### Special Symposium on Water Quality Issues in South Florida

#### Annual Science Meeting of the SFC CESU

**Location:** FIU (WC130)

**February 23rd, 2007**

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<td>Wdowinski: <strong>Water level changes in the Everglades: A comparison between the TIME model and InSAR observations</strong></td>
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<td>Price: <strong>Groundwater Discharge of phosphorus to the coastal regions of south Florida</strong></td>
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<td>Keith: <strong>Seasonal Dynamics of Osprey (Pandion haliaetus) in Port Everglades, FL</strong></td>
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<td><strong>LUNCH On your own</strong></td>
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<td>13:15-13:30</td>
<td>Stalker: <strong>Using Natural Geochemical Tracers to Discern the Dominant Sources of Freshwater into a coastal Estuarine System, Biscayne Bay, Southeast Florida</strong></td>
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<td>13:30-13:45</td>
<td>Walsh: <strong>Tracing Injected Fresh Wastewater Pathways Using Geochemical Mixing Models in the Floridan Aquifer, South Florida</strong></td>
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<td>14:00-14:15</td>
<td>He: <strong>Removal Efficiency of Nutrients, Metals, and Pesticides in STAs</strong></td>
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<td>14:15-14:30</td>
<td>Helmle: <strong>Coral Growth and the Relationship to Freshwater Discharge in Southeast Florida</strong></td>
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14:45-15:00  Lirman: Seasonal Changes In The Abundance And Distribution Of Submerged Aquatic Vegetation In Western Biscayne Bay

15:00-15:15  Brandt: Management of Greater Everglades Ecosystems: The Joint Ecosystem Modeling Laboratory

15:15-15:30  Miralles-Willhelm

15:30-15:45  Lago: Resilience and stability of wetlands: the role of functional diversity

15:45-16:00  Sobczak: A model to describe spatial and temporal variations of nutrient cycling in tree islands of Shark Slough Valley in the Everglades

16:00-16:15  Liston: New Web-Based Approach for Summarizing Watershed Conditions in the South Florida Water Management District

16:15-17:00  Posters, Drinks Etc

Poster will be arrange at the back of the meeting room

Nitrogen isotopic study of benthic macroalgae and seawater in Biscayne Bay, Florida
Courtney Drayer, MGG/RSMAS, University of Miami

Reconstructing Caribbean Salinity Changes Over Time Utilizing Coral Skeleton Geochemistry
Amanda Waite, MGG/RSMAS, University of Miami

Seasonal fish community variation in headwater mangrove creeks in the southwestern Everglades: an examination of their role as dry-down refuges
Jennifer Rehage, FIU

Potential for Use of Natural Plant Pathogens of Brazilian Pepper (Schinus terebinthifolius Raddi) in the Everglades National Park
Kateel Shetty, FIU
Directions to FIU’s University Park Campus:

From Miami International Airport:
Take the I-836 WEST exit from the Airport
Follow I-836 to the Florida Turnpike
Take the Florida Turnpike SOUTH exit
Follow the Florida Turnpike to the Tamiami Trail exit (SW 8th Street)
Take the SW 8th Street EAST exit
Follow SW 8th Street, FIU will appear on the right before SW 107th Avenue

From I-95, Downtown Miami, Ft. Lauderdale, and West Palm Beach:
Take I-95 to I-836 WEST
Follow I-836 to the Florida Turnpike
Take the Florida Turnpike SOUTH exit
Follow the Florida Turnpike to the Tamiami Trail exit (SW 8th Street)
Take the SW 8th Street EAST exit
Follow SW 8th Street, FIU will appear on the right before SW 107th Avenue

From western Palm Beach / Broward County or the Florida Turnpike north:
Take the Florida Turnpike SOUTH
Follow the Florida Turnpike to the Tamiami Trail exit (SW 8th Street)
Take the SW 8th Street EAST exit
Follow SW 8th Street, FIU will appear on the right before SW 107th Avenue

Thursday’s management Committee meeting will be held in Health and Life Sciences Building room 216 (HLS 216)

Friday’s CESU science meeting will be held in the Wertheim Conservatory Auditorium, adjacent to the glass display greenhouse.

