and optical properties at FCE sites along salinity gradient in Shark, Harney and Taylor Rivers. We initiated determinations of DOM ^{13}C stable isotope composition along Shark River estuary and throughout Florida Bay and expanded our database comparing DOC and POC fluorescence characteristics for Shark River estuary. We created the first dataset of DOM photo-induced production or reactive oxygen species (ROS) for Taylor and Shark Rivers and developed methodology and implemented measurements of free radical scavenging capacity of Everglades DOM. A characterization of molecular size fractionation for DOM across FCE was completed and we began new characterization using high-field 2-D NMR.

The relationship between water source, primary productivity, organic matter quality and consumer dynamics continues to be explored through extended long-term measurements of spatial and temporal variation in the abundance, community composition and food web interactions of fishes and alligators from marshes to coastal estuaries. Specifically, we examined the drivers of population dynamics, movements and trophic interactions of freshwater communities, bull sharks, alligators, and snook, including investigations of individual specialization and impacts of extreme climatic events such as the cold snaps in winter 2010 and 2011. We completed acoustic tracking fieldwork for studies of drivers of individual specialization, trophic interactions, and movements of American alligators, and expanded movement work in relation to hydrological drivers by acoustically tracking common snook and largemouth bass. We completed studies using biomarkers (fatty acids) to identify importance of detrital pathways in food webs and assessed the importance of prey pulses from the marsh to diets of estuarine predators, particularly snook and bull sharks. Much of this work was summarized in a cross-site synthesis paper on drivers of top predator movements and consumer-mediated nutrient flow.

Our FCE II research questions were tested in a framework of contemporary and past disturbances in lieu of the anticipated large-scale restorative activities. Retrospective research on climate and disturbance legacies was summarized in a special issue of the *Journal of Paleolimnology*. In that issue, we documented a need for calibration of new potential paleoecological biomarkers, and during our NCE we completed the first hydrogen isotopic biomarker measurement from Everglades plants along a transect with changing water depth. We also conducted an analysis of carbon isotopic composition of DOC and DIC in conjunction with the organic matter characterization work described above, which will calibrate wet-dry season conditions. We completed an analysis of carbon isotopes from slash pine to determine the effects of teleconnections on regulating water availability in the Everglades.

To understand the interactions of human activities with these climate and disturbance regimes, we continued our development of land-use decision models to document connections to changes within the Everglades. We are sharing these approaches with other sites to facilitate cross-LTER comparisons, especially coastal sites to understand the impacts of sea level rise on social vulnerability. Specifically, we completed (1) spatial analysis of land use change in lands transitioning from agricultural to residential uses, (2) ethnographic interviews with homeowners on land management practices, and (3) interviews with policymakers and environmentalists on water management practices as related to land use change

FCE synthesis has been driven partly by the development of conceptual heuristic and mathematical models that link water source and quality changes to long-term socio-ecological data. In this NCE period, we continued to build models to understand the important connections between groundwater sources of P and surface water interactions in the ecotone, particularly adding geochemical processes of desorption and transport from the carbonate bedrock (derived from empirical laboratory desorption experiments). We continued N and P budget development to understand seasonal variations in nutrient flux and storage terms. Our land-use/land-cover models are a primary focus driving the understanding of how policy (e.g., floodplain mapping, zoning) affects development patterns. A major milestone for FCE II was a refinement of the FCE Conceptual Heuristic Model (CHM) to provide a framework and roadmap for model integration, which has been drafted into a synthesis paper that documents lessons learned and future strategies to overcome remaining barriers.

Specific Objectives

The overarching goal of the no cost extension period was to: (1) complete working group activities related to the FCE II project goals, (2) integrate past activities with new objectives of the FCE III program, (3) complete the transfer of data to the Network Information System (PASTA), and (4) complete FCE Schoolyard activities relevant to FCE II project objectives.

Significant results

FCE II research quantified variability in the relative importance of ground and surface water from marine and freshwater sources along the freshwater- oligohaline-estuary gradient. During the NCE period, we completed research that showed how spectral data collected at either the leaf or satellite-scale can be used to indirectly estimate water chemistry of the mangrove ecotone. This was an important discovery because we now have a tool to scale-up our research to address FCE III questions on the effects of the shifting balance of freshwater and marine supplies driven by water management changes and sea level rise. We also discovered that evapotranspiration and surface water volume (mainly driven by rainfall) were the dominant factors influencing flushing times and water chemistry in coastal wetlands with low quantities of surface water inputs. This effect was observed as a result of increased water deliveries in Taylor Slough (due to diffuse restoration practices), which increased groundwater-surface water interactions throughout the region. Increased groundwater connectivity allowed subsurface delivery of nutrients that caused a long-term cascade of eutrophication in the eastern Everglades, an unexpected consequence of restoration. We detailed the hydrological drivers and unintended ecological consequences of these restoration attempts in a special issue of the journal *Wetlands*. The special issue was a

culmination of long-term FCE research directed at discovering the interactions of hydrology and ecology in the Taylor Slough basin, and showed how the “upside-down estuary” hypothesis at the heart of the FCE II proposal is also operational in the upper watershed. Although we didn’t anticipate restorative impacts in either FCE watershed, our long-term studies were able to document a surprising response to diffuse restoration activities in the Taylor Slough watershed that directly addressed hypotheses regarding the suspected impact of groundwater connectivity on the ecology of karst wetlands.

