Southeast Tidal Creeks Summit

Wilmington, NC, December 16-17, 2013

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Agenda

Day 1 - Monday, December 16, 2013

8:00 - 12:00 Optional Tours
Tour 1 - Tidal Creeks in Wilmington North Carolina: Touring the Good, the Bad, and the Ugly
Tour 2 - Living Shoreline and Oyster Reef Restoration Tour to Morris Landing Water Quality Preserve, Holly Ridge, NC

1:00 - 2:30 General Session
Moderator, Susan White, North Carolina Sea Grant

Welcoming Remarks
Susan White, North Carolina Sea Grant

North Carolina Tidal Creeks: Structure and Issues
Mike Mallin, University of North Carolina - Wilmington

Plodding the Pluff Mud Path: Progress Since 2011
Denise Sanger, South Carolina Department of Natural Resources

Tidal Creeks Strategic Plan
Rick Devoe, South Carolina Sea Grant Consortium

Considerations for Freshwater Tidal Creek Systems
Carl Trettin, United States Forest Service

Managing Tidal Creeks to Address Climate Change: Vulnerability & Adaptation
Austin Kane, National Wildlife Federation

2:30 - 2:45 Break

2:45 - 3:45 General Session: Nutrient Management Criteria
Moderator, Susan White, North Carolina Sea Grant

Should Nutrient Management Strategies Consider Site-Specific Variability? Case Study of Phytoplankton Responses to Nitrogen and Phosphorus in Distinct South Carolina Coastal Systems
Dianne Greenfield, University of South Carolina

Developing Numeric Nutrient Criteria for Southwest Florida Tidal Creeks
Jay Leverone, Sarasota Bay Estuary Program

Developing Numeric Nutrient Criteria for Southwest Florida Tidal Creeks Part 2: Creek Classification, Selection, and Sampling Design
Mike Wessel, Janicki Environmental, Inc.

Numeric Nutrient Criteria Development in South Carolina Tidal Creeks and Estuaries
Cassandra West, South Carolina Department of Health & Environmental Control

3:45-4:10 Break

4:10-5:10 Concurrent Sessions

A. Pollution Accumulation - *Magnolia Room*
Moderator, Jessi Baker, NC Department of Environment and Natural Resources

Polycyclic Aromatic Hydrocarbons in Sediments and Oysters Collected in Southeast North Carolina
Ralph Mead, UNC-Wilmington

Indicators of the Occurrence of Vibrio in the Winyah Bay, SC Estuary
Dan Tufford, University of South Carolina

Trace Metals, Including Mercury, in Oyster Tissues and Sediments, New Hanover and Brunswick Counties, NC
Stephen Skrabal, UNC-Wilmington

Assessment of Particulate Removal Associated with the Presence of Oyster (*Crassostrea virginica)* Structure in a Tidally Dominated Creek System: Partitioning of Active and Passive Particle Removal
Mary Grace Lemon, UNC-Wilmington

B. Outreach and Education - *Dogwood Room*
Moderator, Heather Coats, NC Department of Environment and Natural Resources

From Seeds to Shoreline: Engaging Youth in Salt Marsh Restoration
Kimberly Counts, Clemson University

Restoring the Rookery Bay Estuary: Connecting People and Science for Long-Term Community Benefit
Victoria Vazquez, College of Charleston

Protecting Tidal Creeks: Riverkeeper Perspectives
Heather Ward, Waterkeepers Carolina

Building Rain Gardens to Restore Oyster Reefs: Watershed Stormwater Reduction Coupled with Restoring Oyster Reefs in Tidal Creeks
Ted Wilgis, NC Coastal Federation

5:30 - 7:00 Poster and Exhibit Social

Posters: A listing can be found on page 42 of this program.

Exhibitors:

Stantec	***Moffatt & Nichol***
EnviroCert International, Inc.	***MES Program, College of Charleston***
Backwater Environmental	***Water Resources Research Institute***
YSI Inc	***Environmental Services, Inc.***

7:30 - 9:30 Informal Social at Front Street Brewery (located at 9 North Front Street)

Day 2 - Tuesday, December 17, 2013

7:00 - 8:00 Coffee and Continental Breakfast

8:00 - 9:45 Concurrent Sessions

A. Faunal Assessment and Restoration - *Magnolia Room*
Moderator, Gloria Putnam, North Carolina Sea Grant

Monitoring and Improving Intertidal Oyster Resources in South Carolina Through the Use of Helicopter-based Aerial Surveying
Katherine Luciano, South Carolina Department of Natural Resources

Sampling Grass Shrimp in Georgia's Tidal Creeks: Providing a Foundation for Student Research via Long-term Monitoring
Katherine Doyle, Savannah State University

Restoration of Oyster Reefs in Tidal Creeks: Does Landscape Matter?
Marc Hanke, University of North Carolina-Wilmington

The First Steps to Restoring Ecosystem Services Within a "Degraded" Tidal Creek
Keith Walters, Coastal Carolina University

Expanding Living Shorelines Through Stakeholder-driven Site Selections for Intertidal Oyster Reef Building in the ACE Basin NERR, South Carolina
Benjamin Stone, South Carolina Department of Natural Resources

The Eastern Oyster (*Crassostrea virginica*) as a Modifier of Epizooic Microalgal Biomass: the Influence of Oyster Reef Characteristics and Associated Particulates
Troy Alphin, University of North Carolina-Wilmington

B. Physical and Chemical Functions - *Dogwood Room*
Moderator, Dianne Greenfield, University of South Carolina / SC Department of Natural Resources

Ecological Flows Framework for North Carolina Coastal Streams
Eban Bean, East Carolina University

Using Time-series Water Budgets to Assess Tidal Influence on Fluid Composition (Surface and Subsurface Inputs) in Urbanized Tidal Creeks
Leigha Peterson, Coastal Carolina University

Seasonal and Tidal Variations in Pore-water Distributions of Nutrients, Oxygen, Sulfide and Redox-sensitive Metals in an Urban Tidal Creek, Withers Swash, Myrtle Beach, SC
Brent Lewis, Coastal Carolina University

Initial Trends in Dissolved Organic Matter Concentrations and Quality in a Creek Draining a Typical Tidal Salt Marsh of the Southeastern US
Aron Stubbins, Skidaway Institute of Oceanography, University of Georgia

Impact of Beachface Geomorphology on Salt Marsh Flushing in Singleton Swash, Myrtle Beach
Rick Peterson, Coastal Carolina University

Understanding the Water Dynamics in the Freshwater Forested Zone of Tidal Creeks: Implications for Sea level Rise
Brooke Czwartacki, College of Charleston

9:45 - 10:15 Break

10:15 - 12:00 Concurrent Sessions

A. Impacts to Tidal Creeks – *Magnolia Room*
Moderator, Denise Sanger, SC Department Natural Resources

Relationships Between Land Use, Land Cover Change and Changes in Juvenile Fish, and Invertebrate Abundance in the Estuarine Nursery Areas of North Carolina
Gregory Meyer, Forsyth Technical Community College

Impacts of Channelization on Coastal Streams in South Carolina
Anand Jayakaran, Clemson University

Water Quality in Stormwater Detention Ponds and the Impact of Pond Discharges on Ecosystem Processes Within Tidal Creek Receiving Waters
Erik Smith, University of South Carolina

Impacts of On-site Sewage Disposal Systems on Jupiter Creek, an Urbanized Tidal Creek in Southeast Florida, USA
Marie Tarnowski, Florida Atlantic University, Harbor Branch Oceanographic Institute

Use of Host Specific Fecal Indicator Bacteria Microbial Source Tracking to Identify Contributions to Bacterial Impairments in Tidal Creeks Along the Grand Strand, South Carolina
J. Michael Trapp, Coastal Carolina University

B. Restoration - *Dogwood Room*
Moderator, Barbara Doll, North Carolina Sea Grant

Heal Our Waterways: Restoring Bradley and Hewletts Creek Through Community Partnerships and Voluntary Participation
Erin Carey, City of Wilmington - Heal our Waterways

Recent Tidal Creek Restoration Efforts in Tampa Bay
Edward Sherwood, Tampa Bay Estuary Program

Defining Eco-hydrological Function to Support Low Impact Development in Coastal South Carolina
Dan Hitchcock, Clemson - Baruch Institute

High Pollutant Removal in a Large Constructed Wetland Improves a Tidal Creek
Michael Mallin, University of North Carolina -Wilmington

What Water Quality Benefits Does a Constructed Brackish Marsh Provide When Receiving Nutrients From Agricultural Drainage Waters?
Randall Etheridge, NC State University

A New Coastal Stormwater Treatment Technique - Regenerative Stormwater Conveyances
Kevin Nunnery, Biohabitats, Inc.

12:00 - 1:00 Lunch

1:00 - 2:45 Identifying Future Directions for Tidal Creek Efforts - Topical Group Discussion

2:45 - 3:00 Break

3:00 - 4:00 Share Results and Wrap-up

Background Information for Opening General Session Speakers

Susan N. White
Executive Director, North Carolina Sea Grant and the Water Resources Research Institute for the University of North Carolina.
Susan White is the executive director of both North Carolina Sea Grant and the Water Resources Research Institute. Based at NC State University, both programs provide targeted research, outreach and education projects to address critical issues in the state and region. Previously, she was the director of the National Oceanic and Atmospheric Administration's Hollings Marine Laboratory in Charleston, S.C. There she provided research vision and organizational management, including strategic planning with the partner agencies and universities. She also had served as national research coordinator for NOAA's Estuarine Reserves Division and National Estuarine Research Reserve System. She grew up in Orange County, has a bachelor's from Duke University and a doctorate from the University of Georgia.

Michael Mallin
Research Professor, University of North Carolina, Wilmington
Michael A. Mallin is Research Professor at the University of North Carolina Wilmington Center for Marine Science. He has served as Research Director of the New Hanover County Tidal Creeks Program, the Wilmington Watershed Program, and the Lower Cape Fear River Program. His research interests include landscape impacts on water pollution, eutrophication, major storm impacts on water quality, assessing sources of nutrient and fecal pollution, and studying the efficacy of land mitigation of runoff pollution. He is an elected Fellow of the American Association for the Advancement of Science, an Aldo Leopold Leadership Fellow, and has served as President of the Southeastern Estuarine Research Society.

Denise Sanger
Associate Marine Scientist, South Carolina Department of Natural Resource's Marine Resources Research Institute
Dr. Denise Sanger is responsible for overseeing the Environmental Research Section and the Southeast Regional Taxonomic Center. She obtained her Doctorate in Marine Science in 1998 from the University of South Carolina and her Bachelor of Arts degree in Marine Biology in 1993 from the University of California, Santa Cruz. Denise has worked for the SC Department of Health and Environmental Control's Office of Ocean and Coastal Resource Management and SC Sea Grant Consortium. She has experience in coastal and estuarine ecology and coastal zone management. She is particularly interested in the impacts of human land use on the estuarine environment.

M. Richard (Rick) DeVoe
Executive Director, South Carolina Sea Grant Consortium
Rick DeVoe joined the S.C. Sea Grant Consortium, an independent state agency, in 1980, and has served as its Executive Director since 1997. Rick is also a member of the Graduate School Advisory Board and the Masters in Public Administration Program Advisory Board, and an Associate Faculty Member of the Graduate Program in Marine Biology, and Adjunct Faculty Member with the Marine Environmental Studies Graduate Program, all at the College of Charleston. In addition, he serves as a member of the Board of Advisors for the Center for Marine and Wetland Studies at Coastal Carolina University and a Research Associate of the Belle W. Baruch Institute for Marine Biology and Coastal Research at the University of South Carolina. He earned degrees from Fairleigh Dickinson University (B.S., marine biology), CUNY/City College of New York (M.A., biological oceanography), and the University of Rhode Island (M.M.A., marine policy).

Presentation Abstracts - Listed alphabetically by last name

The Eastern Oyster (*Crassostrea virginica*) as a Modifier of Epizooic Microalgal Biomass: the Influence of Oyster Reef Characteristics and Associated Particulates

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Co-Authors: Lawrence Cahoon, Martin Posey, and Anne Markwith - University of North Carolina Wilmington

The intertidal oyster resources of southeastern North Carolina act as critical habitat in coastal creeks and sounds, supporting fisheries, stabilizing shorelines, and improving water quality characteristics through filtration and enhanced deposition. Here we examine the unique three dimensional structure oysters provide as a potential source and modifier of benthic microalgal biomass. We examined epizooic microalgae associated with oyster populations growing within three tidal creek ecosystems in southeastern North Carolina. These mini-estuaries differed in the magnitude of human impacts, based on watershed metrics of population density, percent of impervious surface, and drainage area. Oyster coverage across most of the tidally influenced portion of each watershed is similar, but some metrics of oyster health differ among creeks and locations within the creeks. Data on oyster reef characteristics and microalgal biomass (as chl a levels) and taxonomy associated with oyster shells have been collected near the mouth and in upper regions of each of three target creeks. Data were also collected on the characteristics (total weight, grain size distribution, and percent organics) of other materials associated with oyster shell surfaces. Samples were taken from the surface of the oyster matrix and from within the oyster matrix on each reef. These data suggest an interesting and potentially significant link between intertidal oysters and epizooic microalgal production in this system. As previously reported, oysters support very large microalgal biomass per unit of bottom area but how does this relationship change as oyster reef characteristics shift, and is it influenced by the type and quantity of material associated with living oyster shells? These data suggest a differential link between living oyster populations and epizooic microalgal biomass in intertidal systems based on position within the creek.

About the Speaker: Mr. Alphin currently serves as Senior Research Associate with the University of North Carolina Wilmington in the Department of Biology and Marine Biology and the Center for Marine Science. He is a benthic ecologist and shellfish biologist, who has worked on issues related to trophic dynamics and ecosystem function of tidal creek and estuarine systems, beach renourishment and borrow site impacts, dredging impacts in estuarine systems and beach functionality as well as function of evaluation of erosion control structures. He has worked in estuarine, beach, near shore and offshore systems on the Atlantic coast of the United States and the Gulf of Mexico since 1991. He served as a member of the Shellfish Advisory Committee, to the North Carolina Division of Marine Fisheries, 1999-2012 as well as serving on FMP committees for oysters, clams and bay scallops. He currently serves on the BOD of the East Coast Shellfish Research Institute since 2009 and as the Vice-President since 2010. He has published over 50 peer reviewed scientific articles and presented or coauthored more than 95 presentations at national and international scientific meetings.

Insights into the Impact
Ecological Flows Framework for North Carolina Coastal Streams

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The NC Department of Environment and Natural Resources (DENR) is in the process of identifying flows necessary to maintain ecological integrity of rivers and streams across the state. This ecological flow (EF) approach will provide a planning tool to evaluate the effects of water withdrawals on aquatic ecology. An EF Science Advisory Board has been charged with recommending such an approach to DENR for the state. EF models based on stage-discharge relationships can be applied to much of the state, but in coastal areas the stage-discharge relationships are affected by tides and wind. Existing EF models for non-coastal regions are generally inadequate for the coastal plain due to its low elevations, flat terrain, proximity to tidal influence, saline waters, and lack of historical monitoring data. As a result, a group of coastal stream experts from universities, private industry, and government agencies formed the Coastal Ecological Flows Work Group. The overall objective of the CEFWG was to assess the general ability to establish an EF approach for coastal streams. The CEFWG has assessed applicability of previous coastal work developed stream typology; performed spatial modeling and mapping; evaluated relevant ecological and biological dependencies on flow; developed a framework for potential coastal EF criteria and protocols where possible; and identified factors limiting EF protocols and needed research within coastal systems. The framework recommended by the CEFWG included the following EF determinants: 1) extension of the state-wide flow-by criteria where possible; 2) condition of habitat, primarily for anadromous fish; 3) downstream salinity; and 4) overbank flow. The CEFWG proposed formation of a joint committee to further develop the framework.

