

## COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./DUE DATE		<input type="checkbox"/> Special Exception to Deadline Date Policy		<b>FOR NSF USE ONLY</b>	
				<b>NSF PROPOSAL NUMBER</b>	
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)					
<b>HRD - CENTERS FOR RSCH EXCELL IN S&amp;T</b>					
DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				<b>071298814</b>	
EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)		SHOW PREVIOUS AWARD NO. IF THIS IS <input type="checkbox"/> A RENEWAL <input type="checkbox"/> AN ACCOMPLISHMENT-BASED RENEWAL		IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES <input type="checkbox"/> NO <input type="checkbox"/> IF YES, LIST ACRONYM(S)	
		<b>1547798</b>			
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE <b>Florida International University</b>			ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE <b>Florida International University 11200 SW 8TH ST Miami, FL. 331990001</b>		
AWARDEE ORGANIZATION CODE (IF KNOWN) <b>0096354000</b>					
NAME OF PRIMARY PLACE OF PERF			ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE		
IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)		<input type="checkbox"/> SMALL BUSINESS	<input type="checkbox"/> MINORITY BUSINESS	<input type="checkbox"/> IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE	
		<input type="checkbox"/> FOR-PROFIT ORGANIZATION	<input type="checkbox"/> WOMAN-OWNED BUSINESS		
TITLE OF PROPOSED PROJECT <b>CREST: Center for Aquatic Chemistry and the Environment</b>					
REQUESTED AMOUNT \$ <b>99,985</b>	PROPOSED DURATION (1-60 MONTHS) <b>0</b> months	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE		
THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW					
<input type="checkbox"/> BEGINNING INVESTIGATOR (GPG I.G.2)		<input type="checkbox"/> HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____ Exemption Subsection _____ or IRB App. Date _____			
<input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)		<input type="checkbox"/> INTERNATIONAL ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)			
<input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)					
<input type="checkbox"/> HISTORIC PLACES (GPG II.C.2.j)					
<input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____ PHS Animal Welfare Assurance Number _____		<input type="checkbox"/> COLLABORATIVE STATUS			
<input type="checkbox"/> FUNDING MECHANISM _____					
PI/PD DEPARTMENT <b>Southeast Environmental Research Center</b>		PI/PD POSTAL ADDRESS <b>11200 SW 8th St. Modesto A Maidique OE-148 Miami, FL 33199 United States</b>			
PI/PD FAX NUMBER <b>305-348-4094</b>					
NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Email Address	
PI/PD NAME <b>Todd A Crowl</b>	<b>PhD</b>	<b>1989</b>	<b>305-348-1666</b>	<b>tcrowl@fiu.edu</b>	
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## CERTIFICATION PAGE

### Certification for Authorized Organizational Representative (or Equivalent) or Individual Applicant

By electronically signing and submitting this proposal, the Authorized Organizational Representative (AOR) or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding conflict of interest (when applicable), drug-free workplace, debarment and suspension, lobbying activities (see below), nondiscrimination, flood hazard insurance (when applicable), responsible conduct of research, organizational support, Federal tax obligations, unpaid Federal tax liability, and criminal convictions as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U.S. Code, Title 18, Section 1001).

### Certification Regarding Conflict of Interest

The AOR is required to complete certifications stating that the organization has implemented and is enforcing a written policy on conflicts of interest (COI), consistent with the provisions of AAG Chapter IV.A.; that, to the best of his/her knowledge, all financial disclosures required by the conflict of interest policy were made; and that conflicts of interest, if any, were, or prior to the organization's expenditure of any funds under the award, will be, satisfactorily managed, reduced or eliminated in accordance with the organization's conflict of interest policy. Conflicts that cannot be satisfactorily managed, reduced or eliminated and research that proceeds without the imposition of conditions or restrictions when a conflict of interest exists, must be disclosed to NSF via use of the Notifications and Requests Module in FastLane.

### Drug Free Work Place Certification

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent), is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

### Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency?

Yes

No

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

### Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding \$100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding \$150,000.

### Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

- (1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

### Certification Regarding Nondiscrimination

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

### Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

- (1) community in which that area is located participates in the national flood insurance program; and
- (2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

- (1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
- (2) for other NSF grants when more than \$25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

### Certification Regarding Responsible Conduct of Research (RCR)

**(This certification is not applicable to proposals for conferences, symposia, and workshops.)**

By electronically signing the Certification Pages, the Authorized Organizational Representative is certifying that, in accordance with the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.B., the institution has a plan in place to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduates, graduate students and postdoctoral researchers who will be supported by NSF to conduct research. The AOR shall require that the language of this certification be included in any award documents for all subawards at all tiers.

**CERTIFICATION PAGE - CONTINUED**

**Certification Regarding Organizational Support**

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that there is organizational support for the proposal as required by Section 526 of the America COMPETES Reauthorization Act of 2010. This support extends to the portion of the proposal developed to satisfy the Broader Impacts Review Criterion as well as the Intellectual Merit Review Criterion, and any additional review criteria specified in the solicitation. Organizational support will be made available, as described in the proposal, in order to address the broader impacts and intellectual merit activities to be undertaken.

**Certification Regarding Federal Tax Obligations**

When the proposal exceeds \$5,000,000, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal tax obligations. By electronically signing the Certification pages, the Authorized Organizational Representative is certifying that, to the best of their knowledge and belief, the proposing organization:

- (1) has filed all Federal tax returns required during the three years preceding this certification;
- (2) has not been convicted of a criminal offense under the Internal Revenue Code of 1986; and
- (3) has not, more than 90 days prior to this certification, been notified of any unpaid Federal tax assessment for which the liability remains unsatisfied, unless the assessment is the subject of an installment agreement or offer in compromise that has been approved by the Internal Revenue Service and is not in default, or the assessment is the subject of a non-frivolous administrative or judicial proceeding.

**Certification Regarding Unpaid Federal Tax Liability**

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal Tax Liability:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has no unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

**Certification Regarding Criminal Convictions**

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Criminal Convictions:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has not been convicted of a felony criminal violation under any Federal law within the 24 months preceding the date on which the certification is signed.

**Certification Dual Use Research of Concern**

By electronically signing the certification pages, the Authorized Organizational Representative is certifying that the organization will be or is in compliance with all aspects of the United States Government Policy for Institutional Oversight of Life Sciences Dual Use Research of Concern.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE		DATE
NAME				
TELEPHONE NUMBER	EMAIL ADDRESS		FAX NUMBER	

## **SUMMARY OF PROPOSED WORK**

*This is a CREST Partnership Supplement submitted under NSF 16-525.*

### **The Role of Mangroves in Contaminant Uptake and Retention**

*Summary:* Our newly funded CREST Center for Aquatic Chemistry and Environment (CACHÉ) is designed to measure the levels of contaminants in the fragile South Florida aquatic system, and develop appropriate remediation strategies for them. Specifically, CACHÉ will characterize and quantify contaminants and excessive nutrients, measure their transport and transformations, and model their likely impacts on ecosystem services in a gradient of urbanized freshwater ecosystems.

*Intellectual Merit:* In this Partnership Supplement, we seek to enhance the Center by expanding the expertise on our research team to add an exploration of mangrove ecosystems, which serve as the filter and connection between the freshwater and marine ecosystems. This supplement will: 1) establish a collaborative partnership among the Florida Coastal Everglades (FCE) LTER, Puerto Rico Luquillo LTER, and the University of Puerto Rico (UPR) CREST Center for Mangrove Ecology; 2) enhance our technical expertise and capabilities by supporting two new collaborating scientists with expertise in coastal geology, biostratigraphy, and sedimentology; 3) provide funding to initiate a pilot project comparing S. Florida and Puerto Rico mangrove ecosystems; and 4) provide enhanced educational opportunities through an exchange program between FIU and UPR students from both the CREST and LTER projects. This supplement will provide enhanced research and education opportunities for both the new partner and the existing CREST participants equally.

*Broader Impacts:* This Partnership supplement will enhance the broader impacts of the originally proposed CREST Center by adding opportunities for students and faculty in Puerto Rico to participate in CREST-CACHÉ research and education activities. Additional students will have access to the CREST support for their STEM graduate degrees, as well as proposed professional development activities. Therefore, the supplement will augment the participation of underrepresented students in aquatic chemistry and environment (ACE) fields and enhance their future STEM careers. In addition, by expanding the research component of CACHÉ, this supplement will also enhance the Center's ability to develop technologies for improving water quality analysis and contaminant detection, as well as to translate research findings into actionable information for decision-makers and stakeholders in both Florida and Puerto Rico. Expanding the CREST-CACHÉ partnership network will aid the Center's ultimate goal of impacting global water quality.