Our biogeochemical and organic matter dynamics research further characterized ecosystem connectivity driven by both ecosystem dynamics and water flow. The oligohaline ecotone of Shark River receives about 20% of its DOM and POM from the mangrove marsh during the wet season, but isotope studies show little to no marine sourced organic matter is being transferred to the ecotone. Fluorescence-based composition of POC was found to be very different from DOC, with the latter seemingly being much more degraded and more humified – likely less reactive. Much of the mangrove DOM is highly photo-reactive with high free radical scavenging capacity. Further downstream in Florida Bay, stable C-isotope mass balance modeling suggests that seagrass contributions to DOC range from 70-40% between wet and dry seasons. We may be able to track the respiration of this DOM through ^{13}C -glucose additions, which appeared to give reliable estimates under Florida Bay’s oligotrophic conditions.

These detrital energy sources also appear to support estuarine food webs in the ecotone region, but predators capitalize on an annual primary trophic subsidy when freshwater taxa enter mangrove-lined creeks as the marsh dries down. We discovered that these temporally brief subsidies are important components of annual energy budgets. Freshwater predators mediate the amount of subsidy to estuarine predators, with a high level of individual specialization. American alligators move between the ecotone and the marsh more than previously documented, linking marshes to coastal marine waters. Individual alligators, however, vary in the extent of movements into marshes. Our cross-site studies confirmed that this individual specialization of top predators is wide-spread and important in shaping patterns of consumer-mediated nutrient flow across scales. The level of individual specialization in alligator populations varies across ecosystem types.

Plant and predator populations dynamics at FCE sites showed a strong connection to disturbance events, particularly the cold snap of 2010 and 2011 that killed mangroves along the periphery of the estuaries and decimated tropical (and non-native) consumer populations. Studies of this dramatic cold snap impact are ongoing. Our long-term retrospective disturbance studies planned for FCE III can be guided by positive results from calibration studies completed during this NCE including: (1) a strong connection between hydrogen isotope ratios and the distribution of emergent plants along the salinity gradient, (2) a strong relationship between D/H values of n-alkanes and hydrology, and (3) a measured dampening in the effect of leaf mixing on the relationship between $\text{d}18\text{O}$ of stem cellulose and water. Paleoeological applications of these proxies is ongoing, but most studies are showing strong connections between disturbance events, ecosystem shifts and global teleconnections, suggesting that the latter need to be incorporated in FCE III scenario studies.

Human dimensions research completed during the FCE II NCE highlight the importance of a more interdisciplinary focus on water management policy & practices as it relates to changes in the regional hydrologic system (and related transformations in ecological structure and function). These findings include: (1) Debates over Everglades restoration activities, particularly modifications to the Tamiami Trail (intended to increase water flow into Everglades National Park), have had the effect of creating new forms of political and cultural identity that are rooted in claims to authentic heritage; (2) Suburbanization is an uneven process, predicated on prior land use and cultural attachments to agriculture; (3) Zoning for agricultural retention is less effective in areas adjacent to parcels that have been rezoned out of agriculture (a domino effect), and finally (4) There is little consensus among environmentalists about what constitutes restoration success, partially explaining the difficulties of implementing Everglades restoration plans. These findings also have implications for scenario studies, as they suggest variability in human perception of change within the Everglades and dependent human services. We have recently focused on understanding and modeling changes in land use/land cover (LULC) on the boundaries of the FCE, with particular attention on how policies correlate with LULC change. Results are being integrated into urban growth models to facilitate a more accurate assessment of future growth scenarios.

Key outcomes or Other achievements

Key outcomes of the FCE LTER program during this NCE period include completion of three special journal issues. We added a “key finding” to our list, resulting from the past year of FCE research.

A. Special Issues:

1. Kendrick et al. (2012). Marine and Freshwater Research Volume 63, Special Issue 11.

This special issue on ‘Science for the management of subtropical embayments: examples from Shark Bay and Florida Bay’ is a valuable compilation of individual research outcomes from Florida Bay and Shark Bay from the past decade and addresses gaps in our scientific knowledge base in Shark Bay especially. Yet the compilation also demonstrates excellent research that is poorly integrated, and driven by interests and issues that do not necessarily lead to a more integrated stewardship of the marine natural values of either Shark Bay or Florida Bay. Here we describe the status of our current knowledge, introduce the valuable extension of the current knowledge through the papers in this issue and then suggest some future directions. For management, there is a need for a multidisciplinary international science program that focuses research on the ecological resilience of Shark Bay and Florida Bay, the effect of interactions between physical environmental drivers and biological control through behavioural and trophic interactions, and all under increased anthropogenic stressors. Shark Bay offers a ‘pristine template’ for this scale of study.

