PROGRAM & ABSTRACTS

SECOR

Coastal Ocean Boundaries and Interactions and Assessments (COBIA)
Conference on Southeast Coastal Ocean Research
Savannah, Georgia • April 7–10, 1998

Crossing Disciplines / Crossing Boundaries
Research in the South Atlantic Bight

PREFACE

It is my pleasure to welcome you to the second conference on Southeast Coastal Ocean Research (SECOR), "Crossing Disciplines, Crossing Boundaries." The goals of the conference are:

1. To bring together scientists working in the South Atlantic Bight,
2. To share information on current research efforts in the region,
3. To foster cross-disciplinary connections, and
4. To facilitate the development and utilization of regional scientific resources.

With these goals in mind, thematic sessions were designed to include scientists from different disciplines. The Plenary Session, "Issues in the Coastal Zone," will highlight the important issues that are now facing the southeast coastal region, and was planned with the aim of bringing in perspectives that are a little broader than might traditionally be brought to a meeting of academic marine scientists. The poster session on Collaborative Research Opportunities in the Coastal Zone is a mechanism to highlight regional resources (e.g. facilities, instrumentation, educational programs, databases) and opportunities for collaboration. In addition, specific Program sessions will focus on the research of some of the larger multi-disciplinary projects in the region.

SECOR was sponsored by the S.C.Sea Grant Consortium, and I would like to acknowledge the support and efforts of the following people: Richard DeVoe, Elaine Knight, Ross Nelson, Linda Blackwell, and Monica Mulvey. I would also like to take this opportunity to thank the members of the Steering Committee as well as the Program Chairs, all of whose contributions helped to make this conference possible:

Steering Committee

Gary Kleppel, *University of South Carolina*
Jim Nelson, *Skidaway Institute of Oceanography*
Mac Rawson, *University of Georgia*
Leslie Sautter, *University of Charleston*

Session Chairs

Charlie Barans, *South Carolina Department of Natural Resources*
Alice Chalmers, *University of Georgia*
Madilyn Fletcher, *Baruch Institute, University of South Carolina*
William Moore, *University of South Carolina*
Dwayne Porter, *Baruch Institute, University of South Carolina*
Philippe Van Cappellen, *Georgia Institute of Technology*
Peter Verity, *Skidaway Institute of Oceanography*
Elizabeth Wenner, *South Carolina Department of Natural Resources*

And finally, thank you for your participation. The marked enthusiasm with which this meeting was greeted suggests that collaborative research is alive and well in the Southeast.

Merryl Alber
SECOR Program Chair
Dept. of Marine Sciences
University of Georgia
Athens, GA

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Tuesday, April 7

4:00 p.m.–7:00 p.m. Conference registration and check in
5:00 p.m.–7:00 p.m. Welcome reception, mixer

Wednesday, April 8

Welcome (8:30 a.m.–8:45 a.m.)
Richard DeVoe, *S.C. Sea Grant Consortium*
Gary Kleppel, *University of South Carolina*

PLENARY SESSION: Issues in the Coastal Zone (8:45 a.m.–12:15 p.m.)
Session Chair: Merryl Alber, University of Georgia

11:45–1:30 ... Lunch

Eutrophication (1:30 p.m.–2:30 p.m.)
Session Chairs: Madilyn Fletcher, University of South Carolina and Peter Verity, Skidaway Institute of Oceanography

2:30–3:00 ..... Coffee Break

Land Use-Coastal Ecosystem Study (3:00 p.m.–4:00 p.m.)
Session Chair: Gary Kleppel, University of South Carolina

Reception and Poster session (4:00 p.m.–6:15 p.m.)

The South Carolina Coastal Erosion Study: Understanding Change Within the Active Coastal Zone
Session Chair: Leslie Sautter, University of Charleston

Issues in the Coastal Zone

Land Use-Coastal Ecosystems Study

From Salt Marsh to Shelf

Dinner Banquet (7:00 p.m.–9:00 p.m.)
Master of Ceremonies: Mac Rawson, University of Georgia Sea Grant

Thursday, April 9

Urbanization of Southeastern Estuarine Systems (8:30 a.m.–10:30 a.m.)
Session Chair: Dwayne Porter, Belle W. Baruch Institute

10:30–11:00 .. Break

The Subterranean Estuary (11:00 a.m.–12:30 p.m.)
Session Chair: Billy Moore, University of South Carolina

12:30-2:00 .... Lunch

Biogeochemical Dynamics: From Molecular Approaches to Predictive Models (2:00 p.m.–3:45 p.m.)
Session Chair: Philippe Van Cappellen, Georgia Institute of Technology

Collaborative Research Opportunities in the Coastal Zone (3:45 p.m.–4:15 p.m.)
Session Chair: Charlie Barans, South Carolina Department of Natural Resources

3:45–4:15 ..... Collaborative Research "snapshots"

Reception and Poster Session (4:15 p.m.–6:30 p.m.)

Collaborative Research Opportunities in the Coastal Zone
Session Chair: Charlie Barans, South Carolina Department of Natural Resources, Marine Resources Division

Belle W. Baruch Institute for Marine Biology and Coastal Research, University of South Carolina, Advancing Knowledge Through Collaborative Research and Long-term Databases. Fletcher, M., D.M. Allen, D. Bushek, A. Lewitus, G. Ogburn-Matthews, and D. Porter.

Coastal Georgia Center for Sustainable Development, Water Resources and Coastal Georgia Fisheries. Kyler, D.

Department of Natural Resources Coastal Resources Division, Georgia Coastal Management Program. King, L.

Georgia Sea Grant,The Georgia Sea Grant College Program. Rawson, M.

National Ocean Survey, What's New at The New NOS Laboratory in Charleston. Comar, P.

NOAA Coastal Services Center, Charleston, SC. McCaskill, D.

NOAA - NOS/NMFS Beaufort, NC, NOS/NMFS Cooperative Research on Fisheries Habitat in Coastal and Estuarine Systems: The Beaufort Laboratory. Hare, J.

National Undersea Research Center at the University of North Carolina at Wilmington, Research Opportunities in the South Atlantic Bight. Shepard, A. and T. Potts

North Inlet-Winyah Bay National Estuarine Research Reserve, Georgetown, SC. Providing a Long-Term Perspective on Coastal Zone Processes and Opportunities for New Research. Aadland, C., D. Allen, W. Allen, W. Johnson, P. Kenny, G. Ogburn-Matthews, J. Schubaur-Berigan, and B. Thomas.

Urbanization of Southeastern Estuarine Systems

Biogeochemical Dynamics: From Molecular Approaches to Predictive Models

The Subterranean Estuary

Georgia Rivers Land Margin Ecosystem Research

Inlets: Crossing Disciplines

Friday, April 10

Georgia Rivers Land Margin Ecosystem Research (8:30 a.m.–10:15 a.m)
Session Chair: Alice Chalmers, University of Georgia

10:15–10:45.. Break

From Salt Marsh to Shelf (10:45 a.m –12:15 p.m.)
Session Chair: Jim Nelson, Skidaway Institute of Oceanography

12:15–1:45 ... Lunch

Inlets: Crossing Disciplines (1:45 p.m.–3:30 p.m.)
Session Chair: Betty Wenner, South Carolina Department of Natural Resources

ABSTRACTS

SUSPENDED AND BOTTOM SEDIMENT CHARACTERISTICS IN GEORGIA ESTUARIES. Alexander, C.[1], M. Alber[2], and J. Blanton[1], [1]Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411, [2]School of Marine Programs, University of Georgia, Athens, GA 30602.

As part of the Georgia Rivers LMER program, we are examining particle characteristics and sediment dynamics. Survey cruises on the Savannah, Ogeechee, Altamaha, Satilla and St. Marys Rivers demonstrate striking similarities and differences between these geographically contiguous rivers. At low suspended sediment concentrations, organic matter (% dw) is highly variable (20-60% dw) between the rivers, indicating the Piedmont vs. Coastal Plain character of these rivers. Chlorophyll is low in freshwater regions of the estuary, and increases seaward. At higher suspended sediment concentrations, the variability diminishes and organic matter (% dw) is relatively constant at 20-30%. However, organic matter concentration is well correlated linearly with suspended sediment concentration, indicating that different populations of particles must dominate in different portions of at least some of these estuaries. The potential particulate transformation between these populations represents a focus for future research. Particle concentrations (10-1400 mg/l) are higher by 2-10x at spring tides as compared to neap, indicating significant sediment remobilization on monthly time scales and sediment recycling. Observations of particle concentrations in surface-, mid- and bottom waters demonstrate that particles are rapidly mixed up into the water column within 1-2 hours of the onset of both ebb and flood tides and rapidly clear the water column as tidal current velocities decrease. Particle settling velocity, measured with a modified Owen Tube, demonstrates that the bulk of the material is in a larger, more rapidly settling fraction during peak ebb and flood current flow, whereas the distribution is broader during slack water. The size of suspended material within the water column (calculated from Stoke's Law) varies with current velocity within the estuaries, as well as with sediment concentration.

SPATIAL AND TEMPORAL CHANGES OF COASTAL WETLANDS AND BEACHES OF THE SAPELO ISLAND COMPLEX, GEORGIA. Alkaff, H.F., The University of Georgia, Institute of Ecology, Athens, GA 30602-2202.

Coastal wetlands provide numerous ecological functions and protect urban areas from saltwater intrusion and storm surge. Because these areas occur at the land-sea interface they are strongly influenced by changing sea level. Hence, it is of interest to characterize the effects of sea-level rise anticipated to accompany global climate change in the next century. I used geographic information systems (GISs) to define the impacts of sea-level rise on coastal wetlands. This study presents a quantitative analysis of both perimeter and interior wetland loss and/or gain of the Sapelo Island complex, during the period from 1912 to 1993, due to sea-level rise, land erosion, land use changes, and groundwater withdrawal. Results indicate significant perimeter and interior changes (loss and/or gain) in coastal wetlands of the Sapelo Island complex.

A GIS ASSESSMENT OF THE IMPACT OF SOCIOECONOMIC CHANGE ON TOURISM AND THE COASTAL ECOSYSTEM. Allen, J., K. S. Lu, South Carolina Water Resources Center, Strom Thurmond Institute, Clemson, SC 29634 and Clemson University, Department of Parks, Recreation, and Tourism Management, Clemson, SC 29634.

Recreation and tourism resources are the primary forces that have induced rapid socioeconomic coastal development over the last two decades. As negative elements of tourism get more public attention, the continuing growth of tourism and coastal urbanization has become a critical coastal issue. Coastal change detection and impact assessment have become one of the major study subjects of various research groups and organizations. This study, as an integral part of the NASA/EPSCoR Wetland Research Project, uses GIS to focus on the human aspect of coastal change and its impact. The study area for year one is Murrells Inlet. The Charleston and Beaufort areas will be studied in years two and three respectively with comparisons drawn between all three areas at the culmination of the project. The year one project was divided into three parts: (1) to detect socioeconomic change in terms of population change and development activities; (2) to examine, through a multivariate analysis, the relationships between changes and ecosystem indicators in order to predict the change impact on the coastal ecosystem; and (3) to assess the impact of socio-demographic change and associated ecosystem change on coastal tourism development. Preliminary results indicate that socioeconomic change and associated land use change have significant impact on the ecosystem and in turn on tourism resources, resource accessibility and destination functionality. It appears that the Murrells Inlet area has transformed from a fishing village, to a tourism niche (seafood restaurants), to a current transitional phase of a residential community for the Grand Strand area.

A STUDY OF PLANT DISTRIBUTION CHANGE IN ABANDONED RICE FIELDS IN GEORGETOWN-HORRY, CO., SOUTH CAROLINA. Alsup, D. and C. Coombs, Department of Geology, College of Charleston, Charleston, SC 29424

Brookgreen Gardens is a protected nature park located in Horry Georgetown Counties, South Carolina. Large tracts of abandoned rice fields within this estuarine environment are in varying degrees of secondary succession. Remote sensing and change detection techniques were used to determine if plant species reassemble similarly to the initial undisturbed forested areas, which served as the control. NAPP photography and other low altitude photographs, which were taken over a 50 year time period, as well as a SPOT panchromatic image were used to perform change detection on the spatial attributes of canopy height and canopy cover in these forested areas. These images were used to classify varying degrees of secondary succession within the abandoned rice fields. A combination on line transect and center-point quadrat technique were used to determine spatial location of three plant types: trees, shrubs, and herbs. Species abundance, dominance, and frequency were examined in each community. Statistical analysis using JMP 3.4.1 are being used to determine variation between the disturbed communities and a preserved 250 year old control community.

DEVELOPMENT ISSUES IN THE COASTAL ZONE. Ames, D. Amesco Inc. Hilton Head Island, S.C. 29928.

Architects and planners, with the assistance of scientists, can influence public policy, but have they been successful in protecting the environment, creating sustainable communities and contributing to the wise investment of public resources? This talk will reflect on the changing coasts of South Carolina and Georgia by selecting examples of their real estate development. This includes Myrtle Beach at one density extreme and Spring Island, near Beaufort, at the other. These communities differ in terms of their density, primary market, reliance on public sector investment, regulations and restrictions. They also differ in their impacts on the natural environment in terms of water quality, habitat and vegetation. The developer's perspective on coastal development issues needs to be understood by scientists. With this understanding, the scientific perspective can potentially be used to influence the choices that developer's make.

RELATIONSHIP OF TIDAL CURRENTS AND FINE PARTICLE DISTRIBUTION IN A SOUTH CAROLINA INLET. Amft, J.A., B.W. Stender, J. O. Blanton, C.A. Barans and D.V. Holliday, Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411; South Carolina Marine Resources Division, P O Box 12559, 217 Ft. Johnson Rd., Charleston, SC 29422; and Tracor Applied Sciences, 4669 Murphy Canyon Road, Suite 102, San Diego, CA 92123.

As part of a larger multi-disciplinary program studying larval transport, several instruments were deployed in and around the North Edisto Inlet in coastal South Carolina. The combination of moored instrumentation and sampling methods used in this field study provides a rare opportunity to merge physical and biological information. Standard physical observations of current velocity, temperature, salinity and pressure were complemented by acoustic backscattering data from a multi-frequency echo sounder. Acoustic volume scattering strength at four frequencies allows determination of particle size classes and estimates of particle abundance throughout most of the water column. This presentation will emphasize only the smallest sizes resolved by the acoustic approach, which are assumed to represent a composite of fine inorganic and organic material.

The vertical distribution of a highly turbid bottom layer varied in intensity and height above the bottom. Distinct temporal patterns were directly related to current velocity. The strongest signals were associated with the cyclic resuspension of fine particles during maximum flood and ebb tidal periods. At this location, ebb tides were generally stronger than flood tides, resulting in a larger concentration of fine material throughout the water column during times of ebb flow. The vertical structure of the turbid bottom layer also evolved over the longer neap/spring tidal cycle. A periodic meteorological and hydrographic events, such as wind reversals and frontal passages, perturbed the general distribution pattern of fine particles.

HIGH RESOLUTION COMMUNITY LEVEL PLANKTON DATA AND OCEANOGRAPHIC DATA. Barans, C.A., B.W. Stender, E.L. Wenner, D.N. Knott, J. O. Blanton, J. Amft, P.G. Verity, D.V. Holliday and C.F. Greenlaw, South Carolina Marine Resources Division, P O Box 12559, Charleston, SC 29422, Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411, and Tracor Applied Sciences, Inc., 4669 Murphy Canyon Road, Suite 102, San Diego, CA 92123-4333.

Multi-frequency acoustic profiling was used in the Ogeechee estuary in June of 1997 to describe distributional responses of plankton throughout the water column to natural estuarine cycles and to stochastic events. Discrete temporal changes in vertical densities of specific sized scatterers can be recorded in depth bins as small as 0.125 m throughout the water column at 2 min. intervals, providing a clear description of distributional patterns. The vertical distributions of postlarval shrimp and megalopal crab-sized scatterers appeared positively related to current velocity and diurnal patterns. Similar acoustic data collected in the North Edisto Inlet suggest that the planktonic community was much higher in the water column in the North Edisto in June 1994 than in the Ogeechee estuary in June 1997. Also, similarities were noted between the fall of 1994 and in the Ogeechee estuary during June 1997. Most scatterers the size of postlarval decapod crustaceans migrate vertically in apparent correlation with increased tidal current velocity and subsequent height of resuspended sediment in the water column.

IF WE WEREN'T USING THE WATER, NO ONE WOULD CARE ABOUT ITS QUALITY OR QUANTITY. Barber, N.L., R. Pierce. US Geological Survey, Georgia District Office and US Geological Survey, National Water-Use Program

The traditional view of the hydrologic cycle must be expanded to include the effects of man's use of water for various purposes. Hydrologic studies require consistent, periodic water-use data to analyze these effects, and to plan for increases in water use. The U.S. Geological Survey has been compiling, collecting, and categorizing water-use information at 5-year intervals, beginning in 1950, for use in ground-water models, river-basin budgets, trend analyses, and other studies.

Recent estimates of water use in the United States for 1995 show there has been only a slight increase in freshwater withdrawals compared to the 1990 estimates. This is despite a 6 percent increase in the population. It is estimated the eastern coastal counties in North Carolina, South Carolina, Florida and Georgia have had an 8 percent increase in population in the last 5 years, while fresh ground-water withdrawals have remained at about the same levels and surface-water withdrawals have increased by a small amount.

General trends provide a gross observation of conditions of water demand and availability, but it is typically at the project level that important variations and impacts are observed. Regional commissions, and State and Federal agencies are involved in many important studies in southeastern coastal areas, concentrating on water-quantity issues. One of the larger studies underway is the Savannah Basin Study, which has recently started the reconnaissance phase. The Savannah Basin effort is similar to the Apalachicola-Chattahoochee-Flint and Alabama-Coosa-Tallapoosa Basin studies, and also is headed by the U.S. Army Corps of Engineers. The U.S. Geological Survey 'mega-model' project has just begun on the east coast of Florida to identify and determine site-specific withdrawals from the Floridan aquifer. The Georgia Environmental Protection Division is at the midpoint of a 5-year coastal water-supply program to construct an early warning system for salt-water intrusion, to update ground-water flow models, and to investigate alternative water supplies. Adjacent States are conducting similar studies.

SOME THOUGHTS ON COASTAL GROWTH TRENDS. Becker, R.H., Thurmond Institute of Government & Public Affairs, Clemson University, Clemson, SC 29634-5203.

The story is not new—we are a population living in or seeking the coastal zone. National figures project by the end of the century over 50% of us will be within 50 miles of a coast. This increase will not be the product of natural population increase in the region, but will be made up of in-migrants who will be older, and richer than the population of the locales in which they choose to move. While the issues surrounding these demographic realities and the social economic forces created by this pattern may be pause for concern; it is the changes in land use, land tenure and political—planning responses to growth that need further discussion. It appears the qualities of our common resources are linked to actions and patterns of private land use, and issues of private property.

This presentation will review the demographic patterns expected within the South Atlantic Bight. Those patterns will be framed against current land use, questions of land tenure and existing governmental actions that influence coastal habitation patterns.

AN OVERVIEW OF THE JOINT SOUTH-CAROLINA-GEORGIA SEA GRANT PROJECT ON PROCESSES THAT TRANSPORT LARVAE TO SOUTHEASTERN US ESTUARIES. Blanton, J., J. Amft, C. Barans, D. Knott, B. Stender, P. Verity, E. Wenner and F. Werner, Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411; South Carolina Wildlife & Marine Resources Department, P O Box 12559, 217 Ft. Johnson Rd., Charleston, SC 29422, and Marine Sciences Program, the University of North Carolina at Chapel Hill, CB#3300, Venable Hall, Chapel Hill, NC 27599.