## **CREST Partnership Supplement: The Role of Mangroves in Contaminant Uptake and Retention**

### **JUSTIFICATION FOR SUPPLEMENT**

#### **Background and Purpose**

Our newly funded CREST Center for Aquatic Chemistry and Environment (CACHÉ) is designed to measure the levels of contaminants in the fragile South Florida aquatic system, and develop appropriate remediation strategies for them. Specifically, CACHÉ will characterize and quantify contaminants and excessive nutrients, measure their transport and transformations, and model their likely impacts on ecosystem services along a gradient of urbanized freshwater ecosystems. In this Partnership Supplement, we seek to enhance the Center by expanding the expertise on our research team to include the mangrove ecosystems, which serve as the connection between the freshwater and marine ecosystems. Specifically, in this Partnership Supplement proposal, we seek to expand our existing CREST Center to include a pilot study investigating the role that mangroves may play in buffering coastal marine ecosystems from contaminants and pollutants delivered from freshwater sources flowing through them. In addition, we will begin to collect the data necessary to understand how mangrove ecosystems are likely to respond to a related stress, i.e., increasing sea levels. To accomplish these goals, we will enhance our current expertise and technological approaches by including collaborators from the University of Puerto Rico associated with the UPR CREST Center, the Luquillo LTER program and the University of S. Florida. Linking FIU's CREST and LTER programs with the University of Puerto Rico CREST and LTER programs will greatly enhance our abilities to understand the ecological importance of mangroves as contaminant/excessive nutrient buffers in two contrasting geologies and topologies as well as enhancing the educational opportunities we will be able to provide to both FIU and UPR graduate and undergraduate students and faculty. In addition to enhancing our existing CREST programs, these additional data and collaborators will result in highly competitive research proposals investigating the long term sustainability of mangrove ecosystems and their roles in overall ecosystem services and human health and well-being.

#### **Mangroves as the Filter and Connection Between Freshwater and Marine Ecosystems**

Mangrove ecosystems are the world's richest carbon stores (Donato et al 2011); they maintain high C content in the living biomass of the mangrove trees, while producing highly organic, anoxic soils. However, mangrove forests worldwide vary dramatically in carbon storage, as well as in vulnerability to sea-level rise (Chmura et al. 2003), and the environmental importance of mangrove forests in terms of their ability to take up and store (filter) contaminants from freshwaters prior to entering the marine environment is poorly understood (Nath et al. 2013, Chaudhuri et al. 2014). By extending the focus of FIU's CREST program to include the mangroves that line the rivers and shorelines between marine and terrestrial environments, we can learn much about: (1) the capabilities of mangroves to abate the adverse release of excessive nutrients and contaminants flowing from the urbanized freshwater to marine ecosystems; (2) their capacity to sequester carbon and human byproducts and reduce their release to the atmosphere or oceans; and (3) the potential of whole coastal landscapes to be sustained in the face of accelerating sea level rise. We propose here to organize experts on mangrove ecology, geochemistry, and sedimentology already assembled in Puerto Rico and Florida, along with their

plot networks, toward a common purpose: understanding the roles mangroves play in nutrient, contaminant and carbon sequestration and how these ecosystem functions may be affected by current levels of sea-level rise.