About the Speaker: Dr. Eban Bean is an Assistant Professor in East Carolina University's Department of Engineering and Institute for Coastal Science and Policy since 2012. His research focuses on sustaining and improving water quality on the coast and within the coastal plain. His research has focused on coastal stream water quality dynamics and understanding non-point source pollutants within urban and residential landscapes, specifically from stormwater runoff and discharge from wastewater treatment systems

Heal Our Waterways: Restoring Bradley and Hewletts Creek through Community Partnerships and Voluntary Participation

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In September of 2012 the Wilmington City Council adopted the Bradley and Hewletts Creek Watershed Restoration Plan to address long standing water quality problems in two of the city's largest watersheds. The action is a proactive approach to reducing water pollution through stormwater reduction without the allocation of a TMDL; concentrating specifically on high bacteria counts in the targeted creeks. These elevated counts are caused by increased hydrograph volumes in direct correlation with the expanding percentage of impervious surface in each watershed. The result: progressive shellfishing closures over the last several decades and recreational swimming advisories in Banks Channel at Wrightsville Beach. Efforts outlined in the plan seek to reduce the volume of stormwater reaching the affected waterways to pre- shellfishing closure levels through the installations of Best Management Practices, or BMPs, on public and private lands. A GIS atlas has been developed for the program to track these installations and their impact on the hydrograph of the affected watershed. Participation in the restoration effort is purely voluntary and will rely almost exclusively on watershed residents and businesses as key stakeholders.

This presentation will cover a brief history of the affected creeks and their closures as well as detailing the development of the plan and the establishment of the original community partnerships. Of particular concentration will be the unique challenges of working within a matrix of wholly voluntary participation, the problem of public perception versus reality, and current collaborative projects spearheaded by the City of Wilmington and its partners.

About the Speaker: Erin Carey is the Watershed Coordinator for the City of Wilmington and is currently overseeing the implementation of the Bradley and Hewletts Creek Watershed Restoration Plan. She holds a Bachelor of Science in Environmental Science and a Master of Science in Marine Science from the University of North Carolina at Wilmington. While at the university she specialized in coastal and inland surface water quality analysis as well as the effects of beach renourishment on benthic microalgae. Erin spent three years working for NCDENR as the microbiology lab technician for Shellfish Sanitation before transferring to the Division of Water Quality's Aquifer Protection Section where she worked as an environmental compliance specialist for non-discharge wastewater facilities in the Wilmington region.

From Seeds to Shoreline: Engaging Youth in Salt Marsh Restoration

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From Seeds to Shoreline (S2S) is a South Carolina-based youth wetland restoration initiative in which students learn about the salt marsh ecosystem and actively contribute to salt marsh restoration efforts. Students engage in hands-on science education that includes seed collection, germination, cultivation and planting of Spartina alterniflora, the dominant plant in a South Carolina salt marsh. In conjunction with this, teacher workshops provide the tools necessary to execute S2S effectively and autonomously as teachers received starter kits, educational resources, renewal credits and assistance in developing an implementation plan unique to their individual school needs. S2S spans the length of the school year, is aligned with state science standards and encourages student-driven science investigations.
S2S was piloted in January 2011 with sixteen teachers, eight schools, and nearly 700 students participating. By the 2013 school year, the program has grown to include twenty-six teachers, eighteen schools, and over one thousand students participating largely from coastal counties. A total of forty-eight teachers participated in a series of S2S teacher workshops during the 2012 and 2013 summers. S2S is the first student-driven wetland restoration project in South Carolina, providing an opportunity for community service-learning with emphasis on environmental stewardship. From Seeds to Shoreline is offered in partnership by the South Carolina Sea Grant Consortium, South Carolina Department of Natural Resources, and Clemson Cooperative Extension Service.

About the Speaker: Kimberly Counts is a Water Resources Extension Agent, working for Clemson University Cooperative Extension Service and the Carolina Clear Program. Kim co-coordinates the Ashley Cooper Stormwater Education Consortium (ACSEC), working alongside the county and municipal governments, and a host of educational partners including non-profit organizations, universities, and local and state agencies. As co-coordinator, Kim facilitates the efforts of the ACSEC in working towards the goal of implementing a regional, watershed-scale stormwater runoff education strategy in the Tri-County area. Prior to her time with Clemson, Kim worked for the South Carolina Department of Natural Resources as the stewardship biologist for the ACE Basin National Estuarine Research Reserve. She has earned her Master of Science degree from the College of Charleston's Environmental Studies Graduate Program, and a Bachelor of Science degree from Presbyterian College.

Understanding the Water Dynamics in the Freshwater Forested Zone of Tidal Creeks: Implications for Sea Level Rise

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The southeastern Atlantic lower coastal plain contains areas characterized by a low topographic gradient with drainage systems connected to mesotidal estuaries. The estuarine interface results in long inland reaches of freshwater tidal streams with adjoining forested riparian zones. In these zones, river discharge, geomorphology, climate, and tide stage combine to create heterogeneous, biologically complex systems. Sea level rise would inundate riparian areas and lead to forest ecosystem loss and marsh expansion. These systems require a better understanding of the hydrology and associated linkages to ecosystem services to understand how sea level rise will impact their function in the landscape. Huger Creek, a fourth order freshwater tidal stream and headwater source of the East Branch of the Cooper River, discharges into the Charleston Harbor estuary in South Carolina. This site was studied to determine the effects of a decreasing tidal gradient on water table dynamics and vegetative communities within the riparian wetland. Turkey Creek, a non-tidal tributary of Huger Creek was studied for comparison. In the tidally dominated zone, the water table gradient within the riparian wetland was in the upstream direction along a 600 m stream reach, and experienced water table tidal forcing up to 50 m away from the creek bank. Near the non-tidal boundary, a shift to fluvial dominated hydrodynamics occurred with water table controlled by topography, evapotranspiration, and precipitation. Huger Creek is a freshwater reservoir for the wetland through the daily tide cycle. The tidal and non-tidal forested wetlands were hydrologically distinct, but vegetation communities were insensitive to changes in hydrologic regime. These results demonstrate the need to assess and delineate tidal and non-tidal forested riparian zones separately when considering their role in the landscape. This knowledge is fundamental to understanding how sea level rise may affect habitat quality, nutrient exchange and sediment transport to the estuary.

About the Speaker: Brooke earned her Bachelor of Science degree in Biology from Shenandoah University in 2007, and recently received her Master of Science in Environmental Studies from the College of Charleston. Brooke's thesis research focused on the water dynamics and biological response in a tidal freshwater forested wetland, and was a collaboration between the College, US Forest Service, and Clemson University. Formerly, Brooke was employed by the US Forest Service, the Maryland and South Carolina Department of Natural Resources and the University of Georgia.

Sampling Grass Shrimp in Georgia's Tidal Creeks: Providing a Foundation for Student Research via Long-term Monitoring

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Long-term data sets are invaluable resources that enable analysis of trends over time. Often the protocols implemented to collect such data are designed to answer one specific question. For the last seven years we have employed a sampling regime that allows several variables to be examined efficiently while also providing the basis for multiple student projects at the graduate and undergraduate level. Our methodology targets multiple grass shrimp species in shallow creeks. In the results to date, 91% of grass shrimp collected were daggerblade grass shrimp (*Palaemonetes pugio)*, while only 9% were the common grass shrimp (*P. vulgaris*). Over the years of the study, an average of 28% of all grass shrimp captured between June and August were ovigerous. Approximately 2% of all *P. pugio* were parasitized by the isopod *Probopyrus pandalicola*, which inhibits reproduction and thereby potentially impacts shrimp populations. Data collection occurred in 2 to 4 different tidal creeks from 5 to 12 months in a given year, enabling our data to be further refined into spatial and seasonal patterns, and analyzed with respect to physical parameters. There were large differences in mean shrimp abundance across sites. A tidal creek on Burnside Island, GA consistently yielded over half (54 ± 0.59%) of the total shrimp caught, with the highest catches occurring between June and August. Spatial and temporal data such as these help to elucidate the role of grass shrimp in the estuarine food web as well as their life history.

About the Speaker: Katherine Doyle is a marine science technician at Savannah State University in Savannah, GA. She began work at Savannah State in May 2010 and helps the faculty and students in the Marine and Environmental Sciences department with biological, chemical, and physical oceanographic research. She also assists with boat operations for the department. She earned her B.S. in both Marine Science and Biology with a minor in Chemistry from the University of Tampa (Tampa, FL) in May 2000. Later, she earned her M.S. in Marine Science at the University of Georgia's (Athens, GA) Marine Science program in August 2007.

What Water Quality Benefits does a Constructed Brackish Marsh Provide when Receiving Nutrients from Agricultural Drainage Waters?

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Destruction of coastal marshes and accelerated eutrophication are two of the problems being faced in coastal areas. Strategically located constructed marshes have the potential to provide lost ecosystem services along with reducing the loads of nutrients reaching estuaries. However, the true effectiveness of created marsh systems for improving water quality is unknown. Efforts to quantify the water quality benefits of these systems have been hindered by low sampling frequency and extrapolation of short-term events to long periods of time. Automated on-site monitoring systems have made possible long-term, high temporal resolution water quality monitoring in systems with tidal flow. UV-Visual spectrometers have proven useful for measuring salinity, nitrate, total kjeldahl nitrogen, dissolved organic carbon, phosphate, total phosphorus, and total suspended solids concentrations in brackish marsh waters.
In 2005 and 2006 a brackish marsh was constructed in North Carolina just downstream of row crop agricultural production with the goal of providing ecosystem services similar to those in a natural marsh and reducing the loads of nutrients reaching the estuary. The mass of nutrients entering and leaving the constructed system was calculated using high frequency water quality measurements and continuous flow monitoring over a 20 month period. Long-term intensive monitoring allowed seasonal variations in concentrations to be observed while capturing both normal tidal fluctuations and extreme events. Results show that the marsh retained 40 kg of nitrate from the upstream agricultural production. The export of total kjeldahl nitrogen (120 kg) and dissolved organic carbon (1,400 kg) were expected based on current knowledge of marsh biogeochemical processes. The export of total suspended solids (3,000 kg), although minor, was not expected and is a concern for the marsh's ability to adjust to sea level rise. The implications of this research with respect to water quality monitoring, marsh design, and coastal eutrophication will be presented.

***About the Speaker:** François Birgand, Ph.D. is an Assistant Professor in the Biological & Agricultural Engineering Department at North Carolina State University. Birgand's research and teaching focuses on Biogeochemistry, Ecological Engineering, Water Quality and Watershed Monitoring.

About the Author: Randall Etheridge is an engineering intern at the Southwest Florida Water Management District. His research related to tidal marsh creation was completed while he was a student at North Carolina State University. He will receive a PhD in Biological and Agricultural Engineering from N. C. State in December.

Should Nutrient Management Strategies Cnsider Site-specific Variability? Case Study of Phytoplankton Responses to Nitrogen and Phosphorus in Distinct South Carolina Coastal Systems

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It is generally accepted that elevated levels of nitrogen (N) and phosphorus (P) are associated with eutrophication in a wide range of aquatic systems. In coastal South Carolina (SC), human population density and therefore urbanization is predicted to increase rapidly over the next few decades, which will undoubtedly affect the levels of N and P in receiving tidal creeks and estuaries. In preparation, regulators are considering numeric criteria for N and P in the coastal zone, and biological responses should be incorporated to management decisions. This project examines how N, P, and phytoplankton may vary with land use along the SC coast through field and laboratory studies. Nutrient addition incubation experiments were conducted over 48 hrs in situ in four SC habitats representing distinct land use patterns: a forested tidal creek in Winyah Bay, an urbanized tidal creek in the Ashley River, a salt marsh in the Combahee River, and a stormwater detention pond on Kiawah Island. Phytoplankton biomass and community composition responses to various forms of N, with and without P, were assessed at each site seasonally over two years (2011-2013), and high performance liquid chromatography (HPLC) pigment concentrations are being analyzed using CHEMTAX to determine relative abundances of major algal taxa. Since coastal SC is rich in terrigenous dissolved organic carbon (DOC), which fuels microbial respiration, DOC and the heterotrophy vs. phototrophy balance are also being assessed. Focused monitoring studies are being conducted in the Charleston Harbor and Winyah Bay system to examine N and P dynamics over an annual cycle, and the influence of certain N to P ratios on the physiological responses of key harmful algal bloom species are being assessed in a laboratory setting to determine whether certain ratios may promote bloom formation.

About the Speaker: Dr. Dianne Greenfield is a Research Assistant Professor with USC's Belle W. Baruch Institute for Marine and Coastal Sciences and holds a joint appointment as the Director of the SC Algal Ecology Laboratory at the Marine Resources Research Institute, SCDNR. Her research interests are in marine and coastal phytoplankton ecology, physiology, and nutrient biogeochemistry. More specifically, she studies the causes and consequences of bloom formation, including but not limited to harmful algal bloom (HAB) species in estuarine and coastal waters. Dr. Greenfield uses a wide variety of techniques ranging from microscopy to molecular approaches. Before joining the SCAEL, Dr. Greenfield received a PhD in Oceanography from Stony Brook University where she she investigated how the "brown tide" pelagophyte *Aureococcus anophagefferens* influenced variability in phytoplankton assemblages and the growth/feeding physiology of hard clams amongst Long Island, NY, embayments as well as a Postdoctoral Fellowship from the Monterey Bay Aquarium Research Institute (MBARI) where she used ribosomal RNA-targeted DNA probes to characterize phytoplankton assemblages, particularly related to the ocean observing instrument, the Environmental Sample Processor (ESP).

Restoration of Oyster Reefs in Tidal Creeks: Does Landscape Matter?

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Within tidal creeks of the southeastern United States, the eastern oyster, Crassostrea virginica, is an ecologically and economically important species. Over the last century, oyster populations have drastically declined due to many anthropogenic impacts. In an effort to regain the ecosystem services that oysters provide, substantial efforts have been put forth to restore lost services by creating oyster reefs. Despite many successful restorations, many questions still remain in understanding the dynamics on created reefs that may influence restoration design, especially over a large spatial scale, such as optimal patch size and amount of edge versus interior habitat. This lack of knowledge of landscape factors for created oyster reefs impacts and hinders management decisions when creating oyster reefs in terms of optimizing design and resources. As part of a larger study, we evaluated spatial dynamics for natural oyster populations in tidal creeks of Wilmington, North Carolina; specifically focusing on the relationship between edge and interior, oyster reef size, and whether the reef was an isolated patch or a contiguous reef fringing marsh habitat. In addition, oyster populations at two sites were examined on three size classes of created fringing reefs. Oyster communities differed based upon reef type and demonstrated an edge effect; with increased densities in interior reef locations. Additionally, potential ecological trade-offs for oysters were observed, with large reefs having greater densities of oysters with lower condition compared to small reefs that have lower densities of oysters with increased condition. Oyster communities differed between the two created sites, but generally followed the same landscape patterns as the natural tidal creek reefs. This study emphasizes the importance of location and spatial dynamics during restoration, as oyster reefs cannot be considered as uniform wholes, but may differ substantially with landscape characteristics.