Parking: When you arrive on campus, park in the designated lot (see map) in any unmarked or faculty/staff space. Do not park in and space labeled Admin or executive. Come to the meeting room, and we will give you a hang tag to put in your car. It is a very short walk from the parking lot to the meeting room.
Abstracts

Management of Greater Everglades Ecosystems: The Joint Ecosystem Modeling Laboratory

Laura Brandt, USFWS laura_brandt@fws.gov

Integrating Ecological and Hydrological Models for Adaptive Management of Greater Everglades Ecosystems: The Joint Ecosystem Modeling Laboratory. Best, G.R., US Geological Survey; Brandt, L.A., US Fish and Wildlife Service; Mazzotti, F.J., University of Florida. Adaptive management of restoration of Greater Everglades Ecosystem is required by legislation authorizing the project. Adaptive management and assessment is an organized system of learning to reduce uncertainty inherent in making natural resource management decisions, especially on a large scale. Conceptual models have been used to catalyze integration of existing information to identify vital ecosystem attributes and their linkages with ecosystem stressors. Pre-project evaluations and post-project assessments integrate hydrological and habitat based ecological models to compare and forecast effects of restoration alternatives on selected ecological attributes. The Joint Ecosystem Modeling Laboratory is a SFC-CESU partnership project involving the USNPS, USFWS, USGS, FAU, UM, Audubon, UT (from the Southern Appalachian CESU), and UF. The JEM Lab has been involved in developing and applying ecological models for project evaluation and the Everglades Depth Estimation Network (EDEN). The SFC-CESU provides the perfect venue for the multi-disciplinary collaboration and cooperation necessary for solving complex problem of restoring complex systems.

SERC WQMN: Long-term Declines in TOC, TON and TP Export from the Everglades Mangrove Forests

Henry O Briceno, FIU, bricenoh@fiu.edu

The objective of the SERC Water Quality Monitoring Network is to characterize the status and trends in water quality in South Florida coastal areas. Field sampling occurs over different time periods and on different schedules. Whitewater Bay (22 stations/since1992), Ten Thousand Islands (25/1994), and Marco-Pine Island Sound (28/1999) are sampled monthly. The advantages of having this Network operated from the same facility include site continuity, consistency in analytic methodology, and ease of data integration. The product is a quarterly quasi-synoptic "big picture" as to what is happening in the South Florida coastal waters (including Florida Bay, SW Florida Shelf and Biscayne Bay). By integrating the individual projects into one data file, contour maps, time series graphs, and interpretive reports are generated (http://serc.fiu.edu/wqmnetwork/). Measurements and determinations at each station include salinity, temperature, dissolved oxygen, turbidity, relative fluorescence, light attenuation, dissolved nutrients as nitrate, nitrite, ammonium, dissolved inorganic nitrogen, soluble reactive phosphate, chlorophyll a, alkaline phosphatase activity, and
total unfiltered concentrations of nitrogen, organic nitrogen, organic carbon, phosphorus and silicate. Spatial data analysis delinantes groups of stations which have robust similarities in water quality, resulting from of similar hydrodynamic forcing and processing of materials. Geomorphology, current circulation patterns, precipitation/evaporation and dynamics of freshwater runoff mixing with seawater seem be the dominant forces. Since the early 1990’s, there is a sustained decrease in nutrient concentration in fresh waters draining mangrove forest in the ENP. Temporal trends of these 10 year time series were quantified by simple regression with significance set at P<0.05. The order of decline is TOC>TON>TP, where TOC shows sustained rates of decline of up to 35 uM TOC yr-1 (2%/yr). Time-series analysis using Cumulative Rate of Variation diagrams has rendered valuable insight in the behavior of measured variables and the potentially responsible driving forces. These changes are observed region wide but are marked at the upstream sites in the Everglades, leading us to postulate that some fundamental change in the function of the terrestrial ecosystems is involved, perhaps driven by climatic variability. Similar changes are observed in Florida Bay, Florida Keys, Shelf and Biscayne Bay, although they appear more damped.

Compound Interest: The Value of Long-Term Coastal Water Quality Monitoring in South Florida

Joe Boyer, FIU, jboyer@fiu.edu

SAV Population Variability in the Northeastern Florida Bay Mangrove Ecotone over the past Decade