### **South Florida – Puerto Rico Collaboration as a Model System**

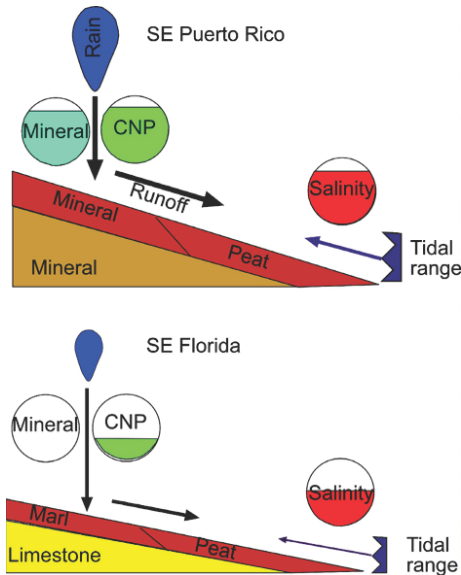
Mangrove forests in Puerto Rico and S Florida overlap considerably in a number of factors that can affect their structure (e.g., temperature; rainfall; tidal amplitude; hurricane regime; species pool), while remaining distinct in others (e.g., geochemistry, slope, and erodibility of adjacent uplands; coastal wave exposure). Both areas experience rising seas, though Florida's rate of relative sea level rise (~2.3 mm per year) was about 50% higher than Puerto Rico's (~1.5 mm per year) during the late 20<sup>th</sup> Century. Both areas contain the full range of hydrogeomorphic settings described by Lugo and Snedaker (1974), which produce profound variation in mangrove forest structure and above-ground production (e.g., Castaneda-Moya et al. 2013; Ross et al. 2001; Pool et al. 1977). The extent to which these relationships apply to the below-ground environment is not as well understood, nor is the capacity of the distinctive variants of mangrove forest to sequester or process nutrients or contaminants from upstream sources

Comparative studies of the mangrove forests in South Florida and Puerto Rico can help frame the importance of environmental variables in carbon sequestration (Figure 1). South Florida mangrove forests occur at the seaward edge of very low-slope terrestrial elevation gradients, with the mineral component of the soils predominantly composed of calcium carbonate. The south Florida land- and seascapes are depauperate in phosphorus, so that small differences in P availability can lead to large differences in the stature of the trees in mangrove forests. The Florida Coastal Everglades LTER project is examining the role that P availability plays in structuring coastal ecosystems in southern Florida, and has identified P-limited and P-rich mangrove forests in the region. In South Florida, mangrove communities on marl substrate show strongly reduced structural development, low soil organic matter, and low porewater salinity (Koch and Snedaker 1997). Coastal mangroves are characterized by entrained marine detrital wrack, much higher porewater salinities, but also have mangroves with reduced forms (Lin and Sternberg 1992).

In eastern Puerto Rico, dwarf mangroves are nutrient-limited but apparently not stressed by salinity, likely explained by high rates of soil flushing (Medina et al. 2010). Understanding how salinity stress and nutrient-limitation differentially drive plant and soil carbon (C) and phosphorus (P) use efficiencies in wetlands dominated by dwarf *R. mangle* is important to better understand the role of mangroves in retaining particulate and dissolved organic matter from marine and terrestrial sources. In contrast to Florida, the mangroves of eastern Puerto Rico are at the seaward end of very steep elevation gradients, in watersheds of igneous origin; their soils are not as carbonate-influenced as those in South Florida, which form over a limestone platform. The Luquillo LTER site is studying how land use and exposure affect the structure of rainforest ecosystems. Luquillo is divided into five watersheds that differ in land use and exposure to weather and storms, but the domain of this LTER site ends up-slope of the mangroves. Because of the differences in land use and exposure, the watersheds of Luquillo supply much different nutrient and sediment loads to the coastal mangrove forests. We propose to use the differences in watershed characteristics as identified by the Luquillo LTER program, as well as the differences

in sediment type between south Florida and Puerto Rico **to build a model of the environmental controls of contaminant and carbon sequestration in mangrove forests.**

For this pilot study, we propose to develop inventories of excessive nutrients, contaminants and carbon stores and sequestration rates from mangrove forests across gradients of sediment type (igneous vs. carbonate), nutrient availability, and inland elevation slope. At each site, we will use standard methods (Howard et al 2014) to assess C stock in living biomass and soils to a depth of 1m. Further, we will address sequestration rates of organic and inorganic carbon by estimating burial rates in the soils.



*Figure 1. Schematic showing relevant contrasting features between S. Florida and E. Puerto Rico mangrove ecosystems. Data collected from these contrasting sites through this partnership supplement will: provide a core data set to write competitive proposals; enhance our existing CREST to include mangrove ecology and expertise; provide unique educational experiences for U. Puerto Rico and FIU CREST and LTER students and faculty.*

To collect these data, the CREST program will bring new expertise into the project. Dr. Joseph Smoak from the University of South Florida is an experienced mangrove sediment carbon chemist and sedimentologist who specializes in developing age-depth models of soils and sedimentary profiles using various radiological techniques. We will use his expertise and laboratory capabilities to do  $^{210}\text{Pb}$  profiles of the surficial sediments to complement collected data on physical characteristics, nutrient, contaminant and C content, to measure the annual rate of carbon sequestration in soils across the environmental gradients. Dr. Jack Meeder is a biostratigrapher and restoration ecologist with 35 years of experience researching coastal wetlands.

