CURRENT RESEARCH, MONITORING, AND EDUCATION PROJECTS

2015–2016

Baruch Marine Field Laboratory
(BMFL)

North Inlet-Winyah Bay
National Estuarine Research Reserve
(NI-WB NERR)

University of South Carolina

Belle W. Baruch Institute
for Marine & Coastal Sciences

North Inlet-Winyah Bay
National Estuarine Research Reserve

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Introduction

The Baruch Marine Field Laboratory (BMFL) has been the center of research activities for scientists and students from the University of South Carolina (USC) and dozens of other institutions since 1969. We conservatively estimate that between senior scientist projects and masters and dissertation studies conducted by graduate students, more than 1,000 grant and institutionally-funded projects have taken place at BMFL. This work has contributed substantially to the more than 1,800 peer-reviewed scientific articles, books, and technical reports that have been published since the Baruch Institute was founded. Independent and multi-disciplinary studies have been conducted by biologists, chemists, geologists, oceanographers, and other specialists who share interests in the structure, function, and condition of coastal environments. Results of research projects are used by educators, coastal resource managers, health and environmental regulators, legislators, and many other individuals and organizations interested in maintaining and improving the condition of estuaries in the face of increasing human activities and changing climate in the coastal zone.

The following annotated list summarizes 73 projects currently being conducted at the BMFL by staff, graduate students, and faculty associated with the University of South Carolina and other institutions. The University of South Carolina is the home institution for 55 of the investigators conducting research at the BMFL. In addition, 68 investigators representing 29 other institutions and agencies are carrying out projects at the BMFL. Dozens of graduate and undergraduate students assist scientists throughout the year to obtain hands-on training in field methods and to conduct research.

A wide variety of basic and applied research is represented. The projects are listed randomly and each project summary includes the title, investigators, affiliations, and project abstract. This list includes only those projects that make regular use of the site. Most of the studies that involve field measurements and collections are being conducted within the North Inlet–Winyah Bay National Estuarine Research Reserve (NI–WB NERR).

Funds for these research projects are provided by a variety of sources, including the National Science Foundation (NSF), Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA) National Estuarine Research Reserve System (NERRS) and SC Sea Grant Consortium, US Department of Energy (US DOE), US Dept. of Defense (DoD), Office of Naval Research (ONR), National Aeronautics and Space Administration (NASA), and the SC Department of Health and Environmental Control (SC DHEC). The Friends of the Institute, an independent organization that supports Baruch Institute activities, also provides assistance and the Belle W. Baruch Foundation provides the long-term stewardship of Hobcaw Barony, maintaining it in a natural state for research and education.

For more information, please contact the individual investigator(s), Dr. Dennis Allen, or Dr. Matt Kimball. Paul Kenny facilitates researcher use of the BMFL and is available for training and assistance. All BMFL staff can be contacted at 843-546-3623. Information can also be obtained from the Institute's website (www.baruch.sc.edu).

Contents

Imaging instrument array for integrated field studies of coastal system structure and processes

Investigators: Dr. Dennis M. Allen[1], Dr. James T. Morris[2], Dr. Scott M. White[3], Dr. Matthew E. Kimball[1], and Kyle Houser[1]

1 - Baruch Marine Field Laboratory, University of South Carolina
2 - Belle W. Baruch Institute for Marine and Coastal Sciences, University of South Carolina
3 - Department of Earth and Ocean Sciences, University of South Carolina

Imaging instruments are being used to measure physical, environmental, and biological features of coastal landscapes and thereby provide new and unique insights into structure and processes at spatial and temporal scales not previously possible. Our hyperspectral, thermographic, and video cameras and a portable spectrometer enable the mapping and quantification of primary productivity, temperature, suspended materials, water movement, animal distributions, and landscape features at scales of centimeters to kilometers – over a wide range of time periods. These instruments can be deployed at ground level (from a tripod or a boom that adjusts height from 1-6 m) or from a helium-filled kite-balloon (Helikite®) that can view study areas from heights up to 150 m. Also available is a terrestrial laser scanner (TLS, also known as ground-based LiDAR) which provides three-dimensional topographic images and analyses of tidal marshes, creek basins, mudflats, oyster reefs, beaches, and other features. Landscape mapping and repeated measurements will be used to investigate factors affecting changes in topography, geomorphology, tidal inundation, plant distributions, productivity, and physiological states. Coupled with extant long-term time series measurements and process-oriented field experiments, the imaging instruments will be used to address impacts and mechanisms of change due to storms, warming temperatures, persistent droughts, sea-level rise, and other climate-related factors. The instrument array is intended to encourage new research activity and collaborations between BMFL-resident, USC campus-based, and visiting scientists from other institutions. Please see www.baruch.sc.edu/ecosystem-and-landscape-analysis for more information and contact us with your interests in using the instruments.

Fluorescent dissolved organic matter dynamics in the North Inlet Estuary

Investigators: Dr. Erik Smith, Tracy Buck, and Susan Denham

Baruch Marine Field Laboratory, University of South Carolina and North Inlet–Winyah Bay National Estuarine Research Reserve

There is growing interest in the use of the inherent optical properties of dissolved organic matter (DOM) as proxies for dissolved organic carbon (DOC) concentrations and biogeochemical cycling in coastal ecosystems. This study employs a fluorescent dissolved organic matter (FDOM) optical probe, recently available as part of Xylem/YSI's EXO water quality sonde, to quantify high-frequency DOC dynamics in the North Inlet estuary. Beginning in August of 2012 an EXO equipped with an FDOM probe together with temperature, salinity, pH, dissolved oxygen, and turbidity probes has been deployed at the Oyster Landing long-term monitoring station of the North Inlet–Winyah Bay National Estuarine Research Reserve. Initial results have shown that over the majority of FDOM ranges observed to date, FDOM measures can serve as a reliable proxy for DOC concentration once temperature sensitivities and turbidity interferences are accounted for. Ongoing sampling is being conducted to understand the effects of different dissolved organic matter sources on FDOM – DOC relationships as well as the potential issues associated with sample quenching at high FDOM concentrations. This study will allow the temporal dynamics of DOC, the largest pool of organic carbon in marine waters, to be resolved at frequencies not previously possible.

Mapping zones of hyporheic flow in tidal creeks

Investigators: Dr. Alicia Wilson, Dr. Willard Moore, and Dr. Susan Lang

Department of Earth and Ocean Sciences, University of South Carolina

Estuaries are important zones of mixing and biogeochemical reaction in surface waters; equally important reactions occur in "subterranean estuaries" in groundwater. These groundwater mixing zones develop over multiple scales, driven by such flow processes as cm-scale flow through ripples, tidal fluctuations, and seasonal variations in mean sea level. This pilot project is designed to combine geochemical sampling and heat-tracer methods to map important zones of mixing as tidal creeks cut the first two confined aquifers at North Inlet. Geochemical samples are obtained via small-diameter temporary wells; thermal data are obtained via buried temperature loggers. Initial efforts have focused on Bly Creek, particularly in determining the timing and depth of thermal overturn below the sediment water interface during periods of surface water cooling.

Sea turtle nest monitoring on Hobcaw Barony

Investigators: Betsy Brabson[1], Robin Baughn[1], Wendy Allen[2], and other volunteers

1 - DeBordieu Colony (Debidue Beach Coordinators), SC
2 - North Inlet–Winyah Bay National Estuarine Research Reserve, Baruch Marine Field Laboratory, University of South Carolina

Nesting activity of the threatened loggerhead sea turtle, *Caretta caretta*, on the Hobcaw Barony portion of Debidue Beach has been monitored by trained volunteers, May-October, since 1992. This 2.2 miles of undeveloped beach, owned by the Belle W. Baruch Foundation, provides important nesting habitat for sea turtles and shorebirds. Volunteers walk the beach each morning during the turtle nesting and hatching period, record information on false crawls and nests, and protect nests from predators with screening. Nests laid in areas subject to tidal flooding are carefully relocated to higher areas. Volunteers also inventory nests 72 hours after the major hatch has occurred to determine hatching success of each nest. Inventories, usually conducted in the evening, typically draw large crowds of interested visitors and provide excellent opportunities to educate others about sea turtles. The volunteers are members of the South Carolina United Turtle Enthusiasts (SCUTE), which covers the northern beaches of the state, from Hobcaw Beach to North Myrtle Beach. Debidue Beach (Hobcaw Beach to Pawleys Inlet) typically accounts for 30-50% of all nests in the north coastal region. Reports summarizing nesting activity and success for Debidue Beach and the entire SCUTE region are prepared and submitted to the SC Department of Natural Resources that oversees the volunteer sea turtle program for the state. Data are also entered and available on the www.seaturtle.org website, and include information on a DNA study to track the nesting behavior of individual turtles.

Assessing the immune response of *Fundulus heteroclitus* due to environmental challenges

Investigators: Dr. Marlee Marsh and students

Division of Business, Mathematics and Sciences, Columbia College, SC

Fish innate immune responses can be evaluated as indicators of immune function and status following exposure to pathogens, biological response modifiers, immunotoxicants, and nutritional regimes. *Fundulus heteroclitus*, an estuarine fish commonly used as a model in immunotoxicological studies, will be collected from North Inlet. We have developed several monoclonal antibodies used to recognize immune responses in several species of fish, including *Fundulus heteroclitus*. Immunohistochemistry will be performed on gill, GI tract, head kidney, spleen and livers. Gonad morphology will be examined. We will also probe fish protein levels using SDS-PAGE and Western Blotting. Antibodies will include probes against lysozyme (neutrophils and macrophages), eosinophilic granular cells (possible mammalian eosinophil homolog), and cyclooxygenase-2 (produced in various cells during inflammation). In addition, two other antibodies that recognize the Aryl Hydrocarbon Receptor and CYP1A (both are proteins that are upregulated in response to toxic compounds in the environment) will be used. We hope to discover direct role(s), if there are any, of innate immune cells in fish immune responses to environmental pressures such as parasites and toxic compounds in the water.

A forty-six year comparison of the vascular flora at three abandoned rice fields, Georgetown, South Carolina

Investigators: Dr. Richard Stalter[1] and Dr. John Baden[2]

1 - St. John's University, NY
2 - US Army Corps of Engineers, NC, Retired

The objective of this study is to inventory the vascular flora at three brackish marshes: Airport, Alderly, and Thousand Acre Rice Field on Hobcaw Barony. We are also investigating the distribution of vascular plant species at Thousand Acre Rice Field along an elevation gradient. To accomplish this, we are surveying plant species and recording the elevation of each taxon above the most flood-tolerant species, *Spartina alterniflora*. After collecting and identifying the vascular plant species present at each marsh, species composition at the three marshes will be compared with previously gathered species composition data: J. Baden thesis (1971), a second study of the flora of the marshes following Hurricane Hugo (September 1989) in 1990-1991, and a third study in 2002-2006. Vascular plant species collections at each of the marshes began April 2013 and will continue through June 2016. A small sample of each taxon will be collected, pressed, and mounted on a herbarium sheet as voucher material to be housed at the A. C. Moore Herbarium, University of South Carolina. Only one sample/taxon will be collected as reference material. Soil samples from each of the marshes will be collected; mineral analysis will be performed by the Nutrient Analysis Laboratory, Cornell University. The significance of this study is that it documents and compares

vascular plant species composition at three brackish marshes over a 46-year period (1969-2016). There are few long-term studies of this kind and fewer where the same investigators follow up their work over 46 years of study.