Peter E. Frezza, Audubon, pfrezza@audubon.org

SAV Population Variability in the Northeastern Florida Bay Mangrove Ecotone over the past Decade Peter Frezza and Jerome J. Lorenz Audubon of Florida, Tavernier Science Center, Tavernier, FL In 1996, a routine submerged aquatic vegetation (SAV) monitoring project was established within the mangrove ecotone of northeastern Florida Bay. The objectives of this project are: 1) Characterize seasonal patterns of submerged vegetation community structure and distribution in the estuarine watersheds along the north shore of Florida Bay from Barnes Sound to Taylor River. 2) Determine any correlations between physical factors and plant distribution patterns. 3) Establish baseline data in order to assess the effectiveness of CERP activities in the future. 4) Provide collaborative and supporting data for other monitoring, experimental research and modeling efforts. Surveying is conducted every six weeks at 4 sites: Taylor River, Joe Bay, Highway Creek and Barnes Sound. At each site, 6 fixed stations along a salinity gradient, ending at Florida Bay, are surveyed. Abundance estimates of SAV are assessed using a point intercept percent coverage method. Surface water salinity, temperature, water depth and water clarity are measured at each station on day of survey. Permanent hydrostations located at the uppermost surveying station at each site continuously monitor salinity, temperature, water level, pH, and dissolved oxygen. SAV communities consisted of a variety of species ranging from freshwater marsh plants and algae to euryhaline seagrasses. Stations of similar annual mean salinity had similar assemblages of
vegetation. Upstream stations (mean salinity ranging 3.5-8.6 psu) consisted primarily of a mixed assemblage of freshwater plants and algae including Utricularia spp., Najas marina, Chara hornemanii, and Ruppia maritima. Downstream stations (mean salinity ranging 10.4-15.5 psu) were dominated by Halodule wrightii, or a mixture of H. wrightii and R. maritima. Since 1996, annual mean salinity at all SAV monitoring stations has steadily increased. Over the same time period, total SAV abundance at upstream stations along all 4 transects has proportionally decreased. Years that were less saline resulted in increased abundance and higher species diversity of SAV. SAV at upstream stations were also prone to seasonal die-off and re-growth in relation to wet/dry season cycles. Relatively rapid increases in salinity on the wetlands at the onset of the dry season resulted in severe or complete die-off of vegetation. Recolonization and continued growth occurred with lowered salinities throughout the wet season. Abundance of SAV at downstream stations near or in Florida Bay has shown an opposite response over time to that of the upstream stations. Total percent coverage of SAV at all downstream stations along all 4 transects have either increased or remained invariant over the past decade. A consistent characteristic at all downstream stations is an increase in the coverage of H. wrightii over the study period. This has occurred concurrently with a decline of R. maritima at the same stations indicating a displacement of this less salt tolerant species.

**Trends in water quality and algal primary production in the Florida Coastal Everglades**

Evelyn Gaiser, FIU, gaisere@fiu.edu

Periphyton is a ubiquitous feature in South Florida wetlands, with high rates of production that regulates water column concentrations of gases and nutrients, fuels detrital and consumer food webs and influences soil formation and quality. Here we examine patterns and drivers of benthic algal primary production using 6 years of data from 17 locations monitored through the Florida Coastal Everglades Long-Term Ecological Research program. Estimates of annual net primary productivity (ANPP) for periphyton range from 0 (at heavily canopied mangrove sites) to greater than 10,000 g C m-2 yr-1 (at shallow sites prone to drying) with an average among sites and years of 1400 g C m-2 yr-1. Maximum estimates exceed those previously reported for benthic communities elsewhere and the mean is an order of magnitude higher than a meta-analysis of benthic algal ANPP estimates reported in the literature. Spatial patterns of production in slough, wet prairie, mangrove and marine benthic habitats are related to nutrient availability, while temporal patterns (over 6 years of data collection) are driven by hydrologic events and their biogeochemical consequences. The role of periphyton in both reflecting and controlling water quality is examined with respect to possible outcomes of Everglades Restoration efforts.
Removal Efficiency of Nutrients, Metals, and Pesticides in STAs

Guoqing He, University of Miami/NPS, ghe1@rsmas.miami.edu

To protect the Everglades oligotrophic ecosystem, agricultural runoff from the Everglades Agricultural Area and the C-139 Basin is discharged into Stormwater Treatment Areas (STAs) to reduce the runoff’s nutrient content, mainly phosphorus, prior to its discharge into the marsh. Detailed mass balance was completed in five STAs (STA1W, STA2, STA3/4, STA5, and STA6) for nutrients, metals, major ions, and pesticides. Results show that these STAs were strong sinks (>50% mass removal) for phosphorus, ammonium, oxidized nitrogen, iron, aluminum, and mercury, and moderate sinks (<50%) for total Kjeldahl nitrogen, arsenic, sulfate, and calcium. For dissolved oxygen, atrazine, and methyl mercury, some STAs were sources and others were sinks. STAs appeared to be neutral (neither a source nor a sink) for conductivity, dissolved organic carbon, total dissolved solids, sodium, potassium, and magnesium. The TP removal efficiency declined as the TP loading rate increased. Higher loading rates were found in STA1W and STA5, which appeared to have been overloaded. The turning point after which a system will deteriorate in performance appeared to be between 1.7 and 2.32 g P/m2/yr. Based on these results, a conservative criterion of 1.7 g P/m2/yr for the interim 50 ppb goal is recommended.