We have defined the role of wind-generated and tidal circulation in the transport of larvae from the continental shelf through inlets using combined field experiments and 3-dimensional numerical particle-tracking simulations that represent the transport of passive larvae from their origins on the continental shelf to influx through the inlet. Circulation through inlets to estuarine nurseries is one of the bottle necks to successful recruitment of commercially important shell-fish species such as the Atlantic blue crab and the white shrimp. Our first study site was the North Edisto Inlet, which connects the continental shelf to a weakly stratified estuary with negligibly small freshwater runoff. Each of four field experiments covered a neap-spring tidal cycle and measured the wind field and oceanographic conditions in the inlet and immediately offshore. We measured the nightly influx density during flood tide of postlarval white shrimp and blue crab megalopae and correlated these densities with wind and oceanographic conditions.

Simulations which were based on conditions encountered in the field indicate that larvae are withdrawn from the continental shelf into the inlet from a narrow zone parallel to the shoreline and extending only 5 km offshore. Downwelling favorable wind conditions were optimum in their ability to concentrate a "pool" of larvae within this zone. A series of papers in this session will summarize the key results derived from this project.

CHARACTERISTICS AND MOBILIZATION OF SUSPENDED SEDIMENTS IN GEORGIA COASTAL PLAIN ESTUARIES. Blanton, J., C. Alexander, M. Alber, G. Kineke and T. Gross, Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411; University of Georgia, School of Marine Programs, Department of Marine Science, Athens, GA 30602; and University of South Carolina, Department of Geological Sciences, Columbia, SC 29208.

The Georgia Land-Margin Ecosystem Research Program (GA LMER) has conducted comparative studies of suspended sediment concentrations (SSC) and characteristics in five coastal plain estuaries. These studies have included detailed experiments on the mobilization and deposition of suspended sediments in the Satilla and Altamaha River, estuaries where there are particularly high concentrations of suspended sediments.

The correlation of organic matter concentration (OMC) with SSC is well defined at SSC concentrations above 200 mg/l. To 0.99 confidence, 10% of the SSC is organic in the Altamaha (a piedmont river) and 14% in the Satilla (a coastal plain river) at high SSC. This correlation becomes ill-defined at concentrations below 30 mg/l and can range anywhere between 2% and 50%.

High concentrations of SSC are mobilized every 6.21 hours (a slack-water cycle). Above 200 mg/l, the particles with well-defined OMC are fast-settling and can reach bottom within an hour or so. At low concentrations (poorly defined OMC), the particles are slow-settling and cannot reach bottom within a slack-water cycle. Thus the fast settling particles spend most of their time near the bottom. Results in the Satilla River indicate that this material should be advected inland in a prevailing landward circulation which is characterized by asymmetric tidal currents and bottom stress that favor landward transport. The slowly settling particles remain suspended for long periods of time and their fate is less well known although some speculation will be offered.

DIFFERENTIAL PERCEPTIONS OF ENVIRONMENTAL ISSUES ON THE GEORGIA COAST. Blount, B., University of Georgia, Department of Anthropology, Athens, GA 30602-1619.

A well established principle in the cognitive sciences is that individuals who have commonality of experience tend to perceive phenomena in the same way, and as a corollary, those whose commonality of

experiences is different will perceive phenomena differently. Three sub-groups on individuals on the Georgia Coast were selected as subject populations to be interviewed about their perceptions of the coastal environment and of related environmental issues. The three groups were commercial shrimpers, commercial water-sports owners/operations, and members of environmental organizations. Intensive, semi-structured interviews were conducted with samples of the populations during the summer months of 1996 and 1997. The interviews showed that each of the three groups had a high degree of internal agreement but that the three groups were different from each other. The shrimpers did not see any significant problems with the current environment itself, but they identified as a major issue the artificial creation of environmental problems by environmentalists, specifically the protection of sea turtles and of weak fish. Individuals in water-sports businesses tended to see the environment as habitat for marine life, and they saw the principal environmental problem as anyone who directly and immediately disturbed the habitat. Environmentalists tended to see the environment in terms absence of pollution, and thus the major environmental issue was pollution. Any cross-group discussion of environment, for policy purposes, would first require clarification as to what the term conceptualizes for each group.

AN OXYGEN, CARBON DIOXIDE, AND NITROGEN MASS BALANCE MODEL OF THE ESTUARINE/INTERTIDAL MARSH COMPLEX OF FIVE RIVERS IN THE SOUTHEASTERN US. Cai, W.-J[1], L.R. Pomeroy[2], M.A. Moran[1], W. Wiebe[1] and Y. Wang[1], Department of Marine Sciences[1] and Institute of Ecology[2], University of Georgia Athens, Georgia 30602.

Concentrations of O_2, dissolved inorganic carbon (DIC), alkalinity, and $NO3+NO_2$ collected during October 1995 and July 1996 are presented. A simple but quantitative biogeochemical mechanism is proposed to interpret the observed concentrations and mass balance in the river and creeks. It is demonstrated here that the aerobic and anaerobic respiration, and the coupled nitrification and denitrification in the intertidal marshes play a critical role in regulating the mass balance of O_2, C, and N in the estuaries.

THE DEVELOPMENT AND APPLICATIONS OF MICROLELECTRODES FOR BIOGEOCHEMICAL STUDIES IN COASTAL SEDIMENTS. Cai, W.-J., Department of Marine Sciences, The University of Georgia, Athens, GA 30602.

I will review the development of microelectrodes (O_2, pH, pCO_2, Mn/Fe/HS) in various laboratories and their current and potential applications. Results from Sapelo Island, GA will be given as examples of how these microelectrodes can help to define the dynamics of biogeochemical systems in coastal and deep sea environments.

THE POTENTIAL IMPORTANCE OF CARBON DIOXIDE FLUX TO COASTAL OCEANS VIA GROUNDWATER DISCHARGE IN THE SOUTH ATLANTIC BIGHT. Cai, W.-J., Department of Marine Sciences, the University of Georgia, Athens, GA 30602.

Dissolved inorganic carbon dioxide (DIC) is an important material that may be carried by the groundwater to the ocean. DIC values in the North Inlet groundwater are about 4mM in all the low salinity waters. The pH values of these waters are all around 5. The high salinity waters have DIC values of 8-12 mM and pH values 5.9-7. I estimate that groundwater DIC flux to the South Atlantic Bight is significant compared to the riverine flux.

Alkalinity data were also collected. The ratio of alkalinity to DIC suggests a dissolution mechanism of carbonate minerals in these waters.

USING THE USGS 2 METER ELEVATION CONTOUR AS AN INDICATOR OF THE EXTENT OF INTERTIDAL WETLANDS IN COASTAL GEORGIA. Chalmers, A.G., University of Georgia, School of Marine Programs, Athens, GA 30602.

In the Georgia Rivers LMER study we have used the 2 meter elevation contour on USGS topographic maps as a "quick and dirty" indicator of the extent of tidal flooding in coastal wetlands. In order to assess how accurately this method actually does delineate intertidal marsh, a GIS analysis of the position of the 2 m elevation contour on maps of Sapelo Island was compared with detailed maps of elevation, vegetation and the marsh/upland boundary that are part of the GIS database for Sapelo Island. A comparison was also conducted of the area within the 2 meter elevation contour and National Wetlands Inventory maps for coastal Georgia.

MODELING STUDY OF CROSS-FRONTAL TRANSPORTS OVER THE INNER SHELF OF THE SOUTH ATLANTIC BIGHT. Chen, C.[1], L. Zheng[1], and J.O. Blanton[2], [1]Department of Marine Sciences, The University of Georgia, Athens, GA 30602; [2]Skidaway Institute of Oceanography, 10 Ocean Sciences Circle, Savannah, GA 31441.

Physical processes controlling the formation and perturbation of the low-salinity front over the inner shelf of the South Atlantic Bight have been examined using a fully three-dimensional primitive equation and turbulent closure model. The model was forced by semidiurnal tides (M_2, S_2, and N_2), river discharges, and winds. Numerical experiments show that this model was capable of simulating the fortnightly and monthly variation of semidiurnal tides. A good agreement was found between computed and observed amplitudes and phases of tides along the coast. The model results also show that the significant cross-frontal water exchange occurred under an upwelling-favorable wind condition through the formation of isolated low-salinity lenses at the outer edge of the front. The formation of isolated lenses depended on (1) the amount of multiple river discharges, (2) the direction and magnitude of the wind, and (3) tidal mixing. As the total amount of river discharges increased, a stronger wind was required to form the isolated lenses. When river discharges were large, tidal mixing acted like a drag forcing to delay the occurrence of isolated lenses. Upwelling, vertical diffusion, and along-frontal advection were found to play a critical role in the formation of isolated lenses. After the wind relaxed, the eddy-like circulation developed over the middle shelf through the current-density adjustment. The residence time of eddies was about one to two weeks. A 3-D animation of the detachment of isolated lenses can be viewed at "http://dolphin.marsci.uga.edu/research_projects/SAB."

CREEK BANK EROSION OF THE TIDAL SALT MARSHES OF MURRELLS INLET AND NORTH INLET, SOUTH CAROLINA. Chose, J.R. and C. Coombs, Environmental Studies Program, University of Charleston and the Medical University of South Carolina, Charleston, SC 29425.

This study takes a look at what factor or combination of factors, both natural and anthropogenic, most influence erosion of salt marsh tidal creek banks. Parameters affecting creek bank erosion will be identified along with determining how many acres of wetlands have been lost due to creek bank erosion. The potential factors influencing erosion of the creek banks in salt marshes include: boat induced waves, erosion control devices, docks/marinas, plant density and species composition, burrowing fauna, oyster beds, tides and currents, wind and waves, storm events, bank slope, channel dimensions, soil type, and stratigraphy. From fieldwork conducted erosion rates at five sites in each estuary will be determined, along with boat activity surveys, and biologic and geologic sampling. Aerial photography and other remotely sensed images are being used to determine erosion rates and historical changes in creek banks locations.

The final product will be the development of a Geographic Information System that will identify areas where erosion has occurred in the past and areas currently undergoing erosion, along with identifying areas that have potential for severe erosion. The information derived from this study will be used to compare a highly urbanized estuary, Murrels Inlet, to a pristine estuary, North Inlet, to determine whether urbanization influences erosion of the tidal creek banks.

PERCEIVED AND OBSERVED IMPACTS OF ECONOMIC DEVELOPMENT ON GEORGIA'S COAST BY THE RECREATIONAL FISHING INDUSTRY AND ITS LOCAL PARTICIPANTS. Cooley, D.R., University of Georgia, Department of Anthropology, Baldwin Hall, Athens, GA 30602-1619.

Nearly all of Georgia's coastal counties are experiencing a rapid population boom due to urban economic growth and the growing demand for coastal residential property and recreation. An understanding of the social and ecological impacts of Georgia's coastal growth was obtained by interviewing those who support recreational fisheries with retail and commercial businesses. Their knowledge of past and present ecological, economic and social issues revealed that coastal growth has had different impacts than planners and policy makers have predicted. The interviews sought to identify how commercial and recreational participants in Georgia's recreational fisheries regard current trends in Georgia's coastal resource management, impacts generated by current activities, and how problems should be addressed. Perhaps the most significant point is that most were convinced that coastal people benefit positively from development through increased levels of income and employment, but will suffer when development, if left unchecked, destroys through overpopulation and habitat destruction the most precious asset of Georgia's coast; the natural wildness and productivity of its expansive forests, and its wildlife, marshes, and fisheries. Determining what levels of development are sustainable is indeed difficult; however, it may be the most important and fruitful point for discussion among planners and community leaders. It seems that it might be productive to strive to incorporate more thoroughly the opinions and voiced needs of coastal communities; needs in conjunction with the stipulations of the new Coastal Management Program, an approach which might succeed in preserving the coastal ecosystem while promoting economic growth in this historically depressed region.

STATE-OF-KNOWLEDGE: GIS DATABASES AND LAND USE/COVER PATTERNS FOR SOUTH CAROLINA. Cowen D., L. Shirley, J. Jensen and M. Hodgson, University of South Carolina, Department of Geography and Liberal Arts Computing Lab, Columbia, SC 29208.

This paper will discuss the current state-of-knowledge investigation regarding GIS and remote sensing related land use and land cover activities in South Carolina and Georgia. The goal of the research is to assess the status and suitability of existing land use/cover databases for the Georgia and South Carolina coastal zone. This includes an inventory of existing land use/cover databases suitable for incorporation into a geographic information systems (GIS) database for South Atlantic Bight (SAB) coastal resources. This effort is taking place in conjunction with the Center for Remote Sensing and Mapping Science (CRMS) at the University of Georgia (UGA). The inventory will involve not only the identification of databases related to coastal watersheds, but also a compilation of information that will be used to assess their suitability for incorporation into a comprehensive SAB database.

INDICATORS OF TRENDS TOWARDS EUTROPHICATION AND TIDAL EXCHANGE OF NUTRIENTS IN WETLANDS - LUCES PROJECT. Craig, A. H., H. L. Windom, C.R. Alexander, Jr., Skidaway Institute of Oceanography, 10 Ocean Science Circle , Savannah, GA 31411; J.P. Schubauer-Bergian, University of South Carolina, Baruch Marine Laboratory, P O Box 1630, Georgetown, SC 29442; Henry J. McKellar, University of South Carolina, Department of Environmental Health Sciences, Columbia, SC 29208.

Nutrient and sediment data were gathered from existing databases in an attempt to assess temporal and spatial indicators of trends towards eutrophication in Georgia and South Carolina estuaries. Historical information was compiled mainly from the USGS National Stream Quality Network, Land Margin Ecosystems Research. National Status and Trends Program, and STORET databases. From this study we hope to identify certain water quality and sediment parameters which provide appropriate indicators of increased nutrient input into salt marsh estuarine ecosystems. Finally, estuaries in Georgia and South Carolina will be proposed as specific locations for study on the relationship of increased nutrient loading to land use.

SUBMARINE GROUNDWATER DISCHARGE FROM THE UPPER FLORIDAN AQUIFER IN THE AREA AROUND PORT ROYAL SOUND, SC. Crotwell, A. M., W.S. Moore, University of South Carolina, Department of Geological Sciences, Columbia, SC 29208.

The four radium isotopes (^{223}Ra, ^{224}Ra, ^{226}Ra, ^{228}Ra) are used as tracers of the interaction of groundwater with surface waters in Port Royal Sound, SC, (PRS). A large enrichment of Ra is seen in the surface waters, and is attributed to a groundwater source. Two possible groundwater sources are the Upper Floridan Aquifer (UFA) and the local surficial aquifers. Both sources are considered to be important in the region. The Ra isotope activity ratios of the two groundwater sources and the surface waters are used to show that, in addition to the shallow surficial aquifers, deeper confined aquifers are a significant source of dissolved constituents to the coastal oceans.

Extensive pumping from the UFA around Savannah, GA, and Hilton Head, SC, has reversed the direction of flow in the aquifer from seaward to landward in the area around PRS. The flow reversal has resulted in the enlargement of the subterranean estuary. This enlargement provides a large source of desorbable ions, such as Ra, Ba NH_4, PO_4, as the saline water encounters aquifer material. The direction of flow suggests a simple recharge of the aquifer under PRS with salt water. However, the tides and seasonal changes in groundwater usage strongly affect the groundwater in this subterranean estuary. The tidal effects drive a significant dispersive mixing force. Changes in groundwater pumping cause mixing over a larger scale. This mixing allows material dissolved in the subterranean estuary to be flushed back to the surface waters.

ESTUARIES OF THE SOUTH ATLANTIC COAST OF NORTH AMERICA: THEIR GEOGRAPHICAL SIGNATURES. Dame, R.[1], M. Alber[2], D. Allen[3], A. Chalmers[2], R. Gardner[3], C. Gilman[1], B. Kjerfve[3], A. Lewitus[3], C. Montague[4], J. Pinckney[5], N. Smith[6], [1]Coastal Carolina University, Conway, SC 29528, [2]University of Georgia, Athens, GA 30602, [3]University of South Carolina, Georgetown, SC 29442, [4]University of Florida, Gainesville, FL 32611, [5]University of North Carolina, Morehead City, NC 28557, and [6]Harbor Branch Oceanographic Institute, Fort Pierce, FL.

Estuaries of the southeastern Atlantic coastal plain are dominated by shallow meso-tidal bar-built estuaries interspersed with shallow sounds and both low flow coastal plain and high flow piedmont riverine

systems. Tidal ranges vary from near 2m in North Carolina and South Carolina to 3m in Georgia declining to less than 0.5m in south Florida. Over the 11° of latitude covered by this area, climate varies from strongly seasonal and temperate in North Carolina to tropical with limited seasons in south Florida.

Although most phytoplankton communities are moderately productive, vascular plant production dominates the region. Harmful algal blooms (cyanobacteria, dinoflagellates and cryptomonads) occur more frequently in the northern and extreme southern parts of the region. Benthic microalagae can be substantial. Numerous commercially important benthic consumers, oysters and clams, are abundant and common throughout the area. Many fin fish and crustaceans are also common throughout the region. Large consumers such as bottle nosed dolphins are common top predators in most systems, while manatees and crocodiles are found in southern Florida.

Urbanization reaches maximum intensity in Florida and it is thought that long term sustainability of this area will be lost within the next 25 years. Many estuaries throughout the region are sensitive to anthropogenic impacts, and eutrophication due to cities and farms has been documented for some. Tidal flushing appears to play an important role in mitigating anthropogenic inputs in regions of moderate to high tidal range.

THE EFFECTS OF URBANIZATION ON THE POPULATION STRUCTURE OF PALAEMONETES PUGIO IN SMALL, HIGH SALINITY ESTUARIES. Daugomah, J.W., M. H. Fulton, G.I. Scott, US Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Charleston Laboratory, Charleston, SC 29412

Coastal development in the United States has caused significant changes in estuarine ecosystems due to urbanization. High salinity estuaries in the Southeastern U.S. have experienced increased inputs of contaminants from nonpoint source runoff (NPS) urban runoff and decreases in areal habitat due to filling of wetlands and dock/bulkhead construction. Urbanization may pose significant risks to estuarine fauna, particularly crustaceans. The grass shrimp *Palaemonetes pugio* is one of the dominant species found in estuarine tidal creeks, accounting for > 50% of all macropelagic fauna on an annual basis. The goal of this study was to compare the population structure of *P. pugio* at sites within a highly urbanized estuary, Murrells Inlet 9(MI) and similar sites in pristine North Inlet (NI). *P. pugio* densities were estimated annually at six sites in MI and compared to a reference site in NI (1992-1994). Additional comprehensive spatial sampling was conducted during the summer of 1995 at 30 sites in each estuary. Three consecutive 25m stream stretches in tidal creeks were sampled at ebb tide by dip net (3mm mesh x 40cm x 25cm) along the base of the *Spartina alterniflora* marsh. Samples were immediately transported back to the laboratory in a cooler and quantified. All samples were then preserved in 100% ethanol for later determination of sex ratios and the proportion of gravid females. The following parameters were measured at each site and statistically compared: 1) adult *P. pugio* density (#/m) and biomass (g/m); 2) adult *P. pugio* sex ratios, proportion of gravid females, and 3) larval *P. pugio* densities (#/m). Results have indicated that urbanization may have a significant impact on *P. pugio* populations. Significant ($p \leq 0.05$) reductions in *P. pugio* densities were found at the inner, mid and outer sites of MI when compared to NI reference sites. Additionally the proportion of gravid females was significantly ($p \leq 0.05$) altered at urban sites when compared to the reference sites. Additional statistical analyses indicated that several factors may influence the population structure of *P. pugio* in urbanized MI. These factors include water quality (DO, pH), grain size and sediment associated PAHs. Potential GIS spatial statistics considering land use attributes and related impacts to *P. pugio* population dynamics will be considered.