Fish and crustacean use of marshes and intertidal creeks: Population and community level changes and relationships with weather and climate-driven changes in conditions within the nursery

Investigators: Dr. Dennis M. Allen, Dr. Matthew E. Kimball, and Paul Kenny

Baruch Marine Field Laboratory, University of South Carolina

Collections of nekton (fishes, shrimps, and crabs) have been made in the Oyster Landing marsh-creek basin since 1984. The objective has been to track the composition, abundance, and biomass and length distributions of nekton and determine patterns, trends, and factors influencing changes over seasons, years, and decades. From 1984-2003, this effort was based on biweekly seine hauls from an isolated pool (low tide) in the intertidal creek. In 1996, we started a new time series from the flooded marsh surface (high tide) adjacent to the creek. From 1996-2003, both the low tide seine and high tide enclosure collections were made on the same day and tide. From 1984-2003, overall abundance in the low tide catch increased, evenness decreased, water temperatures increased, and salinity decreased. For spot, the most abundant fish every year, increasing abundance, earlier arrival in the spring, and decreasing size at arrival and a decreasing growth rate were observed through 2003. From 2003 to 2011, total nekton abundance decreased while salinity increased. Since 2012, the effort has been reduced and focused on documenting the timing and size of ingressing juvenile transient species and their growth rates. These long-term time series are unique within the Southeast region and are becoming increasingly important as we interpret impacts of global climate change on nekton populations and the shallow water habitats that are essential to their development. The results are used to inform the management of salt marsh-estuaries, watersheds, and fisheries in the region.

Development and validation of a novel molecular tool to rapidly detect and quantify harmful algal bloom (HAB) species linked with fish kills and public health concerns

Investigators: Dr. Dianne I. Greenfield[1] and Dr. William J. Jones[1,2]

1 - Belle W. Baruch Institute for Marine and Coastal Sciences, University of South Carolina
2 - Marine Science Program and Department of Environmental Health Sciences, University of South Carolina

This project develops and evaluates sandwich hybridization assay (SHA) applications that detect and quantify SC harmful algal bloom (HAB) species as a novel molecular tool for understanding HAB population dynamics and effective water quality management. The foci are the ichthyotoxic raphidophytes *Fibrocapsa japonica* and *Chattonella subsalsa*, as well as the domoic-acid producing diatom *Pseudo-nitzschia pseudodelicatissima*, since they pose regional environmental and public health threats. Through this project, we will develop rapid species-specific identification and quantification of HAB species using ribosomal RNA-targeted molecular probes. Field samples from across the SC coast, including Winyah Bay and North Inlet, will be used to validate this technology with environmental samples. Results will augment the characterization and prediction of HABs in coastal South Carolina.

Personality-structured predator-prey interactions in intertidal oyster reefs

Investigators: Benjamin Belgrad[1] and Dr. Blaine D. Griffen[1,2]

1 - Marine Science Program, University of South Carolina
2 - Department of Biological Sciences, University of South Carolina

Personality is a ubiquitous feature of natural populations, varying across individuals. We have previous shown that the mud crab *Panopeus herbstii* and the fiddler crab *Uca pugilator* each show variation in personality type along a shy-bold continuum. We have further demonstrated that individual personality plays an important role in foraging decisions that cause cascading effects to influence food webs. While the downward direction of these cascading effects are well known, little is known about the upward direction. In other words, What role does individual personality play in controlling the predation risk experienced by individuals? We are conducting a study to understand how mud crab susceptibility to predation by a range of nektonic predators varies with mud crab personality. Additionally, we are exploring the role that personality plays in spatial dynamics of fiddler crabs in the marsh and mud flat habitats.

Chemical characteristics of estuarine waters: Long-term monitoring at four sites in North Inlet Estuary

Investigators: Dr. Erik Smith and Susan Denham

Baruch Marine Field Laboratory, University of South Carolina and North Inlet–Winyah Bay
National Estuarine Research Reserve

As part of the NERRS System-Wide Monitoring Program, water chemistry sampling was initiated in June of 1993 to monitor concentrations of suspended solids, total nitrogen, ammonium, nitrate, nitrite, total phosphorus, orthophosphate, and chlorophyll a at four locations within the North Inlet–Winyah Bay NERR. Water samples are collected every 20 days with ISCO automated water sampling devices at intervals of 2 hours and 4 minutes over two complete tidal cycles. Sampling and chemical analyses adhere to strict national protocols developed as part of the NERRS System-Wide Monitoring Program. The consistent, long-term collection of water chemistry variables allows for the characterization of short-term variability and detection of long-term change in key water quality parameters. These data also provide critical information for various studies of biological and physical processes in the North Inlet estuary. Data, along with detailed metadata, are sent to the NERRS Centralized Data Management Office (CDMO) for quality assurance and quality control, and then made available via the CDMO website: http://cdmo.baruch.sc.edu. Water chemistry data collected in North Inlet prior to the initiation of the NERRS SWMP sampling (some dating back to 1978) are available via the Baruch website's Data and Publications link: http://www.baruch.sc.edu/water-quality-chemistry-databases.

Hard clam (*Mercenaria mercenaria*) population dynamics in North Inlet estuary tidal creeks

Investigator: Dr. Juliana M. Harding

Department of Marine Science, Coastal Carolina University, SC

Hard clam (*Mercenaria mercenaria*) populations play an ecological and structural role within tidal creek habitats. The population biology and dynamics of hard clams will be quantitatively examined in North Inlet tidal creeks. Hard clam age structure, growth rates, and sex ratios will be evaluated and combined with measurements of environmental variables to describe clam population dynamics in tidal creeks and their effects on habitat structure within the creeks over multi-year time scales.

Synthesis of high and low marsh habitat mapping, vulnerability, and responses to sea-level rise in the South Atlantic

Investigators: Dr. Tom Allen[1], Dr. James T. Morris[2], Dr. J.P. Walsh[3], Dr. Clark Alexander[5], and James Edwards[6]

1 - Department of Geography, East Carolina University, NC
2 - Belle W. Baruch Institute for Marine and Coastal Sciences, University of South Carolina
3 - Institute for Coastal Science and Policy, East Carolina University, NC
4 - Coastal Studies Institute, University of North Carolina
5 - Skidaway Institute of Oceanography, University of Georgia
6 - Marine Science Program, University of South Carolina

Uncertainty of wetland responses to sea-level rise is hampering coastal resource conservation and climate change adaptation. Mapping marsh dynamics has emerged as a high priority for assessing vulnerability to sea-level rise, highlighting the need to synthesize existing marsh habitat maps, develop improved methodologies for their continual monitoring, and gauge the vulnerability of wetlands in critical estuaries. The Baruch Institute is a study site being used to meet these objectives. Specific technology to be used include multispectral remote sensing, LiDAR, NWI coverage, and newly available ALOS PALSAR imagery. Field techniques consist of ground truthing the input datasets. This focused effort will provide for three critical needs: 1) mapping high and low marshes with ultra-high resolution multispectral imagery, including ecotone delineation; 2) estimating the vulnerability of marsh habitat loss from LiDAR hypsometric analysis and spatial situation within the tidal prism; and 3) testing expanded application of new remote sensing algorithms for broad-scale, high-resolution maps using object-based image analysis techniques. We expect to produce a comprehensive assessment of current coastal wetland communities within the Baruch property and to use this spatial information to predict vulnerable wetland areas and their future distribution. We expect to couple the results with Morris' Marsh Equilibrium Model to predict the future extent of these wetlands. Vulnerability maps will highlight potential future wetland loss and sites for adaptive management or restoration. Differential change and vulnerability across the landscape will also direct resource managers to prospective sites and appropriate practices for restoration or adaptation.

The conservation status of the canebrake rattlesnake at Hobcaw Barony, with identification of key areas for conservation of its herpetofauna

Investigator: Dr. Allan L. Markezich

Department of Natural Sciences, Black Hawk College, IL

This ongoing long-term project assesses the abundance and microgeographic and ecological correlations of canebrake rattlesnake (*Crotalus horridus atricaudatus*) occurrence in the approximate 8000 acres of terrestrial communities of Hobcaw Barony. Observations involve timed road and walking surveys and usage of drift fences and cover boards along with various marking techniques of specimens to assess abundance. Data taken on snake occurrences involve coordinates of specific geographic localities, topography, general and specific ecological characteristics of communities, and variables involving specific microhabitat and seasonal associations. Data taken by others and information on historical land usage at Hobcaw Barony are also utilized. Results currently indicate that a relatively small metapopulation of the canebrake rattlesnake exists on the property, with highest densities in specific and relatively small areas. Hardwood forests and palmetto swamplands bordering upland areas are key ecological components of this species' environment at Hobcaw Barony. The study to date indicates that the current conservation status of the canebrake rattlesnake on the property is poor, and that populations may have declined in the past five years. Management efforts should be made to conserve critical habitats on the property and to minimize disturbance of them. People using vehicles should also be vigilant of snakes on the roads to reduce road mortality of individuals, which has increased in the past several years. Similar information on occurrence and abundance of other reptilian and amphibian species is also used to understand geographic and habitat correlates of herpetofaunal diversity (i.e., species richness) on the property. Hardwood forests and freshwater wetlands, and associated ecotones between these and pine forests, are critical areas for herpetofaunal diversity, with the greatest species richness found in the northern portion of the property. Managed pine forests have had the lowest richness.

Quantitative descriptions of oyster (*Crassostrea virginica*) population biology in the North Inlet estuary

Investigator: Dr. Juliana M. Harding

Department of Marine Science, Coastal Carolina University, SC

Oyster (*Crassostrea virginica*) population biology sets the foundation for maintenance and persistence of the biogenic habitat as well as the associated trophic communities and ecological services. These dynamics respond to a variety of factors functioning at time scales ranging from days to decades. This research describes basic oyster population parameters including recruitment intensity and periodicity as well as density, demographics, disease status, and condition index at sentinel sites in the Town, Clambank, Crab Haul, and Bly Creek basins. Environmental data will be collected and integrated with biological data. The integrated data sets will be examined in the context of available historic data and documented environmental changes across decadal time scales.

Biologically relevant sensor networks for climate change studies in intertidal ecosystems

Investigators: Dr. Wenyuan Xu[1], Dr. Brian Helmuth[2], and students

1 - Computer Science and Engineering, University of South Carolina
2 - Marine Science Center, Northeastern University, MA

The intertidal zone – the region between the low and high tide lines along the coasts of the world's ocean – serves as a key test bed to exploring the effects of global climate change on species distributions and abundances. Lots of biomimetic sensor nodes are deployed in these areas to monitor the temperature changes. However, current sensor nodes store the measurement locally, which requires marine scientists travel every a few months to collect data on spot. In this project, we develop a new type of *wireless* biomimetic sensors that can be self-organized as a sensor network and automatically transmit relevant data to a backend data center. With this system and network design, the biomimetic sensor network will make the collected data available online continuously without human intervention, which lets researchers focus on "how to analyze data" instead of "how to measure data". Towards this goal, we divide the project into two tasks: (1) the individual sensor design and (2) the networking design. Extensively deployed and tested onset, we hope that the emerging wireless biomimetic sensors and networks will be the next generation tools for marine scientists to study global climate change.

Examination of swimming abilities of common salt marsh fishes

Investigators: Dr. Matthew E. Kimball[1], Dr. Kevin M. Boswell[2], and Dr. Lawrence P. Rozas[3]

1 - Baruch Marine Field Laboratory, University of South Carolina
2 - Marine Science Program, Department of Biological Sciences, Florida International University
3 - NOAA / NMFS / SEFSC, Estuarine Habitats and Coastal Fisheries Center, LA

Salt marshes are physically and environmentally dynamic aquatic environments, with near constant fluctuations in water depth, flow direction, and flow velocities. Numerous fish species use salt marsh habitats during single or multiple life history stages, and nektonic life stages must rely on swimming abilities to confront and adapt to these ever-changing natural conditions. Further, because many coastal and marsh habitats are under some form of management that regulates water flow, fishes may experience unnatural aquatic conditions such as increased flow velocities at critical marsh access points (e.g., a water control structure in a levee system). Considering this, the swimming abilities of fishes, particularly juveniles, are likely an important factor guiding and limiting their distribution in salt marshes. While the swimming abilities of riverine fish species have been extensively evaluated, the swimming abilities of common salt marsh fishes are largely unknown. We propose to determine the critical swimming speed for juveniles (< 100 mm total length) of common salt marsh nekton species (e.g., mullet, spot, croaker, silver perch, etc.) using a laboratory swim tunnel. The swimming performance of fishes is generally related to fish size (length), and critical swimming speed increases with fish length, therefore by swimming a range of juvenile sizes for each species we expect to accurately determine the relationship between swimming speed and size for the target species.