Coral Growth and the Relationship to Freshwater Discharge in Southeast Florida

Kevin P Helmle, Nova Southeastern University, National Coral Reef Institute, kevinh@nova.edu

Corals naturally store records of their growth and the environment through the accretion of annual skeletal density bands. Near-shore shallow-water corals in South Florida are subject to coastal influences of freshwater drainage and runoff. Coral growth rates from Broward County Florida reveal a 30-year period of high skeletal densities and low extension rates which matches a 30-year period of dramatically increased canal discharge an order of magnitude greater than normal due to Everglades drainage. Comparison of coral extension with environmental variables reveals a positive correlation between extension rate and salinity as represented by sea water density. The 30-year period of high density, low extension skeleton is common to many corals in Broward county dating back to the 1940s. This relationship suggests that corals along Florida’s southeast coast are susceptible to rerouting of freshwater originating from the Everglades due to the managed network of coastal canals.
Seasonal Dynamics of Osprey (*Pandion haliaetus*) in Port Everglades, FL

Edward O. Keith, Nova Southeastern University, edwardok@nova.edu

Osprey (*Pandion haliaetus*) populations were surveyed from 2002-2005 in Port Everglades, Florida. An average of 78 birds/yr were sighted. The Upper-harbor, Mid-harbor and Dania Canal regions accounted for 77% of all sightings. Seventy one percent of the birds observed were perched. The mean number males and females in 2005 was 61 (64%) and 10 (10%), respectively. We were able to individually identify 31% of all birds photographed. There were monthly differences in the number of osprey sighted, suggesting that both migratory and residential osprey utilize Port Everglades. Sightings were most numerous in October and November and decreased in April and May, suggesting osprey use Port Everglades as a wintering location between October and March. Osprey were seen most frequently in red mangrove (*Rhizophora mangle*) trees, most frequently during low tide and when water clarity was between 164-255 cm. During osprey breeding season elsewhere in Florida, there were no active nests identified in Port Everglades, implying that the study area was used primarily for foraging or resting. Birds sighted during the breeding months were most likely non-breeding subadults.

A model to describe spatial and temporal variations of nutrient cycling in tree islands of Shark Slough Valley in the Everglades

Marcelo Lago, AMP, RSMAS, University of Miami., mlago@rsmas.miami.edu

Phosphorous is a scarce and limiting nutrient in the Everglades wetland, but it is abundant in the tree islands of the everglades. In fact, researchers at FIU reported values of phosphorous dissolved in pore water (SRP) in the head of the tree islands of Shark Slough Valley, on average, about one hundred times higher than in the surrounding marsh. The mechanisms suggested in the literature responsible to create and maintain this phosphorous accumulation are the transpiration of the trees in the island (which causes a groundwater flow and transport toward the island) and the phosphorous input because of animal activity (such as bird guano). They must counterbalance on average other nutrient removal mechanisms from the tree islands such as the surface and ground water flow driven by the regional gradient and the rainfall runoff. Data will be presented to show that those mechanisms have daily and seasonal variations, which suggest that the transport driven by transpiration toward the island may not always prevent phosphorous removal from it. This lead also to the question of how much are the losses, or in other words, how much does the annual nutrient input from animal activity have to be to keep the current phosphorous accumulation in the tree islands. In order to answer this question, a model has been developed to estimate spatial and temporal variations of the phosphorous pools and fluxes around the tree islands. Preliminary simulation results from this model will be discussed.
Fish and macroinvertebrate communities in Big Cypress National Preserve cypress forests

Shawn E Liston, Audubon of Florida, sliston@audubon.org

Freshwater forested-wetland habitat may be critical for many fish and macroinvertebrate communities. Trees provide habitat structure (particularly, above-ground root systems, trunks with complex surfaces, and woody debris) that is invaluable as cover, spawning, and feeding sites for resident species. The Big Cypress Swamp ecosystem encompasses a large area of interior southwestern Florida. Although the Swamp is an important part of the regional hydrologic system of the greater Everglades, its ecology has been poorly studied compared to Everglades graminoid wetlands. As part of the Comprehensive Everglades Restoration Program (CERP) Monitoring and Assessment Plan (MAP), we tested a variety of sampling methods for fishes and macroinvertebrates in Big Cypress forested wetlands. Aquatic animals were sampled in three regions of Big Cypress National Preserve: Bear Island, Raccoon Point, and an area near the L-28 Interceptor Canal to provide baseline data on communities prior to the initiation of restoration activities. Sampling was conducted in shallow, seasonally-inundated forests, deeper, longer-hydroperiod forests, and adjacent dwarf cypress prairies, allowing us to describe faunal use of these major habitats. We compare fish and macroinvertebrate communities captured using two types of stationary traps (drop traps and bottomless lift nets), modified throw traps, drift fence arrays, and experimental gill nets. We use these data to describe the distribution, abundance and seasonal variation in aquatic faunal communities in this system. Because the scientific literature contains little information about the ecology of aquatic animals in cypress forests, our study is providing valuable data not only for CERP, but for comparison with other forested wetland systems in the southeastern United States.