RECENT ADVANCES IN MOLECULAR MICROBIAL ECOLOGY: THE LATEST NEWS.
DiChristina, T., School of Biology, Georgia Institute of Technology, Atlanta, GA 30332-0230.

Recent advances in the molecular tools now available to microbial ecologists has dramatically changed the way in which we examine the make-up and dynamics of microbial assemblages in natural water systems. The molecular tools permit microbial ecologists to directly access ecologically relevant information in the form of phylogenetic- or phenotypic-specific macromolecules. Such macromolecules can be extracted from the environment, and thereby also avoid the biases associated with traditional cultivation techniques. Typically, only a small fraction (<1%) of the natural microbial population can be cultivated by standard techniques. The molecular techniques allow microbial ecologists to describe and quantify the relative abundance of specific phylotypes in complex microbial assemblages. Such an approach has resulted in the identification of a bewildering array of as yet unculturable microorganisms, many of which belong to the domain *Archaea*. Specific metabolic properties (e.g., metabolic pathways for energy generation or carbon dissimilation) can be inferred from these phylogenetic analyses, and nucleic acid sequence analysis of genes located proximal to the phylogenetic-specific markers (chromosome walking of environmental DNA retrieved directly from natural biomass) provide a means for confirming the metabolic potential of mixed microbial populations. Whole cells retrieved from the environment are also amenable to molecular-based hybridization techniques when combined with epifluorescent microscopy. Future work in molecular microbial ecology will ultimately be directed toward the development of phenotype- (or function-) specific molecular tools. When such tools become available, an even better understanding of the structure and activity of naturally-occurring microbial populations will be achieved.

TERRESTRIAL CONTRIBUTIONS OF ORGANIC CARBON TO BOTTOM AND SUSPENDED SEDIMENTS IN A COASTAL PLAIN ESTUARY, WINYAH BAY, SOUTH CAROLINA. Eddins, S.G.N., D.F. Williams, University of South Carolina, Marine Science Program, Columbia, SC 29208, and University of South Carolina, South Carolina Honors College, Columbia, SC 29208.

The objectives of our study are: to understand spatial and seasonal variations of terrestrial organic carbon signal in suspended sediments in Winyah Bay, SC, and to investigate longer-term source accumulation in recent sediments. We collected data during five cruises, which reflected various seasonal and freshwater discharge conditions. Winyah Bay is a partially mixed Coastal Plain estuary, bordered by pristine salt marsh in its lower reaches.

Using molecular (lignins) and atomic tracers (elemental and stable isotopic carbon and nitrogen composition), we conclude that C-3 plants appear to be greater contributors to benthic organic matter in Winyah Bay than *Spartina* or plankton. Seaward, isotopic composition of benthic organic carbon follows a gradient from terrestrial to marine values (from -23.7‰ to 28.9‰). During high freshwater discharge (winter, spring), terrestrial inputs dominate the estuary and decrease during low discharge. Nitrogen and biomarker values support the carbon data.

Isotopic composition in suspended sediments ranges between -28.4‰ and -19.5‰. Surface water suspended sediments are isotopically lighter than bottom water ones. As freshwater discharge decreases (summer, fall) planktonic and *Spartina* carbon dilute terrestrial organic matter, especially in bottom suspended sediments (average $\delta^{13}C$= -20.7‰).

Winyah Bay drains one of the largest watersheds on the East Coast. This watershed is subjected to a wide array of non-point and point source pollution. Organic carbon in Winyah Bay appears to be terrestrially dominated, which has important implications on watershed management. Additionally, this study provides needed baseline information on biogeochemical cycling and ecosystem functioning of Winyah Bay.

ALTERNATIVES TO THE PAIRED T-TEST FOR TESTING SPATIAL CHANGE. Edwards, Don [1,2], Dwayne E. Porter[2], Ben Jones[2], Elena-Claudia Moise[3], and W. Scott Street, IV[4]. [1]Department of Statistics and [2]Belle W. Baruch Institute for Marine Biology and Coastal Research, University of South Carolina, Columbia, SC 29208, [3]Abbott Laboratories, Chicago, Ill., and [4]Department of Mathematical Sciences, Georgia Southern University, Statesboro, GA.

Testing for change in a region, e.g., loss of wetlands over a period of several years, is a frequent goal for assessment of conservation strategies. Typically, using digital image processing techniques in conjunction with Geographic Information Systems (GIS) tools, the region is subdivided into cells and percent wetlands estimated for each cell both before and after the period in question. The change in this percentage in each cell can thus be calculated and used as a basis for a formal statistical test. These cell changes are usually spatially correlated, however, which can invalidate a simple paired t-test. For example, when the region is subdivided into smaller cells, results using the paired t-test tend to artificially become more statistically significant. Using both theory and computer simulation, we examine the operating characteristics of the paired t-test and several modified versions of it which attempt to correct for spatial correlation using results from geostatistical (kriging) analyses. The simple test performs poorly under spatial correlation, whereas the alternative tests hold their level well in these instances and have comparable power to the simple t-test when there is no correlation. An example application to Murrells Inlet, SC data is provided.

AN INVESTIGATION IN MODEL PORTABILITY: SECONDARY CIRCULATION IN A SHALLOW WELL-MIXED GEORGIA ESTUARY. Elston, S., H. Seim, J. Blanton, J. Amft, and T. Gross, Georgia Institute of Technology, School of Earth & Atmospheric Sciences, Atlanta, GA 30332-0340; and Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411.

This investigation on secondary circulation in the Satilla River (a Georgia Land Margin Ecosystem Research (GA LMER) site) was motivated by a recent paper by Turrell, Brown, and Simpson (1996) which used a straightforward model with simple channel geometry to estimate the strength of the secondary lateral circulation. Though secondary circulation can be a result of channel curvature or unusual bottom topography, this study focuses on a secondary circulation due to the interaction of the lateral shear of the along channel (axial) current with the axial salinity gradient associated with flood and ebb tides (the strength of the salinity intrusion).

We are interested in the portability of the simple Turrell et al. (1996) model, particularly because, unlike their results, strong lateral shearing in the Satilla River also tends to occur during the ebb phase of the tidal cycle, as initially demonstrated by Acoustic Doppler Current Profiler (ADCP) data. Additionally, this study investigates the impact of more realistic bottom topography on the model results.

It is important to be able to estimate the intensity of lateral circulations in estuaries to better predict the length of the salt intrusion in a system of complex feedbacks, which in turn, allows for a better prediction of the dispersion and distribution of various properties (e.g., larvae, sediment, and pollutants) in the estuarine environment.

LU-CES PROJECT; MICROBIAL INDICATORS AND PHYTOPLANKTON AND BACTERIAL COMMUNITIES AS EVIDENCE OF CONTAMINATION CAUSED BY CHANGING LAND USE PATTERNS. Fletcher, M.[1], P.G. Verity[2], M.E. Frischer[2], K.A. Maruya[2], and G.I. Scott[3], Baruch Institute, University of South Carolina[1], Skidaway Institute of Oceanography, University of Georgia[2], and National Marine Fisheries Service Southeast Fisheries Science Center, Charleston Laboratory[3], Charleston, SC 29412.

For decades, measurement and monitoring of microorganisms and phytoplankton have been used to evaluate the impacts of various anthropogenic factors, ranging from increased nutrients, to toxic contaminants, to specific pathogens. Large data bases exist on specific organisms (e.g., coliforms) or microbial activities (e.g., primary or secondary production) have been served as indicators of human impact and changes in ecosystem processes.

The objectives of this project are: (1) to inventory, analyze, and synthesize approaches for using microorganisms (including bacteria and phytoplankton) as indicators of anthropogenic effects and environmental conditions in SAB coastal waters and sediments; (2) to develop recommendations for the types of microbial data that are most effective in detecting or predicting ecosystem impacts; (3) to identify knowledge gaps and research needed to increase the effectiveness of the most promising microbial indicator systems; (4) to identify specific government agencies that utilize, or should utilize, microbial indicator data in their planning processes; and (5) to identify appropriate mechanisms to utilize new microbial indicators in monitoring studies within state or federal government agencies.

Data will be collected by library and internet searches, inquiries to government agencies, universities, and laboratories in the region who are likely to have relevant data, and coordination with other LU-CES teams. We will then analyze the data with the objective of identifying the microbial indicators (parameters) that correlate best with specific land uses; their strengths and weaknesses as functional indicators; and research needed to strengthen existing approaches and develop new, promising methods.

QUANTITATIVE DETERMINATION OF VARIABLES ASSOCIATED WITH SHOAL BYPASSING EVENTS FOR NINE MESOTIDAL INLETS IN SOUTH CAROLINA. Gaudiano, D. and P. McKee, University of South Carolina, Department of Geological Sciences, Columbia, SC 29208, and CSE Baird 2615 Devine St., Columbia, SC 29205.

Tidal inlets are historically active areas of rapid sediment erosion and accretion. In South Carolina, these dynamic systems undergo an episodic process known as shoal bypassing, which can quickly transport large volumes (up to 1,000,000 m3) of sand in the form of landward migrating shoals from ebb-tidal delta swash bars to adjacent beaches. Quantitative data were collected to determine a relationship between the volume of sand in bypassing shoals, the frequency of bypassing events, and the tidal prism of the inlets. A 50-year aerial photography record was digitized into an existing AutoCAD base map to determine the areas and volumes of the subaerial migrating shoals. The bypassing frequency for an inlet was defined as the average time between bypassing events and ranged from 2 to 10 years. However, gaps in the aerial photograph record prevented highly accurate averages from being determined. Tidal prisms were measured for each inlet with a Sontek Acoustic Doppler Current Profiler in the inlet throats where cross-sectional areas were surveyed. Inlets with larger tidal prisms bypassed shoals containing greater volumes of sand. Based on the available data, no clear relationship exists between tidal prism and bypassing frequency, suggesting bypassing frequency may depend more on the type of bypassing (inlet migration and breaching, stable processes, and ebb delta breaching) the inlet undergoes. This study provides necessary planning data for coastal land owners and developers in the vicinity of inlets. In addition it contributes detailed sand budget data for specific areas of the SC coast.

THE CENTRAL SOUTH CAROLINA SHOREFACE: AN ACTIVE ZONE OF LINKAGE. Gayes, P.T., W.C. Schwab, M.S. Harris and P. Donovan-Ealy, Center for Marine and Wetland Studies, Coastal Carolina University, Conway, SC 29528; US Geological Survey, Woods Hole, MA 02543-1598; Center for Marine and Wetland Studies, Coastal Carolina University, Conway, SC 29528; and Center for Marine and Wetland Studies, Coastal Carolina University, Conway, SC 29528.

A comprehensive mapping and monitoring study of the beach, shoreface and inner shelf of central South Carolina has identified substantial and rapid changes in some large scale submarine coastal features. In particular, repetitive side scan sonar mosaics offshore of Folly Beach have documented an active field of linear rippled scour depressions over the last three years. These features extend perpendicular to the beach from the surf zone offshore for 3 kilometers where they change orientation and trend oblique to the coast. The main sand body ranges from 500 meters to a kilometer wide, four to six kilometers long, and represents a volume of approximately 775,000 cubic meters of coarse sand. The shore-perpendicular sandbody has a strong textural affinity to sands within the active surf zone and to coarse fractions from the back-barrier beach renourishment sands applied to the beach in 1993. The morphology, stratigraphy and surficial sediment characteristics of these shore perpendicular features combined with long beach profile data from the area suggest these are areas of substantial sediment transport and possible offshore loss of sediment from the beach system. The area of active linear rippled scour depressions intersects the surf zone between a local hotspot for erosion and an area of relative coastal stability where relict beach ridges intersect the coast. It is inferred that the large scale linear-ripple depression may play a role in the localized enhanced erosion of the beach and sediment budget.

OPTICAL AND BIOLOGICAL MEASUREMENTS ALONG A TRANSECT FROM CHARLESTON ACROSS THE GULF STREAM. Geesey, M., A. Subramaniam, M. Culver, G. DiTullio, J. Brock, NOAA/CSC, 2234 Hobson Ave., Charleston, SC 29405 and University of Charleston, Charleston, SC 29424.

In November 1997 we sampled surface waters continuously and performed depth-profiles at stations on a transect from Charleston, SC, southeast across the Gulf Stream, and into the Sargasso Sea. A suite of optical, physical, and biological oceanographic measurements were performed including irradiance, temperature, salinity, nutrients, and pigments. These measurements can be used to characterize the transition in marine environmental regimes found in the SAB: from near-coastal, continental shelf, Gulf Stream, to the Sargasso Sea. The irradiance and pigment measurements will be used in the calibration and evaluation of ocean color satellite imagery. This type of imagery allows point data, as acquired here, to be extrapolated over larger areas to provide a larger-scale perspective of the variability in the SAB.

SHORT AND LONG-TERM VARIABILITY OF EBB-TIDAL DELTA SHOALS: MANAGEMENT IMPLICATIONS. Hansen, M., and P. Work, USGS 600 4th St. S., St. Petersburg, FL 33701, and Clemson University, 110 Lowry Hall Clemson, SC 29634.

With the increasing demand for suitable beach fill material, coastal planners often covet ebb-tidal shoal sands due to their (typically) coarse grain size and proximity to the beach. However, these sand bodies are rarely mined because of potential adverse effects on adjacent shorelines. The quantification of sediment volumes in an ebb-tidal delta over short and long time spans can be used to identify the system's natural variability. Understanding this variability may help planners make wiser decisions on the use of ebb-tidal delta material. To address the variability issue, this study has investigated three unstructured inlets in South Carolina over time spans of years, decades, and centuries using modern and historical surveys. Detailed modern inlet surveys have been conducted by the U.S. Geological Survey over the past four years (1994-1997) and compared to historical data. The correlation between retreat rates of adjacent shorelines to shoal volumes provides additional insight on the potential use of ebb-tidal delta material for beach replenishment.

COOPERATION IN MARINE FISHERIES RESEARCH. Harris, D., S. Shipman, Georgia Department of Natural Resources, Coastal Resources Division, One Conservation Way, Brunswick, GA 31520-8687.

Managers of marine fishery resources in the southeastern United States require the assistance of the university research community to address pressing questions regarding the life history and population dynamics of marine fishery resources which are important to recreational and commercial fishers.

Increased population growth, habitat modifications, and the ineffectiveness of management to prevent overfishing of some fishery resources have placed many fish stocks at risk. Resource managers cannot keep pace with research necessary to quantify essential fish habitat and to address questions about stock identification, life history, stock abundance, spawning stock ratios, etc., to the extent needed to compel policy, statutory, and regulatory decisions to ensure the long term sustainability of marine fishery resources.

It is also imperative that managers gain a greater understanding of the important socioeconomic issues associated with marine fisheries management and which state agencies rarely have staff expertise to address. Moreover, the university research community must be a vital partner in the ecosystem approach to management and the complex modeling which is also beyond the capability of most state agencies. This situation demands a more cooperative, integrated approach to addressing the questions for which managers need answers to effect successful management strategies in the future.

A more formal mechanism to facilitate cooperation between the university research community and resource management community may be needed. It is, without question, a matter for serious discussion.

SHORT- AND LONG-TERM GEOMORPHIC EVOLUTION OF THE CENTRAL SOUTH CAROLINA COASTAL ZONE: COASTAL RESPONSE TO A COMPLEX GEOLOGIC FRAMEWORK. Harris, M.S., P.T. Gayes, J.L. Kindinger, J.G. Flocks M.P. Katuna, J.F. Wehmiller, and D.E. Krantz, Center for Marine & Wetland Studies, Coastal Carolina University, P O Box 261954, Conway, SC, 29528-6054; Center for Marine and Wetland Studies, Coastal Carolina University, P O Box 261954, Conway, SC, 29528-6054; US Geological Survey, Center for Coastal Geology, 600 4th St., South, St. Petersburg, FL, 33701; US Geological Survey, Center for Coastal Geology, 600 4th St., South, St. Petersburg, FL, 33701; Department of Geology, College of Charleston, Charleston, SC; Department of Geology, University of Delaware, Newark, DE, 19716; and University of Delaware, Lewes, DE. 19716

The coastal plain and continental shelf between Edisto Island and Bulls Bay in central South Carolina comprises five major coastal reaches (Charleston Harbor, the reach north of the harbor, and three islands south of the harbor), three dominant shore-parallel shelf subdivisions, and at least four emergent Pleistocene barrier systems. Each region reflects a classic mixed-energy coastal morphology; however, the dimension, position, orientation, and morphology of the ancient and modern barrier islands are influenced by subsurface Tertiary and Quaternary geologic systems. These regional and local relationships have been identified from high-resolution single-channel seismic data, ground penetrating radar investigations, onshore and offshore vibracores, on-land boreholes, topographic, bathymetric, and soils maps, and amino acid racemization dating techniques. Separating two dominant geologic terranes, Charleston Harbor has formed between complex Cenozoic deposits to the south and gently dipping to flat-lying Tertiary units to the north. South of Charleston Harbor, the three island-scale morphologies have repeated throughout the Quaternary, reoccupying a complex Tertiary substrate and forming three coastal reaches and over the last 250 thousand years. Major inlets are directly associated with Tertiary structures, centered either within synforms or atop breached antiforms. Minor inlets have formed above Pleistocene inlets and Pleistocene drainage systems. The northern segment of the framework changes from gently-

dipping beds inland to complex structures offshore. The inference is that the drastic difference between the continuous Pleistocene barrier system, 5km inland, and the modern discontinuous barrier islands is the result of a direct linkage between the evolving Quaternary system and the shallow geologic framework. Through multiple high stands of sea level, the geomorphology of the central South Carolina coastal zone is the result of wave and tidal energies interacting with and responding to influences imparted by a highly variable geologic framework. Although existing process-oriented coastal models (wave and tide) generally explain coastal morphodynamics, regional and island-scale variability may be explained with relation to underlying stratigraphic variability. In this region, the geologic framework imparts an enduring imprint through time scales of decades to greater than 250 thousand years.

MODELING WAVE AND CURRENT INTERACTIONS AT PRICE INLET, SOUTH CAROLINA. Hayter, E.J., Y. Yan and P.A. Work, Civil Engineering Dept., Clemson University, Clemson, SC 29634; Georgia Department of Community Affairs, Atlanta, GA; and Civil Engineering Dept., Clemson University, Clemson, SC 29634.