Painted Bunting monitoring project

Investigators: Wendy Allen[1], Dr. Jennifer Plunket[1], Dr. James Rotenberg[2], and citizen science volunteers: Bill Brabson, Marsha Green, Marlene Konsek, Pete Little, Sandy Little

1 - North Inlet–Winyah Bay National Estuarine Research Reserve, University of South Carolina
2 - Department of Environmental Studies, UNC-Wilmington

Painted Buntings (PABUs) are the most colorful of the migratory songbirds that visit the coast of South Carolina. Adult males sport a royal blue head, neon green back and red breast and rump. PABUs return to the area mid-April, nest in shrubs near marshes, and migrate south in the fall to central and southern Florida, Cuba and the Yucatan peninsula of Mexico. Surveys conducted since 1966 have demonstrated a decline in PABUs which lead to the establishment of a monitoring project that includes banding at select sites in the southeast and observations made by citizen scientists. This project, Painted Bunting Observation Team or PBOT, is headed up by scientists at the UNC-Wilmington (www.paintedbuntings.org.) The North Inlet–Winyah Bay National Estuarine Research Reserve (NERR) served as a PBOT banding site, 2007-2012, and has maintained a feeder near the Baruch Marine Field Laboratory (BMFL) since 2007. The NERR established a Painted Bunting monitoring project in summer 2014 to document buntings coming to the feeder. Reserve staff and citizen scientists make timed observations of PABUs and record color band combinations, if present. During the 2015 season, at 22 different Painted Buntings were observed based on their unique band combinations. Citizen scientists are working with Reserve staff again to monitor PABUs on Hobcaw Barony. The project will contribute to a better understanding of PABU longevity, how long the stay during the nesting season, whether they come back to the same site from year to year, and other aspects of their natural history.

Maintenance and operation of IOOS/SECOORA priority WERA HF radar sites

Investigator: Dr. George Voulgaris

Department of Earth and Ocean Sciences, University of South Carolina

The objective of this study is to remotely monitor the ocean surface currents and waves in Long Bay using two high frequency (HF) radar stations. Scientists from the University of South Carolina, operate and maintain two US IOOS/SECOORA identified priority WERA system radar sites (Georgetown, SC and Fort Caswell, NC). One station is located on Hobcaw Barony (33°21'19.60"N, 79° 9'12.56"W) and the other station is located at Caswell Beach, NC (33°53’25.18”N, 78° 1'40.64"W). Each station remotely measures the surface ocean currents up to 120 miles offshore and when combined create maps of temporal and spatial distribution of waves and currents over the entire Long Bay area. Data from these sites are sent to SECOORA and National High Frequency Radar Network for integration, display, and dissemination.

Fine-scale tidal and diel nekton movement and behavior within interconnected estuarine habitats

Investigators: Dr. Guillaume Rieucau[1], Dr. Kevin M. Boswell[1], Dr. Matthew E. Kimball[2], and Dr. Dennis M. Allen[2]

1 - Marine Science Program, Department of Biological Sciences, Florida International University
2 - Baruch Marine Field Laboratory, University of South Carolina

Fish use of the multiple interconnected habitats within estuaries is largely species-specific and varies according to biological and physical factors. Movement of fishes at large and small spatial and temporal scales influences critical life-history functions (e.g., foraging, reproduction), shifts energy and nutrients among habitats, and supports multiple trophic levels within estuarine and coastal ecosystems. Therefore, the ability of resident and transient nekton to move in to, within, and out of various marsh habitats determines the relative value of those habitats. While it is generally acknowledged that habitat connectivity is an influential ecological factor for many estuarine organisms, few studies have focused on the connectivity between adjacent estuarine habitats, particularly at smaller spatial and temporal scales such as within tidal cycles. This is primarily due to the difficulties of sampling in dynamic marsh habitats and the limitations of traditional sampling gears (e.g., nets, traps). Recent advances in high-resolution acoustic imaging now allow for examination of traditional metrics such as presence/absence, abundance, and size of organisms, and also allow for examination of in situ behavioral metrics (e.g., movement, direction, speed, schooling dynamics) and intra/interspecific interactions (e.g., predation, competition) that have been elusive or very difficult to study in estuarine and coastal waters. We plan to build upon our earlier (2012) acoustic imaging sampling efforts in the North Inlet estuary and examine fine-scale nekton movement and behavior in and among subtidal and intertidal estuarine habitats within individual tidal cycles, throughout multiple tidal cycles, and during both day and night.

Public and K-12 community education activities – National Estuarine Research Reserve

Investigators: Beth Thomas and Melissa Heintz

North Inlet–Winyah Bay National Estuarine Research Reserve

Educational activities for the general public and K-12 teachers and students highlighting coastal ecology and integrating findings from research are offered throughout the year. Seasonal schedules of public outreach activities are produced throughout the year, and programs are promoted through informational fliers, Reserve newsletters, newspapers, and the Reserve's website (www.northinlet.sc.edu) and Facebook page in addition to local online community event calendars. Program offerings include estuarine and beach ecology activities for all ages, biking and kayaking programs featuring coastal ecology, open houses and research lectures, and research-based citizen science programs. Professional Teacher Development opportunities and field trips for K-12 public, private, and homeschool students are also available, as well as job shadowing and research experiences for middle and high school students. Off-site outreach includes presentations to environmental and civic groups, local festivals, special outreach programs at regional libraries and museums, afterschool programs for local elementary and middle schools, science and environmental fairs, and career days. Partnerships with other local environmental education providers, including the Belle W. Baruch Foundation, ACE Basin NERR, SC Department of Natural Resources, SC Sea Grant Consortium, Friends of Coastal South Carolina, the Waccamaw National Wildlife Refuge, and the Coastal Waccamaw Stormwater Education Consortium, provide additional opportunities for public education, teacher training, and professional development as well as staff and resources for enhanced programming and outreach.

Goby and blenny movements, fidelity, and habitat use

Investigators: Dr. Juliana M. Harding[1], Dr. Dennis M. Allen[2], and students

1 - Department of Marine Science, Coastal Carolina University, SC
2 - Baruch Marine Field Laboratory, University of South Carolina

Habitat use patterns of demersal oyster reef fishes, including naked gobies (*Gobiosoma bosc*), crested blenny (*Hypleurochilus geminatus*), feather blenny (*Hypsoblennius hentz*), freckled blenny (*Hypsoblennius ionthas*), and striped blenny (*Chasmodes bosquianus*), in Crab Haul Creek, North Inlet are being examined. Artificial nesting substrates and passive integrated transponder (PIT) tags have been and will continue to be used to describe movement and fidelity patterns of these resident fishes. Regular surveys and recaptures of tagged fishes will provide information on site fidelity and home range as well as demographics of resident fish populations. Oyster disarticulation rates will also be examined to describe seasonal availability of natural nesting substrate and related occupancy by these fishes.

Selective advantage of pathogenic *Vibrio parahaemolyticus* in the Eastern oyster (*Crassostrea virginica*)

Investigators: Dr. Charles R. Lovell and Savannah Klein

Department of Biological Sciences, University of South Carolina

Bacteria in the genus *Vibrio* are estuarine organisms that include potentially pathogenic strains. Strains become human pathogens when ingested in undercooked seafood or introduced into wounds. Oysters act as a vector for *Vibrio* diseases because they can concentrate the bacteria during filter feeding. This project will investigate the density of both benign and pathogenic vibrios in oysters in the North Inlet estuary. Oysters will be sampled during warmer times of the year to coincide with periods of maximum *Vibrio* growth. During sampling, 10-15 oysters will be collected from Oyster Landing and then brought back to Columbia for processing in the Lovell lab. Oysters will be washed, shucked, and homogenized individually. The homogenized mixture will then be plated on a *Vibrio* selective growth medium. By using improved PCR primers and protocols that detect virulence factor genes, the number of pathogenic strains of vibrios reared from oysters will be determined. Previous studies have detected low frequencies of pathogenic vibrios in oysters; however, our summer 2014 sampling showed that virulence factor genes occurred in as much as 65% of *Vibrio* isolates reared from Oyster Landing oysters. We will continue sampling oysters at Oyster Landing throughout 2015. We will also deploy oyster biomimics at Oyster Landing. iButton temperature loggers will be embedded in silicone in natural oyster shells to determine temperature fluxes within oysters during low tide exposure. Aerial exposure of oysters has direct effects on internal temperature, and could cause an increase in *Vibrio* population sizes within oyster tissues.

Assimilation rates of dissolved organic carbon by photomixotrophic estuarine phytoplankton

Investigators: Dr. James L. Pinckney

Department of Biological Sciences and the Marine Science Program, University of South Carolina

Phytoplankton provide an energy source for higher trophic levels. However, some phytoplankton species function as both primary producers and heterotrophic secondary consumers. Phytoplankton that are photosynthetically competent but also take up AND assimilate organic compounds are classified as photomixotrophs. Unfortunately, we currently have few estimates of the proportion of the phytoplankton community that function as photomixotrophs, their rate of secondary production, or their temporal variation in abundance. Current paradigms about trophodynamics in marine systems do not consider this potentially important “alternative” pathway for energy flow for phytoplankton. The implication is that we may be missing a significant, fundamental process that affects carbon cycling and trophodynamics in estuarine systems. The proposed research will use a novel approach to provide quantitative measures of the in situ rates and magnitudes of “facultative heterotrophy” in natural, estuarine phytoplankton communities over seasonal time scales in a representative estuarine ecosystem. The purpose of the research is to apply a unique 14C radiolabeling technique to quantify the in situ assimilation rates of dissolved organic carbon (DOC) by estuarine photomixotrophs and estimate the amount of DOC converted to phytoplankton biomass by photomixotrophy over seasonal time scales. This information will provide new insights into carbon dynamics in estuaries, the contribution of DOC to estuarine food webs, and the importance of photomixotrophy in determining the structural and functional characteristics of estuarine phytoplankton communities.

Interspecific competition among some salt marsh perennials in South Carolina

Investigators: Dr. Richard Stalter[1] and Dr. John Baden[2]

1 - St. John's University, NY
2 - US Army Corps of Engineers, NC, Retired

Salt marsh vegetation in the United States is characterized by distinct zonation of vascular plants. Zonation is less pronounced in brackish versus high salinity marshes. Previous transplant experiments indicated several species could not tolerate conditions in areas where they are not normally found. These experiments, however, failed to differentiate the effects of abiotic and biotic (namely interspecific competition) factors. Controlled, reciprocal transplant manipulations have been performed. Growth and survival were monitored to measure the relative importance of interspecific competition and abiotic factors as determinants of zonation patterns between the salt marsh cord grass, *Spartina alterniflora*, and the black needle rush, *Juncus roemerianus*. *Spartina alterniflora* was able to invade the *J. roemerianus* zone when the latter was removed from land that it originally occupied in the marsh. *Juncus* marginally invaded the *S. alterniflora* zone when the latter was removed. *Juncus* did not transplant well; almost 100 % of the transplanted *J. roemerianus* died even when dug up and replanted in place.