Seasonal Changes In The Abundance And Distribution Of Submerged Aquatic Vegetation In Western Biscayne Bay

Diego Lirman, University of Miami / RSMAS, dlirman@rsmas.miami.edu

The inflow of freshwater into coastal lagoons is a key factor influencing the structure and function of these ecosystems. Biscayne Bay, a coastal lagoons adjacent to the city of Miami, is located downstream of the Everglades ecosystem where the extensive water management now in place has modified the historical hydrology, replacing groundwater and overland flows with pulsed releases from canals. In areas where canals discharge directly into littoral habitats, an environment with low mean salinity and high variability is created. In this study, we characterize the salinity patterns of nearshore habitats (< 500 m from shore) and document patterns of seasonal abundance and distribution of submerged aquatic vegetation (SAV) in western Biscayne Bay to evaluate the impacts of water management practices. Seagrasses were the principal component of the SAV community during the 2005 dry season (mean cover = 25.5 %), while macroalgae dominated during the wet season (mean cover = 33.4 %). The distribution and abundance
of SAV were directly related to the tolerance of each taxon to salinity patterns. Seagrass species with high tolerance to low and variable salinity such as Halodule wrightii and Ruppia maritima were found only in canal-influenced areas and increased in abundance and spatial distribution in the wet season when freshwater inflow is highest. The dominance of rhizophytic macroalgae during the wet season was correlated with a bloom of Chara, a taxon commonly associated with freshwater environments. Thalassia testudinum, the most abundant seagrass species, was found throughout the study region, but it decreased in abundance in the canal-influenced areas during the wet season when lower, more variable salinity resulted in lowered productivity. The data presented here showed a significant relationship between salinity patterns and the seasonal abundance and distribution of SAV. These findings support the use of SAV as appropriate indicators of changes in water quality resulting from future restoration projects associated with the Everglades Restoration Plan, which will once again modify the delivery of freshwater into littoral habitats with unknown ecological consequences.

Resilience and stability of wetlands: the role of functional diversity

Fernando R. Miralles-Wilhelm, Florida International University, miralles@fiu.edu

Wetland ecosystems provide valuable ecosystem services at local to global scales. Locally, they provide environmental benefits such as flood control, water quality enhancements and biodiversity habitat. Globally, they play a significant role in the earth’s carbon cycle, and can act both as sinks and sources of greenhouse gases. Understanding the response of wetland ecosystems to perturbations (e.g. hurricanes, land use changes, large scale water management projects) is necessary to guide management and restoration efforts. The dynamics of wetland ecosystems may exhibit multiple stable states, with the implication that large enough perturbations may irreversibly shift the system from a vegetated to an un-vegetated state. Previous investigations have covered a single species model of the vegetation-water table interaction, in which multiple stable states arise because of a positive feedback between water table depth and vegetation cover; this kind of dynamics may make wetlands inherently vulnerable to perturbations. In this research, we present a multiple species formulation, and develop an alternative semi-mechanistic model that incorporates soil water balance and plant carbon balance. These models aim to show the importance of plant functional diversity in flood tolerance for the resilience of wetland ecosystems, and provide insight into the role that different soil and plant physiological characteristics play in determining competitive outcomes between different flood resistance types.
Groundwater Discharge of phosphorus to the coastal regions of south Florida

René M. Price, Florida International University, pricer@fiu.edu

Phosphorus concentrations in brackish groundwaters along the coastlines of south Florida are elevated above surface water concentrations. Brackish groundwaters of the southern Everglades contain 1 to 2.3 \( \mu \text{M} \) concentrations of total phosphorus (TP). These concentrations exceed the expected values predicted by conservative mixing of local fresh groundwater and intruding seawater, which both have TP < 1 \( \mu \text{M} \). The additional source of TP may be from seawater sediments or from the aquifer matrix as a result of water-rock interactions (such as carbonate mineral dissolution and ion exchange reactions) induced by mixing fresh groundwater with intruding seawater. Along the coastline of Biscayne Bay, fresh groundwaters have more variable concentrations of P (0.5 to 4 \( \mu \text{M} \)) and show an inverse relationship with salinity.