About the Speaker: Marc Hanke graduated from Texas A&M Galveston in 2006 with a B.S. in Marine Biology and a minor in Chemistry. In 2009 he graduated from the University of North Florida with a M.S. in Biology. At UNF, he focused on habitat utilization of silver perch and their response to hypoxic conditions across different life history stages. He is currently a fourth year PhD student in the Benthic Ecology lab at the University of North Carolina Wilmington focusing on landscape characteristics of natural and created intertidal oyster reef communities in southeastern North Carolina.

Defining Ecohydrological Function to Support Low Impact Development in Coastal South Carolina

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In the face of dual pressures in coastal South Carolina - residential and commercial development along with potential climate change impacts - stakeholders need clear, accurate, relevant, comparable, easily-accessible information for effective decision-making for watershed management and natural resource protection. This presentation focuses on ecohydrological criteria being developed for sustainable land and water resource guidance in coastal South Carolina, specifically in upland areas that ultimately drain to tidal creeks. Runoff coefficients and derived curve numbers (CNs) â€“ hydrologic metrics that define rainfall-runoff relationships based on watershed and landscape characteristics - have been determined for first-order watersheds with flat topography and shallow groundwater. Results have implications for watershed planning and site engineering, including stormwater management and design. Forested water budgets for the goal of defining pre-development conditions are being refined, including the seasonal influence of evapotranspiration on water table elevation as it drives highly variable streamflow throughout the year. These results have the potential to not only inform coastal stormwater discharge target criteria but also guide the prioritization of conservation and restoration efforts. Stormwater control measures, specifically rain gardens and bioretention systems, have been investigated to determine hydraulic and water quality performance and the influence of groundwater on hydrological and chemical dynamics. Results are being integrated with an online mapping tool so that geospatial data site-based information can be available to decision-makers. An assessment of existing resources (green infrastructure) and their benefits via ecohydrological services at various scales provides useful guidance toward resource protection with the goal of creating resilient communities, whether via conservation or restoration efforts or better site design. These landscape elements are complex within and between these varying scales. With appropriate hydrological, ecological, and community-based assessments and targets, sustainable coastal land use goals may be better achieved to protect the water quality and ecological health of downstream tidal creeks.

About the Speaker: Dr. Dan Hitchcock is an Associate Professor in the School of Agriculture, Forest, and Environmental Sciences, stationed at Baruch Institute of Coastal Ecology and Forest Science located near Georgetown, SC. His areas of expertise include forest and urban hydrology, natural treatment systems, low impact development, and ecological engineering. He is a registered professional engineer in South Carolina. He received both his Ph.D. in Biological and Agricultural Engineering and M.S. in Environmental Health from the University of Georgia and his B.S. in Zoology from the University of Tennessee. Dan enjoys paddling and exploring the waters of coastal South Carolina and beyond.

Impacts of Channelization on Coastal Streams in South Carolina

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The channelization of coastal streams to support agriculture and commercial development has played a critical role in the development of South Carolina's coastal economy. However, the ecological cost of stream channelization or ditching in coastal watersheds is still an area for much needed investigation. With the continued urbanization of South Carolina's coastline, the delivery of sediment laden storm flows from urbanizing landscapes to receiving tidal waters is one of many threats to the state's tidal creeks. In order to quantify impacts of channelization in terms of sediment loadings to receiving reaches, geomorphologic and hydrologic assessments of a reference forested stream and a channelized stream in an urbanizing watershed were carried out in the Lower Coastal Plain of South Carolina. Both stream systems discharged into tidally influenced receiving waters. The study objectives were: (1) to quantify the range of runoff to rainfall ratios; (2) to quantify the range of specific sediment yields; (3) characterize the quantity and quality of particulate matter exported from the two watersheds; and (4) to estimate sediment yields attributable to agriculture, development and. Channel morphology, flow rates and suspended sediment loads were measured to arrive at an estimate of total sediments transported by the two stream systems. The two streams provide information at both ends of the development spectrum and provide insight into how storm flows may be managed so that natural fluvial processes within channelized streams might be enhanced. Comparisons between the two streams and the implications of this research on the management of coastal stream systems in the face of urbanization will be presented.

About the Speaker: Dr. Jayakaran has worked at Clemson University's Baruch Institute of Coastal Ecology and Forest Science in Georgetown South Carolina for the past six years. His research focusses on the impacts of development on coastal watersheds with emphasis on how stream systems are affected by urbanization and channelization. He earned his doctorate degree at Ohioc State University where he studied the impacts of agriculture on first order modified drainage ditches. He has a 25% extension appointment that allows him the resources and time to communicate his research findings to South Carolina's natural resource managers and citizens.

Managing Tidal Creeks to Address Climate Change: Vulnerability & Adaptation

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The National Wildlife Federation (NWF) partnered with the National Oceanic and Atmospheric Administration's (NOAA) Restoration Center to help set the stage for addressing climate change impacts in the coastal watersheds of the Chesapeake Bay, focusing on how to integrate climate change in coastal restoration and conservation activities. The focus of the project was on using a case study to show how to determine the vulnerability of a subwatershed to potential climate change impacts as well as provide a suite of potential adaptation options to address those vulnerabilities. Although the framework was used in the Chesapeake Bay, the process and the information from the project will be useful to those working within this watershed and beyond. The process and approach used for this effort is one that managers can replicate to help them conduct a vulnerability assessment and develop actionable adaptation options efficiently and effectively.

This presentation will focus on the assessment and adaptation development framework and approaches used for this effort and how they can be applied in other areas, such as tidal creek. Additionally, vulnerability results and adaptation options for example tidal creek habitats and species will also be highlighted to illustrate the type of information that can be developed and used from this type of process.

About the Speaker: Austin works with fish and wildlife agencies and other partners to integrate climate change into State Wildlife Action Plans. Austin also specializes in coastal climate change-related efforts, such as developing climate-smart guidance for coastal projects and building state capacity to develop and implement climate adaptation projects. Austin worked as a Science and Policy Analyst with the Environmental Law Institute and as an Assistant Planner for the Hawaii Division of Aquatic Resources. Austin has a Masters of Environmental Management from Duke and a BA in Biology from the University of Virginia.

Assessment of Particulate Removal Associated with the Presence of Oyster (Crassostrea virginica) Structure in a Tidally Dominated Creek System: Partitioning of Active and Passive Particle Removal

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Over the last two decades the eastern oyster (Crassostrea virginica) has received increased attention due to their role as ecosystem engineers. Oysters provide a variety of ecosystem services most notably filtration, substrate stabilization, nutrient cycling and habit. This study focuses on the role of oysters in removing particulates from the water column. A number of field studies have estimated filtration as the removal of suspended solids (TSS) and phytoplankton (Chl a) as water passes over C. virginica reefs. A majority of these studies indicate that there is more material being removed from the water column than would be predicted by oyster filtration rates alone. The physical structure of the oyster reef could impact particulate settlement through hydrodynamic changes and turbulent flow based on background flow velocities. The objective of this study is to determine the relative contribution of oyster filtration and passive sedimentation in intertidal creek systems. Loss of particulates as water travels over a reef was calculated from upstream/ downstream water sampling for Chl a, TSS, and sedimentation rates. These rates were compared to oyster biodeposits rates and published estimates of removal due to filtration. Comparisons were also made based on removal rates before and after oyster reef defaunation. This study will lead to a better understanding of how filtration and hydrodynamic factors interact to remove suspended particulates in dynamic intertidal creek systems and can help to guide future reef restoration efforts focused on water quality improvements.

About the Speaker: Mary Grace is currently pursuing a Master's degree in Marine Science at UNCW working with Michael Mallin, Martin Posey, and Troy Alphin. The focus of her project is partitioning active and passive particle removal across *Crassostrea Virginica* reefs in a small intertidal creek system. Her undergraduate studies were conducted at Tulane University where she double majored in Ecology and Evolutionary Biology and Economics. She completed an Honor's Thesis upon graduation entitled "Effects of Hurricane Katrina on the abundance and biodiversity of breeding birds in Honey Island Swamp, Louisiana." After completing her Master's, she has a short term goal of finding a job related to estuarine ecology and management. She also intends to pursue a PhD related to aquatic and estuarine ecology in the near future.

Developing Numeric Nutrient Criteria for Southwest Florida Tidal Creeks

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The three contiguous SW Florida National Estuary Programs (Tampa Bay, Sarasota Bay and Charlotte Harbor) recently developed numeric nutrient criteria (NNC) for their respective estuaries that were adopted by the USEPA and FDEP. Through the NNC development process it became clear that, while NNC were being developed for freshwater, estuarine and coastal systems, tidal creeks serve a distinct ecological role as areas of high productivity and as nursery habitat for estuarine and coastal fish species. As such, we recommended to state and Federal regulators that tidal creeks have their own water quality standards to protect and support aquatic life in these systems. We proposed to develop and execute protocols for the establishment of water quality standards for tidal creeks in SW Florida in order to provide protection and restoration targets for these critical ecological resources.

We identified over 300 tidal creeks within SW Florida estuaries. We refined several conceptual models (stressor-response, watershed management and conceptual ecological models) and identified forcing functions, drivers and mediating effects for their applicability to tidal creeks. Existing hydrographic, watershed, water quality and biological information was evaluated to assist in creek selection for sampling. We developed a method to classify creeks according to watershed characteristics and in-stream habitat features to arrive at a sampling matrix of sixteen creeks that represented the range of creeks found in SW Florida.

With assistance from six county partners, sampling will begin this fall and will include water quality (nutrients, chlorophyll, turbidity, DO, etc.), biology (fisheries, vegetation), and hydrology (stream flow, tides). Data will be analyzed with the objective of developing a tool/framework that can be applied to developing NNC for SW Florida tidal creeks. Proposed NNC will also include a methodology for implementation and compliance assessment.

About the Speaker: Dr. Jay Leverone is the staff scientist for the Sarasota Bay Estuary Program. Previously, he was a research scientist at Mote Marine Laboratory, studying the ecology of west Florida estuaries, characterizing estuarine habitats and how they are impacted by physical disturbances and water quality degradation. More recently, he has turned his attention to restoring local shellfish populations, particularly scallops and oysters. Dr. Leverone developed improved techniques for enhancing populations of bay scallops along the Florida Gulf coast and has led the way in restoring local oyster reefs. In 2007, he received his Ph.D. from USF College of Marine Sciences where he studied the effects of red tide on early life stages of local shellfish. His current focus as SBEP scientist has been the development of numeric nutrient criteria and a monitoring strategy for tidal creeks, both of which have regulatory implications for local governments.

Seasonal and Tidal Variations in Porewater Distributions of Nutrients, Oxygen, Sulfide and Redox-sensitive Metals in an Urban Tidal Creek, "Withers Swash", Myrtle Beach, SC.

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Long Bay, SC, experiences episodic hypoxia in near-shore waters during summer and early fall. A contributing factor is thought to be inputs of nutrients via storm water runoff and discharge from near-shore and tidal creek sediments. Here we report changing redox conditions from February to July, 2013, and dissolved nutrient concentrations in the sandy tidal creek sediments. A Hg/Au-amalgam microelectrode was used to profile pore water distributions of O2, sulfide, Mn(II), and Fe(II). Pore waters for nutrient analysis were collected using a whole-core squeezer. During winter and spring, the upper 3 cm of the sediment were suboxic. O2 disappeared by 0.5 cm into the sediment, while sulfide was undetectable until ~ 3 cm. Only trace levels of Mn(II) and Fe(II) were detected and dissolved ammonium and total dissolved phosphate (TDP) concentrations were low. These observations indicate slow organic matter (OM) diagenesis in the upper few centimeters of the sediments during the cool winter and spring months. In July, however, oxygen disappeared at the sediment-water interface. Dissolved sulfide was detected by 0.1 cm below the interface, and increased to > 50 micromolar through the upper 1 cm. For cores collected at low tide, porewater TDP and ammonium concentrations were ~ 2 and 10 times greater, respectively, in July than in April. These observations indicate enhanced OM diagenesis, dominated by sulfate-reducing bacteria. In July, porewater nutrient profiles for cores collected on the ebbing tide increased in concentration and shifted upward, suggesting a tidally-variable upward flux of nutrient-rich groundwater on the receding tide.

About the Speaker: Dr. Brent L. Lewis is an Associate Professor in the Marine Science Department at Coastal Carolina University in Conway SC, specializing in the aquatic geochemistry of trace elements. Dr. Lewis graduated from UNC-Wilmington in 1983 with a B.S. in biology and a B.A. in chemistry. He was awarded his doctorate in chemical oceanography at Florida State University in 1990.

Monitoring and Improving Intertidal Oyster Resources in South Carolina Through the Use of Helicopter-Based Aerial Surveying

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Mapping the geographic distribution of intertidal oyster resources in coastal South Carolina is an effort that was originally undertaken through boat-based surveys in the 1890s and 1980s. In more recent years (2003-present), a state-wide oyster database has been established using automated classification and manual editing techniques to delineate oyster reefs identified in geo-rectified digital orthophotography captured by plane over coastal areas of the state. The ongoing acquisition and integration of aerial imagery through helicopter-based surveys conducted by the South Carolina Department of Natural Resources (SCDNR) has provided a valuable source of updated information pertaining to the distribution and health of intertidal oyster beds. Once converted into a digital format and incorporated into the GIS database, imagery is used to assess the existing distribution of resources, and also allows for changes in reef size, shape, and density to be tracked over time. As an added benefit, the aerial imagery allows for the incorporation of oyster reefs that are inaccessible by boat, expanding overall coverage and facilitating the identification of false positives and negatives within the existing data set. Furthermore, helicopter-based aerial imagery acquisition assists in the monitoring and protection of oyster resources by allowing managers to better understand where harvesting pressure is negatively impacting the resource. Using this information, scientists and managers are better able to balance the protection of intertidal oyster resources with the harvesting needs of South Carolina's commercial and recreational permit holders. This presentation will discuss the use of aerial imagery acquisition as a means of improving spatial coverage of our surveys and our understanding of the uses of oyster resources in coastal South Carolina, and will present an overview of the current status of imagery acquisition and plans for the future.