Geographic variations in larval fish ingress to estuaries; long-term patterns of arrival times, abundance, and size distribution from South Carolina to Massachusetts and relations to climate change

Investigators: Dr. Dennis M. Allen[1,2], Dr. Ken Able[3], Dr. Tim Targett[4], Dr. Jeff Buckel[5], Dr. Todd Kellison[6], Dr. Chris Taylor[6], Dr. Jon Govoni[6], and Dr. Jon Hare[7]

1 - Baruch Marine Field Laboratory, University of South Carolina
2 - North Inlet–Winyah Bay National Estuarine Research Reserve
3 - Rutgers University Marine Field Station and Jacques Cousteau National Estuarine Research Reserve, NJ
4 - University of Delaware
5 - North Carolina State University
6 - NOAA Center for Coastal Fisheries and Habitat Research, NC
7 - NOAA National Marine Fisheries Service, RI

Adult fishes which spawn in the ocean during late fall and winter produce larvae that arrive at inlets and then transform into bottom feeding juveniles that inhabit salt marsh and other shallow estuarine habitats until fall. Most studies on the early life stages have been site specific and of short duration. A collaborative effort among investigators from various locations in the Northeast, Middle Atlantic, and Southeast regions is comparing and interpreting patterns of abundance, timing, and size structure during ingress over multiple years. Our time series of larval fishes from the mesozooplankton collections at North Inlet appears to be the longest continuous dataset, with the 35th year of biweekly collections beginning in January 2015. Time series collections in Beaufort, NC (since 1985), Great Bay, NJ (since 1989), and DE (since 2006) will contribute to the analyses. Recently, the SC, NJ, and NC partners, which are the founding components of CCOR (Coastal Collaboration on Ocean Recruitment), contributed long-term ichthyoplankton datasets to the SEAMAP website. NOAA-based ocean sampling programs provide data about spawning locations, timing, and cross-shelf distribution of early stage larvae. Changing climate is expected to alter patterns of reproduction, movement, and growth for many coastal fishes, and preliminary analyses suggest that the phenology and growth of some species are responding to increasing water temperatures.

How does coastal development impact groundwater inputs to tidal creeks?

Investigators: Meghan Shanahan[1], Baker Stevens[1], Dr. Alicia Wilson[1], and Dr. Erik Smith[2]

1 - Department of Earth and Ocean Sciences, University of South Carolina
2 - Baruch Marine Field Laboratory, University of South Carolina and North Inlet–Winyah Bay National Estuarine Research Reserve

The overall goal of this work is to assess the impact of coastal development on groundwater inputs to tidal creeks. The immediate goal of this project is to find out whether the composition of groundwater in the zone of exchange surrounding tidal creeks show any correlation with development of nearby uplands. We hypothesize that the impact of development will be greatest at sites with large uplands and narrow salt marshes and that sites with wide salt marshes will be buffered from development. We will test these hypotheses by sampling groundwater from 15 tidal creeks in South Carolina; Crabhaul Creek will serve as an undeveloped endmember.

Development of monitoring and assessment tools for nitrogen and phosphorus in South Carolina coastal wetlands II: Hydrological Assessments

Investigators: Dr. Dianne I. Greenfield[1,2], Dr. Timothy Callahan[3], Dr. Denise Sanger[2], and students

1 - Belle W. Baruch Institute for Marine and Coastal Sciences, University of South Carolina
2 - South Carolina Department of Natural Resources
3 - Department of Geology and Environmental Geosciences, College of Charleston

Elevated levels of nitrogen (N) and phosphorus (P) are associated with eutrophication in a wide range of aquatic systems. Yet, surprisingly little is known about how variable nutrient levels affect phytoplankton community composition and the resultant primary productivity of coastal South Carolina estuaries. Elucidating the interactions between estuarine nutrient levels and phytoplankton communities in SC is central to understanding ecosystem function. Moreover, establishing linkages between urbanization and hydrology is key to understanding nutrient delivery to coastal zones. As coastal SC is experiencing rapid urbanization, this contributes to the deposition and accumulation of nutrients and fertilizers, thus potentially making SC estuaries susceptible to nutrient (particularly N) loading. This project continues our work assessing biological (phytoplankton) responses to various nutrient conditions in the coastal zone. Although experimental studies are focused elsewhere in SC, monitoring of phytoplankton, nutrients, and basic water quality spans the SC coastal zone, including North Inlet–Winyah Bay.

Hydrology and pollutant removal performance in stormwater ponds typical of the lower coastal plain of South Carolina

Investigators: Dr. Erik Smith[1], Dr. Richard Peterson[2], Colleen Cohn[1], Tracy Buck[1], Susan Denham[1], Austin Waldorf[2]

1 - Baruch Marine Field Laboratory, University of South Carolina and North Inlet–Winyah Bay National Estuarine Research Reserve

2 - School of Coastal and Marine Systems Science, Coastal Carolina University

South Carolina resource managers and stormwater engineers require locally relevant quantitative information on the residential stormwater ponds typical of the coastal plain. Stormwater ponds, especially detention ponds, are the most common best management practice (BMP) for controlling runoff in coastal South Carolina. Despite their prevalence, there are currently no published studies quantifying the extent to which residential stormwater ponds typical of South Carolina's coastal plain can be expected to offer an effective means of moderating hydrologic flows and pollutant loads from developed landscapes. To address this need, the specific objectives of this study are to: 1) Quantify the complete water budget (surface runoff, groundwater input, precipitation, evapotranspiration, storage, and total export) for selected stormwater pond at both the precipitation event scale and over the annual scale; 2) Quantify concentrations of total nitrogen, total phosphorus, suspended solids, and fecal indicator bacteria (*E. coli*) in pond outfall waters, relative to input waters, to determine detention pond effectiveness in their ability to remove or retain these pollutants prior to discharge to receiving waters. Research will directly account for the relative roles of both surface piped and over-land sheetflow inputs as well as and groundwater flowpaths as sources of material delivery to ponds. The study will be conducted in ponds that vary in the degree of impervious surfaces within their catchment area and in the means by which runoff is routed to the ponds. Research results will be incorporated into technical recommendations for regulatory agencies, local stormwater managers, pond management professionals, homeowner associations, and the broader scientific community.

Population monitoring of wintering sparrows in salt marsh

Investigator: Dr. Chris Hill

Department of Biology, Coastal Carolina University, SC

Seaside, Saltmarsh, and Nelson's sparrows are all confined to coastal marsh habitats in winter, and all three winter in South Carolina marshes. The occurrence, site fidelity, and survival of sparrows of these three species will be investigated by mist-netting and banding at high tide roost sites in high marsh hammocks.

Silver nanoparticle accumulation and fate in an estuarine bivalve

Investigators: Shelby V. Butz[1,2], Dr. R.C. Merrifield[1], Dr. James L. Pinckney[2], and Dr. Jamie R. Lead[1]

1 - SmartState Center for Environmental Nanoscience, Arnold School of Public Health, University of South Carolina

2 - Marine Science Program, University of South Carolina

The overall aim of this project is to test the hypothesis: Bioavailability is solely related to nanoparticle (NP) dissolution and subsequent uptake and loss of dissolved silver. Previously, we have seen concentration- and tissue-dependent responses for silver accumulation, with a direct relationship between exposure concentration and silver (Ag^+) accumulation within tissues of *Crassostrea virginica*. Specifically, the target organs for accumulation were determined to be the hepatopancreas and gills when exposed to 10-50 ppb AgNPs in natural seawater. We have also identified through lipid peroxidation assays, there is a significant difference from the control in the 15 and 50 ppb exposures, but no toxic effect was observed in the 1 and 10 ppb exposures. It is unclear if Ag^+ accumulation is a result of ionic of nano-particulate uptake. To determine the mechanism of bioavailability of silver NPs and the consequent role this plays in toxicity, we will use newly developed isotopically labeled Ag107@Au@Ag109 core-shell NPs to identify the mechanism of NP bioavailability and uptake under environmentally realistic exposure conditions. We will achieve this by measuring the ratios of metals (Ag107 and Ag109) in solution and tissue. Initial test organisms include an estuarine dinoflagellate species (*Prorocentrum minimum*) and an estuarine bivalve (*C. virginica*). Future research will couple the bivalve with a mammalian model (mice) to determine trophic transfer rates and efficiency. We have previously shown that the Au layer of theses core-shell NPs prevents dissolution of the Ag core, while the outer layer dissolves freely. These characteristics coupled with isotopic labels will allow us to identify ionic and particulate fractions without difficulty. This study will greatly improve the understanding of how bioaccumulation and toxicity manifest under environmentally realistic conditions and answer the question: Is NP bioaccumulation and bioavailability controlled by dissolution and ion uptake and loss?

Quantifying biogeographic variation in consumer-plant interaction strengths in salt marsh ecosystems

Investigators: Rebecca Atkins and Dr. Craig Osenberg

Odum School of Ecology, University of Georgia

The salt marsh periwinkle, *Littoraria irrorata,* can both facilitate and suppress the smooth cordgrass, *Spartina alterniflora,* a dominant and important species in southeastern US salt marshes. Such variation in the sign and strength of this consumer-plant relationship is likely driven by environmental factors that alter plant productivity and consumer biomass. Our study will document large-scale biogeographic variation in *Spartina* (e.g., density, productivity), *Littoraria* (e.g., size-structure, density, biomass), and the strength of their interaction, as well as environmental factors that may modify their interaction (e.g., nutrient availability, sediment composition, elevation, temperature). From July 2015 through October 2016, and at sites from Florida to Maryland, we will survey 25, 0.0625 m^2 plots quarterly, and establish a field experiment to quantify the strength of the *Littoraria-Spartina* interaction. Experiments will consist of two *Littoraria* density treatments (0 and ambient) and a cage control, each with 5 replicates/site. Experiments will be established in July 2015 and continue through October 2016; they will be sampled monthly, assessing the same variables as in the marsh surveys. Results will be used to: 1) quantify spatio-temporal variation in *Littoraria* and *Spartina* population parameters; 2) quantify interaction strength at ambient *Littoraria* densities; and 3) evaluate the role of consumer density, biomass, size-structure (and metabolic demand), as well as environmental parameters, on the *Littoraria-Spartina* interaction strength. The results also will be extrapolated to better understand how marsh systems may respond to changing temperatures (e.g., due to climate change) or foodweb structures (due to changes in fishing practices and responses of predators on *Littoraria*).

Long-term changes in zooplankton in the North Inlet estuary and relationships with climate change and variability

Investigators: Dr. Dennis M. Allen and Paul Kenny

Baruch Marine Field Laboratory, University of South Carolina

Collections have been made at the same location, stage of tide, and time of day every two weeks since 1981. Oblique tows with 153 µm mesh nets collect copepod and small invertebrate larvae, and 365 µm epibenthic sled tows capture larval fishes, shrimps, and crabs and other large zooplankton species. Seasonal and interannual changes in abundance, diversity, and species composition of the assemblages in Town Creek are documented and correlated to fluctuations in the physical characteristics of the estuary. Information is collected for more than 50 taxonomic groups and species. Recent analyses of the large zooplankton component have shown that, although the composition and overall densities have not changed significantly, there have been large and consistent responses to climatic events including ENSO (El Niño) and drought. Analysis of the 153 fraction has indicated a steady decrease in total small zooplankton, especially copepods, over the past 34 years. Reductions in river inflow, nutrient discharges, and related densities of phytoplankton best explain the major reductions in copepods and larvae of resident invertebrates in the plankton. Changes in the timing of larval shrimp and fish production have been observed for some species. The value of these datasets continues to increase as we formulate and test new hypotheses about impacts of climate change.

Coastal training activities in the North Inlet–Winyah Bay National Estuarine Research Reserve: Protecting water and habitat quality through science-based community training

Investigator: Michelle LaRocco

North Inlet–Winyah Bay National Estuarine Research Reserve

Coastal training activities connect local decision makers to the emerging research and scientific knowledge generated to help the decision makers make more informed decisions on coastal environmental issues. The Coastal Training Program provides needs-based workshops, trainings, and tools to decision makers in Georgetown and Horry counties and these efforts especially target county and municipal staff and officials, and those decision makers that strongly influence local land use, such as planners, developers, engineers, and realtors, as well as those with a role in natural resource management within local counties and municipalities. The Coastal Training Program works to protect water and habitat quality in a region of rapidly developing coastal communities by providing science-based training events on the issues of stormwater management and low impact development principles, habitat protection and restoration, coastal hazards and climate change, and other emerging priority issues. The program frequently partners with the ACE Basin NERR, SC Sea Grant Consortium, the Coastal Waccamaw Stormwater Education Consortium, the Clemson University Extension Service, and the Carolina Clear Program.