As a component of the South Carolina Coastal Erosion study (SCCES), mathematical modeling of wave and current interactions at Price Inlet, South Carolina is described. The following processes are simulated in the model: tide-induced currents and wave transformation induced by bathymetry and wave-current interactions. The model used consists of two coupled modules: a vertically-integrated, two-dimensional (2D) hydrodynamic module, and a wave transformation module that accounts for shoaling, refraction, diffraction and energy dissipation of waves due to wave-bathymetry and wave-current interactions. The first module solves, using a finite element formulation, the 2D forms of the continuity equation and the x- and y- components of the conservation of momentum equation. To simulate nonlinear wave-current interactions, the momentum equations include radiation stress terms to account for wave momenta. This module includes a wetting-drying algorithm to account for the flooding (i.e., wetting) and draining (i.e., drying) of elements along land (i.e., beaches, inlet channel, marshes, shoals) boundaries over the course of a tidal cycle. The wave transformation module coupled to the hydrodynamic module is REF/DIF 1 model developed by Kirby and Dalrymple (1994). REF/DIF 1 is a weakly nonlinear combined refraction and diffraction model that accounts for the effects of currents on wave heights and directions of propagation. It is a finite difference model which necessitates the use of the same rectangular grid with ?x = ?y =50m in hydrodynamic and wave transformation modules for coupling purposes. These two modules are coupled in the following manner. At a given time step, first the hydrodynamic module is without waves to predict the tide- induced flow field, and then REF/DIF 2 is run to predict the wave field using the predicted flow field to account for the effect of currents on waves. Next, the hydrodynamic module is re-run with the waves included to account for the effect of waves on currents. This is followed by 1) re-running REF/DIF 1 using the wave- modified flow field, and 2) repeating both steps for a third iteration to fully account for the nonlinear interaction of waves and currents. Three iterations have been found to be sufficient to achieve convergence. Wave and current interactions at Price Inlet, a mesotidal inlet on the tide dominated central South Carolina coast (with 1.48m and 1.71m mean and spring tide ranges, respectively, in the inlet channel) were modeled using the described model. The size of the modeling domain used is 5.0 km in the longshore direction (with Price Inlet in the middle) and 4.87 km in the offshore direction. 1.3 km (in the onshore-offshore direction) of the inlet channel is included in the grid. The offshore and inlet bathymetry was determined by a survey performed by the U.S. Geological Survey as a component of the SCCES. The channel margin linear bars and adjacent shorelines were surveyed using a hand-held GPS system. The offshore wave conditions at the NDBCC wave buoy off Charleston, South Carolina were used to specify the wave conditions at the ocean boundaries of the modeling domain. The NOS predicted tide in the inlet channel was used as the tide boundary condition along this open water boundary. The predicted tide

along the ocean boundaries was calculated using the NOS predicted tide at the nearest open ocean tide station on the Isle of Palms. Current measurements made along several inlet channel and offshore transects using an acoustic Doppler profiler and wave measurements in the inlet channel were used to partially calibrate the model.

THE EFFECTS OF HURRICANE FRAN ON DIATOM ASSEMBLAGES FROM A BACKBARRIER MARSH, SOUTHEASTERN NORTH CAROLINA. Hilterman, J., R. Laws, and L. Leonard. University of North Carolina at Wilmington, Department of Earth Sciences, Wilmington, NC 28403.

The distribution and taxonomic composition of edaphic (sediment associated) microalgal floras are largely determined by substrate characteristics, especially granulometry and organic content. On low-relief barrier island systems, these characteristics can be suddenly and dramatically altered by large storms which result in significant changes in the microalgae. Hurricane Fran (September 1996) supplied large quantities of coarse, clean sediment to the backbarrier marsh system on Masonboro Island, NC, as a result of overwash. The northern and most stable part of the island received virtually no overwash. The marsh in the middle of island received a large pulse of sand due to the storm, but the berm and dune line have subsequently stabilized and the marsh appears to be in a recovery phase. The southern end was most severely impacted by the storm, and was repeatedly overwashed by astronomically high tides for at least six months after Hurricane Fran. Four months following Hurricane Fran, marsh samples from the middle region were dominated by: *Nitzchia* spp. (19%), *Amphora* spp. (17%), and *Cocconeis* spp. (15%). In contrast samples from the southern marsh consisted mostly of: *Navicula* spp. (36%), *Hantzchia* spp. (10%), *Bacillaria* spp. (10%), and *Caloneis* sp. (9%). Many of the taxa found in the southern, frequently overwashed, sites are unique to the area and not identified elsewhere in the study area. In the middle of the island, as the substrate returns to the pre-storm character, the assemblages become more diverse and richer in epipelic forms such as *Nitzchia* and *Navicula*.

SCIENTIST AS POLICY-MAKER. Hodson, R.E. and M. Alber, University of Georgia, Department of Marine Programs, Athens, GA 30602.

How much responsibility do scientists have to communicate their results to the general public? Does it compromise a scientist's credibility to make policy recommendations? How can a scientist be most effective in providing information to decision makers? This highly anecdotal talk will explore the differences between science and policy, and the difficulties encountered translating marine scientific and technical data into management action and policies. We will also describe UGA's newly expanded school of Marine Programs, which combines research, outreach, and instructional responsibilities and offers the opportunity for an integrated contribution to policy.

EFFECTS OF IGR PESTICIDES ON LARVAL AND ADULT BLUE CRABS. Horst, M.N., A.N. Walker, Mercer Medical School, 1550 College St., Macon, GA 31207.

Use of pesticides for agricultural, recreational and mosquito control purposes has increased in many southeastern states and likely impacts on the biology of estuaries. Our work focuses on effect of one class of insecticides, insect growth regulators (IGRs), in non-target organisms. We selected shell formation in crustaceans as our model system and employed the blue crab, *Callinectes sapidus*, as our major research organism. IGR pesticides such as methoprene are toxic to both zoea and megalopa states of *Callinectes*

with LD_{50} of 10 ppb. Diflubenzuron, another IGR used for gypsy moth control in forests, decreases in vitro chitin synthesis by 50% in explant cultures of postmolt crab tissue at 100 parts per trillion. We observed marked ultrastructural changes in IGR treated tissues, including vesiculation and alteration of the Golgi apparatus. Autoradiographic studies indicated that IGR pesticides can penetrate the embryonic investment coat of crustaceans and depot in the lipovitellin granules where the material is stable until the next molt cycle. We studied effects of IGRs on protein synthesis using Tran-^{35}S-label; total epithelial and cuticular protein synthesis is decreased. Specific alterations of individual polypeptides have not been identified. We also examined alterations in total RNA isolated from control and IGR treated crustaceans and plan to correlate this data with the induction of heat shock proteins, as shown by Western blot analysis. Our results indicate that shell formation in larval and adult crustaceans is exquisitely sensitive to IGR pesticides used in and around estuaries.

BIOGEOCHEMICAL DYNAMICS OF PHOSPHORUS: NEW INSIGHTS FROM NUCLEAR MAGNETIC RESONANCE. Ingall, E., L. Clark, University of Texas at Austin, Marine Science Institute, 750 Channelview Dr., Port Aransas, TX 78373-5015.

Phosphorus (P) availability in coastal ecosystems plays an important role in sustaining biological productivity. Overabundance of this vital nutrient can lead to eutrophication in certain coastal systems. The composition and structure of P in dissolved organic matter (DOM), a significant source of P for algal and microbial metabolism in coastal regions, is virtually unknown. Recent studies of P using nuclear magnetic resonance (NMR) have demonstrated the potential of this technique in compositional and structural studies. For example, the chemical composition of marine ultrafiltered dissolved organic phosphorus (UDOP) was determined using 31P cross-polarized magic angle spinning (CPMAS) NMR on DOM from the Pacific Ocean (12 S, 134W). Throughout the water column, P esters were identified as the dominant class of organic P compounds. Phosphonates, a group of compounds containing a direct C-P bond, are also present in surprisingly high abundance. Relative proportions of P compounds and C/N/P ratios of UDOP are significantly different from fresh organic matter. The relatively high proportion of phosphonates in surface water UDOP suggests preferential utilization of P esters relative to phosphonates during organic matter decomposition. NMR techniques have also been successful in tracking changes in organic phosphorus bond structure during controlled laboratory decomposition experiments. For example, the prevalence of specific phosphorus monoesters changed in a sequence of Spirulina samples decomposed in oxygenated water over a period of two weeks. These changes may reflect the uptake and redistribution of dissolved phosphorus by bacteria.

A NEW IDEA IN MARSH CORING: THE WEDGE. Inglett, P.W.[1], E. Viollier[2], A.N. Roychoudhury[3], and P. Van Cappellen[3]. [1]Department of Soil and Water Science, 106 Newell Hall, University of Florida, Gainesville, FL 32611, [2]Geochimie des Eeaux, University of Paris 7, 75721 Paris, France, [3]School of Earth & Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA 30332.

Standard coring techniques are often ineffective in the unconsolidated and vegetated soils/sediments of marsh environments. We present the design and construction specifications for a novel coring device which overcomes the common problems of compaction, core plugging, root disturbance, and depth limitation to allow the collection of intact, 35+ cm marsh cores. The simple concept uses a sharpened main body and cover plate which are inserted sequentially to obtain a wedge-shaped soil/sediment slice. This design allows core retrieval without the site destructive "digging out" required of other methods. In a typical application, the wedge corer is transferred to the location of analysis where the core can be visually inspected and/or sampled. Following removal of the cover plate, the design exposes a large core surface

area, thus, allowing detailed study of the soil/sediment structure and heterogeneity. To demonstrate the effectiveness of the wedge design, we present depth distributions of solid-phase iron across a salt marsh transect at Sapelo Island, Georgia. The new sampling technique, however, has application to any study requiring undisturbed marsh sediment/soil sampling.

THE INFLUENCE OF LAND USE ON GROUNDWATER DERIVED NUTRIENTS AND ORGANIC INPUTS TO THE SOUTH ATLANTIC BIGHT. Joye, S.B.[1], W.-J. Cai[1], D.A. Bronk[1], and W. Moore[2], [1]Department of Marine Sciences, University of Georgia, Athens, GA, 30602-3636; TEL: (706)542-7370, FAX: (706)542-5888; and [2]Department of Geological Sciences, University of South Carolina, Columbia, SC 29208, TEL: (803)777-2262, FAX: (803)777-6610.

We are assessing the importance of groundwater inputs of water and materials to the South Atlantic Bight (SAB). We are assembling available data to compare the relative role of surface (river, stream) versus ground (confined subterranean and unconfined water table aquifer) waters as sources of labile organic materials, inorganic nitrogen and carbon, and nitrogen trace gases (such as nitrous oxide, N_2O) to the coastal waters of South Carolina and Georgia. We are also evaluating the relationship between land use and groundwater-derived nutrient loads. We predict that groundwater will be an important source of materials to the SAB and that the relative magnitude of this source term will vary according to land use in any particular area. Further, as development pressure in coastal regions expands, water demands will increase as the result of irrigation and potable use. In order to properly manage water resources, it is imperative that we have in place a firm understanding of the role of groundwaters in the budgets of carbon and nitrogen in coastal environments. Towards this end, we are developing a conceptual model to relate groundwater nutrient loading to land use. This model eventually will allow us to make predictions of how changes in land use (urbanization, development) will change the inputs of materials, with resultant changes in patterns of primary production and nutrient cycling in the SAB.

REGIONAL BEACH VOLUME CHANGES FOR CENTRAL SOUTH CAROLINA - A SYSTEM IN NEAR-BALANCE AT MULTIDECADAL TIME SCALES. Kana, T. and J. MacMahan, CSE/Baird, P O Box 8056, Columbia, SC 29202, and University of South Carolina Geological Sciences, Columbia, SC 29208.

Multidecadal and decadal beach volume changes have been computed for a mesotidal, low energy coastline. The study area encompasses nine barrier islands on the South Carolina coast around Charleston for a total distance of 75 km. Typical methods involving historical aerial photos and beach profiles were used to calculate linear shoreline position changes and volumetric changes. The beach volume changes indicate a low level of net sand loss along the coastline. There are areas of high deposition as well as erosion. Considering the dominant trend along the central core of each island, the intra-island variation in beach volume is generally less than the adjacent island change suggesting unique erosion and deposition signatures for each barrier island. Trends are island and site specific therefore, with inlets and their associated shoals serving as important littoral boundaries. Intra-island trends become more variable as transects closer to each inlet are incorporated into the analysis. The average unit volume change in beach volume to -1.5m below sea level for two representative periods (1934-1994 and 1962-1994) is relatively low at -2.1 and -1.2 m3/m/yr, respectively. Average annual change for 1934-1994, for the central part of discrete islands (North to South) to -1.5m MSL in m3/m/yr are given: Bulls Island -1±11, Capers Island -17±5, Dewees Island -11±12, Isle of Palms -1±2, Sullivans Island 19±8, Morris Island -29±16, Folly Beach 1±2, Kiawah Island 5±2, Seabrook Island

TERTIARY STRATIGRAPHY OF THE CENTRAL SOUTH CAROLINA COAST. Katuna, M., T.W. Claer, D.L. Holsclaw, M.S. Harris, P.T. Gayes, and J.L. Kindinger, College of Charleston, Department of Geology, Charleston, SC 29424; College of Charleston, Department of Geology, Charleston, SC 24924; College of Charleston, Department of Geology, Charleston, SC 29424; Center for Marine & Wetland Studies, Coastal Carolina University, Conway, SC 29528; Center for Marine & Wetland Studies, Coastal Carolina University, Conway, SC 29528; and U.S. Geological Survey, Center for Coastal Geology, St. Petersburg, FL 33701.

Over the past three years, an extensive drilling program along the central South Carolina coast has enabled us to investigate the distribution and geometry of the underlying Tertiary stratigraphic units and the development of the modern coastline. Over fifty borings (approximately one hundred feet in depth) were taken along a seventy-five mile long stretch of coastline to determine what role antecedent topography has had upon barrier island location, origin and development. Whenever possible, the borings penetrated the Q/T boundary beneath each of the islands. This highly irregular upper Tertiary bounding surface which underlies the coastal zone grades from younger to older stratigraphic units from north to south. Stratigraphic and biostratigraphic analyses of formational units coupled with seismic surveys and existing water well data have been used to develop a model of the Tertiary geologic framework for the region. The highly irregular upper Tertiary bounding surface underlying the barrier islands grades from younger stratigraphic units to the north to older units to the south, opposite the regional trend within the Georgia Bight. Seismic records, coupled with extensive core data, indicate the presence of multiple shore perpendicular Tertiary bedrock highs beneath barriers to the south of the harbor, and more gently dipping flat-lying units beneath barrier islands north of the harbor, naturally subdividing the area into two distinct Tertiary terranes. Important to the direct influence on the Quaternary system, the antecedent highs are composed of variably competent and resistant siliciclastic Miocene deposits and calcareous Oligocene strata mantled by younger Pleistocene sediments. These Tertiary units have played an important role in establishing long-term trends in coastal stratigraphy and morphology. The relict Pleistocene fluvial drainage system incised into the underlying Tertiary framework consists of channels and valleys, which may also have a profound affect on the location of the islands and associated tidal inlets.

WHAT'S IRON GOT TO DO WITH COASTAL FISHERIES MANAGEMENT? Kawaguchi, T., and A.J. Lewitus, Department of Environmental Health Sciences, School of Public Health, University of South Carolina, Columbia, SC 29208, U.S.A., and Baruch Marine Laboratory and Marine Science Program, University of South Carolina, Georgetown, SC 29442, U.S.A.

Iron has long been recognized as an essential trace metal for the phytoplankton growth. However, the "iron hypothesis" that iron supply might limit phytoplankton growth has been a consideration historically reserved for open ocean populations where iron sources primarily are limited to aeolian dust. It is perhaps counterintuitive to considered iron limitation in coastal water receiving high iron loads from terrestrial and fluvial runoff. Nevertheless, an empirical basis for variable and potentially limiting iron bioavailability in the coastal zone exists; the disappearance of brown macroalgae from many coastal areas of the northern Japan is linked to the reduction in iron availability caused by a coastal deforestation. The fishermen's associations throughout Japan are setting a new paradigm of the coastal fisheries management: They plant trees in the upland watershed.

Here we present the hypothesis that urbanization-associated deforestation can reduce the amount of iron available to estuarine phytoplankton, and that this in turn can adversely affect phytoplankton population. We compared Murrells Inlet, SC, impacted by deforestation, a suburbanized estuary, with North Inlet, SC, a forested estuary, with respect to the concentration of dissolved iron, and the effects of iron enrich-

ment on incubated samples of natural phytoplankton communities and cultured species. The potential for iron depletion by phytoplankton was greater in populations transferred to Murrells Inlet water than in those transferred to North Inlet water. Also, the stimulatory effect of iron enrichment on phytoplankton in Murrells Inlet water was taxonomically selective.

ASPECTS OF PREY ESCAPE AND PREDATORY RISK WITH RESPECT TO FOOD AVAILABILITY. Kirtland, K.A., G.S. Kleppel, Department of Environmental Health Science, University of South Carolina, Columbia, SC 29208.

All animal populations are influenced by predation and food availability. This paper is part of a larger study of successful escape behaviors by fishes from attacks by avian predators. Escape success was measured as a function of food availability in *Fundulus* spp. We measured the speed of "fed" and "starved" *Fundulus confluentus*, from southeastern wetlands, that were being attacked by a great blue heron, *Ardea herodias*, a predator of many coastal fishes. *F. confluentus* were kept in saltwater tanks prior to being exposed to the predator. Experimental fishes were fed or starved for 96 hours while in the tank. Each experimental group was placed into a plexiglass aquarium where the attack and escape were filmed with an 8 mm camcorder. Frame by frame analysis was used to measure the speed of the attack and escape. The average speed of a heron attack was relatively slow (1.25 ± 0.3 m/s) while the fed and starved fish attempted escapes with average speeds of 0.49 ± 0.3 m/s and 0.43 ± 0.1 m/s, respectively. Each experimental group of fish escaped 80% of the heron attacks. Wilcoxon Rank Sum tests indicated no difference between the number of successful escapes or the speed of either fed or starved *F. confluentus* while under attack by a great blue heron.

QUATERNARY STRATIGRAPHY AND DEPOSITIONAL HISTORY OF THE CENTRAL SOUTH CAROLINA COAST AND INNER SHELF: IMPLICATIONS TO COASTAL CHANGE. Kindinger, J.L., M.S. Harris, P.T. Gayes, J.G. Flocks, W.C. Schwab and M.P. Katuna, US Geological Survey, 600 - 4th Street South, St. Petersburg, FL 33701; Department of Marine Science, Coastal Carolina University, Conway, SC 29526; Department of Marine Science, Coastal Carolina University, Conway, SC 29526; US Geological Survey, Center for Coastal Geology, 600 -4th South, St. Petersburg, FL 33701; US Geological Survey, Quissett Campus, Woods Hole, MA 02543; Department of Geology, University of Charleston, Charleston, SC 29424.

South Carolina's central coast and inner shelf (to 10m of water depth) from North Edisto River to Bull's Inlet has a complex Quaternary history of transgressive and regressive sedimentary sequences. These sequences were identified from 612 line-km of high-resolution single channel seismic profiles, side-scan sonar mosaics, 81 vibracores, ground penetrating radar, Amino acid racemization, and compilation of previous investigations as part of a continuing multiyear cooperative USGS/South Carolina Sea Grant Consortium coastal erosion study. The Quaternary stratigraphy within the study area can be divided into two sedimentary units: (1) late Pleistocene with at least three stratigraphic sequences and (2) Holocene with only a transgressive portion of a sequence. The late Pleistocene unit overlies a highly variable Tertiary framework comprised of Oligocene to Pliocene aged materials. Late Pleistocene inlets and streams have incised to and into the Tertiary Marks Head and Ashley Formations. The top of the Tertiary is an erosional unconformity as identified in seismic profiles. Pliocene to Pleistocene formations reported from the coastal plain of South Carolina around Charleston Harbor are absent on the inner shelf, but may be found below 10m water depth. Pleistocene units are discontinuous beneath the islands and thin offshore. This suggests that if deposits from these formations were present and/or discontinuous on the inner shelf

they were stripped away by subsequent erosion. The late Pleistocene unit ranges from 3 to 30m in thickness with an average of 12m thickness and is composed of relatively thin, stacked, discontinuous, overlapping bedded sequences. The regional distribution of Pleistocene sediments is dependent on the structure and antecedent topography of the Tertiary units. The distinguishing seismic character of this unit includes the numerous erosion channels formed during at least three regressions. Regional drainage patterns for coastal South Carolina reportedly were established during this period of time (240 to 200 ka BP). The exposed late Pleistocene deposits were reworked and/or removed as sea level rose after the last glacial episode creating a ravinement surface with shell lag deposits that separates the late Pleistocene unit from the Holocene transgressive deposits. Thickness of the Holocene transgressive unit ranges from 3 to 5m inshore and averages approximately 4m. Offshore the Holocene thins to a feather edge in approximately 7 to 10m of water, coincident with the attachment of shoreface attached ridges. Barrier-island stratigraphy indicates that the Holocene transgression has been punctuated by eustatic fluctuations. The modern configuration of the central South Carolina coastline is defined by a variety of sand-dominated depositional environments, primarily barrier islands and ebb-tidal deltas. The barrier islands have evolved in response to Holocene sea-level rise and have been previously described as regressive and accretionary (i.e., Kiawah Island, SC) with a basal contact on the late Pleistocene unconformity. Seismic profiles collected across the region indicate that inlets associated with these barrier islands have remained in the same general position, migrating within a single incised valley throughout the late Quaternary.