High Pollutant Removal in a Large Constructed Wetland Improves a Tidal Creek

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Hewletts Creek, in Wilmington, North Carolina, drains a large suburban watershed and as such is impacted by high fecal bacteria loads and periodic algal blooms from nutrient loading. During 2007 a 7.6 acre wetland was constructed to treat stormwater runoff from a 589 acre watershed within the drainage. A rain event sampling program was carried out in 2010 to evaluate the efficacy of the wetland in reducing pollutant loads from stormwater. During eight storms sampled, the wetland served to greatly moderate the hydrograph, retaining and/or removing 50-75% of the inflowing stormwater volume within the wetland. Fecal coliform bacteria had an average load reduction of 99% and overall concentration reduction of > 90%. Particularly high (>90%) load reductions of ammonium, nitrate and orthophosphate occurred, and substantial reductions of total phosphorus and TSS loads were achieved. Long-term before-and-after sampling in downstream Hewletts Creek proper showed that, following wetland construction, statistically-significant decreases for nitrate, ammonium and fecal coliform bacteria were realized. The factors influencing microbial nitrogen removal from stormwater were examined from the wetland in 2011. The abundance and activity of sediment anammox and denitrifying communities were measured using quantitative PCR and 15N tracer incubation experiments, respectively. Denitrification was found to be the dominant N removal pathway in both bare sediments and plant rhizospheres. The activity of both anammox and denitrification were found to be higher in the rhizosphere compared to bare sediment. Increased water temperature stimulated denitrification in macrophyte rhizospheres, but had no effect on rhizosphere anammox, while in sediment samples both denitrification and anammox were negatively correlated with water temperature. Pickerelweed had overall highest denitrification, with alligatorweed second. Pickerelweed, cattail, giant cutgrass, and bur-reed had highest anammox. Parrott feather had poorest N removal for both processes. These results indicate wetland plants play a species-specific role in enhancing sedimentary N removal processes

About the Speaker: Michael A. Mallin is Research Professor at the University of North Carolina Wilmington Center for Marine Science. He has served as Research Director of the New Hanover County Tidal Creeks Program, the Wilmington Watershed Program, and the Lower Cape Fear River Program. His research interests include landscape impacts on water pollution, eutrophication, major storm impacts on water quality, assessing sources of nutrient and fecal pollution, and studying the efficacy of land mitigation of runoff pollution. He is an elected Fellow of the American Association for the Advancement of Science, an Aldo Leopold Leadership Fellow, and has served as President of the Southeastern Estuarine Research Society

Polycyclic Aromatic Hydrocarbons in Sediments and Oysters Collected in S.E. North Carolina

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Polycyclic aromatic hydrocarbons (PAH) have been analyzed in sediments and oysters collected form a variety of locations within coastal New Hanover County, Lockwood Folly and Bald Head Island. Preliminary data suggests sediments and oysters collected near anthropogenically impacted (marina) or poor tidally flushed creeks had elevated concentrations of PAHs (100's Âµg/g) while more pristine locations had reduced concentrations. Many of the oysters collected from the different stations did not necessarily reflect the distribution and concentrations of PAHs in the sediments. For example, sediments collected from upper reaches of Lockwood Folly were enriched in 5 membered ring PAHs relative to oysters collected at the same station. This suggests the oysters are bioaccumulating the smaller molecular weight; more water soluble PAHs in their tissues. The source of PAHs to the sediments and oysters appears to be from a mixture of pyrogenic (e.g. wood combustion) and petrogenic (e.g. fossil fuel combustion) sources, the exact contribution of each source though is unclear at this time.

About the Speaker: Associate Professor in Department of Chemistry and Biochemistry at UNCW and my research interests are analytical chemistry and marine organic geochemistry. I received a BS in Chemistry from Florida State University, PhD in Chemistry from Florida International University, Post-doc at University of South Carolina Chemical Oceanography.

Relationship Between Land Use Land Cover Change and Changes in Juvenile Fish and Invertebrate Abundance in the Estuarine Nursery Areas of North Carolina

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Land use and land cover change analysis was performed for years 1980 and 2000 of a study area covering 71 estuarine catchments adjacent to tidal creeks juvenile fish and invertebrate sampling stations along the North Carolina coast. The stations were selected by the North Carolina Division of Marine Fisheries (NCDMF) as assessment locations for fish and invertebrate nursery areas. Abundance of a selected set of juveniles of estuarine-dependent species was estimated using the trawl catch of the species by the NCDMF's Program 120, a long-term sampling program. Changes in land use and land cover and in the abundance of species were analyzed using a classification and regression tree (CART) analysis. Landscape variables were also considered to find which factors were related the most to the observed changes in juvenile fish and invertebrate abundance. The variables were mean bottom temperature, mean bottom salinity, average station depth, distance from each station to the closest inlet, number of point sources and the human population density in the 14-digit watershed in year 2000. CART analysis indicated that there was a negative correlation between the percentage change in conversion of wetland and forested lands to agriculture and developed areas and change in abundance of juvenile Atlantic croaker, blue crabs, and southern flounder between 1980 and 2000. CART analysis also suggested that some abiotic factors influenced change in catch. Catch of brown shrimp and southern flounder increased with increasing bottom salinity (salinity > 14 ppt). Increased bottom temperature was associated with increases in Atlantic menhaden and pinfish, and to a lesser extent, brown shrimp and Atlantic croaker. Distance to inlets influenced the change in catch of spot, brown shrimp, and to a lesser extent, Atlantic menhaden and Atlantic croaker. Station depth significantly influenced the change in catch of southern flounder and brown shrimp. The number of juvenile pinfish increased in overall abundance between 1980 and 2000 in those catchments where human population density was low.

About the Speaker: After a Master's degree in Forestry and Ecology from North Carolina State University, Gregory Meyer was hired by the North Carolina Department of Environment and Natural Resources as an Environmental Specialist/GIS Analyst. There, he worked with a multi-disciplinary team of experts that developed the North Carolina wetland maps. He joined the staff of East Carolina University in 2001 where he worked briefly before entering the Coastal Resources Management PhD program (CRM). IN CRM, his area of concentration was Geosciences, with a secondary track in Coastal Ecology. His dissertation research concentrated on the relationship with land use and land cover change with juvenile fish abundance and distribution in North Carolina's estuaries. After graduation, he took a faculty position with the University of North Carolina at Wilmington, where he taught GIS and environmental sciences. Currently, he is an adjunct at Forsyth Technical Community College in Winston Salem, NC.

A New Coastal Stormwater Treatment Technique-Regenerative Stormwater Conveyances

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Regenerative stormwater conveyance (RSC), a new best management practice being applied in Maryland and North Carolina, combines stormwater management with wetland and stream restoration. It was developed in Maryland for stormwater outfalls in the coastal plain, that often discharge into coastal estuarine systems such as tidal creeks. Applicable in new development, retrofit, and restoration scenarios, RSC's use sand-bedded channels, wide parabolic grade control weirs, and shallow pools. The are often installed downstream of stormwater outfalls that have created highly eroded, unstable channels. The practice can convey within a site, to other stormwater treatment practices in a treatment train, or from outfalls into receiving streams. This design flexibility aligns with philosophies such as low impact development and green infrastructure.

Specifically, the systems combine features and treatment benefits of swales, infiltration, filtering, and wetland practices. RSC water quality improvement potential is now being investigated (U. of Maryland and N.C. State University), and preliminary results are promising. An additional advantage is that RSC's can often be designed to convey flows associated with events up to and including the extreme floods (i.e., 100-year storm) in a non-erosive manner, which results in reduced channel erosion impacts commonly seen between stormwater practice outfalls and receiving waters. Due to the ability to safely convey larger flows, these systems do not require flow splitters to divert smaller events to them for treatment. As part of the conveyance system, they also reduce the need for storm drain infrastructure. Finally, these regenerative conveyance systems have the added benefit of providing dynamic and diverse ecosystems for a range of plants, animals, amphibians, and insects. These ecosystems enhance pollutant uptake and assimilation and provide a natural and native aesthetic to sites.

About the Speaker: Kevin Nunnery has been a Senior Ecologist at Biohabitats, Inc (Raleigh, NC office) for the past 8.5 years. Biohabitats is a multi-disciplinary company, focusing on conservation, regenerative design and ecological restoration. With headquarters located in Baltimore, MD, for the past 30 years Biohabitats has done literally hundreds of water quality projects in the Chesapeake Bay watershed intended to improve water quality and aquatic habitat. While working at Biohabitats, Kevin has helped develop and implement innovative stormwater projects in North Carolina and Virginia. He holds bachelors degrees from UNC and NCSU, a MS in Restoration Ecology from NCSU and a Ph.D. in Restoration/Wetland Ecology from Duke University.

Using Time-Series Water Budgets to Assess Tidal Influence on Fluid Composition (surface and subsurface inputs) in Urbanized Tidal Creeks

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The quality and health of coastal waters are largely dependent upon that of the inland sources (e.g. rivers and streams). Importantly, each source of surface water input to the nearshore represents a composite of fluid from overland and subsurface sources, each of which can have vastly different nutrient and chemical compositions. Throughout the Grand Strand, South Carolina, terrestrial-borne fluid and materials are transported seaward via fifteen drainage canals (known locally as "swashes"). Within the last ten years, eighty percent of these anthropogenically modified tidal creeks have been federally listed as impaired. To assist remediation of these waters, it is essential to first constrain the relative contributions from each source (surface and subsurface) to the total volumetric discharge. We have constructed continuous time-series water budget records for two swashes (tidal and nontidal) using the radiotracer radon-222 as a proxy for groundwater discharge. Throughout the study, groundwater composition in Withers Swash (tidal) ranged from 0.0% to 81.4% while surface water (overland flow, marine water, and precipitation) contributed 100.0% to 18.6% during flood and ebb tide, respectively. Contribution percentages from each source varied less in Dogwood Swash (nontidal), where groundwater comprised 1.3% to 29.9%, surface water 68.3% to 96.1%, and precipitation 0.7% to 10.5%. Although a clear tidal periodicity is present in the short-term water budget records for the tidal swash, monthly mean groundwater compositions of total discharge agree well between the two swashes (8.1% for Withers Swash and 7.7% for Dogwood Swash). Future efforts will apply nutrient concentrations, measured from each source, to these water budgets to generate comprehensive nutrient fluxes. Such productions may provide useful in swash remediation and assist management of coastal loading.

About the Speaker: Leigha is a current student of Coastal Carolina University pursuing a master's degree in Coastal Marine and Wetland Studies. Before graduate student status, she was enrolled in the Bachelor of Science degree program at CCU where she studied Marine Science with a minor in Coastal Geology. Upon completion of the Master's program, she looks forward to pursuing a doctoral degree in the newly formed School of Marine Systems Science at Coastal Carolina University. Working under the direction of Dr. Richard Peterson, she has developed a scientific affinity for subsurface fluid dynamics and specifically the interaction of surface and sub-surface fluids as revealed by geochemical techniques. Recent projects have included source water assessments to urban coastal creeks, investigating discharge rates and mixing potential of below-ground glacial melt water, and developing natural isotopes as tracers of cold seep and hydrocarbon discharge.

Impact of Beachface Geomorphology on Salt Flushing in Singleton Swach, Myrtle Beach

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Singleton Swash is a natural tidal creek in northern Myrtle Beach, South Carolina that suffers from periodic geomorphologic influences as longshore currents divert its effluent pathway to the south along the beach. This wandering of the swash discharge channel threatens neighboring properties and represents a significant management struggle, but also influences the degree to which tidal flushing maintains the health of the salt marsh ecosystem within the swash. These effects have caught the attention of local residents who have historically taken keen interest in the behaviors and functioning of the swash. We report here on a collaboration between local government and academic entities to monitor the swash using remote sensing and in-situ water quality records. Digital photographs from beach cameras record annual and interannual variability in the swash channel migration, which are compared to in-situ data on water level (and associated tidal variations), temperature, and salinity within the swash body. These results suggest that as the swash channel migrates southward along the beachface, tidal flushing becomes decreasingly effective within the swash, ultimately leading to stagnant water conditions within the salt marsh ecosystem. This presentation will discuss future plans to expand the academic-government collaboration into a holistic study that can quantify the effects of geomorphology on water quality parameters throughout the swash and salt marsh ecosystem.

About the Speaker: Rick Peterson is an Assistant Professor in the School of Coastal and Marine Systems Science at Coastal Carolina University. Prior to starting at CCU in 2009, Rick received his Ph.D. from the Department of Oceanography at Florida State University. Rick is a geochemist, using naturally-occurring radionuclide tracers to understand various processes in the marine environment. Rick has a number of projects underway along the Grand Strand of South Carolina using radon and radium isotopes to examine groundwater-surface water interactions.

Impacts of Septic Systems on Water Quantity and Quality

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The impact of on-site wastewater treatment systems (OWTSs) on the N load and baseflow in streams of urbanizing watersheds was investigated. Synoptic samples and baseflow measurements of streams affected by low (LDS) and high density (HDS) OWTSs were taken four times from 2011 to 2012. Results suggest an increase in baseflow in HDS watersheds which may off-set effects of development and maintain baseflow under drought conditions but also indicated a positive correlation between nitrate-N concentrations and OWTS density within the watershed. The Soil and Water Assessment Tool (SWAT) was calibrated to predict stream discharge in a gauged watershed of Gwinnett County, Georgia and used to quantify the influence of OWTSs on water quantity. Analysis showed a 5.9% increase in water yield due to the addition of OWTSs. Results provide data that may be used to inform users and watershed planners about the influence of OWTSs on water quality and quantity.

Recent Tidal Creek Restoration Efforts in Tampa Bay

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Co-author: Dr. Brandt Henningsen, Southwest Florida Water Management District (SWFWMD), Surface Water Improvement and Management Section (SWIM Section)

Present research, monitoring, and management efforts in Tampa Bay have focused on improving the understanding of tidal creek ecological function to the broader estuary. Previous research initiatives have highlighted the unique and critically-important habitats inherent to tidal creeks within Tampa Bay, and, as a result, several key management and restoration actions have been developed to guide the region in improving these systems. Tidal creek restoration has opportunistically occurred in the region and has been focused on restoring tidal creek connections to the estuary through the removal of salinity barriers, restoring watershed hydrologic function through ditch blocking and other site rehabilitation techniques, and/or creating new oligohaline habitats for the benefit of fish and wildlife that were not previously present.

From 1989-2013, the SWFWMD SWIM Program working with various partners have performed 90 habitat restoration projects, restoring/creating 3264 acres of various coastal habitats. These ecosystem restoration projects are providing a mosaic of habitats that naturally would be found in a healthy, balanced, integrated estuarine ecosystem (various estuarine, transitional, upland, and freshwater wetland habitats), providing habitats for many differing species. Emphasis has been placed on the restoration of tidal creeks and oligohaline habitats where possible and practical. Project development, at times, has been hampered by the lack of available restoration sites harboring freshwater sources necessary to help establish salinity gradients. To date, 46 of the 90 restoration sites (51.1%) seasonally or perpetually exhibit oligohaline habitats (28.5% of all restored acreage = 931.5 ac). Project sizes have varied from 0.2 to 181 acres. Site studies and field observations indicate that restoration sites are providing valuable nursery grounds for various sport and commercially important fishes as well as a host of other invertebrate and vertebrate species.