2. Anderson and Gaiser 2013. Journal of Paleolimnology Volume 49, Special Issue 1.

In this special issue, we report on efforts to reconstruct paleoclimate/paleolimnology of the Florida Everglades, applying a wide range of techniques including sedimentological,

micropaleontological and biogeochemical approaches. The papers included here describe results obtained by studies conducted in Everglades National Park and the greater South Florida Everglades by Florida Coastal Everglades Long Term Ecological Research Program (FCE LTER) collaborators. This multi-investigator project contrasts nutrient dynamics in two inland-to-marine transects aligned along separate drainages in southern Florida that differ in their susceptibility to coastal pressures and in volume of freshwater delivery. This effort focuses on the paleoecological aspects of FCE LTER research that address scales of ecosystem transformations driven by climate variability and change and human activities. The central question addressed by this body of work is “How is the shape of the freshwater-to-marine gradient in the Florida coastal Everglades controlled by changes in climate, freshwater inflow (i.e. through human activities), and disturbance (i.e. sea level rise, hurricanes, fire)?”

3. Sullivan et al. 2013. Wetlands Volume 31, Special Issue 2.

Wetland restoration success depends on understanding ecohydrological complexities in addition to the historical extent and legacies of past modifications. Restoration effectiveness in the Florida Everglades has been studied for several decades. We focused this special issue on the effects of hydrologic restoration in the southeastern Everglades, as this region provides a model for understanding wetland and estuarine response to management and restoration along an urban-agricultural-wetland boundary. We synthesize several decades of interdisciplinary wetland ecosystem restoration studies examining the influence of hydrologic and biogeochemical changes on spatial and temporal patterns of ecosystem structure and function. Our goal is to improve restoration effectiveness by revealing connections between water management activities and ecosystem changes. Synthesis of these long-term data suggests restoration success is contingent on quantifying the influences hydrologic restoration on landscape connectivity within and outside of the Everglades boundaries, in addition to its interactions with organisms and their complex food webs. Rehabilitating habitat structure and connectivity in the southeastern Everglades can be accomplished through increasing delivery of clean freshwater to its primary flow-way, Taylor Slough. This compendium indicates that reversal of water quality impacts of rehydration is possible given timely and informed approaches that improve the flow clean freshwater to the Everglades

B. New Key Finding

Seagrass Ecosystems are a Globally Significant Carbon Stock: LTER researchers have found that seagrass ecosystems remove significant amounts of carbon dioxide from the atmosphere and store it in below-ground soils. If seagrass ecosystems continue to be lost due to nutrient enrichment, coastline modifications and sea level rise, a globally significant amount of carbon could be lost to the atmosphere.

The protection of organic carbon stored in forests is considered as an important method for mitigating climate change. Like terrestrial ecosystems, coastal ecosystems store large amounts of carbon, and there are initiatives to protect these ‘blue carbon’ stores (Fig. 1). Organic carbon stocks in tidal salt marshes and mangroves have been estimated, but uncertainties in the stores of seagrass meadows—some of the most productive ecosystems on Earth—hinder the application of marine carbon conservation schemes. A team of international seagrass researchers, led by the

FCE and VCR LTERs, compiled published and unpublished measurements of the organic carbon content of living seagrass biomass and underlying soils in 946 distinct seagrass meadows across the globe. Using only data from sites for which full inventories exist, they estimated that, globally, seagrass ecosystems could store as much as 19.9 Pg organic carbon (Fig. 2). According to a more conservative approach that incorporates more data from surface soils and depth-dependent declines in soil carbon stocks, they estimated that the seagrass carbon pool lies between 4.2 and 8.4 Pg carbon. This means that the present rates of seagrass loss could result in the release of up to 299 Tg carbon per year, assuming that all of the organic carbon in seagrass biomass and the top meter of soils is remineralized (Fig. 3).