### Visiting Researchers/Consultants

Dr. Joseph Smoak is a professor at the University of South Florida and holds a Ph.D. in geology with a specialty in radiogeochemistry. He is an expert at using radionuclides as tracers to establish age-depth models in wetland soils. He uses the models to study the fate of organic carbon in wetlands. He studies organic carbon sequestration rates in wetlands and how sequestration rates may change as the climate warms and sea level rises. Dr. Smoak also has experience using radionuclide tracers to examine anthropogenic alteration of aquatic ecosystems including historic contamination of lakes and coastal ecosystems. He is currently a principal investigator on a National Science Foundation project examining organic carbon burial and soil accretion rates in the mangrove forest of Everglades National Park. As part of that project he

serves as Task Team Leader for the Peatlands Carbon Task Team. In addition, he is co-lead of the FCE LTER Organic Matter Dynamics working group.

Dr. John Meeder is an emeritus research scientist at Florida International University in the Southeast Environmental Research Center. He earned his PhD at Rosenstiel School of Marine and Atmospheric Sciences, University of Miami in Marine Geology and geophysics. His expertise is in paleoecology, biostratigraphy, sedimentology and coastal wetland ecology. He recently has been working on the effects of sea level rise on coastal response, having identified a global transgression based upon South Florida stratigraphy. His two dimensional depositional model developed in southeast Florida is used to predict coastal response at different sea level rise scenarios based upon sediment accretion rates and the distribution of plant communities in the biogenic depositional system. He is currently working on further development of this model in the southeast saline Everglades and the controls on mangrove peat initiation and development.

### **Proposed 2016 Supplement Management and Activities**

PI Crowl will oversee and coordinate all CREST Center activities. Professors M. Ross, J. Kominoski and J. Fourqurean are collaborators in FIU's LTER and CREST programs. They will provide coordination among FIU students and scientists and our two visiting faculty/scholars with UPR program directors Zimmerman and Ramirez (see letters of collaboration).

Specific activities include:

1. Convene a 3-day organizational meeting in Puerto Rico
  - a. Participants: key researchers familiar with mangrove ecosystems in the two areas including PhD students currently active in CREST/LTER activities.
  - b. Objective: select several sites encompassing the major hydrogeomorphic conditions in NE Puerto Rico and southern Florida which may represent the movement of water, sediments and contaminants in the two areas, and the capacity of mangroves to store or process carbon and nutrients/contaminants.
2. Select sites in each area for further study of soil and vegetation.
  - a. Collect and sample sediment profiles along a single mangrove transect (2-3 cores in distinct environments).
  - b. Develop chronostratigraphy for each core, and measure CNP, heavy metals, and other selected chemical compounds at intervals within the cores.
  - c. Characterize vegetation structure and composition within a plot established at each coring site.
3. Document change in the extent and character of the mangroves in each site over time, using aerial photography, satellite imagery, or other remote sensing data.
4. Develop an exchange program for PhD students to enhance UPR students' expertise and contaminant chemistry and FIU students' expertise in mangrove ecology and physiology.
5. Develop ideas for future publications and proposals that would extend the proposed CACHÉ research, based on results obtained from the pilot project.



### **Broader Impacts**

This Partnership supplement will enhance the broader impacts of the originally proposed CREST Center by adding opportunities for students and faculty in Puerto Rico to participate in CREST-CAChE research and education activities. Additional students will have access to the CREST support for their STEM graduate degrees, as well as proposed professional development activities. Therefore, the supplement will augment the participation of underrepresented students in aquatic chemistry and environment (ACE) fields and future STEM careers. In addition, by expanding the research component of CAChE, this supplement will also enhance the Center's ability to develop technologies for improving water quality analysis and contaminant detection, as well as to translate research findings into actionable information for decision-makers and stakeholders in both Florida and Puerto Rico. Expanding the CREST-CAChE partnership network will aid the Center's ultimate goal of positively impacting global water quality.

### **Data Management Plan**

Data will be managed in accordance with CREST CAChE's established data management plan, submitted with our initial NSF proposal.

### **References Cited**

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