About the Speaker: Ed Sherwood is Senior Scientist at the Tampa Bay Estuary Program. Mr. Sherwood received his B.S. degree in Marine Biology from the University of West Florida in 1999 and his M.S. degree in Marine Fisheries Ecology from the University of Florida in 2003. He has worked previously as a marine fisheries researcher with the Florida Fish and Wildlife Conservation Commission and an environmental projects manager with the Environmental Protection Commission of Hillsborough County. As Senior Scientist with the Tampa Bay Estuary Program, he is responsible for the technical assessment and analysis of the program's projects to protect, restore, and sustain the Bay's ecosystems. His roles include grant proposal preparation, estuarine monitoring design, implementation and interpretation, database quality control, environmental impacts review, and statistical and geo-statistical analysis. He has worked on a number of research projects within the Tampa Bay watershed focused on restoring estuarine water quality and fisheries resources. His current interests involve the ecological restoration of Tampa Bay tidal tributaries.

Trace Metals, including Mercury, in Oyster Tissues and Sediments, New Hanover and Brunswick Counties, NC

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Co-authors: Skrabal, S.A., Kipp, L.E., Sherard, S.B., Vick, A., Mead, R.N.

A suite of trace metals has been analyzed from 19 intertidal oyster reef complexes, including the heads and mouths of five tidal creeks off the Atlantic Intracoastal Waterway in New Hanover County, and from Lockwood Folly estuary and Bald Head Island in Brunswick County, NC. Arsenic concentrations at all sites were higher than the national 85th percentile (16 µg/g), and often exceeded the median for the southeastern U.S. (20.6 µg/g). This may reflect natural conditions such as high levels in the underlying sediments and soils or anthropogenic sources such as historical pesticide use. Some values for copper and zinc exceeded the national median (140 µg Cu/g, 2200 µg Zn/g) and 85th (290 µg Cu/g, 4600 µg Zn/g) percentiles, with the largest impacts near highly developed watersheds and marinas, likely due to antifouling paints. In some creeks, these metals were more concentrated at the head relative to the mouths, likely due to fine-grained sediment accumulation and poor flushing of the heads. Cadmium and cobalt were always below national median levels. Mercury concentrations ranged between 0.06 and 0.19 Î¼g/g, and averaged close to the national median of 0.10 µg/g. Since mercury is bioaccumulative, mainly in the form of methylmercury, we calculated a bioaccumulation factor of 50,000 to 100,000, given a typical dissolved concentration of 2-4 ng/L in estuarine waters of the Cape Fear. We are currently evaluating the relationship between metal contents of the oyster issues and sediments near the reefs.

About the Speaker: Dr. Stephen Skrabal is professor in the Department of Chemistry and Biochemistry at UNCW and associate director for education at the UNCW Center for Marine Science. Over the course of his nearly 18 years at UNCW, he has been involved in over $3.8 million of funded research from sources including the National Science Foundation, North Carolina Sea Grant, and the Strategic Environmental Research and Development Program. His research interests include trace metal behavior and speciation in coastal and estuarine environments, sediment-water interactions, and the effects of photochemistry on trace metals and organics in resuspended sediments.

Water Quality in Stormwater Detention Ponds and the Impact of Pond Discharges on Ecosystem Processes within Tidal Creek Receiving Waters

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Stormwater detention ponds are a relatively recent, but increasingly significant, component of the Southeast's coastal watersheds. For example, in the northern portion of the South Carolina coast, the number of ponds and their cumulative surface area increased by 91% and 61%, respectively, from 1994 to 2006 (the latest available date). Most of these ponds have direct discharge structures that ultimately drain to coastal waters. In fact, ponds often now represent the "headwaters" of many tidal creek systems. Understanding the water quality conditions in coastal ponds and assessing the potential impacts of their discharges on receiving waters is therefore essential for evaluating the effects of development on the ecological condition of the region's tidal creeks.

A systematic study of 26 residential ponds, located throughout the northern portion of SC's coastal zone, was conducted to address how these ponds function as ecological systems, how they respond to nutrient enrichment associated with development, and the effects their discharges have on ecosystem processes in tidal creek receiving waters. Across all ponds, concentrations of total nitrogen (TN) were less variable than total phosphorus (TP), which varied by over two orders of magnitude and tended to increase with increasing residential development density. Total phytoplankton biomass and production were strongly related to TP concentrations. The bulk of net organic production within ponds was in the dissolved form. While phosphorus appeared to be efficiently cycled within ponds, nitrogen inputs tended to be converted to and accumulate as dissolved organic nitrogen. Bioassay experiments revealed that material discharged from these ponds did little to stimulate autotrophic primary production in tidal creek waters, but significantly increased the metabolic activity of heterotrophic microbial communities. Pond discharges thus have the potential to alter the autotrophic/heterotrophic balance of tidal creeks, which likely contributes to low dissolved oxygen conditions present in many of these creeks.

Expanding Living Shorelines Through Stakeholder-Driven Site Selections for Intertidal Oyster Reef Builidng in the Ace Basin, NERR, Sout Carolina

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Productive environmental conditions and abundant wild populations of Eastern oysters (Crassostrea virginica) generate very high rates of natural oyster recruitment in South Carolina estuaries and tidal creeks, such that the provision of suitable substrate can lead to the rapid development of new oyster reef habitat. Intertidal, fringing reefs, which are the dominant form of oyster reef habitat throughout much of the southeastern United States, are known to serve as important natural breakwaters that protect the adjacent salt marsh. The overall goal of the project presented here, funded by the NERRS Science Collaborative, is to address the local management problem of the continued loss of shorelines through erosional processes that is likely to be exacerbated under scenarios of future global climate change-driven sea level rise. This project intends to increase the potential resiliency of ecological communities in the ACE (Ashepoo-Combahee-Edisto) Basin NERR to climate change-driven sea level rise by creating living shorelines, while engaging community stakeholders in all stages of the project, from problem definition to site selection, monitoring and evaluation. Habitat restoration and enhancement efforts in this project are utilizing a variety of both natural (oyster shell bags and loose shell) and artificial substrates (oyster castles and crab traps) drawing on a long and effective history of such efforts by the South Carolina Department of Natural Resources. Researchers are providing expertise in matching reef-building strategies to site characteristics, measured in collaboration with stakeholders in the field. Stakeholders from across the ACE Basin NERR are then tasked with prioritizing potential restoration sites and allocating finite resources among these sites. This presentation will provide an overview of the habitat restoration and enhancement efforts achieved to date, highlight the effectiveness of collaborating with stakeholders, address challenges encountered, and outline future work.

About the Speaker: Benjamin Stone is a Wildlife Biologist II with the South Carolina Department of Natural Resources Shellfish Research Section. Ben received his bachelors in Marine Biology from the College of Charleston and worked various field positions in Washington State, North Carolina, and Alaska before returning to Charleston to get a masters degree in Environmental Studies and beginning work at the SCDNR. He has been working as a biologist for the Shellfish Research section at the SCDNR for about three years.

Initial Trends in Dissolved Organic Matter Concentrations and Quality in a Creek Draining a Typical Tidal Salt Marsh of the Southeastern US

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Tidal salt marshes are critical mediators of the flux of carbon between terrestrial and marine ecosystems, as well as globally significant hotspots of productivity. High levels of biological and photochemical activity on salt marshes fix new carbon and modify carbon imported from other systems, such as with the flooding tide. Much of this carbon is exported as dissolved organic matter (DOM). As tidal salt marshes are dynamic at multiple temporal scales (tidal, diurnal and seasonal), the quantity and quality of DOM export requires assessment across these scales. We present initial data from a well instrumented creek draining a semi-diurnal tidal salt marsh near Savannah, Georgia. Optical measurements of colored dissolved organic matter (CDOM) made in situ every 15 minutes are linked to laboratory analyses of DOM quality, dissolved organic carbon (DOC) concentration, and DOC bioavailability to assess the variations in DOM quality within the creek. Initial data from summer/fall 2013 reveal strong trends in DOM concentration and quality across the tidal cycle (high to low tide on a given day) and across the lunar cycle from spring to neap tide.

About the Speaker: Aron Stubbins is an Associate Professor in Marine Biogeochemistry at the Skidaway Institute of Oceanography, Department of Marine Sciences, University of Georgia, Savannah. Dr. Stubbins is originally from Machynlleth, Wales, and studied Marine Biology (BSc; 1998) and Marine Biogeochemistry (PhD; 2002) at the University of Newcastle-upon-Tyne, England, before moving to the US. His research focusses upon the biogeochemical cycling and ecological roles of dissolved organic matter, and aquatic photochemistry. Dr. Stubbins has been on tens of shipboard and land-based research expeditions, publishes regularly, and is the Associate Editor of the journal Estuarine and Coastal Shelf Science (biogeochemistry).

Impacts of On-site Sewage Disposal Systems on Jupiter Creek, an Urbanized Tidal Creek in Southeast Florida, USA

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Effluent from on-site sewage disposal systems (OSDS, septic tanks) is generally known to impact groundwaters and surface waters with nitrogen and other contaminants, but little research has quantified this problem in urbanized tidal creeks along the Indian River Lagoon (IRL). This study assessed the effects of OSDS on contamination of groundwaters in Jupiter River Estates and surface waters of Jupiter Creek and the Southwest Fork of the Loxahatchee River (SWFLR) that flows into the southern IRL. An array of deep and shallow monitor wells were installed in varying proximity to OSDS's on two residences; surface water sampling stations were established in Jupiter Creek and downstream waters of the SWFLR. The wells and surface waters were sampled three times in the wet season of 1994 and three times in the dry season of 1995. In monitor wells closest to the OSDS, groundwaters were enriched (~ 1 mM) with ammonium at one site, and nitrate at the other. Ammonium and nitrate were also enriched in Jupiter Creek during both seasons. Aqueous $\delta^{15}N$ was lowest (+ 2.58 o/oo) in the deepest well, and enriched in shallow wells (+ 7.3-28.9 o/oo) most impacted by OSDS. Enriched aqueous $\delta^{15}N$ values were also observed in surface waters of Jupiter Creek and the SWFLR, confirming sewage contamination. Fecal coliform counts were highest in shallow groundwaters in the wet season, with surface water counts exceeding State standards at all stations in Jupiter Creek and the SWFLR in the wet season. Direct measurements of groundwater flow indicated flow rates up to 6 ft/day, similar to the estimated hydraulic conductivity of 14 ft/day. These results demonstrate that high densities of OSDS, which are often sited in urbanized areas with low elevations and poor soil characteristics, can be a significant source of nitrogen and contaminant loading to the IRL.

About the Speaker: Marie Tarnowski is a Florida Atlantic University (FAU) Environmental Science master's student conducting her thesis research through the harmful algal bloom (HABs) lab at Harbor Branch Oceanographic Institute. Her research will be conducted in Indian River County, FL, determining the potential sources of nutrients that are flowing from 3 main relief canals and the St. Sebastian River into the Indian River Lagoon, using markers that are specific to septic tank contamination. Marie earned her undergraduate degree in Marine Biology at the University of North Carolina Wilmington in 2010 where her studied coastal ecology and human impacts on coastal fish populations. Afterwards, Marie spent 2.5 years managing the Sustainable Aquaculture Program at the Cape Eleuthera Institute, Eleuthera, The Bahamas, where her research focused on the dynamics of nutrients produced by farmed fish in mangrove creeks and the open ocean environment. Marie began her graduate program at FAU in the spring of 2013 and expects to graduate in the fall of 2014.

Use of Host Specific Fecal Indicator Bacteria Microbial Source Tracking to Identify Contributions to Bacterial Impairments in Tidal Creeks along the Grand Strand, SC

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Long Bay in Northeastern South Carolina is a popular tourist destination with approximately 70 miles of beaches. An important conduit of stormwater into these coastal waters is through tidal creeks that discharge across the beach face into marine bathing waters. Many are 303(d)-listed for fecal indicator bacteria (FIB) impairments. Swimming advisories are permanently posted with warnings to avoid swimming following rainfall. TMDL's have been and or are in the process of being developed and implemented in many of the creeks. Thus, geographic and host-animal source information is needed to help direct reductions of loadingefforts.
Coastal Carolina University's Environmental Quality Laboratory (EQL) partnered with local governments to adopt a series of new genetic based qPCR methods to address local impairments. Regional sources have been identified as human, canines, birds, and urbanized wildlife. To address these sources, species specific assays for the prior have been employed along with a general warm blooded assay to assess the magnitude of other possible sources. These tools are used as part of a multi tracer weight of evidence approach to help corroborate results. Other parameters tested as part of this multi-tracer approach include traditional water quality parameters and chemical based human markers.
Studies have recently been completed in Withers Swash, a tidal creek draining a large portion of downtown Myrtle Beach, and the northern end of Murrells Inlet, a mesotidal, high salinity estuary. These studies have utilized a watershed framework which allows for defined subwatersheds specific plans for remediation. Study results have shown prolific canine inputs and point source human inputs. Additionally, strong indications of the importance of sediment based FIB inputs have been observed. These results have resulted in a public education campaign on dog waste, illicit discharge responses, and a list of suggested action items to address public policy.

About the Speaker: Michael Trapp is currently the Laboratory Director for Coastal Carolina University's Environmental Quality Laboratory. His research focuses is the movement of stormwater through the coastal zone from developed areas in the the nearshore ocean and its consequences on of the bio-geochemistry of those systems. He holds a PhD in Maine and Atmospheric Chemistry and MS in Chemistry from the University of Miami and a BS Florida Southern College in Biology and Chemistry.

Indicators of the Occurrence of *Vibrio* in the Winyah Bay, SC Estuary

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There are several studies on the distribution of *Vibrio vulnificus* and *Vibrio parahaemolyticus* in estuarine waters around the world, but little information on the distribution of both organisms in South Carolina waters. Monthly sampling of surface and bottom water from 9 sites in Winyah Bay and the Waccamaw River was conducted over the period April-October 2012. Both organisms were enumerated on CHROMagar *Vibrio* media. The *V. vulnificus* counts were highest when salinity ranged between 5 ppt and 20 ppt. *V. parahaemolyticus* did not show a clear pattern with salinity, suggesting other factors that interact to control its occurrence and abundance. Turbidity showed a positive association with both *V. vulnificus* and *V. parahaemolyticus*. In this study were particularly interested in the relation between *Vibrio* and conductivity in order to couple this relation with future climate scenarios calculated by the Pee Dee River and Atlantic Intracoastal Waterway Salinity Intrusion Model 2 (PRISM2). PRISM2 integrates predictions of future streamflow and sea level in an artificial neural network model that predicts specific conductance at several locations in the Winyah Bay estuary. Based on the model results, increasing sea level will results in expanded range of occurrence for *V. vulnificus* in the Winyah Bay estuary due to increased specific conductance. The model was tested by predicting for post hurricane Sandy sampling date (29OCT2012). The *V. vulnificus* counts fell within the predictive interval of the model. Thus, the conservative model is able to predict for *V. vulnificus* under normal and post low impact storm events. In the future the increased relative risks of optimum *Vibrio* growth based on specific conductance will increase up to 36X depending on location and sea level predictions. These increased periods of optimal growth conditions for *Vibrio*s may result in increased risk for swimmers and shellfish consumers.

About the Speaker: Dr. Daniel Tufford is a Research Associate Professor in the Department of Biological Sciences at the University of South Carolina. He holds a PhD (1996) in Environmental Health Sciences from the University of South Carolina (USC). He also has appointments as Research Associate in the Belle W. Baruch Institute for Marine and Coastal Science (USC), as Senior Associate Faculty in the Environment & Sustainability Program (USC), and as adjunct faculty in the Masters of Science in Environmental Studies Program at the College of Charleston (Charleston, SC). Dr. Tufford's main research interests are in the areas of water resources, wetland ecology and watershed hydrology. He has been especially active in the area of climate impacts, computer modeling, and GIS. Modeling has always been a primary interest, however, Dr. Tufford also has an active field program and does a great deal of analytical chemistry work related to water quality.