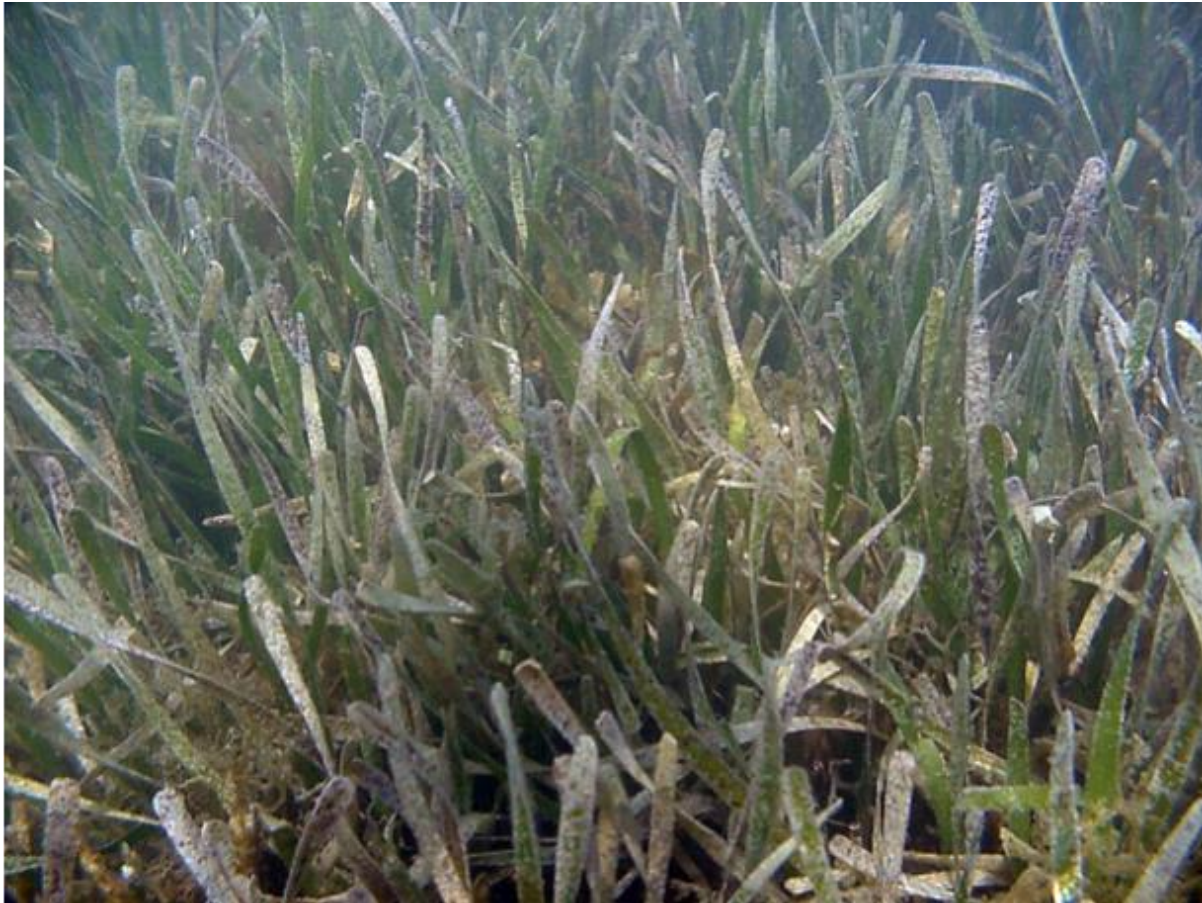


Fig 1. A seagrass bed at the Florida Coastal Everglades LTER site (photo by Jim Fourqurean)

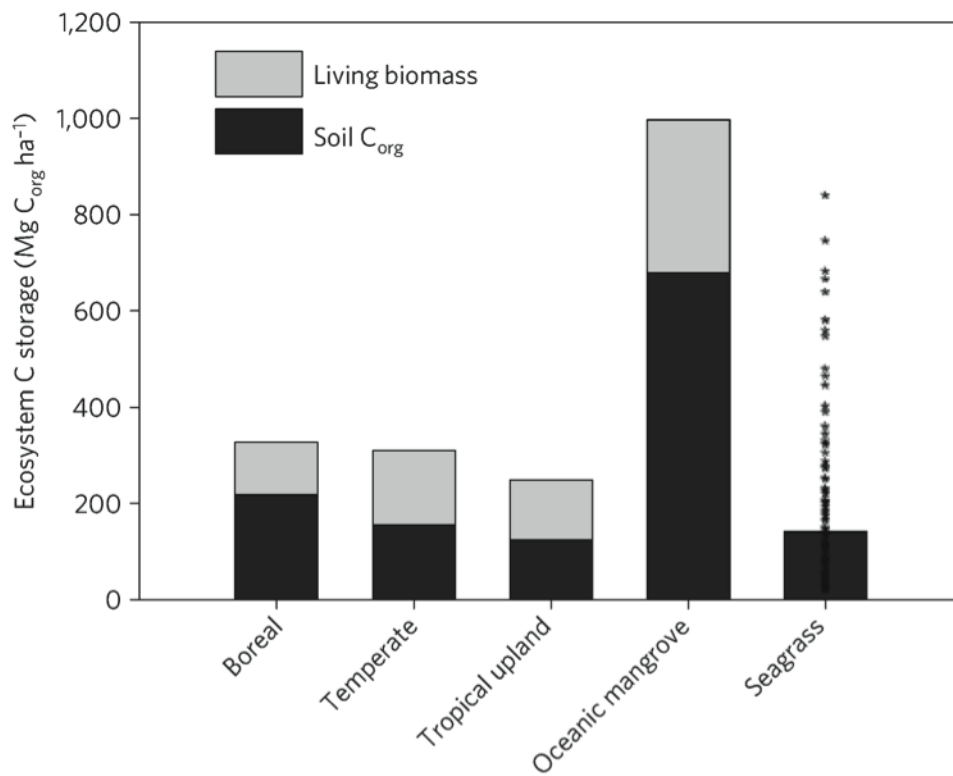


Fig. 2. A comparison of seagrass soil C_{org} storage in the top metre of the soil with total ecosystem C_{org} storage for major forest types.