ANALYSIS OF NATURAL AND ANTHROPOGENIC SHORELINE CHANGE ALONG MESOTIDAL BARRIER ISLANDS OF SOUTH CAROLINA USING GIS METHODOLOGY.
King, E.F., M. Katuna, M. Colgan and M. Keevican, Geology Department, College of Charleston, Charleston, SC 29424, Geology Department, College of Charleston, Charleston, SC 29424, Geology Department, College of Charleston, SC 29424 and NOAA Coastal Services Center, 2224 S. Hobson Ave., Charleston, SC 29405.

Major economic development is occurring along the South Carolina coast from Hunting Island to the Santee River Delta. Most barrier islands are undergoing rapid coastal change, threatening recreational beaches, houses and commercial structures. A comprehensive geographic information system (GIS) has been developed for the central South Carolina coast to better understand shoreline change and to help establish set-back lines for coastal zone management. This diverse GIS data base includes historical shorelines (from 1880 to present), wading depth beach profiles and offshore bathymetric data. Georeferenced elevation points have been converted to digital elevation models (DEMs) that provide a three-dimensional image of beach topography and offshore bathymetry by interpolating continuous elevations between profile lines. By superimposing DEMs, locations of major erosional and accretional areas are easily discernible. Computing differences in grid morphology produces a much better visual image of annual elevation change than do conventional methods. Data sets for Hunting Island and Folly Beach, two barrier islands renourished in the early 1990's, have been analyzed and modeled in this manner. These case studies provide examples of how GIS analyses can be used to determine natural and anthropogenic shoreline change.

THE SOUTH ATLANTIC BIGHT LAND USE - COASTAL ECOSYSTEM STUDY.
Kleppel, G.S. and M.R. DeVoe. Department of Environmental Health Sciences, University of South Carolina, Columbia, SC 29208 and South Carolina Sea Grant Consortium, 287 Meeting Street, Charleston, SC 29401.

The South Atlantic Bight Land Use - Coastal Ecosystem Study (LU-CES) is a multi-year investigation of the influence of changing land use practices on coastal resources in the southeastern United States. The program is supported by the NOAA Coastal Ocean Program and is motivated by the recognized demographic changes in the region which will result in a 180% increase in population between 1960 and 2010, coupled with a change to an older, wealthier, more educated and leisure oriented population. This new demographic is expected to cause an alteration of the landscape from natural and agricultural to suburban, urban and industrial. Such changes will, without doubt, challenge the abilities of scientists, managers and policy makers to identify, obviate or, at least, minimize impacts to valuable coastal resources. LU-CES seeks to determine areas of greatest susceptibility to impacts derived from changing land use practices and to develop tools and conceptual models, appropriate for use on local to regional scales, minimize such impacts. In its initial stages, the LU-CES program is supporting eight projects to identify the state of knowledge (SOK) about a variety of processes in regional coastal systems. Included among these are (SOK) studies of physicial processes, biogeochemical processes, eutrophication, microbial communities processes and contaminant alterations in the sediments. In addition, data base and GIS formats are being developed to facilitate data I/O and modeling during subsequent field-research years. Descriptions of each SOK study will be presented in a poster format during this session.

MID-SHELF SUBMARINE GROUNDWATER DISCHARGE IN ONSLOW BAY. Kloster, M., J.M. Krest, University of North Carolina, Department of Marine Science, Chapel Hill, NC, 27599-3300, and University of South Carolina, Department of Geological Sciences, Columbia, SC 29208.

Recent research indicates that submarine groundwater discharge is an important but underestimated and poorly constrained process that significantly impacts ocean chemical composition (Tsunogai et al, 1996; Moore, 1996). In the South Atlantic Bight, Onslow Bay provides an excellent location for studying submarine groundwater discharge along a passive margin. The direct submarine discharge of significant volumes of saline water discharge has been measured at two middle shelf (30 meter deep) sites in Onslow Bay (Simmons, 1992). The bay has no large direct input of fresh water from rivers and streams, is effectively isolated from coastal exchanges by the large shoals at both terminal capes, and is geologically well described.

During the last year we have sampled mid-shelf submarine monitoring wells and completed monthly sampling transects of the bay, measuring water column abundance of radium and helium to determine the magnitude and distribution of mid-shelf submarine discharge in Onslow Bay. Persistent excess concentrations of ^{223}Ra (0.5-1.0 dpm/100L), ^{224}Ra (3-5.5 dpm/L), and ^{4}He (3.8-3.9X 10^{-8} scc/g.) have been measured in mid-shelf bottom water during the study period. Additionally there appears to be a correlation between ^{223}Ra and $\delta^{3}He$ in mid-shelf waters. The offshore wells are discharging saline water with a significantly negative $\delta^{3}He$ (~-20vs. -1.5 for air saturated sea water), indicating a deep sediment source of this submarine discharge. The dispersion of surface bay water and the quantity of mid-shelf submarine discharge can be modeled using ^{223}Ra ($t_{1/2}$= 11.4d), ^{224}Ra ($t_{1/2}$= 3.66d) and ^{226}Ra($t_{1/2}$=1600 y).

THE INFLUENCE OF WIND FORCING ON THE INGRESS OF BLUE CRAB MEGALOPAE INTO A SOUTH CAROLINA COASTAL INLET. Knott, D.[1], J. Amft[2], C. Barans[1], J. Blanton[2], B. Stender[1], P. Verity[2], E. Wenner[1], and F. Werner[3]. [1]Marine Resources Research Institute, SC Department of Natural Resources, Charleston, SC 29422-2559, [2]Skidaway Institute of Oceanography, Savannah GA, 31411, and [3]Marine Science Program, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599.

Blue crabs spawn in the lower estuary and larvae are exported to the coastal ocean where they develop to the postlarval megalopal stage. The subsequent ingress of megalopae through coastal inlets preceeds their settlement and recruitment to the salt marsh nursery habitat. In South Carolina, ingress and settlement peak between August and November, with a secondary spring peak. We measured megalopal ingress by collecting daily surface plankton samples in the North Edisto River Inlet on nocturnal flood tides during two-week cruises in the spring and fall of 1993 & 1994. Surface and near-bottom samples were also collected during some of these cruises at offshore stations in the shallow coastal ocean near the inlet. Each plankton collection was classified into one of four wind stress quadrants, for non-lagged and lagged wind conditions. With the exception of the spring 1993 cruise, when very few megalopae were collected, ingress was significantly greater during upwelling winds. Likewise, vector-scalar correlation, which accounts for the magnitude as well as the precise direction of wind stress, showed significant association between ingress and upwelling winds with an onshore component during the fall 1993 cruise. During that period, ingress was 1-2 orders of magnitude greater than the other seasons. A dissimilar result was obtained during the fall 1994 cruise, when downwelling wind stress was significantly correlated with ingress. However, these contrasting results are both consistent with 3-D model simulations of the study area, which yielded significant ingress of passive particles released at the surface during both upwelling and downwelling conditions.

CHANGING PATTERNS OF SULFATE REDUCTION IN SALT MARSH SEDIMENTS ACROSS A GRADIENT OF SPARTINA ALTERNIFLORA GROWTH FORMS. Kostka, J.E., A. Roychoudhury, and P. Van Cappellen, Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31406 and Georgia Institute of Technology, Atlanta, GA 30332.

This inter-disciplinary study combined geochemical analyses with direct rate measurements of sulfate reduction in sediments ranging from a tidal creek embankment vegetated by the tall form of *Spartina alterniflora* to the interior or the marsh occupied by the short form of *Spartina* at Sapelo Island, Ga. The primary goal of the study was to determine the spatial/temporal variability in the rates and pathways of microbial respiration in salt marsh sediments. Sulfate reduction rates were observed at up to 4000 nmol/cm^3/d, overlapping with the most rapid rates reported for marine sediments. In the top 10 cm of marsh sediment, sulfate reduction rates were 2-4 times higher in the short *Spartina* zone compared to the creek bank, where macrofaunal activity and porewater exchange are at a maximum. From 10-50 cm depth, rates approached zero in the short *Spartina* zone (which was sulfate depleted) whereas rates of 100-400 nmol/cm^3/d were observed in the creek bank and tall *Spartina* zones. Patterns of microbial respiration were consistent from May to August sampling periods. Geochemical measurements revealed that dissimilatory Fe(III) reduction rates were conversely related to those of sulfate reduction, and vertical zones overlapped. Partitioning of carbon oxidation pathways in salt marsh sediment appears to be controlled to a large extent by the intensity of sediment mixing, pore water exchange, and the below-ground growth of *Spartina* which is controlled in a feedback loop by the geochemistry of the surrounding sediment.

EVIDENCE FOR SUBSTANTIAL GROUNDWATER CONTRIBUTIONS TO SOUTH CAROLINA COASTAL WATERS. Krest, J.M., W.S. Moore, University of South Carolina, Department of Geological Sciences, Columbia, SC 29208.

Recent work near Georgetown, SC has found indications of significant groundwater fluxes to the coastal ocean. The bulk of this work has been conducted at the Belle W. Baruch Institute for Marine Biology and Coastal Research, located about 56 km south of Myrtle Beach. The Institute's field lab is situated on the

North Inlet salt marsh, a relatively pristine system which directly connects a large, forested peninsula to the coastal ocean. In order to characterize the groundwater in this system, water samples were collected from a series of wells beginning in the forest and extending across the marsh. By comparing the groundwater samples with samples taken from the tidal creeks and the inlet, the magnitude of the groundwater contribution to the surface waters has been determined.

This study used a variety of tracers to characterize the system's surface and sub-surface waters. Samples were analyzed for radium isotopes (^{226}Ra, ^{228}Ra, ^{224}Ra, and ^{223}Ra), nutrients (reactive phosphate, inorganic carbon and inorganic nitrogen), and major anions and cations. From the radium activities, we estimate a groundwater flux of 3 to 4 $cm^3\ cm^{-2}\ d^{-1}$ for the salt marsh. Extrapolating to South Carolina's total marsh area, this corresponds to nutrient exports of 60 X 107 $\mu M\ y^{-1}$ reactive phosphate. These values are, respectively, 10 times and 4 times the annual river fluxes for the entire state.

FACTORS IMPORTANT IN THE METHYLATION OF MERCURY IN CONTAMINATED AND REFERENCE SITES IN COASTAL GEORGIA. Lee, R.F., J.K. King, M. Frischer, G.B. Kim, R.G. Smith, H. Windom, Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411.

High concentrations of mercury are found in an estuary adjacent to a former chlor-alkali plant near Brunswick, Georgia, referred to as the LCP Superfund Site. Sediment concentrations of total mercury in this contaminated estuary range from 100µg/g, to 1µg/g. Two reference areas that were studied included an estuary adjacent to the LCP site and an estuary on the Skidaway River (Savannah, GA) with total mercury concentrations of 0.6 and 0.4µg/g, respectively. The most toxic mercury species is methyl mercury, which is neurotoxic and is strongly retained by fish and shellfish. Our research focus was to determine factors important in the formation of methyl mercury in our study areas. Total mercury and methyl mercury concentrations were determined in sediment, pore water, estuarine water and microbial mats from the various study areas. Concentrations of methyl mercury in water from the LCP site, the site adjacent to LCP and Skidaway River were 90, 0.3, and 0.07ng/liter. Addition of moblydate, a known inhibitor of sulfate reducing bacteria, to sediment slurries or sediment cores or microbial mats resulted in inhibition of methylation of mercury. Stimulation or inhibition of sulfate reduction rates resulted in a corresponding stimulation or inhibition of mercury methylation. For example, pyruvate addition was a strong stimulator of both sulfate reduction and mercury methylation rates. The abundance of different sulfate-reducing bacteria groups in the LCP sediments and reference sediments is being carried out using *in situ* hybridization with 16S rRNA oligonucleotide probes. Microbial mats were common on the sediment surface of both reference and contaminated sites. These mats actively methylated mercury due to the actions of sulfate reducing bacteria found in anaerobic zones of the mats.

SEDIMENT LOADING IN SMALL TIDAL CREEK SYSTEMS. Leonard, L.A., R.A. Laws, Dept. of Earth Sciences, 601 S. College Rd., Wilmington, NC 28403.

A three year study of sediment loading in tidal creeks of New Hanover County, NC indicates that current land use practices are changing the quantity and quality of particulates associated with rain-induced runoff. Although total suspended solid (TSS) loads are mostly driven by tidal activity, the type of material in suspension (i.e., inorganic vs. organic) is influenced by seasonal and precipitation patterns.

In general, TSS levels decrease in the winter and increase in the summer and are elevated during rain events. Both organic (OSS) and inorganic suspended solids (ISS) are positively and significantly correlated with amount of precipitation throughout the year. In the winter, post-rain OSS and ISS levels are significantly higher than non-rain levels. In the summer, OSS concentrations differ significantly from non-rain concentrations during high intensity (>1") rain events.

Time series analyses of TSS, OSS, and ISS concentrations show that "non-rain" concentrations have not changed appreciably over the three year study period. Data collected during rain events, however, show significant increases in TSS and OSS. These increases are correlated with increased development in the watersheds. For the period 1990-1996 residential land use increased by about 16% while the vacant or undeveloped area in the watershed decreased by about 21%. Peak ISS levels over the last three years appear to be associated with localized construction activities. Our data further indicate that the composition of the runoff varies seasonally. These results suggest that different management strategies should be employed seasonally to control particulate loading in these systems.

PHYTOPLANKTON UPTAKE OF DISSOLVED ORGANIC NITROGEN: IMPLICATIONS TO THE POTENTIAL EUTROPHICATION OF SOUTHEASTERN SALT MARSH ESTUARIES. Lewitus, A.J., E.T. Koepfler, K.C. Hayes, B.M. Willis, R.J. Pigg, Baruch Marine Laboratory, University of South Carolina, P O Box 1630, Georgetown, SC 29442 (AJL, BMW), and Coastal Carolina University, Marine Science Department, Conway, SC 29526 (ETK, KCH, RJP).

Increased development of the southeastern U.S. coast will lead to altered patterns of nutrient loading to the areas salt marsh estuaries. The relative proportion of nitrate to other nitrogen sources will likely increase, and the resultant response of estuarine phytoplankton should be an important consideration in predictive models evaluating coastal eutrophication. However, anthropogenic input of DON should also be considered, as this pool may affect the composition and productivity of phytoplankton communities. We present evidence that, in North Inlet, an undeveloped salt marsh estuary near Georgetown, SC, the phytoplankton bloom community (primarily small flagellates) has a high ability to use DON substrates. Although ammonium, the major form of inorganic nitrogen in North Inlet, had no effect on bloom phytoplankton population growth, glycine greatly stimulated the growth of these same populations. Comparisons of bacterial vs. phytoplankton physiological responses (growth, production, glycine uptake in the presence or absence of antibiotics) to DON enrichment suggested that the stimulatory effect of DON on phytoplankton growth resulted primarily from direct uptake of the organic substrate, rather than indirectly through bacterial breakdown. Because light is limiting to phytoplankton growth during the bloom (North Inlet is a shallow turbid estuary), it was hypothesized that the stimulatory response to glycine was due to its use as a respiratory substrate, and not as a nitrogen source. Our results suggest that phytoplankton communities in undeveloped southeastern salt marsh estuaries may be "poised" to respond to anthropogenic loads of DON substrates, such as amino acids or urea.

RELATIONSHIPS BETWEEN NUTRIENT QUALITY, IRON BIO-AVAILABILITY, AND PRIMARY PRODUCTION IN AN UNDEVELOPED VS. URBANIZED SALT MARSH ESTUARY. Lewitus,A.J.[1], T. Kawaguchi[2], J. Keesee[1], and B. Willis[1], [1]Belle W. Baruch Institute for Coastal Research, University of South Carolina, P O Box 1630, Georgetown, SC 29442 and [2]Department of Environmental Health, University of South Carolina, Columbia, SC 29208.

Our ability to predict the impact of coastal development on estuarine ecosystem function (e.g., eutrophication) depends largely on understanding the mechanistic links between nutrient loading and phytoplankton

community structure and regulation. This information is particularly important in the southeastern U.S., where many estuaries are experiencing increased and altered nutrient loading from escalating urbanized development. We compared the composition, production, and nutritional responses of phytoplankton communities in neighboring salt marsh estuaries; undeveloped forested North Inlet and urbanized deforested Murrells Inlet. Total DIN and the ratio of NO3 levels corresponded with a greater proportion of diatoms to nanoflagellates in Murrells Inlet. However, the relatively greater DIN levels did not correspond with higher phytoplankton biomass or daily integrated primary production. In fact, photosynthesis vs. irradiance analyses indicated that the efficiency and capacity for photosynthesis were lower in the urbanized estuary. The results suggest that Murrells Inlet is in the early stages of degradation prior to the stage where eutrophication may occur, and support the hypothesis that at least two byproducts of urbanization are acting in concert to decrease the efficiency of primary production in Murrells Inlet: 1) increased NO3 loading has caused a shift in phytoplankton composition, favoring larger diatoms which have relatively slower nutrient turnover rates and relatively higher iron requirements than smaller flagellates, and 2) reduction of organic chelators (forest-derived DOM) by clearcutting has reduced iron bio-availability to Murrells Inlet phytoplankton.

SPATIAL AND TEMPORAL VARIABILITY IN MICROBIAL COMMUNITY STRUCTURE OF REDOX-STRATIFIED SALT MARSH SEDIMENTS. Lowe, K. and T. DiChristina, Georgia Institute of Technology, School of Biology, Atlanta, GA 30332-0230.

Sediment samples were collected seasonally from three salt marsh sites (tidal creek bank, tall *Spartina* and short *Spartina*) situated on a barrier island (Sapelo Island, GA). Traditional cultivation techniques were employed to describe the resident microbial populations inhabiting the redox-stratified marsh sediments. Several metabolic types of microorganisms were identified, including those capable of reducing oxygen, nitrate, nitrite, manganese-oxides, iron-oxides, uranyl carbonate, selenate, selenite, and sulfate as sole terminal electron acceptor. Although the relative abundance and depth profiles of each metabolic type varied according to sampling site and season, total microbial numbers were highest in the spring and fall, and lowest in the summer. Current work involves the use of 16S rRNA-based oligonucleotide probes in parallel with traditional cultivation methods to determine the spatial and temporal variability in the microbial assemblages inhabiting these redox-stratified environments.

COMPARATIVE WAVE CHARACTERISTICS ON TWO BEACHES IN SOUTH CAROLINA. MacMahan, J., University of South Carolina, Geological Sciences, Columbia, SC 29208.