Tales from the 17-mile stretch

Dave Rudnick, SFWMD

New Web-Based Approach for Summarizing Watershed Conditions in the South Florida Water Management District

Robert Sobczak  Resource Management Division, Big Cypress National Preserve, Ochopee, FL, USA

This presentation provides an overview of a recently developed web page (www.fgcu.edu/bcw/hcu.htm) which displays graphical watershed summaries for several major watersheds in the South Florida Water Management District (SFWMD) – including Lake Okeechobee, Water Conservation Areas 1-3, Big Cypress National Preserve, Everglades National Park, and the Corkscrew Regional Ecosystem Watershed. The watershed summaries detail the complex inner workings within and among these watersheds in a graphical format devised to improve the ability of stakeholders to stay on top of current conditions within the watersheds, and enhance their ability to place current conditions within a historical context. Each watershed summary consists of a one-page graphical overview of natural and managed aspects within each watershed. They are updated weekly and retain information for the previous 12 month period. Each watershed summary also contains an interactive map which orients web viewers with respect to major roads and landmarks, geographically displays current hydrologic conditions, and serves as a portal for displaying historic graphs at individual sites of importance. A special type of calendar graphic is used to display multi-decadal data sets in order to highlight yearly and multi-yearly trends. Wherever possible, consistent graphical coding is used so that web viewers can quickly make contemporary and historic comparisons within and across watersheds.
This effort was made possible by funding and support from the Big Cypress Basin (SFWMD) and Florida Gulf Coast University. Special thanks to Florida Gulf Coast University web team for the time and expertise they have dedicated towards this project.

**Using Natural Geochemical Tracers to Discern the Dominant Sources of Freshwater into a coastal Estuarine System, Biscayne Bay, Southeast Florida**

Jeremy C Stalker, Florida International University, jstalker@fiu.edu

Estuaries are a balance of saltwater influx from the open ocean and freshwater inputs from precipitation, surface water runoff, and submarine groundwater discharge. The goal of this study is to use naturally occurring geochemical constituents as tracers to identify, differentiate and quantify the sources of freshwater, i.e. rainfall, canal flow, and groundwater, discharge to an estuarine system. This objective is addressed using stable isotopes of oxygen and hydrogen, as well as dissolved cations and anions in Biscayne Bay, a sub-tropical estuary located on the carbonate platform of south Florida. In this study, discrete samples of precipitation, canal water, terrestrial groundwater, marine groundwater, and bay surface water are collected monthly and analyzed for the stable isotopes of hydrogen and oxygen as well as for major cations and anions from July 2004 to July of 2006. Stable isotope results indicate it is possible to separate canal water from precipitation and groundwater as a source of freshwater into the bay. However it is not possible to separate groundwater discharge from precipitation. To separate submarine groundwater inputs from precipitation, Sr/Ca concentration ratios, and dissolved calcium concentrations present in freshwater end-members were measured and averaged creating a tertiary mixing diagram. Surface samples taken at sites in Biscayne Bay are then plotted on this diagram to separate the three end members. Geochemical modeling results show a spatial and temporal variance in the dominant freshwater source. While the majority of sites are dominated by canal water, sites along the western shore of Biscayne Bay show significant (10-20%) inputs of freshwater from submarine groundwater discharge, and sites further east near the Atlantic Ocean are influenced primarily by precipitation.

**Tracing Injected Fresh Wastewater Pathways Using Geochemical Mixing Models in the Floridan Aquifer, South Florida**

Virginia Walsh, Miami-Dade Water and Sewer Department, Miami, Florida

Treated domestic wastewater traditionally has been discharged offshore in south Florida via ocean outfalls. In response to environmental concerns associated with ocean outfalls, deep well injection of treated wastewater into the non-potable Lower Floridan Aquifer (LFA) has become increasingly used as an alternative. The LFA is saline, and the discharge of fresh wastewater into it raises concerns of geochemical reactions as a result of the mixing of the two waters, as well as the buoyant transport of the wastewater upwards into the Upper Floridan Aquifer (UFA). The Miami-Dade Water and Sewer Department (MDWASD), Miami-Dade County, Florida, operates two deep-well injection facilities in Miami-Dade County, and injects an average of 430 million liters per day into a deep saline aquifer (chlorides 600 μmol l⁻¹) approximately 900 meters below land
surface into the LFA. Although the LFA is separated from overlying brackish aquifers (chlorides 200 \(\mu\text{mol l}^{-1}\)) by a confining unit 150 meters thick, evidence of migration of injected wastewater has been detected in the UFA. The injected wastewater is a source of freshwater recharge chemically distinct from the native brackish aquifer water. Ammonium contained in the injected wastewater is significantly higher (average 325 \(\mu\text{mol l}^{-1}\)), than native aquifer water background levels (2 - 4 \(\mu\text{mol l}^{-1}\)), and exhibits a high seasonal variability in response to the wet and dry climatic conditions in south Florida. Geochemical data indicate that the injected ammonium behaves conservatively when mixed with native water, and thus can be used as a tracer of injected wastewater. Mixing models, using ammonium, major ion chemistry and stable isotope data, were developed to identify source and pathways of the recharge.