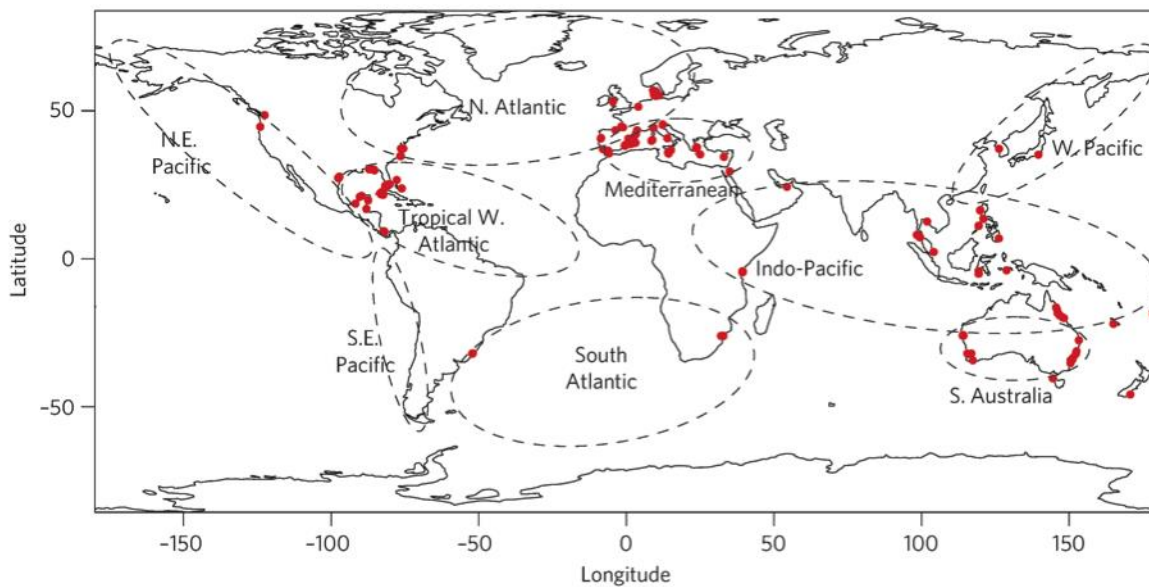


Fig. 3. Locations of data on the C_{org} content of seagrass meadows, showing seagrass bioregions.

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

In 2013, RET and RAHSS funding provided a variety of training and professional development opportunities in the field and the lab for K-12 students and teachers.

In March 2013, RET Teresa Casal and RAHSS interns Christopher Naranjo and Felipe Tamayo accompanied Dr. Victor Rivera-Monroy and Jennifer Tisthammer, FCE partner and Assistant Director of the Deering Estate, in surveying the mangrove community found on the Estate property. During that field trip they identified three creek side sites found along the Cutler Creek and Dr. Rivera-Monroy taught them to identify the predominant mangrove species, how to take the physical measurements, and collect soil/porewater samples. Unfortunately, an unexpected delay has arisen with the discovery of Tequesta Indian remains that have been found in the area surrounding these study sites. We are currently working with the Deering Natural Areas Management team to develop a sampling strategy that does not impact the remains.

During this NCE period, FCE graduate students created citizen science programs (Coastal Angler Science Team), launched blogs, and discovered new diatom species.

- a. FCE Graduate Student Jessica Lee created Coastal Angler Science Team (CAST) to examine Everglades restoration efforts.
<http://cast.fiu.edu/?tag=coastal-angler-science-team>
<http://news.fiu.edu/2013/05/grad-student-launches-science-team-to-examine-everglades-restoration-efforts/62290>
<http://www.miamiherald.com/2013/07/18/3505486/local-anglers-tag-fish-for-fiu.html>
<http://www.boatingindustry.com/news/2013/06/10/west-marine-announces-40000-marine-conservation-grants-for-2013/>
- b. FCE Graduate Student Ross Boucek has been promoting blogging for public communications (LTER Newsletter - Bloggers fill important communication niche) and launched a student led blog for the Florida Chapter of the American Fisheries Society, From Reefs to Rivers: Florida's Fisheries Science Blog,
<http://floridafisheriesscience.blogspot.com/>
- c. FCE Graduate Student Sylvia Lee described three new diatom species from the Everglades. <http://floridacoastaleverglades.blogspot.com/2013/09/three-new-everglades-diatom-species.html>
The Mastogloia species complex is in press in the journal Diatom Research.
Envekadea metzeltinii was published in the journal Phytotaxa and can be accessed through the following doi: <http://dx.doi.org/10.11646/phytotaxa.115.1.2> For even more detail about this species, visit the Diatoms of the United States website:
http://westerndiatoms.colorado.edu/taxa/species/envekadea_metzeltinii

How have the results been disseminated to communities of interest?