Effect of wrack accumulation on salt marsh vegetation

Investigators: Dr. Richard Stalter[1] and Dr. John Baden[2]

1 - St. John's University, NY
2 - US Army Corps of Engineers, NC, Retired

In this first study of the effect of wrack on the survival of salt marsh vegetation in a SC salt marsh, the objectives are to 1) investigate the effect of wrack coverage on salt marsh vegetation in five vegetation zones within a salt marsh, and 2) to monitor seedling establishment and survival in plots in five arrays during the growing season (2004 to present). Four arrays consisting of a string of permanent marsh plots were established in March 2004. A fifth array was established in a pure stand of *Spartina alterniflora* in March 2005. Each array was 1.8 m wide and consisted of eight 1.0 x 1.8 m plots in a row parallel to the water's edge. Within each of these plots, a central 0.5 x l.0 m sample plot was marked off, surrounded by a 0.25 m wide buffer zone including a 0.5 m buffer between adjacent sample plots. In early March 2004, wrack was collected and placed at a thickness of 15 cm (and held in place with 6.5 cm mesh fish net) on each array except for one control plot. Sampling occurs throughout the growing season (April through October), vegetation within each examined experimental and control plot sampled (stem count per species) with three randomly located 20 x 20 cm quadrats located within the larger plots. Vegetation of all species within each quadrat is cut at ground level to determine standing crop (grams of vegetation/m^2). Preliminary analyses indicate that with the exception of *Spartina patens*, all salt marsh species experienced l00% kill after wrack cover for two months. *Spartina patens* experienced a 50-75% reduction in density, though some *S. patens* survived wrack cover for a period of one year. We continue to assess survival of wrack impacted plants and monitor recruitment and growth in specific wrack impacted zones. Recovery of salt marsh vegetation in each zone was accomplished within five years.

The National Estuarine Research Reserve System Centralized Data Management Office

Investigators: Dr. Dwayne E. Porter[1,2], Melissa Ide[3], Jennifer Kessee[3], Amber Knowles[3], Brooks Folk[3], Lee Shutt[3], Dan Ramage[2], and Jeff Jefferson[1]

1 - Belle W. Baruch Institute for Marine and Coastal Sciences, University of South Carolina
2 - Arnold School of Public Health, University of South Carolina
3 - Baruch Marine Field Laboratory, University of South Carolina

NOAA's National Estuarine Research Reserve System (NERRS) acknowledges the importance of both long-term environmental monitoring programs and data and information dissemination through the support of the NERRS System-wide Monitoring Program (SWMP). The goal of the SWMP is to "identify and track short-term variability and long-term changes in the integrity and biodiversity of representative estuarine ecosystems and coastal watersheds for the purpose of contributing to effective national, regional and site specific coastal zone management." This comprehensive program consists of three phased components: estuarine water quality monitoring (phase I), biodiversity monitoring (phase II), and land-use and habitat change analysis (phase III). The Centralized Data Management Office (CDMO) was established in support of the System-wide Monitoring Program involving 28 sites around the US and Puerto Rico. The purpose of the CDMO, housed at the North Inlet–Winyah Bay NERR, is the management of the infrastructure and data protocol to support the assimilation and exchange of data, metadata, and information within the framework of NERRS sites, coastal zone management (CZM) programs, and other education, monitoring and research programs.

Long-term monitoring of grass shrimp as a bioindicator of non-point source runoff in South Carolina watersheds

Investigators: Dr. Peter Key, Dr. Michael Fulton, James Daugomah, and Blaine West

NOAA Center for Coastal Environmental Health and Biomolecular Research, SC

Long-term ecological monitoring is important to developing fundamental understandings of both biogenic and anthropogenic effects on ecosystem health. Long-term monitoring may provide great insight into natural factors such as disease, pests, and weather (e.g., global climate change, drought, floods, and increased intensity of tropical storms and hurricanes), which may affect populations throughout a geographical region. In addition to population perturbations caused by natural stressors, is the complexity of differentiating anthropogenic effects of chemical and biological contaminants in aquatic ecosystems from natural background effects. There is a clear need to develop accurate ecological forecasts using long-term ecological data sets. Long-term ecological monitoring data thus can be

used not only to ascertain effects of natural and anthropogenic stressors, but also when properly used in conjunction with GIS and advanced modeling techniques may enhance predictive capabilities. The grass shrimp, *Palaemonetes pugio*, is the dominant motile macrobenthic invertebrate in tidal creek systems of the southeastern United States and is an important prey item for higher trophic levels. The North Inlet Oyster Landing site is maintained as a long-term reference site for comparison to estuarine sites with other land uses. Grass shrimp populations are sampled monthly using a push-netting approach.

Saltwater intrusion monitoring

Investigators: Dr. Alicia Wilson[1] and Dr. William Clendenin[2]

1 - Department of Earth and Ocean Sciences, University of South Carolina
2 - SC Department of Natural Resources

Knowledge of the location of the freshwater-saltwater interface in coastal aquifers is critical for managing coastal groundwater resources, for predicting saltwater intrusion, and for calculating groundwater-related chemical exchange between aquifers and the coastal ocean. This project installed permanent wells to monitor salinity and saltwater intrusion in the upper (up to 100 ft depth) aquifers at North Inlet, as part of DNR's long-term coastal monitoring network. To date, the stratigraphy from the well logs has been used to support the development of regional groundwater flow models by Ph.D. student Tyler Evans. The models are further constrained by hydraulic head and salinity observations from the wells. Monitoring is ongoing.

South Carolina Estuarine and Coastal Assessment Program (SCECAP)

Investigators: Dr. Denise Sanger[1], Martin V. Levisen[1], Stacie Crowe[1], Dr. Robert F. Van Dolah[1], and David E. Chestnut[2]

1 - South Carolina Department of Natural Resources
2 - South Carolina Department of Health and Environmental Control

The SC Department of Natural Resources (SCDNR) and the SC Department of Health and Environmental Control (SCDHEC) have been conducting an ongoing comprehensive collaborative coastal monitoring program (SC Estuarine and Coastal Assessment Program; SCECAP) since 1999. The goal of SCECAP is to annually monitor the condition of the state's estuarine habitats and associated biological resources. SCECAP integrates measures of water and sediment quality with multiple measures of biological condition at a large number of sites throughout the state's coastal zone. It also expands historical monitoring activities that have primarily focused on open water habitats (e.g., bays, sounds, tidal rivers) to include an assessment of conditions in tidal creeks, which serve as important nursery habitat for many species. The SCECAP program, combined with the other cooperating programs, provides a number of benefits including 1) the ability to identify areas of estuarine habitat that are impaired or degraded with respect to a suite of sensitive biological, chemical, and physical measures; 2) a cost-effective standardized protocol that is used by both SCDNR and SCDHEC that is consistent with protocols used in other US coastal states, thus allowing better regional prioritization of stressors and impacts; 3) more comprehensive periodic reports on the condition of water quality and habitat condition throughout the state's coastal zone than could be accomplished by the individual programs alone. As of the summer 2015, over 700 sites have been sampled statewide, with 9 located in the North Inlet estuary and an additional 32 stations located in the adjacent Winyah Bay.

Long-term measurements of production and physiological ecology of *Spartina alterniflora*

Investigators: Dr. James Morris[1,2] and Karen Sundberg[1]

1 - Belle W. Baruch Institute for Marine and Coastal Sciences, University of South Carolina
2 - Department of Biological Sciences and the Marine Science Program, University of South Carolina

Salt marsh grass, *Spartina alterniflora*, dominates the intertidal marsh in North Inlet estuary. Regular measurements of grass density and height allow for estimates of growth and primary production rates in both control and fertilized plots. Abiotic conditions that are measured include pore water salinity, phosphate, ammonium, sulfide, and iron concentrations to provide insights into factors that affect production. Large monthly and interannual variations in the amount of organic material produced by the cordgrass are related to such factors as sea level and precipitation patterns. This time series was initiated in 1986.

Experimental varying of the marsh platform and macrophyte response

Investigators: Dr. James Morris[1,2] and Karen Sundberg[1]

1 - Belle W. Baruch Institute for Marine and Coastal Sciences, University of South Carolina
2 - Department of Biological Sciences and the Marine Science Program, University of South Carolina

The objective of this study was to design a simple experiment to investigate how varying the marsh platform in relation to mean sea level would affect macrophyte production, stand dynamics, and biomass allocation patterns of salt marsh plants. One specific goal was to ascertain aboveground and belowground allocation patterns and quantify where the bulk of belowground biomass was located in relation to marsh elevation and sea level. The experiments were initiated in 2003. Currently there are three marsh planters ('marsh organs'), each with six treatment platform levels that span the upper half of the tidal range, and six replicates per treatment. In general, the marsh organs are planted in March with salt marsh plugs (currently *Spartina alterniflora*) collected nearby; stem height measurements are obtained monthly as an estimate of standing biomass; and plants are harvested at the end of the growing season, to determine aboveground and belowground productivity. In recent years, replicates have been selectively harvested such that we now have an age treatment in addition to the elevation treatment. The frequency of inundation results in significant variation in stand densities and plant heights, and we are observing different biomass allocation patterns with time. These changes in stand densities and macrophyte morphology may have profound effects on the ability of salt marshes to accrete allochthonous sediments and maintain pace with sea-level rise. Furthermore, allocation patterns may ultimately influence net annual primary productivity within salt marshes.

Stock structure of spotted seatrout: Assessing genetic connectivity at its northern latitudinal limits

Investigators: Dr. Jeffrey A. Buckel[1], Dr. Timothy A. Ellis[1], and Dr. Jan R. McDowell[2]

1 - Center for Marine Sciences and Technology, Department of Applied Ecology, North Carolina State University
2 - Virginia Institute of Marine Science, Department of Fisheries Science, College of William and Mary

Spotted seatrout (*Cynoscion nebulosus*) are one of the most economically important marine recreational fish species in the United States. Although heavily studied throughout the center of the species' geographic range, including in the northern Gulf of Mexico and along the Atlantic coast of Florida, there exists limited information on the stock structure of spotted seatrout in North Carolina and Chesapeake Bay. Based on tag-return data, populations in both North Carolina and Virginia were considered one unit stock in North Carolina's recent stock assessment. However, no comprehensive genetic analysis of spotted seatrout at its northern latitudinal limits has occurred, which is essential to determining if the current North Carolina spotted seatrout assessment is using an appropriately defined unit stock. We will use sensitive genetic markers (i.e., microsatellite loci) to assess the spatial and seasonal demographic independence of spotted seatrout inhabiting estuaries in North Carolina and Chesapeake Bay. In addition, we will expand our analysis to include samples collected from estuaries in South Carolina, Georgia, and Florida, in order to better understand the genetic connectivity of spotted seatrout throughout the US South Atlantic.

Spatially variable habitat quality contributes to within-population variation in reproductive success

Investigators: Dr. Blaine D. Griffen[1,2] and Alexandra P. Norelli[2]

1 - Department of Biological Sciences, University of South Carolina
2 - Marine Science Program, University of South Carolina

Variation in habitat quality is common across terrestrial, freshwater, and marine habitats. We investigated how habitat quality influenced the reproductive potential of mud crabs across 30 oyster reefs that were degraded to different extents. We further coupled this field survey with a laboratory experiment designed to mechanistically determine the relationship between resource consumption and reproductive performance. We show a >10-fold difference in average reproductive potential for crabs across reefs of different quality. Calculated consumption rates for crabs in each reef, based on a type II functional response, suggest that differences in reproductive performance may be attributed to resource limitation in poor quality reefs. This conclusion is supported by results of our laboratory experiment where crabs fed a higher quality diet of abundant animal tissue had greater reproductive performance. Our results demonstrate that spatial variation in habitat quality can be a considerable contributor to within-population individual variation in reproductive success (i.e., demographic heterogeneity). This finding has important implications for assessing population extinction risk.