Restoring the Rookery Bay Estuary: Connecting People and Science for Long-term Community Benefit

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One of the few pristine, mangrove-forested estuaries in the U.S., the Rookery Bay Estuary in Naples, Florida is a recognized breeding ground for commercial and recreational fish like snook, tarpon and snapper. Each year, thousands of tourists are drawn to its vast expanses of natural space, where they fish, swim, kayak, and experience manatees, dolphins, and coastal birds in their native surroundings. The health of the estuary and its wildlife depend on seasonally appropriate flows of freshwater that range from nearly 134 million cubic feet per day in the wet season to none in the dry season. These freshwater flows also sustain communities in surrounding Collier County and on nearby Marco Island. Population growth and saltwater intrusion of community and government wells are placing further stress on available fresh water. Compounding the situation are the area's highly managed water control structures and canals that mitigate flooding, but also disrupt the natural sheet flow conditions necessary for estuarine health. This project aims to restore and adaptively manage the quantity, timing and quality of the fresh water flowing into Henderson Creek and the Rookery Bay Estuary to ensure the health of the natural resources to meet long-term community needs. Balancing the water needs of people with those of the natural systems on which they depend for jobs and recreation is becoming an increasing challenge as communities grow and sea levels rise in southwest Florida. This project will address this challenge by increasing knowledge of the water flow parameters necessary for estuarine health in Rookery Bay, understanding the attitudes of water users to inform future educational efforts, and developing a community-based decision-making tool for water use and allocation. This collaborative project is guided by an advisory group consisting of hydrological engineers, social researchers, resource managers, and community stakeholders.

The First Steps to Restoring Ecosystem Services within "Degraded" Tidal Creeks

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Tidal creeks are vital to nearshore coastal environments providing a range of critical ecosystem services from flood control to increased biodiversity. A type of creek system in the greater Myrtle Beach, SC region known as a swash experiences both the historic and ongoing effects of urbanization compromising abilities to provide many of the ecosystem services of typical tidal creeks. For example, swash oyster populations are a fraction of levels within non-swash creeks that also are reduced substantially from levels observed in previous centuries. Regenerating historic services in swash systems will require a variety of approaches including the restoration of living resources such as oyster reefs. Success of reef restoration efforts is dependent on a scientific understanding of whether changes in the physical or biological conditions within swash creeks negatively affect living resources. A comparison of swash and non-swash tidal creeks was begun to identify conditions that might impede reef restoration efforts. Basic parameters (e.g., salinity) were monitored seasonally and during rainfall events to evaluate any deleterious effects of existing stormwater management practices. Yearly bivalve recruitment, survival, and growth within swash and non-swash creeks also were measured. Although salinities are reduced in swash creeks, levels fall within reported optimal ranges for oyster survival and growth. Rainfall events significantly reduced salinities within swash creeks, but effects were transient typically not extending beyond a single tidal cycle. Phytoplankton biomass was greater within non-swash creeks, but survival and growth of bivalves were similar between the different creek systems. The only factor identified as a possible limitation on the success of any reef restoration efforts was recruitment; swash oyster recruitment was <<<< than in non-swash creeks. The restoration of oyster populations to swash tidal creeks should consider transplanting spat-on-shell or live oysters into constructed reefs to maximize chances for success of any oyster restoration effort.

Protecting Tidal Creeks: Riverkeeper Perspectives

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Tidal Creek ecosystems are critical nursery habitats, feeding grounds, and spawning areas for many fish, shellfish, mammals and birds and important areas for recreation and shellfish harvesting. Tidal creeks also deliver pollution from point and nonpoint sources directly into coastal estuaries and sounds. Problems arising in smaller tidal creeks are quickly visible to educated observers and local residents, thus serving as early warning systems for pollution, human health concerns, and habitat loss in sounds, estuaries, and the ocean.

In many ways, North and South Carolina's riverkeepers act as first responders, offering unique, on-the-ground assessments of the health of tidal creek ecosystems and communities. Riverkeepers observe stressors in real time along the full length of watersheds, confront industry and development challenges, understand the difficulty in mobilizing grassroots support in rural areas, and often devise innovative management recommendations and solutions. This presentation offers their case studies and perspectives.

About the Speaker: Heather Ward is Executive Director for Waterkeepers® Carolina (WKC) — a science-based, advocacy group representing all ten Waterkeeper® programs in our state. WKC's charitable purpose is to protect the environmental, recreational, and commercial integrity of North Carolina's 17 rivers and to safeguard drinking water supplies for our state's 9.7 million residents by supporting member riverkeeper projects. Heather earned her PhD in Coastal Resources Management from East Carolina University, taught college geography, and enjoyed 17 years of federal and military service.

Developing Numeric Nutrient Criteria for Southwest Florida Tidal Creeks Part 2: Creek Classification, Selection, and Sampling Design

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In this companion presentation to Dr. Jay Leverone's presentation on developing numeric nutrient criteria for southwest Florida tidal creeks, we describe the methods used to identify creeks and distribute effort for a synoptic sampling effort. The process to identify creeks for additional sampling included the identification of the population of creeks in southwest Florida, a method to classify creeks based on the watershed characteristics, the selection of representative creeks for additional sampling, and the sampling design for additional sampling to link watershed inputs, instream processes, and biological responses. Over 300 creeks were identified between Tampa Bay and Estero Bay Florida. A limited allocation of effort for additional sampling meant that a classification system was necessary to help ensure that the effort was distributed in a manner to capture the range of creek types within the identified population. The classification system was developed using regional, remote sensing data on land use land cover, information on soils, nutrient loads, creek morphology, topography, and distance to the nearest inlet or pass. Hierarchical agglomerative cluster analysis was used to differentiate creek types and 4 groups of creeks were identified. Sixteen creeks were then evenly distributed among the four creek types. A sampling design was established to collect synoptic measurements of water quality, water column and benthic chlorophyll, and fish community structure. This presentation will detail the methods used to collect data that will be used in conjunction with existing empirical data to develop nutrient criteria that can be used as management level targets and thresholds to support designated uses of tidal creeks in southwest Florida.

About the Speaker: Mike Wessel (Vice President, Janicki Environmental) is a quantitative environmental scientist and a proud UNCW Seahawk Alumni. Mike received a BS in marine biology from UNCW and an MS in biostatistics from the University of South Florida. Mike spent the 1990's working as a fisheries scientist in Tampa Bay and has worked for the last 10 years as an environmental consultant for public sector clients evaluating relationships between state and federal water quality and water supply regulations to measures of ecological integrity in southwest Florida estuaries. Recently, Mike and his colleagues at Janicki Environmental, worked with the three National Estuary Programs in southwest Florida to develop site specific numeric nutrient criteria for their estuarine waters which have subsequently been adopted into Federal rule.

Numeric Nutrient Criteria Development in SC Tidal Creeks and Estuaries

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According to the United States Environmental Protection Agency (EPA) nutrient overenrichment is one of the top causes of waterbody impairment in our nation. A condition of eutrophication often results in unsightly algal blooms, areas of low dissolved oxygen and changes in aquatic community composition. In accordance with The Clean Water Act, the EPA has requested that states and tribes develop and implement scientifically defensible numeric limits for total nitrogen, total phosphorus, chlorophyll a and a measure of water clarity for all waterbodies. In response, the South Carolina Department of Health and Environmental Control (DHEC) has compiled the SC Coastal Nutrient Database which contains 182,000 water nutrient records and approximately 19,000,000 water quality records from 799 sampling stations along the coast. Data sources include DHEC's own Ambient Surface Water Quality Monitoring Program, the National Estuarine Research Reserve's Central Data Management Office, the United States Geological Survey and generous contributions by local scientists. GIS software has been employed to broadly characterize 10 major estuary regions. Exploratory data analysis utilizing R statistical computing language to reveal relationships between parameters and large scale predictive modeling efforts for individual estuary regions and the entire coastline are currently underway. The objectives of this project are to develop Numeric Nutrient Criteria that will: a) be protective of the physical, chemical and biological integrity of SC coastal waters; b) be useful in identifying waters not meeting regulatory designated uses; c) inform decision makers as to the potential causes of biological impairments; and d) be realistically attainable.

About the Speaker: Dr. Casandra West is currently serving the S.C. Department of Health and Environmental Control (DHEC) in the Bureau of Water where she is presently developing Numeric Nutrient Criteria for S.C. tidal creeks and estuarine waters. Concurrently, she is part time teaching faculty at the University of South Carolina (USC) in the Department of Biological Sciences. She received her Ph.D. from USC in 2012 where her research largely focused on the abundance, molecular mechanisms of emerging pathogenicity and preferred micro-niches of *Vibrio* spp. in the North Inlet Estuary, S.C. She is a member of the American Society for Microbiology and was previously a SREB Doctoral Scholar and an ARM Environmental Services Fellow.

Building Rain Gardens to Restore Oyster Reefs: Watershed Stormwater Reduction Coupled with Restoring Oyster Reefs in Tidal Creeks

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Bradley Creek Elementary School is located on a 19-acre site that is situated in the headwaters of Hewlett's Creek. The creek contains high quality shellfish waters, primary fishery nursery areas, and productive oyster habitat. The North Carolina Coastal Federation is conducting oyster reef restoration in the creek. However, the majority of the creek is closed to shellfishing with impaired water quality and degraded estuarine habitats. The primary culprit is stormwater. The drainage area surrounding Hewlett's Creek is the largest and most urbanized of all the tidal creek watersheds in New Hanover County and Wilmington, and the high quantity and poor quality of the stormwater flowing into the creek is very significant.

The Federation is leading a three year initiative together with New Hanover County Schools, the Soil and Water Conservation District, and the City of Wilmington's Stormwater Services to install a series of stormwater reduction measures around the school to significantly reduce stormwater entering Hewletts Creek. To date six rain gardens, bioretention areas and stormwater wetlands have been installed, and they are capturing and treating over 120,000 gallons of stormwater when it rains. The rain gardens and wetlands are also serving as "living classrooms" by providing lessons on plants, soils and hydrology for the students and teachers.

This presentation will describe the stormwater project and oyster reef design and construction. The link between oyster restoration and rain gardens strengthened the water quality, habitat and outreach initiatives in this watershed. Project funding, planning, design and installation will be discussed.

About the Speaker: TedWilgis coordinates coastal habitat restoration projects, designs and implement stormwater reduction projects, and engages students and the public in education and environmental stewardship initiatives for the North Carolina Coastal Federation. He has a BA in Zoology, and he is a graduate student finishing a MS in Marine Biology from UNCW

Poster Session Viewing List December 16, 2013 5:30 - 7:00

1. **Ecological Flows Framework for North Carolina Coastal Streams**
   Eban Bean, East Carolina University

2. **Insights into Seasonal Dynamics of Heterotrophic Bacteria and Autotrophic Picoplankton in Groves Creek Tidal Salt Marsh**
   Thais Bittar, Skidaway Institute of Oceanography, University of Georgia

3. **Primary Productivity and Respiration in Fresh-to-Oligohaline Tidal Creeks**
   Lauren E. Bohrer, University of North Carolina Wilmington

4. **Examining the Clonization and Survival of E. coli from Varying Host Sources in Drainage Basin Sediments and Stormwater**
   Matthew Curtis, Coastal Carolina Univeristy

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    Heather Young, Coastal Carolina University

Poster Abstracts - Listed alphabetically by last name

Ecological Flows Framework for North Carolina Coastal Streams

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The NC Department of Environment and Natural Resources (DENR) is in the process of identifying flows necessary to maintain ecological integrity of rivers and streams across the state. This ecological flow (EF) approach will provide a planning tool to evaluate the effects of water withdrawals on aquatic ecology. An EF Science Advisory Board has been charged with recommending such an approach to DENR for the state. EF models based on stage-discharge relationships can be applied to much of the state, but in coastal areas the stage-discharge relationships are affected by tides and wind. Existing EF models for non-coastal regions are generally inadequate for the coastal plain due to its low elevations, flat terrain, proximity to tidal influence, saline waters, and lack of historical monitoring data. As a result, a group of coastal stream experts from universities, private industry, and government agencies formed the Coastal Ecological Flows Work Group. The overall objective of the CEFWG was to assess the general ability to establish an EF approach for coastal streams. The CEFWG has assessed applicability of previous coastal work developed stream typology; performed spatial modeling and mapping; evaluated relevant ecological and biological dependencies on flow; developed a framework for potential coastal EF criteria and protocols where possible; and identified factors limiting EF protocols and needed research within coastal systems. The framework recommended by the CEFWG included the following EF determinants: (1) extension of the state-wide flow-by criteria where possible; 2) condition of habitat, primarily for anadromous fish; 3) downstream salinity; and 4) overbank flow. The CEFWG proposed formation of a joint committee to further develop the framework.

Insights into Seasonal Dynamics of Heterotrophic Bacteria and Autotrophic Picoplankton in Groves Creek Tidal Salt Marsh

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Microbial activity is an important process in production and export of carbon in tidal salt marshes. Autotrophic plankton fix new carbon and heterotrophic bacteria modify autochthonous and allochthonous dissolved organic carbon on flooded salt marsh platforms and creeks, influencing the quality of carbon that is exported from the marsh on ebbing tides. Water column samples were collected weekly from spring through fall 2013 at high tide in a first order tidal creek within the Groves Creek salt marsh (Savannah, GA). We are investigating the interaction between bacterioplankton and autotrophic picoplankton communities and the quality and quantity of dissolved organic and inorganic carbon within Groves Creek salt marsh across a seasonal range of temperature, salinity and precipitation. Bacterial abundance was obtained by combining DNA staining and flow cytometry. Picoplankton community composition was also analyzed by flow cytometry using side scatter (SSC), red (670 nm) and orange (585 nm) fluorescence emission (Ex 488 nm). Preliminary results indicate seasonal shifts in bacterial abundance and in dominant groups within the picoplanktonic community.

Primary Productivity and Respiration in Fresh-to-Oligohaline Tidal Creeks

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Three freshwater-to-oligohaline tidal creeks, one urban, one suburban, and one rural, were sampled approximately monthly in 2011 and 2012 to determine seasonal phytoplankton productivity and respiration. Preliminary ex-situ light-dark bottle productivity experiments were conducted in a controlled environment by placing sample water in BOD bottles in a flow-through pond at the UNCW Center for Marine Science for 4-5 hr periods centered at mid-day. Experiments were subsequently moved into a field situation, and seasonal productivity and respiration data were obtained contemporaneously at urban Burnt Mill, suburban Smith Creek, and rural Harrison's Creeks, respectively. Water quality data were collected along with in-situ light-dark bottle experiments in order to assess environmental factors influencing primary productivity and respiration. Results from preliminary experiments showed that respiration and primary productivity were higher in Burnt Mill Creek in comparison with the two less-developed tidal creeks. The in-situ productivity experiments have shown that Burnt Mill Creek (36% watershed impervious coverage) experienced the highest rates of respiration and net primary productivity (mg of O2/L/day) in May and June, Smith Creek (28% impervious coverage) experienced the highest rates of R and NPP in July, and Harrison Creek (<10% impervious surface coverage) experienced the highest R and NPP in June and July. Data indicate that rural blackwater Harrison's Creek is strongly dominated by respiration as opposed to phytoplankton production. For all three creeks combined, net and gross primary production were both positively correlated with water temperature, and gross primary production was also positively correlated with chlorophyll. At the completion of land-use data collection, percent watershed development and percent impervious surface coverage will also be tested for influence on productivity and respiration.