RET and RAHSS recipients have worked closely with the Education & Outreach Coordinator in disseminating the results within and beyond our local community. Collaborating with the Association of American Geographers (AAG) in the My Community, Our Earth (MyCOE) Global Connections and Exchange Program (GCE) funded by the US State Department. FCE RETs Teresa Casal, Catherine Laroche, Jennifer Gambale, and Terri Reyes worked with our partners at the Deering Estate to provide 75 informal research experiences for students and professional development to an additional classroom teacher in the Global Studies Magnet at Felix Varela Senior High School.

The MyCOE project presented FCE results and related topics to 6,884 contacts in the classroom and through community events held at the Deering Estate. Through MyCOE-GCE, RETs and Deering staff produced 65 projects focused on the themes of: Environment; Food Security; Green Economy; and Climate Change and have been uploaded to the MyCOE-GCE Project Gallery found on the AAG website.

Lisa Giles has used her RET opportunity to work at the Key Largo Mesocosm Facility with Drs. John Kominoski and Stephen Davis. Collaborating with her mentors, graduate, and undergraduate students Lisa is testing the effects of storm surge (salinity) and defoliation caused by hurricanes on soil carbon flux. During her RET, Lisa established mangrove propagules in a 2x2 factorial design to test the effects of increased phosphorus and disturbance on propagules growing in 24 mesocosms. The ongoing study collects weekly soil, pore water, surface water, and tissue samples from each mesocosm and are used to determine carbon flux. Although Lisa has satisfied the obligations of her RET, she and Dr. Kominoski are developing teaching modules to explain the effects of climate change and hurricanes on the mangrove community. Lisa intends to use these modules with middle and high school students enrolled in her online Environmental Science class. Dr. Kominoski also plans to use the modules in a scientific writing course.

Products

Publications

Journal

- Briceno, H.O., J.N. Boyer, J. Castro, and P. Harlem. 2013. Biogeochemical classification of south Florida's estuarine and coastal waters. *Marine Pollution Bulletin* 75: 187-204. DOI: 10.1016/j.marpolbul.2013.07.034
- Chambers, L.G., S.E. Davis, T. Troxler, J.N. Boyer, A. Downey-Wall, and L.J. Scinto. 2013. Biogeochemical effects of simulated sea level rise on carbon loss in an Everglades mangrove peat soil. *Hydrobiologia* 726: 195–211. DOI: 10.1007/s10750-013-1764-6
- Chambers, R.M., R.L. Hatch, T. Russell. 2013. Effect of water management on interannual variation in bulk soil properties from the eastern coastal Everglades. *Wetlands* 34(Suppl 1): 47-54. DOI: 10.1007/s13157-013-0393-1
- Olson, E.L., A.K. Salomon, A.J. Wirsing, M.R. Heithaus. 2012. Large-scale movement patterns of male loggerhead sea turtles (*Caretta caretta*) in Shark Bay, Australia. *Marine and Freshwater Research*. 63(11): 1108-1116. DOI: 10.1071/MF12030
- Ruiz, P.L., J.P. Sah, M.S. Ross, A.A. Spitzig. 2013. Tree island response to fire and flooding in the short-hydroperiod marl prairie grasslands of the Florida Everglades. *Fire Ecology* 9(1): 38-54. DOI: 10.4996/fireecology.0901038
- Troxler, T., M. Ikenaga, L.J. Scinto, J.N. Boyer, R. Condit, G. Gann, D.L. Childers. 2012. Patterns of soil bacteria and canopy community structure related to tropical peatland development. *Wetlands* 32(4): 769-782. DOI: 10.1007/s13157-012-0310-z
- Vaudo, J.J., M.R. Heithaus. 2012. Diel and seasonal variation in the use of a nearshore sandflat by a ray community in a near pristine system. *Marine and Freshwater Research* 63: 1077-1084. DOI: 10.1071/MF11226
- Watanabe, A., K. Moroi, H. Sato, K. Tsutsuki, N. Maie, L. Melling, R. Jaffe. 2012. Contributions of humic substances to the dissolved organic carbon pool in wetlands from different climates. *Chemosphere* 88(10): 1265-1268. DOI: 10.1016/j.chemosphere.2012.04.005
- Wirsing, A.J., M.R. Heithaus. 2012. Behavioural transition probabilities in dugongs change with habitat and predator presence: implications for sirenian conservation. *Marine and Freshwater Research*. 63(11) 1069-1076. DOI: 10.1071/MF12074

Book Chapters

- Boyer, J.N., and H.O. Briceno. 2012. Water residence time is a significant driver of ecosystem structure and function in estuaries, pp. 119 in Kruczynski, W.L. and P.J. Fletcher (eds.) Tropical Connections: South Florida's Marine Environment. IAN Press, University of Maryland Center for Environmental Science: Cambridge, MD.
- Heithaus, M.R., and J.J. Vaudo. 2012. Predator-Prey Interactions, pp. 505-546 in Carrier, J.C., J. Musick and M.R. Heithaus (eds.) Biology of Sharks and Their Relatives, Second Edition. CRC Press: Boca Raton, FL.
- Rudnick, D.T., S.P. Kelly, C.J. Madden, K.M. Cunniff, J.N. Boyer, and S. Blair. 2012. An unprecedented phytoplankton bloom occurred in eastern Florida Bay from 2005-2008, pp. 126-128 in Kruczynski, W.L. and P.J. Fletcher (eds.) Tropical Connections: South Florida's Marine Environment. IAN Press, University of Maryland Center for Environmental Science: Cambridge, MD.