The Winyah Bay Master Naturalist Program: Transforming community members into active stewards of our diverse South Carolina habitats

Investigator: Dr. Jennifer Plunket

North Inlet–Winyah Bay National Estuarine Research Reserve

The Winyah Master Naturalist Course is designed to train community members to become active volunteer stewards of our coastal environment. Participants gain skills in nature interpretation, research methods, and resource protection through 12 day-long field classes occurring on Fridays from March to June. The course involves field trips with expert interpreters to the mountains, forests, swamps and marshes that make South Carolina a unique and beautiful classroom for the nature enthusiast. Students will learn to 'read' the landscape through developing an understanding of the geology, ecology and human impacts on natural habitats. Participants completing the course and 30 hours of approved volunteer work will receive a Master Naturalist certification and will be eligible to join a local chapter and participate in advanced volunteer training courses. Participants do not need to have a background in the natural sciences; a diversity of backgrounds, skills and interests is welcomed.

Indirect predation effects on bivalve filtration rates within South Carolina intertidal oyster reefs

Investigators: Dr. Keith Walters, Dr. Eric Koepfler, and students

Department of Marine Science, Coastal Carolina University

Studies designed to examine the indirect effects of resident and transient decapods on bivalve filtration rates are being conducted within the North Inlet estuary since September 2012. Our purpose is to: 1) determine if the presence and taxonomic identity of decapod predators affects bivalve filtration and significantly reduces a reef's ability to improve water quality; 2) establish if predator mechanical and/or chemical cues affect bivalve filtration behavior; 3) determine if predator presence or injured conspecifics equally effects bivalve filtration. To model the effect of indirect species interactions on oyster reef filtration capacity a series of controlled, manipulative experiments are being conducted within 20-L tanks ($n>5$). Bivalves and decapods collected from North Inlet are used to create treatments for various experiments that are run over normal high tide intervals (~6 hr). Draw-down or initial minus final readings for chlorophyll and total particulate organic matter are recorded during experiments. Determination of decapod indirect predation effects on bivalve filtration will increase the accuracy of oyster reef ecosystem services estimates.

Evaluating intertidal oyster reef restoration success

Investigators: Dr. Keith Walters, Thomas Funk, and students

Department of Marine Science, Coastal Carolina University

A series of oyster reefs, shell-filled mesh bags, were created within inlet (Hog, Murrells, and North) and swash tidal creeks (Whitepoint, Singleton, and Withers) to evaluate the success of reef restoration efforts. In the North Inlet estuary, reefs were created within Bly Creek in June 2014, and along with coincident natural reefs have been the focus of graduate and undergraduate researchers and CCU classes (e.g., Marine Ecology). The following data were or continue to be collected to evaluate constructed reef development and assess the ability of inlet and swash constructed and natural reefs to attract and support important fishery species: (1) yearly oyster spat recruitment; (2) numbers, sizes, and distribution of oysters on constructed and natural reefs; (3) numbers and species richness of resident and transient nekton associated with reefs; (4) short-term predation on reef-resident bivalve and decapod fauna. Although oyster recruitment onto reefs is similar, preliminary results suggest inlet oysters survive better as juveniles and live longer as adults compared to swash creek populations. Nekton seasonally captured during high tides within baited minnow traps, pull traps, and gill nets indicate constructed reefs are colonized quickly. Survival of tethered bivalve and decapod individuals within mudflat and constructed and natural reefs documented initial differences in structural complexity and the role of complexity in the survival of reef-resident taxa. The ongoing studies are providing valuable experiences for students, identifying demographic differences that influence reef development, and demonstrating the value of reef restoration efforts to intertidal resident and transient taxa.

Physical characteristics of estuarine waters: Long-term monitoring in the North Inlet and Winyah Bay estuaries

Investigators: Dr. Erik Smith and Tracy Buck

Baruch Marine Field Laboratory, University of South Carolina and North Inlet–Winyah Bay National Estuarine Research Reserve

As part of the NERRS System-Wide Monitoring Program, the physical characteristics of the water in four tidal creeks of the North Inlet–Winyah Bay NERR have been monitored using YSI data loggers since 1994. A new, fifth site in the mainstem of Winyah Bay was added in 2016. These data loggers are deployed at 0.5 m above the sediment surface and record water depth, temperature, salinity, pH, dissolved oxygen, and turbidity at 15 min intervals throughout the year. The site in Winyah Bay has data loggers deployed in both surface and bottom waters to account for the vertical stratification that exists in this location. The instruments are calibrated and deployed according to strict NERRS protocols. The consistent, long-term collection of this physical data allows for the characterization of short-term variability and long-term change in North Inlet waters, and provides base-line data critical for various studies of biological and physical processes in the North Inlet estuary. Data, along with detailed metadata, are sent to the NERRS Centralized Data Management Office (CDMO) for quality assurance and quality control. Data can be accessed via the CDMO website: http://cdmo.baruch.sc.edu/.

Influences of individual phenotypic traits on the dispersal decisions of the sand fiddler crab, *Uca pugilator*

Investigators: Eilea Knotts and Dr. Blaine D. Griffen

Department of Biological Sciences, University of South Carolina

Dispersal decisions across different spatial scales are important for understanding population processes. Because these decisions are potentially influenced by individual state, understanding which phenotypic traits (i.e., morphological, behavioral, physiological) are predictors for dispersal can have important implications for understanding ecological responses to stress. Combining field and laboratory experiments, our research explored which phenotypic traits (i.e., body size, sex, activity level, energetic state) were main predictors of dispersal for *Uca pugilator* from two origin habitats: open mudflat and *Spartina alterniflora* marsh. As a whole population, carapace width was the significant predictor for dispersal onto the mudflat. When split by origin habitat, carapace width was significant for predicting dispersal of crabs originating from the open mudflat while activity level was only slightly significant for predicting dispersal of crabs originating in the *Spartina* marsh. This suggests that the morphological trait of body size (i.e., carapace width) plays a larger role than personality (i.e., activity level) on influencing dispersal from the *Spartina alterniflora* cord grass onto the exposed mudflat.

Decadal-scale assemblage changes of subtidal creek fishes in the North Inlet estuary

Investigators: Dr. Matthew E. Kimball, Dr. Dennis M. Allen, and Paul D. Kenny

Baruch Marine Field Laboratory, University of South Carolina

Estuaries support abundant and diverse fish assemblages, and serve as important nursery grounds for early life history stages of many species. Changes in environmental, physical, and biological factors, potentially operating at multiple temporal and spatial scales, may alter fish assemblages over time. A biweekly trawl survey was conducted from 1981 to 1984 as part of a LTER monitoring program to examine the salt marsh fish assemblage of the North Inlet estuary. Using identical protocols at the same tidal creek, sampling was re-initiated for another 4-year period (2012 - 2015) to determine if any changes occurred in the composition and demographics of the fish fauna between the two periods. Preliminary comparisons of the two datasets revealed significant changes in fish assemblages. Overall, the number of species was similar for the two sampling periods (past = 86; present = 84), but the recent total catch was five-fold lower (n = 4,781) than in the 1980s (n = 25,026). Of the ten most abundant species collected, eight declined in abundance. Bay anchovy, the most abundant species during the 1980s, saw a 140-fold decrease in abundance and is now nearly absent. Other species were dominant in catches during both periods (e.g., spot, Atlantic brief squid, Atlantic croaker), but collected in much-reduced numbers at present. The five most abundant species that accounted for 92% of the total catch each year in the 1980s, now account for 65%. Additional planned analyses will evaluate relationships between changes in the nekton assemblage and environmental conditions 30 years later.

Weather and climate measurements: Long-term monitoring at Oyster Landing Pier

Investigators: Dr. Erik Smith and Tracy Buck

Baruch Marine Field Laboratory, University of South Carolina and North Inlet–Winyah Bay
National Estuarine Research Reserve

As part of the North Inlet–Winyah Bay National Estuarine Research Reserve (NERR), a fully functional meteorological station (National Weather Service installation) is located on the Oyster Landing Pier in the North Inlet estuary. Wind speed and direction, air temperature, humidity, barometric pressure, solar radiation, and precipitation are recorded at 15-minute intervals. Data are telemetered via the NOAA GOES satellite system to the NERR Central Data Management Office, and made available in near real time at http://cdmo.baruch.sc.edu. For most parameters, records have been collected for more than 20 years. Long-term, continuous weather records provide data for determining the effects of climatology on the various biological and physical processes being studied in the North Inlet estuary.

A geospatial inventory of stormwater ponds for the eight coastal counties of South Carolina

Investigators: Dr. Erik Smith[1], Dr. Denise Sanger[2], Dr. Andrew Tweel[2], and Erin Koch[2]

1 - Baruch Marine Field Laboratory, University of South Carolina and North Inlet–Winyah Bay National Estuarine Research Reserve
2 - South Carolina Department of Marine Resources

Stormwater ponds, especially detention ponds, are the most common best management practice (BMP) for controlling runoff in coastal South Carolina. There have been dramatic increases in both pond number and cumulative surface area along the coastal zone of South Carolina as a direct result of development, especially residential development along the coast. The current distribution of ponds existing in this region and their cumulative impacts are presently unknown, however. A quantitative inventory and classification scheme will provide the necessary foundation and context for understanding stormwater pond use and impacts in coastal SC as well as guide future pond management and research decisions. The objectives of this study are therefore to: 1) Create a geospatial inventory of coastal stormwater ponds currently existing in the eight coastal counties of SC; 2) Develop a preliminary classification of coastal stormwater ponds by intersecting pond inventory with a range of available geographic, environmental, and demographic datasets; 3) Conduct a change analysis for four intervals from 1994 to 2013 to identify time periods of pond construction and the relationship between pond construction rates and changes in land use and demographic patterns.

NERR emergent vegetation bio-monitoring: Effects of sea level on the spatial dynamics of salt marsh vegetation communities in the North Inlet estuary

Investigators: Tracy Buck and Dr. Erik Smith

Baruch Marine Field Laboratory, University of South Carolina and North Inlet–Winyah Bay
National Estuarine Research Reserve

As part of a NERRS system-wide initiative, the North Inlet–Winyah Bay NERR is monitoring salt-marsh emergent vegetation with the aim of quantifying variability in salt marsh macrophyte community spatial structure (species composition, relative abundance, and biomass) along elevation gradients, from creek bank to upland edge, in response to changes in tidal height and flooding frequency due to sea level rise. Long-term monitoring is conducted in accordance to established NERRS protocols using a stratified sampling approach of fixed transects and repeated measures within permanent sample plots. This consists of two marsh segments with three fixed transects and 20 sampling plots per transect. Surface Elevation Tables (SETs) have also been established adjacent to the lower and higher elevations of the creek-bank to forest-edge transects in each marsh region to determine changes in marsh surface elevation associated with long-term changes in and vegetation and tidal dynamics. Sampling within each permanent plot includes: percent cover for each species or cover category; species' shoot/stem density; species' maximum canopy height; species' aboveground biomass by non-destructive sampling techniques; water table height at low tide; porewater salinity, and nutrient and sulfide concentrations. Soil organic content and bulk density adjacent to each plot were determined in 2008. Elevation data (mm scale vertical resolution) for each plot is determined at biannual intervals to allow for the calculation of duration and frequency of tidal inundation at each plot.