**Water level changes in the Everglades: A comparison between the TIME model and InSAR observations**

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Water level is a key parameter in wetland ecosystems, affecting flow and spatial extent of wetlands. As part of the Everglades restoration effort, the TIME model (Tides and Inflows in the Marshes of the Everglades) was developed by US Geological Survey and University of Miami, enabling us to investigate interacting effects of freshwater inflows and coastal driving forces in and along the mangrove ecotone of the Everglades National Park. The TIME model solves for the spatial and temporal distribution of main hydrological parameters in both surface- and ground-water, including water levels, flows, and salinity, and is constrained by field measurements at its boundaries. The model has been calibrated for the 1996-2002 time period, because reliable field observations are available for that time period. Wetland application of Interferometric Synthetic Aperture Radar (InSAR) is a new and powerful technique providing high resolution maps (7-50 m pixel resolution) of water level changes between two SAR image acquisitions, with centimeter level accuracy. The high spatial resolution provides an opportunity to observe detailed spatial variation of water levels, indicating dynamic interaction of tides and freshwater inflow, and the role of vegetation resistance to surface water flow. In this study, we use twelve InSAR-measured water level change maps using ERS-1/2, RADARSAT-1 and JERS-1 SAR images acquired during 1996-1997. The InSAR-based observations were compared with model simulation calculated by the TIME model for the same time periods as the InSAR observations. The comparison shows similarities in the orientation and shape of the longer wavelength fringes, but many differences in the shorter wavelength features. Investigation of coincidence and discrepancy between the two mapping methods will provide new scientific insight, especially regarding the role of spatial variation of water level. Eventually, the InSAR analysis can be used to calibrate, verify and refine the existing numerical model.
Posters

Potential for Use of Natural Plant Pathogens of Brazilian Pepper (Schinus terebinthifolius Raddi) in the Everglades National Park

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Brazilian pepper an exotic invasive hardwood tree species is now covers hundreds of thousands of acres in south and central Florida, as well as many of the islands on the east and west coasts of the state. Brazilian pepper (Schinus terebinthifolius Raddi) is native to Brazil, Argentina and Paraguay. Significant infestation of Everglades National Park (ENP) by Brazilian pepper has occurred in an area known as the “Hole-in-the-Donut”, (HID) covering over 3,000 ha that were previously agricultural lands. Biological control is proposed as a tool useful for ecosystem restoration and management. Most of the potential hazards of classical exotic introduced biocontrol agents can be avoided by selecting pathogens that are already endemic in the area where they are to be used. We have initiated studies to discover and develop potential native microbial biocontrol agents of Brazilian pepper. Periodic field survey for occurrence of disease were made, putative pathogens were isolated and tested for pathogenicity using detached leaf assay and seedling inoculation. We have found that native microbial pathogens of Brazilian pepper trees do occur with capability to cause severe damage. Various culture media to induce sporulation in fungal pathogens and inoculum formulations to increase the efficiency of the biocontrol agents are needed for successful development of biocontrol agents. The continued need to protect the National Parks diverse plant community makes it imperative that the discovery and use of native microbial biocontrol agents be included in the over all invasive plants management and restoration processes.

Seasonal fish community variation in headwater mangrove creeks in the southwestern Everglades: an examination of their role as dry-down refuges.