Conference Papers and Presentations

- Sah, J. P., M. S. Ross, and P. L. Ruiz. 2013. Spatio-temporal Pattern in Plant Communities along Hydrology Gradient in Shark Slough Tree Islands, Everglades National Park, Florida. Society of Wetland Scientists (SWS) Annual Meeting. Duluth, Minnesota.

Thesis/Dissertation

- Sarabia, Robin Elizabeth. 2012. Spatiotemporal variation in abundance and social structure of bottlenose dolphins in the Florida Coastal Everglades. Master's thesis, 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.

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

The FCE Information Management System contains 135 datasets, of which a total of 125 are also publicly available online at <http://fcelter.fiu.edu/data/core/>.

Ten (10) datasets of the 135 FCE IMS system datasets are ‘restricted’ dissertation research and only the EML metadata are viewable by the public. Datasets include climate, consumer, primary production, water quality, soils, and microbial data as well as other types of data.

Product type: Software or Netware

Excel2EML which is available for download at <http://fcelter.fiu.edu>

/research/information_management/tools/. Researchers enter pertinent metadata into an Excel metadata template, based on EML 2.1.0 and the LTER EML Best Practices, Version 2 document released in August 2011, and the Perl conversion program converts the Excel template into EML compliant XML.

Product type: Software or Netware

The FCE IMS group in collaboration with Dr. Colby Leider (University of Miami Music Engineering Department) developed the design specification for a custom iOS application called LEDeX (The Long-term Ecological Data Explorer) to facilitate exploration, manipulation, and annotation of long-term ecological data signals on a mobile platform.

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
William Anderson	Faculty
Jim Fourqurean	Faculty
Colby Leider	Faculty
Mark Rains	Faculty
Victor H. Rivera-Monroy	Faculty
Len Scinto	Faculty
Ross Boucek	Graduate Student (research assistant)
Jessica Lee	Graduate Student (research assistant)
Sylvia Lee	Graduate Student (research assistant)
Teresa Casal	K-12 Teacher

Name	Most Senior Project Role
Lisa Giles	K-12 Teacher
Catherine Laroche	K-12 Teacher
Nick Oehm	K-12 Teacher
Edmond Goldman	High School Student
Christopher Naranjo	High School Student
Jamie Odzer	High School Student
Sara Osorio	High School Student
Felipe Tamayo	High School Student
Susan Dailey	Other Professional
Linda Powell	Other Professional
Michael Rugge	Other Professional
Adam Hines	Technician
Olga Sanchez	Technician
Rafael Travieso	Technician

What other organizations have been involved as partners?

Name	Location
Deering Estate	Miami, Florida
Everglades Foundation	Palmetto Bay, Florida
Everglades National Park	Homestead, Florida
Louisiana State University	Baton Rouge, Louisiana
Miami-Dade County Public Schools	Miami-Dade County, Florida
South Florida Water Management District	West Palm Beach, Florida
University of Miami	Coral Gables, Florida
University of South Florida	Tampa, Florida

Have other collaborators or contacts been involved?

Yes

Impact

Impact on the development of the principal discipline(s)

By making datasets more broadly available through the PASTA system, the FCE program has expanded opportunities for knowledge generation in the ecological and social sciences. Discoveries about the high rates of blue carbon sequestration in subtropical coastal forests and bays; the global distribution of black carbon; the effects of delayed freshwater restoration on saltwater encroachment, including altered ecotone plant production and increased soil carbon efflux; the importance of climate oscillations and extreme events in modifying long-term trajectories, including mangrove production, soil accretion and nutrient mobilization; and the role of freshwater detrital resources to energy budgets of migratory estuary consumers are examples of contributions from the FCE II program to general ecological knowledge that improves fundamental understanding of coastal and wetland ecosystem function. Further, our growing human dimensions research has fostered a deeper appreciation for the importance of integrated socio-ecological studies to unraveling the causes for long-term environmental change, and their feedbacks to societal transformation.

Impact on other disciplines

By providing a long-term context for assessing the influence of water management changes on the Everglades landscape, FCE II research discoveries are informing State and Federal decisions about restoration. Results are presented to the U.S. Congress biannually through a “Stoplight Indicator Reporting” tool. During FCE II, published results of LTER research in Taylor Slough were used to advise future engineering plans – FCE eco-hydrological studies revealed how diffuse restoration technologies to restore ecosystem connectivity were enhancing rather than reducing below ground seepage of nutrients across the urban-wildland boundary. As a result, engineers have designed seepage barriers to prevent further nutrient excursions and water loss from Everglades National Park. By inviting agency scientists as collaborators, FCE has helped resource managers make better decisions for a more sustainable future.