Linkages between intertidal creek geomorphology and nekton use determined from Terrestrial Laser Scanning

Investigators: Dr. Scott M. White[1], Alex Gorr[1] (undergraduate), and Dr. Matthew E. Kimball[2]

1 - Department of Earth and Ocean Sciences, University of South Carolina
2 - Baruch Marine Field Laboratory, University of South Carolina

Previous work in 1997-1999 examining nekton use in 8 intertidal creeks tributaries of Clambank Creek revealed variations in geomorphology (e.g., depth, bank steepness, etc.) that correlated to higher use by resident and transient nekton. The nature of these patterns suggest that nekton actively select creeks with preferred geomorphic characteristics, which has implications for essential fish habitat, conservation and restoration efforts. To examine the stability of the intertidal creek geomorphology and the consistency of nekton habitat preferences, the geomorphology and nekton use of these same 8 intertidal creeks will be measured again 15 or more years later. Geomorphological characteristics originally measured once in 1997 using traditional surveying techniques will be re-measured in 2016 using terrestrial laser scanning, and seasonally starting in early 2017 to allow comparison of small seasonal changes within creeks and large, decadal changes among creeks. The goal of this study is to answer the questions 1) how much has the geomorphology of these creeks changed and 2) does the current level of nekton use follow the same preferences previously identified for habitat quality? In addition, this research will examine short-term (seasonal) changes in creek characteristics and whether or not any changes are substantial enough to influence nekton use patterns.

Characterization of oyster cement

Investigators: Dr. Jonathan Wilker[1] and Paul Kenny[2]

1 - Department of Chemistry, Purdue University, IN
2 - Baruch Marine Field Laboratory, University of South Carolina

Marine species such as mussels, barnacles, and oysters produce adhesive and cement materials for affixing themselves to surfaces. The strong bonding, wet adhesion capabilities, and biological origin of these materials indicate promise for developing new biomedical materials such as surgical glues and dental cements. In an effort to develop such applications, we are beginning by characterizing adhesive materials produced by marine organisms. Prior studies have determined some of the key chemical reactions and bonding motifs used by mussels for production of their adhesive. For the current project, our main objective is to characterize the chemistry within the cement of the Eastern or Atlantic oyster *Crassostrea virginica*. Oysters are collected near the Baruch Marine Field Laboratory and then grown in laboratory aquaria. Chemical methodologies are used to analyze the cement, including wet chemistry and spectroscopic techniques. Insights gained will provide both fundamental understanding of how a marine biological material functions as well as providing insights for the design of new biomedical adhesives.

The allelopathic effects of domoic acid on natural phytoplankton species

Investigators: Elise Van Meerssche[1] and Dr. James L. Pinckney[1,2]

1 - Department of Biological Sciences, University of South Carolina
2 - Marine Science Program, University of South Carolina

Harmful Algal Blooms (HABs) have been one of the biggest environmental challenges in the past few years and will be for decades to come. There has been a clear increase in the frequency, magnitude, and geographical distribution of HABs. *Pseudo-nitzschia*, a ubiquitous diatom genus, recently reported along the South Carolina coast, can release domoic acid (DA), a neurotoxin, which can cause toxicity in fish and shellfish and also acute symptoms in humans. Most of our knowledge is based on the effect of DA on *Pseudo-nitzschia* consumers. However, nothing is known about its allelopathic effect on other phytoplankton species. The release of DA even at low concentrations could be a mechanism used by *Pseudo-nitzschia* to outcompete other phytoplankton species by inhibiting their growth. Furthermore, DA could also be used by mixotrophic organisms as an organic nutrient, thus stimulating growth of other mixotrophic species. In both cases, the release of DA could result in a change in the phytoplankton community composition. Bioassays with natural phytoplankton communities will be spiked with different concentrations of DA and incubated in both light and dark conditions. The possible allelopathic effects will be monitored by the measurement of pH, chlorophyll *a* fluorescence, cell abundances, DA, nutrients, photopigments and dissolved organic carbon (DOC) concentrations. This information will provide new insights into the impact of DA on phytoplankton community composition in coastal regions.

Marsh sedimentation and mapping research from North Carolina to Georgia: Insights from South Carolina

Dr. J.P. Walsh[1,2], Dr. Reide Corbett[1,2], Luke Stevens[1,2], Dr. Tom Allen[1], James Edwards[3], Dr. James Morris[4], and Dr. Clark Alexander[5]

1 - Institute for Coastal Science and Policy, East Carolina University, NC
2 - Coastal Studies Institute, University of North Carolina
3 - Marine Science Program, University of South Carolina
4 - Belle W. Baruch Institute of Marine & Coastal Science, University of South Carolina
5 - Skidaway Institute of Oceanography, University of Georgia

Marshes are critical habitat ecologically and economically. Their natural variation in type (vegetation, sedimentation) is considerable and hypothesized to be related to geological, hydrological, anthropogenic, and other factors. To better understand broad variations in marshes and associated sedimentation from NC to GA, we are examining marsh type and sedimentation along river-ocean gradients in areas with different tidal and fluvial forcings. In South Carolina, sedimentation will be studied using cores collected on transects in the Winyah Bay-North Inlet area, including two sites on the Hobcaw Barony property. A Russian corer will be used to sample the upper ~1 m of marsh. Sediments will be subsectioned with depth and analyzed for grain-size distribution, loss on ignition (proxy for organic material) and radioisotopes. Pb-210 and Cs-137 activities will be used to determine sedimentation rates. RTK-GPS will be used to determine core positions and elevations across the marsh zone. Field photographs and vegetation descriptions will serve to define the marsh vegetation and will aid in related efforts to classify LANDSAT imagery in the Southeast. The core analyses for this ongoing research are being conducted by an ECU MS student, Luke Stevens. This work is part of a larger project, funded by the South Atlantic Landscape Change Cooperative, involving Tom Allen (lead PI, ECU), Clark Alexander, James Morris, and J.P. Walsh.

Investigating the consumption rates of the stone crab, *Menippe* spp.

Investigators: Dr. Blaine Griffen[1,2] and Eric Hancock[1] (graduate student)

1 - Marine Science Program, University of South Carolina
2 - Department of Biological Sciences, University of South Carolina

In order to complete a bioenergetics model for the stone crab, consumption rates across a range of temperatures need to be measured. Metabolic, growth, and regeneration rates already exist for the species but food consumption rates vary widely based on individual studies. During eight trials conducted between October 2015 and September 2016, crabs will be collected from Clambank Creek. Once taken from the traps/burrows, crabs will be tagged using B-tags and recorded for size, weight, and health data. A 24-hour starvation period will precede the beginning of each trial. Within this 24-hour period, sufficient oysters will be gathered from the nearby saltmarsh, then oyster clumps will be washed, dried, and weighed. The oyster clumps and crabs will randomly assigned cages so that each cage has ~3,100 grams of oyster and all but three cages have a crab. These cages will be placed into subtidal waters around Oyster Landing, marked with buoys, and will remain undisturbed for one week. Once removed, crabs will immediately be separated from oysters to prevent farther consumption. Oyster clumps and shell fragments will be cleaned of all mud, dried, and weighed (then returned to the saltmarsh). Individual crabs will be released after any change in number of legs missing is recorded unless a crab's consumption rate is abnormally high or low, which will warrant further examination of tissues in the laboratory. A consumption rate formula will then be calculated based on carapace width and water temperature to be used in the completed bioenergetics model.

Blood fluke parasites in the North Inlet estuary: Diversity and life cycles

Investigators: Dr. Isaure de Buron and Dr. Dennis Kyle

1- Department of Biology, College of Charleston
2- Department of Global Health, University of South Florida, Tampa FL

Blood flukes are pathogenic parasites that infect the cardiovascular system of their fish hosts. Their life cycle uses annelids as intermediate hosts. The objectives of this project are 1) to determine which species of fluke infects seatrout in the North Inlet estuary compared to other South Carolina estuaries and 2) to sample annelids regularly throughout the year in order to unravel the specifics of the life cycles of these particular parasites. This study will also allow us to determine a potential seasonal pattern of infection by the flukes in seatrout and will give us insight into the diversity of blood flukes in the North Inlet estuary.

Effects of the October 2015 flood on the fauna of North Inlet salt marsh creeks; impacts of the spillover from Winyah Bay on zooplankton, nekton, and oyster reefs

Investigators: Dr. Dennis M. Allen[1], Dr. Matthew E. Kimball[1], Paul D. Kenny[1], Eric R. Haffey[1], Philip Fahy[2], and Dr. Juliana M. Harding[3]

1 - Baruch Marine Field Laboratory, University of South Carolina
2 - Marine Science Program, University of South Carolina
3 - Department of Marine Science, Coastal Carolina University, SC

The so-called 1000-year rain event that deposited up to two feet of rain over much of South Carolina during the first week of October 2015 resulted in record discharges from local rivers into the Winyah Bay estuary. Although several creeks connect the central portion of Winyah Bay (Mud Bay) and the North Inlet estuary, flooding tides from the respective inlets usually meet at a tidal node near the Bay and lower salinity water from Winyah Bay does not penetrate to the heart of the North Inlet estuary. After the October flood event, a massive spill-over from the Bay pushed low salinity water far into North Inlet creeks. Uncharacteristically, brown and turbid (river-like) water dominated the North Inlet creeks into the winter. To assess changes in the nekton (trawls and goby/blenny nest surveys) and zooplankton (153 micron surface and 365 micron sled), we initiated a new sampling program that compares catches at the long-term (35 years) sampling location in the middle of North Inlet with those made at No Man's Friend Creek at the Winyah Bay interface. The occurrence of catfish, gar, other fishes, prawns, shrimps, and zooplankton (including larval fish) species typical of the tidal freshwater areas influenced by the rivers flowing into Winyah Bay was unprecedented. We also observed high mortality of oysters in beds that have been alive for decades or longer. Monitoring of the settlement of planktonic oyster larvae will provide insights into the process of repopulating the reefs. Characteristically high salinity conditions were re-established in the North Inlet estuary in spring 2016, but nekton and zooplankton collections will continue through the spawning seasons for most resident and ocean-based populations to determine whether the persistent low salinity conditions during late fall and winter impacted warm-season fauna. This opportunity to understand effects of this historic perturbation on the long-studied North Inlet estuary was made possible through a grant from the Office of the Vice President for Research of USC.

Shorebird monitoring in the North Inlet estuary

Investigators: Wendy Allen[1], Dr. Jennifer Plunket[1] and Paul Kenny[2]

1 - North Inlet–Winyah Bay NERR, Baruch Marine Field Laboratory, University of South Carolina
2 - Baruch Marine Field Laboratory, University of South Carolina

Shorebirds (Aves: Charadriiformes), are a diverse group of birds including plovers, sandpipers, curlews and oystercatchers. Of the more than 50 different species that occur in North America, more than half are considered a species of concern or "highly imperiled" due to declining numbers. A shorebird monitoring effort was initiated in the spring of 2016 to assess populations of shorebirds in the North Inlet estuary, primarily during migration periods, March – June and July – October. Shorebird surveys in the North Inlet estuary are conducted biweekly during these periods by boat and land near high tide. Species are identified and counted and data is entered into an on-line database using protocols established by the International Shorebird Survey (ISS) administered by the Manomet Center for Conservation Services. Color-marked individuals are also noted. This project will help establish baseline information on the species and numbers of shorebirds utilizing the North Inlet estuary during periods of migration and will compliment winter shorebird surveys that are conducted each year. It will also feed into the larger ISS database that includes information from about 1,200 locations in North America that is contributing to a better understanding of shorebird population numbers, key stopover locations, migratory routes, and other aspects of shorebird life histories.