Nearshore wave measurements outside the surf zone in water depths less than 20m have been nonexistent for South Carolina. An inexpensive digital wave sensor was designed and constructed to measure pressure fluctuations (wave characteristics). Wave measurements were taken simultaneously over two months on the 3m and 10m isobaths during summertime conditions to determine the wave climate off two beaches on the South Carolina central coastline. The neighboring beaches, Isle of Palms and Dewees Island, have varying bathymetries as well as different erosion patterns. The nearshore wave measurements were also compared to an offshore directional NOAA buoy which is deployed in 38m of water approximately 80km ESE of Charleston, SC. A wave simulation model, REFDIF1, was applied to the study area to compare the offshore wave measurements to the inshore wave measurements. There was a 54±11\% reduction in wave height between waves measured at the NOAA buoy and waves at the 3 and 10 mesobaths. The mean significant summertime wave height was 46±17 cm, and wave period was 8.3±1.5 s. Using the offshore buoy data as input, an annual mean significant wave height of 67±55 cm at the 3 and 10m isobaths was calculated. The average annual wave period 7.6±2.4 s was computed

from the NOAA buoy. The wave characteristics were similar outside the surf zone off each beach in the study area despite differences in erosion and accretion rates and varying bathymetries. Measured mean water levels were compared with wave heights to investigate the influence tidal modulation has on the waves and on morphology. The effects of the tidal modulation on wave height were negligible for waves outside the surf zone betweeen the 3 and 10m isobaths.

SEDIMENT NUTRIENT DYNAMICS ON THE SOUTH ATLANTIC BIGHT CONTINENTAL SHELF. Marinelli, R.L., R.A. Jahnke, D.B. Craven, J.R. Nelson and J.E. Eckman, Skidaway Institute of Oceanogrpahy, 10 Ocean Science Circle, Savannah, GA 31411.

South Atlantic Bight (SAB) continental shelf sediments are relict sands which fall within the photic zone at water depths between 14-45 meters. These sediments are sites of benthic primary production; sources of organic matter to the shelf system; and possibly sinks for regenerated nutrients. Nutrient dynamics in SAB sediments were examined along two transects (off Georgia and Florida) using a corer which retains porewater in permeable sands. Inorganic nutrient distributions show substantial variation in magnitude and profile shape over small horizontal spatial scales (meters). Numerical models of diagenesis in these sediments suggest that porewater advection via current flows over wave ripples and bioturbational features is more important than irrigation in promoting nutrient exchange. Reaction rates in SAB sediments are comparable to those in nearshore muddy habitats. Time series measurements show gradual increases in depth-integrated nutrient concentrations at a Georgia shelf transect station from spring through fall, probably related to seasonally increasing temperature and metabolic rates. Rapid regeneration rates in sediments and higher nutrient concentrations downcore suggest that sediments are an important source of nutrients fueling benthic primary production. While ammonium is rapidly produced in these sands, nitrate is uniformly low and measurable in the oxic sediments. The absence of high nitrate concentrations in the suboxic or anoxic zone suggests that denitrification may not be important in SAB shelf sediments.

THE ECOTOXICOLOGY OF PCBs AND TOXAPHENE IN THE TURTLE/BRUNSWICK ESTUARY. Maruya, K.A., Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411; P. Peronard and L. Francendese, U.S. Environmental Protection Agency, 100 Alabama Street, Atlanta, GA 30303; F. N. Nicholson, Georgia Department of Natural Resources, One Conservation Way, Brunswick, GA 31523.

Polychlorinated biphenyls (PCBs) and camphenes (also known as "toxaphene") are suspected endocrine disrupting chemicals that persist in salt marsh sediments of the Turtle/Brunswick River estuary in southeastern Georgia. These and other hydrophobic organic chemicals were introduced into salt marshes adjacent to large chemical facilities as early as the 1920s. Estimated inventories of these contaminants released into the local environment range in the thousands to millions of kg. In 1995, a survey of PCB and toxaphene contamination in sediments, water and biota was initiated. Marsh sediments in Purvis Creek were found to contain up to several hundred parts per million PCBs, the direct result of inadequate waste management practices at the LCP Chemicals facility in the upper estuary. The predominant source of PCBs is Aroclor 1268, a highly chlorinated, extremely persistent mixture used exclusively at LCP. Similarly, very high levels of toxaphene have been detected in sediments from the Terry/DuPree Creek system near the discharge outfall of the Hercules Chemical facility, near downtown Brunswick in the lower estuary. Both Aroclor 1268 and components of toxaphene have been detected in prey and predator fish from several locations, including Jekyll Island. Analysis of fish and invertebrates from Purvis Creek indicate that food web transfer is an important pathway for the mobilization of Aroclor 1268 from the

localized source (marsh sediments) into the estuary proper. An ongoing project will identify and catalog prominent toxaphene components in sediment and fish using negative chemical ionization GC-MS. Periodic surveys of contaminants in target media will help assess the effectiveness of remediative efforts in this impacted estuary and will assist in the selection of "sentinel" species for future monitoring efforts.

THE CONCENTRATION AND ISOTOPIC COMPOSITION OF DISSOLVED INORGANIC CARBON IN GROUND WATER AND SUBMARINE GROUND WATER DISCHARGE: PRELIMINARY RESULTS FROM ONSLOW BAY, NC AND NORTH INLET, SC. McCorkle, D.C. and C. Gramling, Department of Marine Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA 02543.

We present dissolved inorganic carbon and titration alkalinity concentrations (DIC and TA) and DIC carbon isotopic compositions ($\delta^{13}C$ and $\Delta^{14}C$ values) in ground water and surface water (river, estuary and continental shelf) samples from two study areas: Onslow Bay, North Carolina, where we sampled five deep onshore wells and three shallow mid-shelf wells, and North Inlet, South Carolina, where we sampled a transect of shallow wells underlying a salt marsh. DIC concentration and isotopic values in the ground water samples are dramatically different from those in surface waters, as a result of both biological processes (primarily root respiration, which elevates DIC and lowers $d^{13}C$ values) and geochemical processes (primarily the dissolution of carbonate rocks, which increases TA and lowers $\Delta^{14}C$ values). We show how these data can be used to identify direct ground water inputs into estuaries and the coastal ocean. Important attributes of this approach to estimating SGWD are that ground water carbon geochemistry is not influenced by salinity-driven desorption effects (which can cause strong enrichments in elements such as radium and barium), and that the DIC carbon isotopic signal is not "erased" by photosynthesis or particle scavenging (as can happen with nutrients and trace metals). We see clear carbon isotopic evidence for ground water discharge in both a tidal creek on the Onslow Bay, NC intracoastal waterway and the mid-shelf wells in Onslow Bay, and in a creek draining the salt marsh at North Inlet, SC.

A DECISION MAKING PROCESS FOR SETTING MARINE RESOURCES POLICY. Miglarese, J.V., S.C. Department of Natural Resources, Marine Resources Division, P O Box 12559, Charleston, SC 29412.

Coastal zone and marine resources' issues are numerous and dynamic. The most controversial issues are centered primarily around the publics' use of the natural resources. By virtue of the resource managers' public trust responsibilities and the publics' involvement, no decision can be made solely on scientific input. Technical solutions, therefore, are not solutions unless they are presented in the context of a public policy process.

The author describes a public policy decision-making model that assesses and evaluates each policy component and then synthesizes these components into relevant decisions. The decisions are primarily "issue-driven," i.e., public and marine resource points of dispute. They encompass resource managers' delegated authority by state legislatures and allow for a more rational approach to dealing with a more savvy and politically active public constituency. The components of the policy process to be assessed are technical (science), social, economic, cultural, political, regulatory/legal, and administrative. The emergence of an active, involved public not only complicates the decision-making process, but also brings credibility to the decisions.

Marine scientists and resource managers have unique roles in the decision- making process; however, we are no longer given the public's full trust. Thus, a comprehensive and expanded analytical approach is needed for collective decision-making that links the best available science with the resource issue.

FRESH GROUND WATERS ON THE SOUTHEASTERN ATLANTIC CONTINENTAL SHELF: A REVIEW OF WATER QUALITY DATA OBTAINED FROM OFFSHORE WELLS.
Mirecki, J.E., F.T. Manheim, University of Charleston, Department of Geology, Charleston, SC 29424 and US Geological Survey, Marine and Coastal Geology Program, 384 Woods Hole Rd., Woods Hole, MA 02543-1598.

The presence of fresh and brackish water beneath the continental shelf of the South Atlantic Bight (South Carolina-Georgia) was examined on the basis of four sources of data: 1) interstitial water samples obtained in the 1965 JOIDES offshore boreholes, 2) the 1976 USGS AMCOR (Atlantic Margin Coring) program (temporary water wells), 3) data from the 1978 COST GE-1 well, and 4) produced water from a 1979 Tenneco exploratory borehole. Wells were screened in either confined aquifers principally Eocene limestones, or unconfined aquifers in permeable unconsolidated Quaternary and Tertiary sediments. Fresh and brackish waters (salinities ranging between 1 and 24 ppt) were identified in samples from these wells.

Interstitial water samples from AMCOR core 6005 obtained approximately 4km east of Georgetown SC showed distinctively low salinities, ranging from 35 ppt at the sediment-water interface to 24 ppt at depths of 38-48 meters below the sea floor. These data suggest a source of fresh ground water on the continental shelf, likely from units of Tertiary age. Farther south off the coast from Jacksonville FL, several wells were drilled into the Tertiary age limestones by Tenneco and JOIDES. Fresh water samples (approximately 1ppt) were obtained at depths exceeding 100m below the sediment-water interface from the confined Floridan Aquifer (Ocala Limestone). Hydraulic heads were determined at these wells, indicating that the potentiometric surface of the Floridan Aquifer occurred at altitudes of 5 to 10 meters above sea level. These examples, combined with more recent investigations of coastal hydrogeology near Hilton Head, SC indicate that the presence of fresh ground water in offshore aquifers are important. Fresh waters may serve as a barrier to saline intrusion, and should be considered in coastal groundwater models.

SPATIAL USE OF SOUTH ATLANTIC BIGHT BY LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)
Mitchell, S., Gray's Reef National Marine Sanctuary, 10 Ocean Science Circle, Savannah, GA 31411

Gray's Reef National Marine Sanctuary is one of the largest nearshore live-bottom reefs off the southeastern United States. The National Oceanic and Atmospheric Administration (NOAA) manages Gray's Reef and the other national marine sanctuaries to protect their natural resources. For each sanctuary, a management plan is developed to encourage compatible public uses, and to promote scientific understanding and public awareness of the marine environment.

The objectives of this project are to monitor: migratory pathways; movements during the inter-nesting period; diving behavior; offshore reef utilization; inshore spatial use (identification of preferred water areas); seasonal and daily habits; and foraging patterns of loggerhead sea turtles in the South Atlantic Bight.

Gray's Reef is one of the largest nearshore hard bottom reefs off the Georgia coast. Loggerheads of various size and age groups are observed by divers and fishers on a year-round basis. Observations by sanctuary staff document the presence of a number of loggerhead sea turtles within boundaries of GRNMS and in nearby waters. Protection within the sanctuary and outside of sanctuary boundaries for

this species must be based on reliable biological data. Many studies have focused on post nesting female movements, but few have been conducted on adult male and juvenile daily behavioral patterns of use. This project will analyze habitat availability, utilization, and preference. Seasonal use of ocean areas and general patterns of movement within feeding, resting, and nesting sites will be studied. Data that contribute to the recognition of ocean pathways, areas of use by both male and female loggerheads, and general dive patterns (depth and time at depth) will significantly enhance current and future efforts for protection of this species. Satellite telemetry can successfully be used to track these elusive animals. Seasonal and daily dive and movement patterns will be monitored with Telonic ST-6 backpack mounted satellite transmitters. Few studies have been done and data are insufficient concerning seasonal behaviors and daily cycles of juveniles, subadults and adult males, which comprise the majority of the sea turtle population. Effective conservation management for this species requires additional data, principally concerning habitat availability, utilization, and preference, for sound decision making.

Adult loggerheads will be captured offshore. Monitoring is to continue for the life of the transponder, which is approximately 9-12 months. Variables to be measured include: location, dive depth, and time at depth. A loggerhead sea turtle will be monitored in order to 1) help explain the movement and dive patterns of loggerheads, 2) develop a biological model to make these patterns more predictable, and 3) explain the interactions between sea turtles and various habitat components.

USE OF COMPOUND SPECIFIC ISOTOPE ANALYSIS TO DETERMINE MICROBIAL TRANSFORMATION OF CARBON IN SURFACE SEDIMENTS OF THE ALTAMAHA AND SAVANNAH RIVERS, GEORGIA. Molina, M., R. Burke, and R. Hodson, U.S. EPA and University of Georgia, Institute of Ecology, Athens, GA, U.S. EPA, Athens, GA and University of Georgia, School of Marine Programs, Athens, GA 30602.

The structure of the sedimentary microbial community was studied along the estuarine zone of the Altamaha and Savannah Rivers using phospholipid fatty acids (PLFA) analysis. This technique was combined with stable carbon isotopic analysis of both the bulk sediment and components of the microbial lipids to determine the sources of the organic carbon (marine vs. terrestrial) utilized by different microbial groups. The results indicated that total microbial PLFAs exhibited seasonal variability in both rivers. The highest biomass was observed at the higher salinity stations and it was dominated by prokaryotic PLFAs. This group composed 40 to 60% of the total microbial biomass in the Altamaha, and 26 to 64% of the total biomass in the Savannah. Compound specific isotope analysis (CSIA) of PLFA fractions indicated mixed sources of organic carbon utilized by the microbial community. At the upstream locations in both rivers, the $\delta^{13}C$ of most PLFAs reflected a strong terrestrial C source (-25 to -32‰). At the mouth, both the bulk sediment and the phospholipids reflected a heavier isotopic value (-21 to -25‰). The microbial community at mid river stations indicated a slight preference for terrestrial C3 sources, while the bulk sediment reflected either a mixed C source (C3 and C4 vegetation) or a marine input. In general, CSIA of PLFAs indicated that although the microbial community in many instances transforms C with similar isotopic values as the bulk sediment, it could also show selective utilization of specific C sources different to what the bulk organic C may indicate.

WHAT IS A SUBTERRANEAN ESTUARY? Moore, W.S., Department of Geological Sciences, University of South Carolina, Columbia, SC 29208.

In many coastal aquifers, groundwater derived from land drainage measurably dilutes sea water that has invaded the aquifer through a free connection to the sea. In this mixing zone, chemical reactions of the brackish water with aquifer solids modify the composition of the water; much as riverine particles and suspended sediments modify the composition of surface estuarine waters. To emphasize the importance of mixing and chemical reaction in these brackish coastal aquifers, I call them subterranean estuaries.

Geochemical studies within subterranean estuaries have preceded studies of the effect of these systems on the coastal ocean. The mixing zone between fresh groundwater and sea water has long been recognized as an important site of carbonate diagenesis and possibly dolomite formation. Biologists have likewise recognized that terrestrial inputs of nutrients to the coastal ocean may occur through subterranean processes.

Further evidence of the existence and importance of subterranean estuaries comes from the distribution of chemical tracers in the coastal ocean. These tracers originate within coastal aquifers through chemical reactions of the brackish water with aquifers solids. They reach the coastal ocean as the surface and subterranean systems exchange fluids. Exchange between the subterranean estuary and the coastal ocean may be quantified by the tracer distribution in the coastal ocean.

Anthropogenic effects on subterranean estuaries are causing significant change to these systems. Groundwater mining, sea level rise, and channel dredging impact these systems directly. The effects of these changes are only beginning to be realized in this vital component of the coastal ecosystem.

EFFECTS OF EUTROPHICATION ON PRIMARY PRODUCTION, SEDIMENT ACCRETION, AND CARBON PRESERVATION IN COASTAL WETLANDS. Morris, J.T., Baruch Institute and Dept. of Biological Sciences, University of South Carolina, Columbia, SC 29208.

Results of a 12-yr study in a North Inlet salt marsh demonstrate that soil respiration increased by 795 g C m^{-2} yr^{-1} and carbon inventories decreased in sediments fertilized with nitrogen and phosphorus. Fertilized plots became net sources of carbon to the atmosphere, and sediment respiration continues in these plots at an accelerated pace. Soil organic matter in fertilized plots decreased by 171 g C m^{-2} in the top 5 cm of the sediment column since 1984. The increased rate of sediment respiration greatly exceeds the 14 g C m^{-2} yr^{-1} annual loss rate of sediment organic matter, which indicates that the increase in sediment respiration is largely balanced by an increase in primary production. Aboveground primary production increased in fertilized plots to 2.0+0.3 kg/m^2 (+1SE) from 0.7 +0.05 kg/m^2 on control sites. Though soil carbon has declined, the elevation of fertilized plots has increased due to an acceleration in sediment accretion. Thus, carbon preservation and sediment accretion are sensitive to rates of nutrient loading.

AERIAL PHOTOGRAPHIC SURVEY OF HURRICANE INDUCED ALTERATIONS TO MASONBORO ISLAND, NC. Moundalexis, A.E., R.A. Laws, L.A. Leonard, University of North Carolina at Wilmington, Department of Earth Sciences, Wilmington, NC 28403.

Hurricanes Bertha (July 1996) and Fran (September 1996) impacted the foreshore and backshore environments of southeastern North Carolina's barrier island system. This study examines the impact of the storms on Masonboro Island, an undeveloped, transgressive island bounded by stabilized inlets. Historically, this island has retreated at an average rate of 2m yr^{-1}. Analysis conducted on pre-storm and post-storm aerial photographs indicates that following Hurricane Fran the entire island recessed, approximately 100m in the southern region, 37m in the center region, and 36m in the northern region. This

differential retreat appears to be controlled by jetties at the northern end which affect sediment delivery to this system and an Oligocene headland at the island's center. Over the length of the island, this retreat translated into the formation of storm overwash fans and terraces with a maximum cross-shore axial width of 200m. Given variable pre-storm relief, due in part to the jetties and headland, overwash sediment movement into back barrier marshes varied. The greatest encroachment (35m) occurred in the southern region which historically has been vulnerable as this area is topographically lower with fewer dunes to provide storm protection. In the middle region, less encroachment (14m) was evident due to headland influences. The northern region underwent the least amount of encroachment (0.8m) as wave refraction around the jetty has led to a wider beach with more dunes. Results suggest that Masonboro Island's storm response is controlled by underlying geology and anthropogenic alterations.

PRIMARY PRODUCTION IN THE MID-SHELF REGION OFF GEORGIA: THE PLANKTONIC AND BENTHIC ENVIRONMENTS. Nelson, J.R., R.A. Jahnke, R.L. Marinelli, C.Y. Robertson and J.E. Eckman. Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411.

The euphotic zone in the mid-shelf region of the South Atlantic Bight often extends to the sediment surface between the coastal front and the 40-50 m isobath. As a consequence, benthic microalgae (predominantly diatoms) make a significant contribution to total primary production over a broad portion of the shelf. In the summer, when the overlying water column is oligotrophic in character and light levels at the sea floor reach 8-10% or more of surface PAR (photosynthetically available radiation), areal benthic microalgal productivity can match or exceed that of phytoplankton integrated over the entire water column.

In this presentation, we compare the water column and benthic environments on the SAB shelf in terms of a number of factors which regulate planktonic and benthic microalgal biomass and productivity. We draw upon both literature sources and the results our recent studies to consider light and nutrient regimes, the role of physical dynamics, and potential biological controls. Light-photosynthesis relationships are compared and considered in terms of the distinct differences between optical environments in the water column and in the surface sand sediments of the mid-shelf region. A reservoir of apparent viable benthic diatoms in subsurface sands may buffer the benthic microalgal populations to physical and biological disturbance.

CHANGES IN PARTICULATE ORGANIC CARBON AND CHLOROPHYLL A $\partial^{13}C$ IN THE ALTAMAHA AND SATILLA RIVER ESTUARIES. Otero, E.[1], R. Culp[1,3], J.E. Noakes[3] and R.E. Hodson[2]; [1]University of Georgia, Department of Microbiology, Athens, GA 30605, [2]University of Georgia, School of Marine Programs, Athens, GA, 30605, [3]University of Georgia, Center for Applied Isotopes Studies, Athens, GA 30605.