Examining the Clonization and Survival of E. coli from Varying Host Sources in Drainage Basin Sediments and Stormwater

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It is widely understood that stormwater drainage has a significant impact on the health of tidal creek systems via regular inputs of runoff from the surrounding watershed. Due to this hydrologic connection, contamination of the upstream drainage basin will have a direct effect on estuaries and tidal creeks that often act as receiving waters. This study builds on the growing body of research emphasizing the importance of drainage basin sediments as they enhance the persistence and transport of the fecal indicator bacteria E. coli within a watershed. Experiments presented here use microcosm environments with drainage basin sediments and stormwater to investigate E. coli colonization of stagnant waters and examine the importance of host sources to bacterial survival. Microcosms using environmental sediments of high bacterial concentration and sterile overlying waters are used to examine the ability of E. coli to colonize the water column in the absence of flow. The colonization of sterile sediment environments is

also examined using two common host sources (human and avian). Each experiment uses sediments of varying grain size and organic content to examine the influence of physical characteristics on bacterial prevalence.

Comparison of Regulatory Fecal Indicator Bacteria and Host Specific Genetic qPCR Markers in Fecal Matter of Common Sources to Tidal Creeks

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Fecal indicator bacteria (FIB) are an important form of pollution resulting in a growing number of water quality impairments. These FIB are of particular concern in tidal creeks, which often serve as conduits of stormwater, transporting high concentrations of pollution from land to the aquatic environment. The field of microbial source tracking aims to identify the sources of FIB pollution so that targeted remediation strategies can be used to improve water quality. The use of quantitative polymerase chain reaction (qPCR) technology to identify the host source of FIB has been growing over recent years. However, interpretation of these results in terms of regulatory bacteria remains difficult. Here we conduct a comparison of regulatory FIB (E. coli) to host specific qPCR assays on direct fecal grab samples using common sources of FIB along the Grand Strand of South Carolina. Several specimens of canines and sea birds are used to understand variability in the ratio of these two measurements. Additionally, we present a time series study where fecal material is aged and ratios of the E. coli and genetic markers are compared. Results suggest that specimen to specimen variability makes interpretation of qPCR results difficult to attribute a percentage of the FIB load to a particular host. Furthermore, the time series study shows that the ratio of FIB to genetic marker changes over time. Thus, temporal variability of the addition of waste to the system further complicates interpretation.

Comparing Density of Resident Fishes among North Carolina Saltmarsh Creeks and Relation to Habitat Alteration Scores

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Anthropogenic alterations to saltmarsh watersheds along the U.S. South Atlantic coast can impact the production of common resident taxa. We deployed a 1 m^2 throw trap monthly in summers 2012 and 2013 in the vegetated portions of five variably altered saltmarsh creeks in coastal North Carolina to compare the density of resident macrofauna: the mummichog *Fundulus heteroclitus*, mosquitofish

Gambusia holbrooki, sheepshead minnow *Cyprinodon variegatus*, and grass shrimp *Palaemonetes* spp. For each species, the relationship between density and a combination of biotic and abiotic variables was examined using poission-distributed generalized linear models (GLMs). Model parsimony was evaluated using Akaike Information Criteria (AIC). The GLM that best fit the data (lowest AIC score) for each species included creek as an explanatory variable. Salinity, depth, and percent coverage of *Spartina alterniflora* were additional factors that explained patterns of faunal density. Percent imperviousness also explained patterns of density, but the direction of the effect was dependent on species. Results of this study emphasize the importance of imperviousness and vegetative cover in affecting the density of resident species inhabiting saltmarsh creeks along the U.S. South Atlantic coastline.

Establishment of a Research, Monitoring, and Exploration Program on the Lower Ogeechee River Estuary, GA (ERM EXPLORE)

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In the wake of an extensive fish kill event in May 2011 on the relatively pristine Ogeechee River in Southeast Georgia, there has been an increased awareness of the need for regular monitoring activities along the river and within its watershed. This proposed two-year project has a primary objective of establishing a research, monitoring, and exploration program for the Lower Ogeechee River Estuary. The objectives will be to monitor the chemical and biological conditions in the region initially through assessments of water and sediment, microbial community, invertebrates, and selected fish species. A component of the project will target raising awareness of the need and opportunities for local communities to be involved with monitoring of the river as well as engage and mentor undergraduate and graduate students in ecological and toxicological research. Additionally, underprivileged middle and high school youth will be given the opportunity to explore this waterway in their nearby community while learning about point and non-point source pollution.

Insights into the Impact of Tropical Systems on Tidal Marshes: Results from High Frequency Monitoring in a Constructed Marsh during Hurricane Sandy

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Tropical weather systems are known to play an important role in the delivery of sediment to coastal marshes based on marsh accretion studies. Large volumes of water move through coastal marshes during and following extreme weather events from rainfall and storm surges. These large fluxes of water can move substantial amounts of nutrients, organic matter, and suspended solids, but there is little known about the dynamics of these materials during the storm events. The recent development of automated on-site monitoring systems makes possible the collection of nutrient and material concentrations at a high-temporal resolution. With these systems concentrations can be measured at a frequency that was impossible in the past due to costs and during hurricanes without safety risks for researchers.
The monitored marsh was constructed in North Carolina, using a reference based design, between row crop agricultural production and a nutrient sensitive estuary. Flow measurements and material

concentration measurements made at a high frequency were used to calculate accurate material mass balances. UV-Visual spectrometers have proven capable of measuring nitrate, total kjeldahl nitrogen, dissolved organic carbon, organic suspended solids, and total suspended solids concentrations in marsh waters. The complex flow regime that resulted from the high wind tides and rainfall creates similarly complex nutrient dynamics from the mixture of estuarine, marsh, and agriculture drainage waters. During and following Hurricane Sandy the constructed marsh was a sink for nitrate (18%, 18 kg), organic suspended solids (11%, 95 kg), and total suspended solids (15%, 380 kg). The marsh was a source of 100 kg of dissolved organic carbon during the event. The methods used to calculate these mass balances will be presented along with a description of the complex nutrient and flow dynamics that were observed in the marsh during Hurricane Sandy

Results from Varying Approaches used to Assess Oyster Reef Associated Fauna within South Carolina Tidal Creeks

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Tidal creeks are an essential habitat vital to nearshore coastal productivity, but effective nekton and demersal fauna sampling is complicated by the complete or partial loss of water twice daily during low tide periods. One successful nekton sampling approach applied in a series of tidal creek studies, block-netting creek openings at high tide, is only practical for relatively small first order creeks that empty completely at low tide. Compounding sampling difficulties attributable to low tide, the extended distances among tidal creeks in the current study (100 km) places practical constraints (e.g., manpower) on obtaining enough replicate samples to enable valid statistical comparisons. Generating enough samples through the use of pull or drop nets frequently used in other subtidal or intertidal studies is only possible over reasonably short distances. The second and third order inlet and swash tidal creeks selected in this study necessitated a combination of modified pull trap, gill net, and baited minnow trap approaches to sample effectively nekton communities associated with oyster reefs restored as part of a community outreach project. Average August 2013 catches from pull traps and gill nets were <1 cpu, with both approaches failing to capture a single fish 50% of the time. Baited minnow traps averaged 9 cpu, but 97% of the total fish catch consisted of only two taxa. Results demonstrate the difficulties inherent in attempting to assess the ability of large-scale reef restoration projects within local tidal creeks to ameliorate the negative effects of oyster habitat loss on reef-associated fauna. Requisite studies of sampling efficiencies and possible alternative approaches to evaluating intertidal oyster reef restoration success are discussed.

Visualization and Quantitative Analysis of Historical Trends in Land Use Change and Tidal Creek Emergent and Submerged Habitats

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Geographic Information Systems (GIS) are commonly used to map, monitor, and analyze landscape changes through time. The purpose for this project is to compile a GIS database, compute change analysis, and test methodologies for creating benthic habitat maps in small tidal creek watersheds. The database development consists of both historical records as well as new data collected with up-to-date technology. An historical archive of aerial photography (dating back to the 1930s), thematic maps (e.g. land cover), and a variety of field samples collected through time have been assembled. These data are organized in an ArcGIS geodatabase and disseminated via the UNC Wilmington GIS website. New satellite images from DigitalGlobe's WorldView-2 sensor and Landsat 8 have been obtained and are being analyzed to capture new upland land cover and intertidal and sub-tidal habitat types. The two tidal creek watersheds, Howe and Pages, in New Hanover County, North Carolina, are investigated and

compared. Howe is an urbanized watershed consisting of a large mixture of mostly residential and commercial development and a high level of impervious surface. Pages creek is less developed, mostly single family residential, although the density of development is increasing rapidly and large tracts of apartments and commercial areas are under construction in the headwaters of the creek. Data analysis through image processing and spatial analysis have documented this growth in development and procedures for documenting change have been tested. A new technique for randomly identifying field sites has also been developed. This approach uses a spatially balanced GIS procedure for collecting creek habitat data. These data are then used for classifying the Worldview-2 imagery into the various emergent and submerged habitat classes. Lastly, a comparison is made between upland land use development and tidal creek habitats in order to develop a comprehensive management plan for the tidal creek watersheds.

How Does Neuse River Bottom-Water Hypoxia Affect Dissolved Oxygen Distributions in its Tributaries?

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The Neuse River Estuary (NRE), like many estuaries on the US east coast, experiences bottom water hypoxia during summer. Hypoxic and anoxic conditions have been linked to the extensive fish kills that occur in the upper NRE. Tributaries connected to the NRE have been identified as critical nursery areas for estuarine finfish and shellfish, but little is known about the distribution and variability of their dissolved oxygen (DO) levels. Measurements of salinity (S), temperature (T), and DO were made using a CTD profiler along a transect that stretched across the main channel of the NRE to several kilometers

upstream in Hancock Creek, a typical tributary of the NRE, in both calm and windy conditions. These measurements are combined with those from an autonomous vertical profiler (AVP) and ADCP that measured vertical profiles of S, T, DO, and currents at a point along the centerline of the main channel of the NRE. In future work, these types of measurements will be used to investigate the influence of processes in the main part of the NRE on conditions in its tributaries.

Diagenetic Markers Indicate Potential for Photochemical Release of Sedimentary Algal Toxins.

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The photorelease of algal toxins from resuspended sediments may have a significant impact on the water quality of tidal creeks. Algal toxins have significant impacts on human health, ecosystems, and costal economies. Sediments can be resuspended into the water column in tidal creek systems by natural processes such as storms, or by anthropogenic processes including dredging, boating, and near-shore development. Harmful algal blooms release toxic organic compounds into water systems and underlying sediments. Upon resuspension these toxins may be photoreleased into the water column. In Southwestern Florida, Karenia brevis blooms have occurred offshore and transported toxin laden water and sediments into tidal creek areas. These tidal creeks are home to Florida Manatees, which are classified as a vulnerable species, and which have a history of illness and death associated with exposure to brevetoxins. It is hypothesized that the photorelease of algal toxins may be influenced by the extent of diagenetic sediment processing. Florida tidal creek sediments impacted by K. brevis ("red tide") blooms were subjected to resuspension and irradiation. Long Chain Carbon Preference Index (CPI24-34) is a geochemical proxy that may be used to compare the photolability of sediments from different tidal creek systems. Results show that the state of diagenetic processing is correlated with the photorelease of dissolved organic carbon and nutrients from sediments. Bradley Creek sediment, with a CPI24-34 value of 3.44, is more diagenetically altered than near-by estuarine sediments. The possible correlation between the observed photorelease of the brevetoxin PbTx-2 (as much as 0.6 nmol/L/g dry sediment) and CPI24-34 is currently being investigated.

A comparison of Nutrient Concentrations and Diatom and Dinoflagellate Distributions in 1st, 2nd, and 3rd Order Tidal Waterways (Savannah, GA)

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Healthy estuarine environments provide ecosystem services such as food, recreation, water purification, and flood protection. High nutrient concentrations, high dinoflagellate to diatom ratios, and low-diversity

communities can be early indicators of environmental degradation. This study looked for these early indicators in three connected waterways (1st order-Country Club Creek, 2nd order-Herb River, and 3rd order-Wilmington River). In June 2012, phytoplankton and water samples were taken from each waterway over three days, and from an eight-station transect between the Wilmington and Country Club Creek. Water samples were analyzed for silicate, phosphate, ammonia, and nitrate. Diatoms and dinoflagellates > 20 Âµm in size were identified to the genus level. No consistent differences in nutrient concentrations were found between the three waterways; however, there was a significant increase in ammonia concentration following a rain event. Despite a lack of significant differences in phytoplankton standing stocks among the waterways, standing stocks were highest in the 1st order waterway (mean 9259/L) during 3 of the 4 sampling events. No significant differences in dinoflagellate to diatom ratios were found between the three waterways, although dinoflagellates were more common in the 3rd and 1st order creeks. Dinoflagellates typically represented <10% of the community, but reached >50% in one Wilmington River (3rd order waterway) sample. The community was diverse (mean HÊ¹ = 1.9) with Rhizosolenia and Chaetoceros dominating in early summer. The diatom and dinoflagellate analysis is currently being repeated to determine standing stocks and community composition under late summer-early fall conditions when the water is on average 1.6Ëš C cooler. Preliminary results indicate that Skeletonema is dominant in late summer. Additional study will be needed to determine if the observed trends are consistent across seasons and years.

The Impacts of Urban and Suburban Stormwater Runoff on Selected Metabolic Processes within Southeastern North Carolina Tidal Creeks

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Growing scientific evidence suggests that stormwater runoff is the most pressing problem impacting coastal waterways. The components of stormwater runoff can negatively impact a range of water quality parameters in the receiving water body. This project aims to better characterize stormwater runoff from two different types of landscapes, while assessing the variable impacts of stormwater inputs on tidal creek primary productivity and respiration. Monitoring sampling was conducted at two sites along Hewlett's Creek to provide baseline data about estuarine waters of variable salinity unimpacted by stormwater. Ex-situ manipulations were also carried out to assess stormwater impacts on receiving waters. Receiving water was collected from the same two sites along Hewlett's Creek the day prior to an expected rain event. Stormwater was collected from an urban and suburban stormwater flow during significant rain events. A suite of bioassays was undertaken using 10% and 30% stormwater amendments to each respective type of receiving water; a biochemical oxygen demand assay, a chlorophyll a incubation assay, and a light/dark bottle incubation assay were carried out to derive information about stormwater impacts on receiving water productivity and respiration. Moreover, a post-rain assessment was conducted at the two sampling sites the day following a rain event to gauge the impact of in situ stormwater impacts on the parameters of interest. Initial results suggest that stormwater from each type of impervious cover categorization variably impact photosynthesis and respiration in tidal creek receiving water. Physical parameters like salinity and dissolved oxygen were significantly different after a rain event. Furthermore, stormwater inputs seemingly increased the oxygen demand of estuarine receiving waters as demonstrated by light/dark incubations. DOC content was also significantly increased at both sites after rain. However, considerably more experimentation must occur before further conclusions can be posited.