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The role of abiotic factors in the organization of communities is one of the most fundamental questions in ecology. The structuring effect of abiotic conditions may be particularly important along transition zones or ecotones. In the Everglades ecosystem, mangrove-lined creeks link freshwater marshes to estuarine habitats. Previous studies have shown that these rivers are used by a diverse array of saltwater and estuarine fishes. The rivers may also represent critical habitat for freshwater-marsh fishes (including non-indigenous taxa) during seasonal dry periods. Historically, channels and pools at this ecotone served to concentrate fishes for avian predators. In this study, we examine seasonal and long-term dynamics of fishes in the oligohaline to mesohaline reaches of rivers within the southwest region of Everglades National Park. In particular, we asked: (a) how does use by fishes of the upper-river habitat change over various time scales; (b) how do those changes relate to variation in abiotic conditions; and (c) how do changes in the fish community relate to anthropogenic activity (current management and future...
We examined seasonal dynamics in the fish community of ecotonal creeks in the southwestern region of Everglades National Park, specifically Rookery Branch and the North and Watson rivers. Twelve low-order creeks were sampled via electrofishing, gill nets, and minnow traps during the wet season, transition period, and dry season. Catches were greater in Rookery Branch than in the North and Watson rivers, particularly during the transition period. Community composition varied seasonally in Rookery Branch, and to a greater extent for the larger species, reflecting a pulse of freshwater taxa into creeks as marshes upstream dried periodically. The pulse was short-lived, a later sample showed substantial decreases in freshwater fish numbers. No evidence of a similar influx was seen in the North and Watson rivers, which drain shorter hydroperiod marshes and exhibit higher salinities. These results suggest that headwaters creeks can serve as important dry-season refugia. Increased freshwater flow resulting from Everglades restoration is expected to enhance this connectivity.

Reconstructing Caribbean Salinity Changes Over Time Utilizing Coral Skeleton Geochemistry

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In 2002, a large number of coral cores (Montastraea faveolata and Siderastrea sidereal) were collected from the Lesser Antilles (Barbuda to Union Island) with the primary objective being the examination of the interaction between salinity, water, and temperature in the Atlantic and the Caribbean. Here, we discuss the use of stable isotopes and the trace element composition of coral skeletons as a multi-proxy approach to reconstructing regional climate, water mass flow, and riverine (Amazon and Orinoco) inputs. As instrumental records from all of the collection locations demonstrate similar variations in water temperature, changes between the oxygen isotopic signatures of the corals at the individual localities should be principally a reflection of the salinity conditions. To this extent, early findings from specimens collected at Bequia, Union Island, Guadaloupe, and St. Croix exhibit differences in oxygen isotope composition, with the specimens originating from the more southerly islands exhibiting oxygen isotopic values which are more negative than their northern counterparts. This suggests that the southern portion of the Caribbean is influenced by lower salinity waters originating from the input of the Amazon and Orinoco, and ITCZ associated precipitation. On a local scale some corals demonstrate less pronounced cyclicity in oxygen isotopes, while maintaining a clear annual carbon cycle. This seems to suggest that run off from land may be both amplifying the carbon signature and masking the oxygen isotope signature. Preliminary investigation suggests that fine tuning both age control and sampling techniques can eliminate some of the observed ambiguity and highlights the need for more refined practices for the analysis of coral geochemical records.
Biscayne Bay, Florida is a complex coastal environment with many possible natural and anthropogenic sources of nitrogen. Such sources include precipitation, N fixation, nutrient regeneration/recycling, landfill soil leaching, groundwater and agricultural runoff, septic tank leakage, and treated waste water effluent. In order to understand the relative importance of these various inputs samples of benthic macroalgae, seagrasses, and seawater were collected from Biscayne Bay, transecting from canals through the bay to offshore reef sites. Macroalgae was identified by species, decarbonated, and analyzed for $\delta^{15}N$ and $\delta^{13}C$. The mean $\delta^{15}N$ and $\delta^{13}C$ for the algal tissue were +5.4 (±0.3‰) and -15.1 (±0.1‰), respectively. Measured nearshore algal samples differed greatly from offshore samples with a high $d^{15}N$ value of +12.0 (±0.1‰) and a mean of +8.6 (±3.0‰), in comparison to offshore samples that averaged +4.7 (±2.5‰). Despite the variation in $d^{15}N$, the $d^{13}C$ values for both nearshore and offshore samples fell within the accepted parameters for algal communities. Seawater was analyzed for $d^{15}N$ in DIN (dissolved inorganic nitrogen) and DON (dissolved organic nitrogen) through the cadmium reduction method (Mcllvin and Altabet, 2005). The mean $d^{15}N$ for the DIN was +4.5 (±3.9‰) and the DON was +5.8 (±3.3‰). Canal DON $d^{15}N$ values contained the heaviest measured values at ~+18‰, while nearshore and offshore DON values were lighter, 4.9 (±1.6‰). DIN values were more spatially variable with canal and nearshore sites ranging from ~+10‰ through ~-4.5‰. This study will continue over the next two years to examine possible temporal C and N isotope variations and will expand to include a larger geographic region focusing on areas with high nutrient levels and harmful algal blooms (HABs).