Two types of rivers in Georgia outflow to the South Atlantic Bight. The Altamaha and Satilla rivers are representative of piedmont and blackwater types, respectively. The estuaries of these rivers differ drastically in their organic matter content. These constituents may affect the distribution of microalgal biomass in these waters due to increase light attenuation. In this study we examine the distribution of $\partial^{13}C$ signature of particulate organic carbon (POC) and chlorophyll a (Chla) within these two contrasting estuaries. Samples were collected from April 1995 to July 1996 on both estuaries following the salinity gradient. Del ^{13}C analysis was conducted on POC concentrated on prewashed quartz filters and on pigments extracted from GF/F filters. The Chla fraction from these pigments was separated using a

HPLC protocol. Results show similar concentration of POC in both rivers, being a smaller proportion of the total organic carbon in the Satilla River due to the highest concentration of dissolved organics. The range of Chla in both rivers was from <1 ug/L to about 30 ug/L, however the Satilla showed maximum levels at intermediate salinities. $\partial^{13}C$ signature of POC fluctuated from -28 to -21 parts per thousand (ppt PDB), usually increasing with salinity. Chla $\partial^{13}C$ covaried with that of POC, explaining 80 and 30% of the variation in the Altamaha and Satilla estuaries, respectively, suggesting microalgae contributes more C to particulates in the Altamaha than in the Satilla river.

ON THE INTERACTION OF ATMOSPHERIC FORCING, CIRCULATION, BATHYMETRY AND PELAGIC PRODUCTION. Paffenhöfer, G.A., Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411.

Circulation on the Southeastern shelf is dominated by atmospheric forcing, tides and the Gulf Stream. Whereas the former two forces displace water and resuspend sediments, the letter can replace shelf water through meanders, near bottom intrusions, and near-continuous inflow due to diverging isobaths north of Cape Canaveral. Due to near-continuous out flow in the eastern part of the Gulf of Mexico, significant amounts of particulate matter originates from pronounced upwelling on Campeche Banks off Yucatan which leads to strong primary and secondary production. Anticyclonic circulation in the Gulf of Mexico, together with limited in- and outflow, implies that the Gulf serves as a planktostat. It provides through the above mentioned flow/circulation regime a quasi-continuous supply of planktonic organisms and particulate matter for the SE continental shelf. This supply represents a major enrichment for the SE shelf which otherwise receives some enrichments of particulates only from freshwater sources and the atmosphere. These enrichments, ranging from nutrients to zooplankton, lead to the rapid development of phyto- and zooplankton communities on the SE-shelf which also supply organic matter to the benthic community.

In essence, continuous atmospheric forcing (trade winds), topography and bathymetry, major upstream upwelling, and intermittent atmospheric forcing (cross-shelf displacement) often result in high abundances and production of phyto- and zooplankton on the U.S. Southeastern shelf, with pronounced effects on the nearshore environment and the benthos.

DEFINING THE ROLE OF DATABASE MANAGEMENT IN SUPPORT OF LONG-TERM MULTIDISCIPLINARY ENVIRONMENTAL RESEARCH EFFORTS. Porter, D.E., [1,2], J. Allen[4], T. Siewicki[5], M. Gielazyn[2], D. Edwards[1,3], and W.K. Michener[6]. [1]Baruch Institute for Marine Biology & Coastal Research, [2]Marine Science Program, and [3]Department of Statistics, University of South Carolina, Columbia, SC 29208; [4]Strom Thurmond Institute, Clemson University, Clemson, SC 29634; [5]NOAA NOS - Southeast Fisheries Center, Charleston, SC 29412; [6]Joseph W. Jones Ecological Research Center, Newton, GA 31770.

Long-term multidisciplinary environmental research is both a scientific and management imperative for effective coastal resources research and planning. The establishment of a sound database management supports baseline studies, historical and trend analyses, impact and risk assessment, and modeling of both natural and anthropomorphic phenomenon. Advances in information technology are rapidly changing the manner in which research and resource management agencies obtain, manage, analyze and share the data and information required for effective resource management. The technology revolution is providing new opportunities to collect and integrate *in situ* and remotely sensed data independently, while affording cost-effective mechanisms for the exchange of data and information among local, state and federal resource agencies and research institutions. In support of the NOAA-funded Land Use-Coastal Ecosys-

tems Study, we are identifying existing data management capabilities and anticipated needs. A result of our initial efforts will be preliminary guidelines for the establishment of program-wide data management protocols.

HOST-PARASITE RELATIONSHIPS AND DISEASE STATUS AS A MEASURE OF ECOSYSTEM HEALTH. Porter, D.E.[1,2,3], D. Bushek[1,2,3], D.L. White[2], J. Keesee[1], [1]Belle W. Baruch Institute for Marine Biology and Coastal Research, [2]Marine Science Program, [3]School of the Environment, University of South Carolina, Columbia, SC 29208.

Parasites and diseases are natural components of healthy ecosystems. They are often common, but overlooked until they become problematic for one or more species in the system. Occasional, short-lived outbreaks and chronic, low intensity infections are normal in healthy ecosystems. Intense acute or persistent infections are, however, indicative of problems that are often related to habitat degradation. We propose that patterns of parasitism and disease can and should be used as measures of ecosystem health as well as indicators of habitat restoration success. In this poster, we compare and contrast data on the spatial and temporal patterns of the parasitic oyster pathogen *Perkinsus marinus* in a developed and an undeveloped estuary in South Carolina. Results indicate a positive relationship between disease intensity and development, indicating the utility of this criterion in determining ecosystem health. This methodology can measure the success of habitat restoration, and indicate the effect anthropogenic and natural disturbances on ecosystem health.

LINKING LAND USE TO ESTUARINE HEALTH: AN OVERVIEW OF THE U.S.E.S. PROJECT. Porter, D.E., Baruch Institute for Marine Biology and Coastal Research and the Marine Science Program, University of South Carolina, Columbia, SC 29208.

The coastal region of the southeastern United States is being developed at a rapid rate. The NOAA-funded Urbanization and Southeastern Estuarine Systems (USES) project is a long-term study of the comparative responses to anthropogenic activities in and adjacent to a developed estuarine system (Murrells Inlet, SC) with system responses of a relatively pristine estuarine system (North Inlet, SC). These two estuaries, located within approximately 32km of each other, are similar in geomorphology, geological history, and other environmental features. Although not identical, one can regard North Inlet as the "control" site and Murrells Inlet as the "experimental" site. A multidisciplinary research team studies bacteriology, chemical contaminants, eutrophication and nutrients, toxicology, and watershed dynamics. Techniques of geographic information processing combined with environmetrics are used to integrate research studies for spatial and risk assessment modeling. This project is designed to conduct research that will systematically develop a knowledge base that takes into account upland development, fisheries management requirements, and impacts of land-use patterns on water quality and system dynamics. Models are being developed to provide a scientifically valid basis for land-use planning in the coastal zone. This presentation provides an overview of the USES project. Following presentations will deal with specific components of this project.

COUPLING ESTUARINE HYDRODYNAMICS AND BIOGEOCHEMISTRY: APPLICATION TO A HIGH RESOLUTION ESTIMATE OF THE INORGANIC NITROGEN FLUX FROM THE SCHELDT ESTUARY TO THE NORTH SEA. Regnier, P., C.I. Steefel, University College Cork, Department of Civil and Environmental Engineering, Cork, Ireland, and University of South Florida, Department of Geology, Tampa, FL.

A coupled, fully transient, multicomponent reaction-transport model has been developed to estimate long-term fluxes of reactive compounds in strong tidal estuaries. The model is applied to the nitrogen cycle in the Scheldt estuary in Belgium and The Netherlands. The model provides a realistic description of the estuarine residual circulation and includes the essential feedback mechanisms between interdependent chemical species. The rate formulations were determined independently from laboratory experiments. The problem of coastal eutrophication and the control of algal blooms by the riverine fluxes of nitrogen to the North Sea has been considered. Modelling results and present data indicate that the recent restoration of sub-oxic conditions in the Scheldt after extensive waste water purification within the catchment area has created a significant reduction of the denitrification reaction and, hence, an increase in the N loading to the coastal area. Operating in conjunction with the reduction of heterotrophic processes in the estuary is the significant increase of the nitrification reaction which is now the dominant transformation process affecting nitrogen speciation. Using the typical case of the Scheldt estuary, we have also demonstrated that the short duration of the algal blooms requires estuarine flux estimation methods with a high temporal resolution. The need to resolve the processes and fluxes temporally calls into question the traditional sampling strategy based on instantaneous longitudinal profiles. Our model results indicate that the temporal variability of the synoptic scale should be resolved in detail. In this respect, long-time series of field data are imperatively needed.

CHARACTERIZATION OF THE SPATIO-TEMPORAL VARIATIONS IN A GEORGIA BIGHT BARRIER ISLAND SURFICIAL AQUIFER SYSTEM. Schultz, G. C. Ruppel, Georgia Tech, School of Earth and Atmospheric Sciences, Atlanta, GA 30332-0340.

On the Georgia Coast, estuarine biology, the biogeochemistry of marsh substrates, and geochemical cycling are greatly affected by the spatial and temporal distribution of fresh water in the surficial aquifer system. The freshwater lens is of particular importance because it serves as a barrier against salt intrusion into the surficial aquifer and constrains the location of the groundwater divide. During summer 1997 we initiated the first comprehensive collection of an integrated surface geophysical and hydrological data set to characterize spatial (lateral and vertical) distributions of fresh and saline water saturated sediments and subsurface geological features on a sand-dominated Georgia Bight barrier island (Sapelo Island). Geophysical data collected at five different survey locations are used to develop an interpreted composite across-island lens profile and to invert the depth to the fresh-salt water interface. To refine the interpretation, we rely on vertical electrical soundings and water quality data from shallow pieziometers. Our preliminary results indicate that the general freshwater lens shape is consistent with a steady state analytical Dupuit-Ghyben-Herzberg model (DGHM). Interpreted depths to the fresh-salt water interface are compared to assess temporal changes (tidal and seasonal) in the shape of the interface and local subsurface drainage patterns. We postulate that the freshwater lens and water table configuration may be disturbed due to the effects of variable tidal run up, soil properties, recharge and discharge, and drainage patterns. In other coastal settings spatio-temporal variations in the distribution of fresh and saline saturated sediments play an important role in ecological zonation.

THE SOUTH CAROLINA COASTAL EROSION STUDY: UNDERSTANDING CHANGE WITHIN THE ACTIVE COASTAL ZONE. Sautter, L., M.S. Harris, M. Hansen and M.R. DeVoe, Department of Geology, University of Charleston, Charleston, SC 29424; USGS, 600 4th St., South, St. Petersburg, FL 33701; and S.C. Sea Grant Consortium, 287 Meeting St., Charleston, SC 29401.

The South Carolina Coastal Erosion Study is a cooperative research program sponsored by the U.S. Geological Survey Coastal and Marine Programs, and managed by the S.C. Sea Grant Consortium. Seven principal investigators representing four universities have collaborated with USGS investigators in this five-year study initiated in 1994. The overall goal of the program is to identify, quantify, and understand the factors and processes controlling the recent evolution of the coastal system, ultimately to determine the sediment budget for this classic mesotidal, mixed-energy coast. The study area extends approximately 40 km north and 40 km south of Charleston Harbor and includes 9 barrier islands and 8 tidal inlets. This poster session will focus on geologic framework influences on coastal evolution and hydrodynamics of the study region. Side-scan sonar mosaics, high-resolution shallow seismic profiles, long beach profiles, high-precision bathymetric surveys, inlet modeling, and wave hindcast models have been used to improve conceptual and physical models of this classic mixed-energy coastline. These studies are being used to describe and predict coastal sediment budgets and factors influencing compartmentalized changes along the coast, and they will ultimately be used to construct a regional sediment budget for use in coastal management and resource decisions.

IMPACTS OF URBANIZATION ON ESTUARINE WATER QUALITY. Scott, G., M. Fulton, G. Richards, B. Thompson, L. Webster, G. Seaborn, K. Nelson, J. Bemiss and T. Siewicki, NOAA, NOS, Charleston Laboratory, Charleston, SC 29412-9110

Urbanization of coastal areas may result in increased runoff of chemical and biological contaminants into estuarine surface water which may impact water quality. Two estuaries, highly suburbanized Murrells Inlet (MI) and pristine North Inlet (NI), were studied in terms of the spatial distribution of fecal coliform and selected pathogenic (e.g., *Vibrios, Salmonella, Shigella* and *Campylobacter*) bacteria. A grid (Inner, Mid and Outer estuarine stations) of 30 stations within each estuary was sampled for surface water and oysters to determine the density of fecal coliform bacteria. Additionally, fecal coliform bacteria were biotyped (API) to identify the bacterial groups comprising the fecal coliforms. *E. coli* were further analyzed by Pulsed Field Gel Electrophoresis (PFGE), Fatty Acid Profiling (FAP) and Antibiotic Drug Resistance (ADR) in an attempt to determine if the *E. coli* were emanating from human or wildlife sources. Results indicated that surface water fecal coliform densities were elevated in MI relative to NI and that *E. coli* was the dominant bacteria comprising the fecal coliform group. There were no site-related differences in fecal coliform densities or composition in oysters. Results of PFGE, FAP, and ADR will be discussed in terms of their potential to distinguish human and wildlife pollution sources.

TIDAL PRESSURE GRADIENT FORCE BALANCES IN A CURVING ESTUARINE CHANNEL. Seim, H.E., T.F. Gross, J.O. Blanton, Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411.

The Satilla River estuary of coastal Georgia follows a shallow (5-10m) curving channel through Spartina marshes and is driven by 2-3 meter tides. The pressure gradient force balance is dominated by the barotropic-baroclinic pressure gradients and tidal acceleration. But the other terms due to curvature and bottom friction will also have important contributions. This one dimensional view of the estuarine circulation was tested by a month long installation of S-4 current meters, bottom mounted ADCP, Salinity-Temperature-Pressure recorders and a BASS bottom boundary layer current meter frame. Along channel separation of the STP sensors provided well resolved barotropic and baroclinic pressure gradients. Water column shear and integral transport were provided by the ADCP data. The bottom boundary layer measurements provided direct cross correlation measurements of Reynolds stress tensor within the turbulent boundary layer. Vertical stratification by salinity and sediment, baroclinic pressure gradients and

acceleration effects were all present complicating the turbulent parameterization such that the simple logarithmic profile drag coefficient was shown to be an inadequate method. The Taylor coefficient, <u'w'>/<q^2>, relating Reynolds stress to turbulent kinetic energy, is seen to be tidally variable, between zero during flood tide to the nominal value of 0.15 during ebb. How such non-linear tidal variations can be tidally averaged to provide the canonical view of estuarine circulation will be discussed.

INORGANIC NITROGEN LOADING IN HILLSBOROUGH BAY, FLORIDA: TRANSIENT EFFECTS ASSOCIATED WITH STORM EVENTS. Senanayake, D., C.I. Steefel, University of South Florida, Department of Geology, Tampa, FL.

Limiting the nutrient loading to the Tampa Bay estuary may improve the growth of seagrasses and improve the overall quality of the Tampa Bay watershed. As a preliminary step to understanding nutrient loading and recycling within Tampa Bay, we are investigating the flux of inorganic nitrogen from the Alafia River into Hillsborough Bay, a segment of the greater Tampa Bay estuary. Unusually high concentrations of ammonium (up to 200 μM) in low salinity surface waters (0-0.5 m depth) 3 to 7 days after storm events suggest stormwater runoff from a nearby fertilizer plant as a source. However, 2-3 days after minor storm events, higher ammonium concentrations are observed in deeper, more saline waters than in the shallow low salinity waters, suggesting other local sources for the ammonium loading to the bay. These high ammonium concentrations associated with saline bottomwater may be the result of tidally-driven flow from Hillsborough Bay into the Alafia River. We are currently investigating the use of nitrogen isotopes to fingerprint these ammonium loads, which along with *in situ* determinations of the rates of the important biogeochemical reactions, should provide the basis for a high resolution estimate of inorganic nitrogen loading to Tampa Bay. It is clear, however, that accurate estimates of nutrient loads cannot be achieved without a high time resolution to the sampling because of the strongly transient character of the inorganic nitrogen fluxes.

PROCESS STUDIES: BIOGEOCHEMICAL CONTROLS ON TOXICANT IMPACT AND TROPHIC TRANSFER IN THE SOUTH ATLANTIC BIGHT. Shaw, T.J.*, G.T. Chandler**, and T. Cowan*, *Department of Chemistry and Biochemistry, **Department of Environmental Health Sciences, University of South Carolina, Columbia, SC 29208.

The goal of this proposal is to evaluate the state of knowledge (SOK) of the processes which determine physical/chemical dynamics and impacts of toxicants in coastal ecosystems of the South Atlantic Bight. We have focused on three broad areas of research which are generally not linked as research areas, but are inextricably linked in terms of evaluation of chemical availability and persistence of toxic compounds in coastal ecosystems. These are: 1. Biogeochemical cycling; 2. Toxic impact and; 3. Trophic transfer. We will evaluate the state of knowledge in these disciplines for organic toxicants (e.g., PHAs, PCBs and pesticides) and (where applicable) heavy metals. In addition, we are coordinating closely with the group led by Cai et al. to integrate processes related to nutrient cycling in this study. While concentrating on the region between NC and GA referred to as the South Atlantic Bight (SAB), we have included process studies from other regions which may have application to problems indigenous to the SAB. This study is used in conjunction with toxicant concentrations in the ecosystem reservoirs (i.e., the focus of SOK proposal by Windom, Scott, et al.), to predict behavior in terms of mobility and impact as ecotoxicological importance.

FLUORESCENT DOM MIXING PATTERNS IN THE SATILLA RIVER, GEORGIA. Sheldon, W., M.A. Moran, University of Georgia, School of Marine Programs, Department of Marine Sciences, Athens, GA 30602.

Many terrestrially-derived compounds present in aquatic dissolved organic material (DOM) fluoresce strongly when exposed to UV light, and this property has been exploited in coastal circulation studies to trace the output of river water. We used this approach to study the dynamics and mixing patterns of fluorescent DOM (FDOM) in the Satilla River estuary by performing low tide longitudinal surveys of fluorescence and salinity during July 1995, October 1996, and December 1997. Fluorescence measurements were corrected for self-absorption and changes in fluorescent efficiency that occur during freshwater/seawater mixing, and then compared with fluorescence predicted by a simple end-member mixing model. Deviations from predicted fluorescence were considered net changes in FDOM concentration, indicative of non-conservative mixing. In the upper estuary (10-30 km from the ocean), FDOM was conservatively mixed during 1995 and 1996 cruises. In 1997, however, relative FDOM concentration gradually decreased in this region by up to 15%, suggesting removal (e.g., flocculation, degradation) or fluctuations in FDOM input to the estuary. In contrast, highly non-conservative mixing was observed in the lower reach of the estuary (0-10km) during all three cruises. Major changes in relative FDOM concentration (-40% in 1995, +25% in 1996, +40% in 1997) occurred in proximity to the Intracoastal Waterway (ICW). Additionally, data from 1997 indicate that a mixture of Satilla River and ICW water, with intermediate FDOM content, is transported to the shelf. These results suggest that significant lateral transfers of FDOM occur between the Satilla River and ICW that vary both in magnitude and direction.

LIPID BIOMARKER DISTRIBUTIONS IN ALTAMAHA ESTUARINE SEDIMENTS - IMPLICATION FOR DEPOSITION OF MARINE AND TERRESTRIAL ORGANIC MATTER. Shi, W., and M.-Y. Sun, University of Georgia School of Marine Programs, Department of Marine Science, Athens, GA 30602-2206.