Impact on the development of human resources

The RET and RAHSS awards have impacted the development of human resources for teachers, K-12 students, practitioners, and the general public directly through their research projects and through community engagement events at the Deering Estate and the Ft. Lauderdale Museum of Discovery and Science.

In 2013, Jamie Odzer continued working as an FCE RAHSS intern with Dr. Joel Trexler and graduate student Michael Bush. In January, Jamie presented her results at the South Florida Regional Science & Engineering Fair where she received a Superior rating, the Outstanding Scientist Award by the Dade County Science Teachers’ Association, and the NOAA 2013 Taking the Pulse of the Planet Award for her poster entitled 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? Advancing to the State Science and Engineering Fair of Florida, Jamie received 3rd Place in the Environmental Science Division, NOAA 2013 Taking the Pulse of the Planet Award for Florida, and the Florida Lake Management Society Award. Jamie further advanced for the second year as an FCE RAHSS intern to the Intel International Science and Engineering Fair where she received the Best Overall Project in Ocean Science/Marine Geoscience by the Consortium for Ocean Leadership. In addition, Jamie received 2nd Place at the Florida Junior Academy of Science Symposium (March 2013).

Sara Osorio, also a second year RAHSS intern, has continued working with Dr. Evelyn Gaiser. In August (2013), Sara presented a poster entitled “Changes in diatom assemblages along a salinity gradient in a restored mangrove forest” at the North American Diatom Symposium. Sara is currently preparing to present an updated version of the poster in 2014 at the South Florida Regional Science & Engineering Fair, the FCE LTER All Scientists Meeting, and will speak in the Keller Science Theatre at the Ft. Lauderdale Museum of Discovery & Science on January 11, 2014.

Our first year interns, Felipe Tamayo and Christopher Naranjo completed part of their RAHSS internship with Dr. Victor Rivera-Monroy and RET Teresa Casal at the Deering Estate. In March

2013, Felipe and Christopher went into the field with Dr. Rivera-Monroy and Teresa to select study locations. Despite the setbacks encountered regarding the Tequesta remains, Felipe was able to present an overview of his work at the Ft. Lauderdale Museum of Discovery & Science in March 2013 for Everglades Days.

Felipe continues to work as an FCE intern under the direction of Dr. Jennifer Rehage and Ross Boucek. Felipe will also give a presentation of his current work in understanding the factors affecting the fitness of invasive and native fish of south Florida.

Also in 2013, second year RAHSS intern Edmond Goldman presented the results of his work with Dr. Ligia Collado at the South Florida Regional Science & Engineering Fair where he received an Excellent rating and the South Florida Regional Stockholm Junior Water Prize, for his poster entitled The Cutler Slough Rehydration Project: Seasonal variations in the marine macroalgae community of Deering Bay, Florida.

Michael Barroso and Sanje Lara worked with Nicholas Oehm to gain a better understanding of the Everglades communities and then with wildlife filmmaker and FCE partner Richard Kern to produce The Hardwood Hammock Habitat video. The video is now posted on OdysseyEarth.

Our final RAHSS intern, Orlando Hurtado, is working with Dr. Tiffany Troxler and Olga Sanchez in the South Florida Wetland Ecosystem Lab. Orlando continues working and in the process of developing his own research project.

Lastly, RETs Teresa Casal, Catherine Laroche, Terri Reyes, and Jennifer Gambale are working with Jennifer Tisthammer at the Deering Estate, and Stephanie Bestelmeyer, JRN LTER Education and Outreach Coordinator to launch the FCE-Deering Everglades DataJam. The Everglades DataJam is a partner program to the JRN LTER Desert DataJam and will use LTER data posted in the EcoTrends website.

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 July 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.

Activities

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he FCE LTER program had made both systematic and procedural changes to its information management system (IMS) during the extension of FCE II:

- 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 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 135 'primary' datasets. A total of 125 'public' datasets and 10 'restricted' dissertation datasets.
- Completed 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 and 9 GIS 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 called LEDeX (Long-term Ecological Data Explorer) 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.

Key Outcomes

The FCE IMS contains 135 datasets, of which a total of 125 are publicly available online at [http://fcelter.fiu.edu /data/FCE/](http://fcelter.fiu.edu/data/FCE/). The FCE LTER program is nearly in full compliance with the LTER PASTA system as all FCE program data, with the exception of 10 'restricted' dissertation research data sets and 9 GIS data sets have been uploaded into PASTA. These GIS data sets are currently being re-formatted and will be added to the LTER PASTA system by early 2014.

The FCE LTER Program 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 462,991 'Data' page visits made in 2013, up from 391,986 visits in 2012. We continue to receive general questions from our visitors and requests for schoolyard visits and presentations.

Goals

- Begin work on website redesign of the FCE Data section that will include a web version of the FCE data-processing visualization tool (LEDeX) (graphing of FCE data via the web).
- Add newly changed FCE Database Schemas to website under 'Information Management' section.
- Expand FCE GIS data in the FCE IMS and online.

Impact on technology transfer

Nothing to report

Impact on society beyond science and technology

Nothing to report