Using Marine Debris Surveys to Engage and Educate the General Public about Tidal System Vulnerability in the Southeast

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Along with the important issues of sea level rise and ocean acidification, the accumulation of marine debris along beaches and tidal creeks is considered to be a 21st century global challenge. This man-made debris can affect human health and safety, the economy, and biota of the aquatic environment. To address this challenge, the University of Georgia Marine Extension Service has developed programs that effectively engage and educate the public about tidal creeks, estuaries and the impacts that marine debris can have on these systems. We will showcase educational outreach and stewardship programs that actively remove the debris items along tidal creeks and salt marshes using marine debris shoreline surveys. The shoreline surveys serve as a tool to educate the general public on the issues of marine debris and how they can take an active approach in preventing the amount of marine debris entering coastal and ocean systems, thereby alleviating future impacts (ecological, economic and social) of marine debris.

The Relationship Between Nutrients and Phytoplankton Abundance in the Savannah River Estuary

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Phytoplankton abundance and distribution are dependent upon several factors including light availability, temperature and nutrient concentration of the water column. The purpose of this study was to determine the relationship between nutrient concentrations and phytoplankton abundance in coastal and estuarine waters of Savannah, GA. Ten liters of water were filtered through a 20 µm plankton net for each sample; temperature, salinity, and turbidity were recorded on site. Nutrient concentrations were determined in the laboratory using spectrophotometric techniques. Abundance of phytoplankton increased (10 to 103 cells/mL±41.6) in Tybee Creek over 3 month period. The abundance of phytoplankton increased, while the concentrations of nitrate and phosphate decreased. Phosphate concentration steadily decreased over the study period, with the greatest decrease in the Savannah River (3.72 to 1.46 µM ±1.6). An occasional increase of nitrate concentrations was observed in Lazarreto Creek (25 to 31 µM±5.2). The increase in nitrate concentration was considered a result of rainfall events similar to what was observed by (Randall et al., 2001). The Savannah River had the lowest phytoplankton density during each sampling event, which may be due to eutrophication and reduced light availability.

The Groves Creek Project: Organic Matter Transport and Transformation in a Salt Marsh and Tidal Creek Complex.

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Tidal exchanges through salt marsh and creek systems significantly modify biological and chemical characteristics of estuarine waters because the flooded marsh can be either a source or sink for particular constituents. We have initiated a 15 month project in the Groves Creek marsh to quantify organic imports and exports through the marsh/creek system. Groves Creek is unique among tidal creek research sites because the entire creek/marsh complex has been mapped to a vertical resolution of ~2cm at a horizontal resolution of ~1m using RTK GPS. Major creeks, minor drainages and marsh berms have been instrumented to estimate water flow across all marsh boundaries, and fluxes across them can be constrained to an unprecedented degree.

Research focuses on four system components: exchanges of constituents between creek and marsh, photochemical transformation of organic matter on marsh platforms, biological responses to OM quality, and a high-resolution hydrodynamic model of fluxes. Physical (salinity, temperature, pressure, water velocity), chemical ([O2], CDOM fluorescence, turbidity, spectral absorbance) and biological (chlorophyll fluorescence) data are collected continuously at a large creek and small creek site within the marsh at 15 minute intervals using in situ sondes. These data are augmented by periodic collection of creek water samples for additional biological, chemical and isotopic data. All the data will be tied to the Delft 3-D hydrodynamic model to quantify exchanges of material across the entire marsh boundary. Our aim is not only to assemble a material budget for exchange, but also to use the high resolution chemical characterization of organic matter to assemble a reactivity budget for the system. We hypothesize that the state of the marsh/creek complex as a source or sink of reactive OM to the estuary is highly dynamic on subtidal time scales and is tied closely to the interplay of diurnal, semi-diurnal and seasonal environmental cycles.

Long-term and Short-term Changes of Greenhouse Gas Emissions from a Constructed Salt Marsh in Eastern NC

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Little research on greenhouse gas (GHG) emissions exists in tidal salt marsh restorations with salinity ranges of 15-30 ppt. We conducted monthly gas flux measurements during a three-year period along with twelve daily carbon dioxide (CO2) monitoring events to provide a clearer understanding of how environmental factors in restored salt marshes impact GHG fluxes.
Since March, 2011, long-term GHG samples were collected and analyzed by applying a replicated static chamber method within three distinct plant zones (S. alterniflora, J. roemerianus and S. patens) at a recently restored tidal salt marsh in Carteret County, North Carolina. Along with monthly gas samples, pore water salinities, temperature, conductivities and soil redox potentials were measured at the same frequency. Soil pore water samples were also collected seasonally to analyze the available sulfate and nitrate concentrations in the rhizosphere. The results show pore water salinity was in the hypothesized range of 20-30 ppt. CO2 flux was 1.2-41.9 mg C/m2/hr, methane (CH4) flux was -0.006-0.048 mg C/m2/hr, and nitrous oxide (N2O) flux was -0.018-0.018 mg N/m2/hr. CH4 flux appeared to be inhibited by the high concentrations of sulfate (400-3200 mg/L) in the soil pore water ($p<0.1$) and the aeration in plant aerenchyma ($p<0.05$). The little N2O flux, on the other hand, was not correlated to any environment factors, which may be due of the lack of nitrate (0.04-1.54 mg/L) in the soil pore water.
Since March, 2013, a CO2 gas flux analyzer was used for measuring short-term flux changes at the same marsh. Results show CO2 flux was affected by precipitation during the day, and by tidal movements and precipitation at night. Results from this research will be used to provide design and management recommendations for future tidal marsh restorations to minimize GHG emissions and maximize carbon sequestration.

Spring-Neap Variation in Clutch Size Correlations and Embryonic Development for the Daggerblade Grass Shrimp Palaemonetes Pugio

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The daggerblade grass shrimp Palaemonetes pugio is found throughout the Atlantic and Gulf coasts. It serves as a vital food source for many invertebrate and fish species that have significant economic importance to fisheries and marine life. In this study, we sought to determine possible relationships between weight (g) and clutch size, length (mm) and clutch size, and developmental stage of P.pugio over the monthly tidal (spring-neap) cycle in Country Club Creek (Wassaw Sound Estuary, GA, USA). A developmental stage scoring was derived, grouping the 11 published embryonic development stages into 6 stages from fertilized egg (group 1) to post-nauplius with visible eye condensation (group 6). Thirty shrimp were collected by dip net at low tide during one spring and one neap tide monthly from May 31 to October 25, 2013. Based on data collected, a correlation between length or weight and the number of eggs was determined. By using the regression percentage (R2-value) and regression equation, we were able to

determine a quantitative method for predicting egg count in grass shrimp for use in future toxicological studies.

Synoptic Water Quality Sampling of Tidal Creeks along the Grand Strand, SC - An Undergraduate Research Experience

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The Grand Strand of South Carolina is a popular tourist destination with approximately 70 miles of beaches. An important conduit of terrestrial sourced material into the regional coastal waters is through fifteen tidal creeks that discharge across the beach face. The discharge from these tidal creeks carries large amounts of dissolved and particulate nutrients and organic material, fecal bacteria, pollutants and other chemical species into the near shore ocean. These biogeochemically important constituents are important drivers of the overall water quality in the region potentially affecting the occurrence of harmful algal blooms, human health risks in bathing waters, and the existence of hypoxic conditions. To gain a long term data set across the entire region a senior level research course has been developed which centers around a capstone project where the tidal creeks are synoptically sampled. The course also teaches students about the biogeochemistry of these systems, how do design a sampling strategy to produce high quality representative data, and to make regulatory level measurements under the state certified EQL lab QA/QC procedures. Parameters measured include; chlorophyll, dissolved oxygen, phosphate, nitrate, ammonia, total nitrogen and phosphorus, DOC, TSS/VSS, turbidity, and iron. Students are then asked to answer a hypothesis driven question using the data collected by their study, previous semesters, and land use data from the region.

Effects of Sediment Composition on the Microphytobenthic Biomass

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The microphytobenthos is an important component of the estuarine ecosystem. An understanding of the controls of the microphytobenthos is especially important in the wake of coastal urbanization. Many studies have quantified biomass and investigated various biotic and abiotic factors. Few have looked at the impact of sediment composition on production and biomass. Studies of sediment grain size have been done, but show controversial results. This research proposes to identify a significant relationship between sediment composition and microphytobenthic biomass via two approaches. The first takes an observational, multivariate approach whereas the second is a manipulation. Each approach will test

parameters including: chlorophyll a, EPS, grain size and TOC. The results of this research will give insight to urban siltation and possibly offer mitigation actions.

Relationships Between Abiotic Environmental Factors and Vegetation in the Big Bay Creek Salt Marshes of the Ashepoo-Combahee-Edisto (ACE) Basin, SC

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As a key transitional habitat between freshwater inland and saltwater ocean, salt marshes are one of the most productive ecosystems in the world. However, they are being threatened by climate change and human activity. In order to protect, conserve, and predict the future changes in the salt marsh, it is important to study the mechanisms involved in the development and sustenance of the salt marsh vegetation, the primary measure of productivity. In this study, the relationships between multiple abiotic factors (elevation, porewater salinity, porewater pH, and soil composition) and vegetation abundance and distribution were investigated. The study site consisted of 6 transects perpendicular to the creek, with a total of 45 plots where vegetation density, percent cover, mean maximum height of Spartina alterniflora, sediment samples, and elevation data were collected. In addition, porewater samples were collected and analyzed for pH and salinity at 28 of the 45 plots. After evaluating the data collected with a Spearman nonparametric correlation matrix, forward and backward stepwise regressions, multiple linear regressions, and PRIMERÂ® 6 nonparametric multivariate BEST test, elevation, organic matter, and porewater pH were found to be the most significant independent variables to explain the variability in percent cover and density of Spartina alterniflora, Juncus roemerianus, and Salicornia virginica.

Assessing Impacts of Land Use on Coastal Stream Metabolism

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Coastal streams connect terrestrial and estuarine ecosystems, however they remain relatively understudied compared to their inland counterparts. These streams are a conduit for nutrient and material loading and are susceptible to changes in land use, which can alter tributary loading and modify the processing and fate of nutrients and carbon within streams and the greater estuarine ecosystem. In order to assess the impact of land use on stream function, whole stream metabolism of five headwater streams of the New River Estuary, NC was measured using a one-station method. Watershed development of the streams ranged from 1 to 23% impervious cover.

Whole stream metabolism was determined by continuously monitoring dissolved oxygen (DO) concentration and correcting for reaeration using two methods to estimate the oxygen reaeration coefficient (k), an integral element of metabolism calculations. Gross primary production increased with watershed development, although all five streams were net heterotrophic. However, large variability in metabolism calculations of these generally low flow streams could have obscured results. Low streambed

gradients and ephemeral conditions common to coastal streams may preclude use of the one-station method and we are currently evaluating the two-station method with direct calculation of k using tracers. Other trends in productivity were also observed as a function of land use. Percent impervious cover of the watershed showed a negative relationship with CDOM and water column Chl-a was higher and more variable in watersheds with higher impervious surface. Increases in Chl-a concentrations of streams in impacted watersheds coincided with large diel excursions in DO (up to 10mg/L change daily), whereas less impacted streams had less pronounced diel patterns (< 1mg /L change). Historically, NC coastal streams were predominantly blackwater with high CDOM and low Chl-a, however it appears that increased impervious cover can alter trophic status.

The Influence of Nitrogen Form on the Growth and Toxin Levels of Microcystin-Producing Cyanobacteria in Coastal Stormwater Detention Ponds

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Extensive development across the coastal zone yields alterations in land use patterns, which impacts stormwater runoff and nutrient transport (nitrogen, N, and phosphorous, P) into receiving tidal creeks. In coastal South Carolina (SC), stormwater detention ponds are used as a best management practice to reduce flooding and act as catchments for runoff. These systems are typically poorly flushed and tend to stagnate and accumulate nutrients making them perfect environments for the development of dense and pervasive harmful algal blooms (HABs), including those caused by cyanobacteria. Cyanobacteria HABs are particularly common events in detention ponds located within the residential/golf course communities of Kiawah Island (SC), and many abundant genera (Microcystis, Aphanizomenon, Oscillatoria, Anabaena, and Anabaenopsis) produce the potentially lethal hepatotoxin microcystin. Cyanobacteria blooms are affected by N inputs, such as those that may be associated with landscaping and turf fertilizer applications. This study examines two Kiawah Island brackish ponds systems surrounded by golf courses to determine whether different forms of N promote cyanobacteria growth and microcystin. The two study sites (pond numbers K005 and K109) are shallow, terminal ponds with a history of recurrent cyanobacteria blooms. 48 hr nutrient addition bioassays were conducted during June and August of 2013, and treatment bottles contained singular N additions as nitrate, ammonia, urea, or P additions as orthophosphate as well as combinations of each N form with P in order to test whether phytoplankton were limted by P. Control treatment had no additions. At the end of each experiment, phytoplankton assemblages (counts and biomass as chlorophyll a), as well as nutrients and microcystin concentrations are examined. In addition to the summer semimonthly monitoring efforts, if a bloom occurs during routine fall monthly monitoring efforts, the ponds will be sampled, water quality parameters recorded, the bloom species identified and microcystin analyses will also be run.

Volunteer-based Stewardship of Murrells Inlet Drives Watershed-based Management Efforts Targeted at Improving Water Quality in Tidal Creeks

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The health of the estuarine environment in Murrells Inlet, SC is critical to the cultural identity and economy of the community. In 2008, a Volunteer Water Quality Monitoring Program (VMWQP) was implemented, sampling at 8 locations throughout the Murrells Inlet watershed. A particular concern is fecal bacteria contamination that has led to shellfish bed closures and the approval of a TMDL in 2005. Hence the volunteers have been measuring E. coli and total coliforms. Five of the sites are primarily freshwater tributaries with some tidal influence and two are located within tidal creeks. The VMWQP has enabled the volunteers to take ownership of their data and understand the implications of water quality in the tidal creeks.

Recent expansions in acreage of shellfish beds closed to harvesting motivated the volunteers to take action to halt this trend. At their behest, development of a watershed-based plan has been undertaken with funding from USEPA's 319 program. Several volunteers are participating directly in the plan's development, enabling the volunteers to have a significant input on the future management of Murrells Inlet; specifically in encouraging decision-makers to fund explicit projects that protect water quality in the estuary. They have also successfully asked the municipalities to embark on microbial source tracking efforts to better target management initiatives. This has included the use of genotypic and chemical tracers to better resolve host animal sources of fecal bacteria. The volunteers have personally undertaken a short-term project to sample upstream in four of the most contaminated tributaries in an effort to better resolve geographic sources. Through their diligent and timely efforts, additional information is now available to better inform development and implementation of the watershed-based plan. The volunteers are now highly motivated to continue monitoring to document water quality improvements that should arise from implementation of their management recommendations.

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