Estuarine benthic community and biochemical processes are significantly affected by relative contribution of marine vs. terrestrial organic matter. This study is trying to examine deposition of organic matter from marine vs. terrestrial sources by determining fatty acid distributions in the Altamaha estuarine sediments. The variations in fatty acid distribution were followed along with three lines: salinity gradient (0-10‰), sediment depth (9 - 10cm), and biochemical forms (free - solvent extractable vs. bound - saponification released). Source specific fatty acids include: polyunsaturated 20:5 (marine algae biomarker), saturated C_{20} - C_{32} (terrestrial higher plants), branched *iso*- and *anteiso*- 15:0 fatty acids (bacteria source) and C_{14} - C_{16} saturated and unsaturated fatty acids (aquatic organism sources).

Results showed that 1) the most intensive deposition of organic matter (both marine and terrestrial) occurs at site with salinity of 4‰; little marine lipids deposit at site with salinity of 9‰ (starting point of mixing); and small fraction of total terrestrial lipids is transported down to the mouth; 2) variations in depth profile of lipids along with salinity gradient implied that physical and biochemical processes such as tide, settling/resuspension, and utilization by benthic organisms strongly affect organic matter fate in estuarine sediments; 3) terrestrial and marine organic matter may deposit as different biochemical forms (e.g., terrestrial as bound while marine as free), representing different reactivity or biochemical availability during benthic diagenesis. Other lipid biomarkers such as alcohols and steroids in the same samples are currently under investigation and will be related to this issue.

PATTERNS OF PLANKTON VARIABILITY AS RELATED TO BOTH CYCLIC AND STOCHASTIC EVENTS BASED ON HYDROACOUSTICS AND NET SAMPLING. Stender, B.[1], C. Barans[1], D. Holliday[2], C. Greenlaw[2], E. Wenner[1], D. Knott[1], J. Amft[3], J. Blanton[3], and P. Verity[3], [1]Marine Resources Research Institute, SCDNR, Charleston, SC 29422-2559; [2]Tracor Applied Sciences, San Diego, CA 92123-4333; [3]Skidaway Institute of Oceanography, Savannah, GA 31411.

During two consecutive years, vertical distributions of the plankton community as interpreted from acoustic backscattering samples were described within the tidally dominated North Edisto Inlet, South Carolina. Samples were collected during 8-minute periods throughout the water column at 0.5-m intervals at three stations across the inlet and along an offshore transect in May 1993, and ever 2 min. at a single site within the inlet in June and September-October 1994. Inverse calculations interrelating the returns from four frequencies allowed estimates of biovolume density (mm^3m^{-3}) by size. Mid-sized scatterers (0.79 mm ESR), the size of shrimp postlarvae and crab megalopae, formed subsurface layers during the daytime that fluctuated in depth temporally. These fluctuations were directly above the small scatterers (0.13 mm ESR) that have been shown to be cyclically resuspended in proportion to tidal current velocities (Amft et al., SECOR 1998). Zooplankton was widely distributed vertically during nighttime. Large scatterers (5.0 mm ESR), probably fish larvae or small pelagic fish, occurred in vertical patterns similar to those of the zooplankton, but their distributions often were slightly higher in the water column than those of mid-sized scatterers. The vertical distributions of each size class reached greatest height in the water column in June corresponding with increased current velocities. Among the predictable cyclic patterns were spatial and temporal differences across the inlet, sometimes coinciding with passage of small axial convergent fronts and major downwelling wind events. Major changes in plankton community composition occurred after a large upwelling event.

SCIENCE AND DECISION MAKING IN COASTAL MANAGEMENT. Stevens, S., Department of Natural Resources, Coastal Resources Division, Ecological Services, Brunswick, GA 32520-8687.

Regulatory authorities are often based in compromise. Compromise between those wishing to protect natural resources and those wishing to consume those same natural resources. The evaluation process for issuance of approval to impact natural resources is therefore based in compromise as well. Often State administrators are asked to make critical decisions on use of natural resources without clear scientific support for the decision. Such decisions may be based upon long standing acceptance of the value of a particular natural resource or simply a consistent application of laws over time. Seldom is there an opportunity to design and carry out a scientific study to address a specific natural resource impact. Regulatory authorities require decisions to be made within a time certain and decisions must be traced to the particular legal authority. Scientists often are hesitant to undertake a research project which addresses a coastal management issue because of their own personal research interests and lack of prestige associated with such issues. Scientists and coastal managers must work together as resource users move into more critical coastal habitats such as transitional areas between uplands and wetlands. Decisions on resource use are more complicated and more critical every day. Without scientific input to support decisions about resource use, these critical natural resources may be lost.

MECHANISMS OF SURFACE AND SHALLOW GROUND WATER HYDROLOGY AND NUTRIENT FLUXES INTO TWO HIGH SALINITY ESTUARIES. [1]Tufford, D.L., H.N. McKellar, Jr.[1,2,3], C.M. Aelion [1,2,3], M.H. Wahl[1], C.W. Corbett[3], D.E. Porter [2,3], [1]Department of Environmental Health Sciences, [2]Belle W. Baruch Institute for Marine Biology and Coastal Research, [3]Marine Science Program, University of South Carolina, Columbia, SC 29208.

The South Carolina Coastal Plain is facing rapid development, bringing hydrologic modification and potential alteration of watershed nutrient export. In pristine, forested (37-ha) and developing (11-ha) sites that drain into two high salinity estuaries, we sampled stream surface water during 10 storm events (1993 and 1994) for discharge, sediments, and dissolved inorganic nutrients and organic carbon. We also sampled ground water (1994 and 1995) from nested wells in the channels at 5 depths ranging from 0.6m to 4.9-m. We simulated runoff volume and sediment and nutrient fluxes with a nonpoint source pollution model (AGNPS).

The suburban stream typically displayed higher runoff volume, higher sediment and oxidized nutrient concentrations, and lower carbon and ammonium concentrations. This reflects development effects including increasing streamflow and hyporheic zone oxidation due to deeply incised channels, decreasing organic matter input to streams, and increasing sediment transport from less bank stabilization by riparian vegetation. Ground water concentrations at the suburban site were higher in nitrate and lower in ammonium and carbon. Oxidized nitrogen concentrations were low at both sites relative to ammonium, indicating a large capacity for denitrification. Denitrification and dissimilatory nitrate reduction to ammonium in shallow subsurface sediments at the forested site were greater than from the developed site. Simulations suggest that sediment in both streams originated predominately within the channel, supporting the field observation of no overland flow into streams except over connected impervious surfaces. Scenario analysis showed that increasing impervious surface area increased runoff volume linearly and peak flow rates exponentially.

INFLUENCES OF PHYSICAL OCEANOGRAPHIC PROCESSES ON CHLOROPHYLL AND PARTICLE DISTRIBUTIONS IN COASTAL AND ESTUARINE WATERS OF THE SOUTH ATLANTIC BIGHT. Verity, P.G., J. O. Blanton, J. Amft, B. Stender, C. Barans, Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411, and South Carolina Wildlife & Marine Resources Department, P O Box 12559, Charleston, SC 29422-2559.

Coastal and estuarine waters of the South Atlantic Bight are highly productive, with primary production of 600-700 $gC \cdot m^{-2} \cdot y^{-1}$. While controls and fate of this production are conceptually well understood, the importance of meteorology and physical circulation processes on phytoplankton and other suspended particles has not received equivalent attention. This study describes the effects of wind-generated and tidal currents on the concentration and distribution of phytoplankton and other suspended particles in the North Edisto estuary and adjacent waters. Moored instruments were deployed and shipboard sampling was conducted during 4 two-week field studies in May and August 1993, and June and September 1994. Chl *a* in shelf waters was more or less homogenous independent of the wind and tidal regime. Within the estuary, however, chl *a* concentrations were positively correlated with the alongshore component of wind stress; chl *a* was not correlated with the weaker cross-shelf component of wind stress. The quick response time to wind forcing (6-12 hrs) implied a direct effect on chl *a* distributions, apparently through resuspension of settled and/or epibenthic algal cells. Tidal current resuspension was also important, as pennate and centric diatoms with attached detritus and sand grains increased with increasing velocity of ebb and flood tide currents. Resuspension of chl *a* began at velocities as low as 10 cm/sec., and homogenization of 5-7m water columns was fully achieved at velocities of 20-30 cm/sec. Moored acoustical data showed resuspension of benthic particles in water depths of at least 15m, which was greater during higher current velocities (ebb and spring tides).

GEOCHEMICAL DYNAMICS ASSOCIATED WITH CARBONATE PRESERVATION OF MOLLUSCAN HARDPARTS. Walker, S.E., P. Van Cappellen, University of Georgia, Geology Department, Athens, GA 30602, and Georgia Institute of Technology, School of Atmospheric Sciences, Atlanta, GA 30332.

While molluscs are one of the most important fossil groups, little is known about the early fossilization process once the shells are buried below the sediment-water interface. Geochemistry in association with paleonotological experiments emplaced below the sediment surface are necessary to understand the early processes involved in turning molluscan hardparts into fossils. Experiments emplaced in a geochemically complex salt marsh environment (Sapelo Island, GA) indicate that molluscs (Geukensia and Littorina) are best preserved below 20 cm of sediment depth, rather than below 1 to 10 cm of the sediment surface, as paleontologists have suggested. The preservation potential of molluscs is directly tied to the geochemical milieu of the system: anoxia occurs within the first few cm of the sediment-water interface. Sulfate reduction of organic matter is thus intense, resulting in high levels of hydrogen sulfide, which promote iron sulfide deposits (including pyrite) on some of the shells. Reduction of ferric oxyhydroxides and sulfate also create high levels of pore water alkalinity, which would at first appear to promote the preservation of shells especially after 10 cm of sediment burial as the geochemical profiles suggest. However, preservation is poor on the experimental mollusc shells buried to a depth of 20 cm. This depth is closely correlated with the sulfate geochemical profile for this system rather than the alkalinity profile that is usually invoked for shell preservation. Thus, alkalinity and sulfate behavior both need to be examined to fully understand the early processes affecting shell preservation in organic-rich depositional environments.

THE GEORGIA RIVERS LAND MARGIN ECOSYSTEM PROJECT. R. G. Wiegert[1], M. Alber[1], C. Alexander[2], J. Blanton[2], A. Chalmers[1], R. E. Hodson[1], M.A. Moran[1], L. Pomeroy[3], and W. Wiebe[1]. Dept. of Marine Sciences[1] and Dept. of Ecology[3], University of Georgia, Athens GA 30602, [2]Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411.

The Georgia Rivers LMER project is studying the transport and modification of organic and inorganic matter carried from the land into the sea by the five major coastal rivers of Georgia (Savannah, Ogeechee, Altamaha, Satilla, and St. Marys). These rivers range through the Blue Ridge, Piedmont and Coastal Plain provinces, with differing watershed size and land use patterns. These differences in the rivers result in differences in water chemistry and in the concentrations of dissolved and particulate materials transported to the estuaries. When coupled with large differences in flushing times of these estuaries, this results in differences in the observed patterns of inorganic nutrients, dissolved organic matter, and sediment concentrations.

THE HISTORICAL GEOGRAPHY OF THE COAST: THE IMPACT OF HUMAN OCCUPATION ON THE COAST OF SOUTH CAROLINA. Winberry, J.J., Department of Geography, University of South Carolina, Columbia, SC 29208.

The boundary between the land and the sea is a complex place, both physically and culturally, but it can be defined also as a limited resource. The coast of South Carolina extends about 185 miles from Georgia to North Carolina, and its human geography reflects a long history of occupation and exploitation. That history is tied to an intimate relationship between the land and its people, a relationship that seemed for a long time not to disrupt the special character of the coast. It began some 12,000 years when the Native Americans occupied it with a way of life seemingly adapted to the resources available. European settlement began an exploitation that was also tied to the geography of the region with the introduction of rice

followed by indigo and later Sea Island cotton. For almost 200 years after the settlement of Charleston these agricultural activities dominated the geography of the coast and were associated with some major modifications of the environment. That period also lay the foundation for a particular gullah culture that especially came to occupy the Sea Islands. The early 20th century saw an apathy dominate the coastal areas that ironically preserved their rich heritage, both physically and culturally, but the last half of the century has seen a growing pressure of conflicting land uses, all of which seek to occupy their maximum extent. In many ways, the coast is a harbinger of the policy issues and decision processes that will be facing our society in many different environments in the years ahead.

BIOGENIC SILICA IN COASTAL SEDIMENT: AN INDICATOR OF COASTAL NUTRIENT ENRICHMENT? Windom, H.L., C.R. Alexander, Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411.

Sediment cores collected from salt marshes in the Savannah and Ogeechee River estuaries have been analyzed for organic carbon and biogenic silica. Pore water dissolved silica was also analyzed. Results indicate that biogenic silica variations with depth in these cores are not explained by simple diagenesis. Results may reflect changes in the rate of delivery of diatom detritus to the sediment surface in response to changing water column production. Results from ^{210}Pb dated cores appear to be consistent with the historical development of the regional river basins and estuarine response of diatom production.

TOXICITY OF SEDIMENT-ASSOCIATED PAHs TO THE ESTUARINE CRUSTACEANS, *PALAEMONETES PUGIO* AND *AMPHIASCUS TENUIREMIS*. Wirth, E.F., M. H. Fulton, G.T. Chandler, P.B. Key and G.I. Scott. National Ocean Service, Charleston, SC 29412 and Department of Environmental Health Sciences, University of South Carolina, Columbia, SC 29208.

Polycyclic aromatic hydrocarbons (PAHs) may enter estuarine systems through a variety of sources, including urban runoff. In a study of crustacean populations, differences in abundance have been identified between a relatively pristine estuary (North Inlet, SC) and a nearby estuary (Murrells Inlet, SC) which has undergone extensive development and has higher PAH sediment concentrations. The goal of this study was to assess the potential of sediment-associated PAHs to adversely affect crustacean populations. Two crustacean species, larval *Palaemonetes pugio* (grass shrimp) and *Amphiascus tenuiremis* (benthic copepod), were exposed to sediments spiked with a mixture of PAHs representative of those measured in sediments from Murrells Inlet. These species were assessed for lethal and sublethal effects to determine if PAH exposure can alter local populations of estuarine crustaceans. Sediments were spiked with a PAH mixture at 1X, 5X, 10X or 100X the average PAH concentration found at contaminated sites within Murrells Inlet. Larval grass shrimp were exposed to PAHs for 7 days while reproductively active copepods were exposed for 14 days. Endpoints for both species included survival, while additional sublethal endpoints for reproduction were assessed in copepods. For the larval grass shrimp, LC50 values of 8.20X and 5.55X were calculated at 96 and 168 hours respectively. Female copepod survival was significantly reduced by 24% at the 10X treatment and dose dependent decreases appeared evident in average number of nauplii and copepodites, as well as estimates of potential and realized reproductive outputs. The potential ecological significance of these findings will be discussed.

INS AND OUTS OF INLETS: INVESTIGATING MECHANISMS OF LARVAL EXPORT AND REINVASION USING "LARVAL MIMICS." Wolcott, T.G., D. L. Wolcott, NC State University, Department of Marine Earth & Atmospheric Sciences, Raleigh NC 27695-8208.

Transport of plankton patches was explored by deploying lagrangian drifters (Larval Mimics of LM's) that "behave" like larvae, responding to environmental measurements and swimming vertically by subtly altering their neutral buoyancy. Export of LM's from the moderate tidal-range Indian River through Fort Pierce Inlet, FL, was strongly influenced by small-scale features (slicks, fronts, convergences), and dependent on point of release. Counterintuitively, "larvae" released right at the inlet at the usual time for many species (high slack water) were not transported maximal distances offshore; in fact, they were deposited in nearshore water and subject to being sucked back into the estuary on the next flood tide. Larvae released further up-estuary would reach the inlet when flow rate was high, and momentum would carry them farther offshore. Reinvasion of estuaries was explored in the Ogeechee R., GA, a high tidal-range system. On flood tides, LM's were again disproportionately associated with slicks and fronts. Trajectories revealed that stations that might intuitively appear sequential (e.g., upcurrent-downcurrent) may in fact sample quite different water masses and plankton assemblages due too small-scale physics. Few LM's entered the nursery habitats thought to be the destination of re-invading larvae. Surprisingly, flows induced by salinity gradients set up during flood may prevent larvae that swim near the surface from entering creeks and marshes. Larvae cannot be treated as passive particles, and future studies must focus on the importance of adaptive behaviors.

LONGSHORE SEDIMENT TRANSPORT ON THE CENTRAL SOUTH CAROLINA COAST. Work, P., Department of Civil Engineering, 110 Lowry Hall, Clemson University, Clemson, SC 29634-0911.

Predictions of longshore sediment transport rates within the surf zone are frequently made to assess the impact of coastal structures on nearshore processes, estimate the longevity of beach nourishment projects, or determine setback requirements for coastal development. Available predictive equations are largely empirical, and largely unverified for full-scale (field) applications. Calibration is often achieved by comparing observed shoreline changes to shoreline change model results. Wave data for forcing of such models are often lacking for the time period of interest, forcing reliance on output from wave hindcast models.

Long-term (decades) longshore sediment transport calculations have been made for the central South Carolina coast based on historical wave data and hindcast information. Statistics of the hindcast and measured wave parameters are also compared for the vicinity of Charleston, SC. The U.S. Army Corps of Engineers Wave Information Study (WIS) serves as the source of the hindcast data. Measurements are from National Data Buoy Center wave gauges.

Offshore wave conditions are transformed to conditions at breaking via different methods for comparison. The first is a simple analytical approach, neglecting the influence of tidal shoals and currents on wave transformation. The influences of the shoals and tidal currents are then added, analytically and then numerically, the latter approach employing numerical models for both the tidal currents and wave transformation.

Calculated longshore gradients of the longshore sediment transport rate are compared to historical zones and rates of erosion for the South Carolina coast from historical data and more recent beach profile measurements.

FRAMEWORK GEOLOGY AND GEOMORPHOLOGY SEAWARD OF THE SANTEE RIVER DELTA. Wright, E, P. Gayes, S. Harris, S. Crosby and T. Miller, Marine Science Department, Coastal Carolina University, P O Box 261954, Conway, SC 29528, USA.

The Santee River is a prominent coastal feature of the South Carolina coastline, forming the largest delta along the Atlantic coast of the United States. Unlike the thin to absent sediment cover along the inner shelf north and south of the delta, previous studies seaward of the delta indicate an increased sediment cover with shore-parallel sediment features. These features, preserved as a result of the riverine sediment supply, provide an opportunity to study the Holocene evolution of the shelf. The previous studies, which used bathymetric and surface sedimentologic data, have been limited by a paucity of subsurface data.

This study examines high-resolution seismic data collected across the shelf as a grid of over 650km. The seismic data reveal a series of surfical scarps located between 5-25m depth, with a prominent scarp at -20m. Exceeding 4m in relief, these scarps exhibit a linear trend when correlated by depth. Seaward of the -20m scarp, low bedform-like mounds increase in number, suggesting some reworking of these sediments. A strong, gently sloping reflector underlies these scarps to the south and indicates little topographic control Below this reflector, the underlying stratigraphy is composed of a series of prograding sequences overlying a prominent, seaward and southward dipping reflector, interpreted elsewhere along the coast as the Eocene limestone surface.

This study represents the initial results in determining the Quaternary stratigraphy of the inner shelf seaward of the Santee River delta. To determine the origin of these scarps, future studies, using side-scan sonar to examine continuity and coring to determine depositional history, are planned.


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