Dietary composition and prey selectivity of diamondback terrapins (*Malaclemys terrapin*) in the North Inlet estuary

Investigators: Dr. Scott L. Parker and Amanda DiBella

Department of Biological Sciences and Coastal Marine and Wetland Studies Program, Coastal Carolina University, SC

The diamondback terrapin (*Malaclemys terrapin*) is a physiologically and ecologically specialized turtle endemic to brackish coastal estuaries along the southern and eastern coasts of the United States. Currently, the species faces new anthropogenic threats such as crab pot mortality and an increasing demand for terrapin meat from overseas

Asian markets. Diamondback terrapin are important intermediate predators in salt marsh ecosystems and may play a vital role in determining the health and biological diversity of these estuarine environments through consumption of herbivorous periwinkle snails and crabs. The objective of this project is to assess the dietary composition and patterns of prey selectivity in diamondback terrapins (*Malaclemys terrapin*) in the North Inlet–Winyah Bay National Estuarine Research Reserve from June through August 2016. In order to achieve this objective, we will quantify the diet of wild terrapins in the field and conduct an experiment to evaluate terrapin prey choice in the laboratory. Composition of invertebrate prey items will be determined by analysis of terrapin fecal samples, and the abundance of terrapin prey species will be quantified by sampling invertebrates found along elevational gradients within the salt marsh. Feeding trials will be conducted in an outdoor seawater facility at the Baruch Marine Laboratory to determine whether the selectivity of diamondback terrapins for prey items parallel that of wild terrapins in the field. This study will quantitatively determine prey selection patterns in diamondback terrapins and will also provide the initial step to elucidate the trophic role of diamondback terrapin in our economically and ecologically important salt marsh ecosystems.

The correlation between environmental hydrocarbon contamination and parasitic infection in *Fundulus heteroclitus*

Investigators: Michaela McElveen (undergraduate), Michelle Troup (undergraduate), and Dr. Marlee Marsh

Columbia College, Columbia, SC

Fundulus heteroclitus is a fish native to the eastern coast of North America and estuarine habitats. *F. heteroclitus* is considered to be adaptable to a wide range of temperatures, pH, salinities, and levels of pollution. For these reasons it makes an ideal indicator of environmental health. One hundred fish will be collected (beginning in early summer 2016) from a polluted site near Georgetown, SC in conjunction with the SC Department of Natural Resources. Each fish will be weighed, measured, bled, necropsied, and observed for parasites. Tissue samples from the liver, gills, and GI tract will be obtained. Immunohistochemistry will be performed to determine the presence of the Aryl Hydrocarbon Receptor 2 (AhR2) which will serve as an indicator of environmental exposure to polychlorinated biphenyls (PCBs). Additionally, fish antibody (IgM) levels will be determined. The monoclonal antibody (mAb) 5B6 will be used to probe for AhR2 while mAb D58 will be used to probe for fish IgM. Tissues will be compared to a control group of *F. heteroclitus* (collected in 2015) from the essentially pristine North Inlet estuary. The resulting data will provide information about the relationship between hydrocarbons present and the health of the fish.

Examining the environmental impact of the 1000-year flood on the estuarine fish *Fundulus heteroclitus*

Investigators: Peyton Lee (undergraduate), Anna Outlaw (undergraduate), and Dr. Marlee Marsh

Columbia College, Columbia, SC

Fundulus heteroclitus, a fish native to the coastal waters of eastern North America, thrive in estuarine environments. A large influx of freshwater due to historic flooding in October 2015 (1000-year flood) has possibly altered their habitat in the ACE Basin, as well as impacting their health. In this experiment, 50-100 fish will be collected from the North Inlet estuary and the length, weight, and sex of the fish will be recorded. Fish will be examined for the presence of parasites, and serum, gills, liver, and gastrointestinal tract will be collected and examined using immunoassays (e.g., immunoblotting and immunohistochemistry). The tissue will be processed, embedded, and cut at the Histology Core Lab at Clemson University. Four different antibodies will be used to examine serum and tissues (gills, liver and GI tract) to locate immune proteins and cells of interest. The data will be compared to baseline data of *F. heteroclitus* collected prior to October 2015 from the North Inlet estuary (August 2015). Collection of fish will begin in early summer 2016 and data are expected to be analyzed by January 2017.

Terrestrial response to sea-level rise as detected through dendrochronology, geomorphology, and hydrology

Investigators: Dr. Raymond Torres[1] and Dr. Richard Keim[2]

1 - Department Earth and Ocean Science, University of South Carolina
2 - School of Renewable Natural Resources, Louisiana State University

We propose to evaluate the rates of salt marsh advance into the terrestrial landscape using dendrochronology. The corresponding tree ring chronology will be used to assess rates of geomorphic change of the terrestrial and intertidal landscapes and the patterns and dynamics of surface and near surface freshwater and salt water flows.

Shell repair in *Geukensia demissa* and predation preferences of *Callinectes sapidus*: Do crabs target mussels with weakened shells?

Investigators: Madelaine Gillis, Dr. Keith Walters, and students

Department of Marine Science, Coastal Carolina University

Shell damage in bivalves often is an indication of unsuccessful predation attempts. The extent of shell damage and size-dependent tradeoffs in marsh mussel growth and repair, as well as the effects of shell damage on crab predation preferences were examined in a series of lab and field experiments. Since September 2011, evaluation of damaged mussels collected within Hog, Murrells, and North inlets suggested shell damage was significantly different among inlets and shell repair was evident in damaged mussels. Mussels (small, medium, large) damaged (undamaged, moderate, extensive) in the lab and caged within North Inlet mid-marsh elevations indicated increased damage suppressed growth, but only medium, moderately damaged mussels repaired shells. Medium, moderately damaged mussels also experienced greater mortality suggesting mussels enter a critical stage around 55 mm with conflicting energy demands for both growth and repair. A series of wet lab mesocosm experiments and field trials were conducted to determine if blue crabs target damaged mussels. In mesocosms, crabs showed a preference for damaged mussels; crabs consumed damaged mussels in 68% of all successful predation attempts. Unsuccessful crabs targeted undamaged mussels first more frequently than successful crabs (55% vs 33%). In field experiments the preference for damaged mussels was not observed consistently and may have been masked by various mitigating factors. Both mussels and crabs play a vital role in maintaining healthy salt marsh systems. Mussel response to shell damage and the ability of crabs to detect weakened mussels increasingly may be important with changes in coastal conditions (e.g., ocean acidification).

Low-temperature tolerance of juvenile tarpon *Megalops atlanticus*

Investigators: Marvin M. Mace III, Eric R. Haffey, and Dr. Matthew E. Kimball

Baruch Marine Field Laboratory, University of South Carolina

Juvenile tarpon occur in South Atlantic Bight (SAB) estuaries near the northern limit of their distribution (i.e., SC), but it is currently unknown whether these individuals can survive winter, grow to maturity, and contribute to the adult population. To determine juvenile tarpon potential overwinter survival, we conducted laboratory experiments during winter (November-February) to estimate minimum lethal temperatures of tarpon exposed to 1) ambient fluctuating winter water conditions and 2) a constant rate of temperature decline. Most juvenile tarpon exposed to ambient winter water conditions experienced loss of equilibrium (LOE) at a mean (± SE) temperature of 13.6 ± 1.0 °C, near the minimum mean lethal temperature of 13.7 ± 1.1 °C. When exposed to a constant rate of temperature decline, mean temperatures at LOE (9.6 ± 0.3 °C) and death (9.2 ± 0.2 °C) were similar, but lower than when tarpon were exposed to ambient winter water conditions. A combination of our results with all published data on the cold tolerance of juvenile tarpon revealed an overall mean minimum lethal temperature of 11.9 ± 0.3 °C. Based on available long-term temperature records from SAB estuaries, overwinter survival of juvenile tarpon is unlikely in most aquatic habitats (e.g., tidal creeks, flats, open water) within these estuaries. However, juvenile tarpon are common in small, shallow, and often tidally-restricted environments in and around estuaries (e.g., ditches, pools or ponds, impoundments) where conditions may be more favorable; therefore, these potential habitats could serve as important nursery and overwintering areas in this region and elsewhere.

Factors affecting the performance of Passive Integrated Transponder (PIT) tag antenna arrays in estuarine environments

Investigators: Dr. Matthew E. Kimball[1], Marvin M. Mace III[1], Eric R. Haffey[1], Kirkland Dickson[2], Robin Bulger[3], John Tesensky[3], and Matthew P. Kennedy[4]

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3 - Rogers Fellow in Environmental Science, Cornell College, IA
4 - Marine Science Program, University of South Carolina

Monitoring marine and estuarine fish populations can be labor intensive and restricted over temporal and spatial scales that may not capture the entire range of fish behavior. Recently, passive integrated transponder (PIT) tags have been used for behavioral studies of some common estuarine fish species. PIT tags are ideal for such studies because autonomous antenna arrays can be set up to monitor for tagged fish 24 hours a day all year long, requiring

only minimal labor commitments during initial antenna construction and only periodically thereafter for system maintenance, data downloading, and tagging of fish. Although there are many advantages to using such a tag detection system, potential problems can arise when deployed in estuarine environments. One such issue is variation in read range (i.e., distance from antenna a tagged fish will be detected) due to environmental factors (e.g., salinity) and antenna design (e.g., gauge of wire used to construct antennae). As environmental conditions in estuaries are in near constant flux and the design of PIT tag antenna arrays are not standard among studies, we plan to conduct two experiments to determine variation in read range and amperage for typical antenna array designs deployed in commonly encountered estuarine water salinities (e.g., oligo to polyhaline). Results from these experiments will be useful for designing effective and efficient antenna arrays as well as interpreting results from studies where PIT tagged fish are monitored with autonomous antenna arrays in dynamic estuarine environments.

The effects of inhibited carbonic anhydrase on the phytoplankton communities in coastal waters

Investigators: Eilea Knotts[1] and Dr. James L. Pinckney[1,2]

1 - Department of Biological Sciences, University of South Carolina
2 - Marine Science Program, University of South Carolina

Carbon concentrating mechanisms (CCMs) are used by phytoplankton in order to concentrate dissolved inorganic carbon (DIC) within their cells. These adaptions were evolved to enhance uptake of DIC at present surface water concentrations. However, mechanisms, such as the carbonic anhydrase enzyme (CA), are active, energy-consuming processes that may become redundant in the future due to increased concentrations of CO_2 in surface waters. In order to gain a better understanding of the carbonic anhydrase enzyme, recent studies have investigated the CA enzyme through the use of inhibitors: acetazolamide (AZ) and ethoxyzolamide (EZ). Most of our knowledge is based on individual cultures or oligotrophic water samples. However, there are few studies that look at the mechanism's effects on estuarine phytoplankton communities and none have measured the in situ effects on community composition. Using bioassays of natural phytoplankton communities, our research will explore how community composition is altered when the competitive advantage of the CA enzyme is reduced. These changes will be monitored with measurements of chlorophyll *a* fluorescence, cell abundances, microscopy, photopigments, nutrients, and the inhibitors: AZ and EZ. This study will provide a better understanding of how the CA enzyme impacts the composition of phytoplankton communities in coastal waters.

Occurrence and parasite fauna of an understudied resident salt marsh fundulid: The spotfin killifish *Fundulus luciae* (Baird, 1855)

Investigators: Kristen Trevey[1], Dr. Erin J. Burge[2], Dr. Juliana M. Harding[2], and Dr. John J. Hutchens, Jr.[3]

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The small estuarine spotfin killifish (*Fundulus luciae*) is notable for spending its entire life cycle on emergent intertidal salt marsh along the United States east coast. *Fundulus luciae* is closely related to the mummichog (*F. heteroclitus*) which has been studied extensively in a variety of fields; however much less is known about the spotfin killifish. Our first objective has been to document populations of *F. luciae* in South Carolina–it appears that only one peer-reviewed article has done so, and was limited to two specimens. Monthly dip net collections from salt marsh pit traps began in August 2014 and will continue through summer 2015. Additional sites include Waties Island and Huntington Beach State Park. Spotfin killifish have been collected at all three sites. A subset of fish captured each month is preserved for subsequent parasite surveys. Examination of these *F. luciae* specimens will be performed to identify ecto- and endoparasites with emphasis on identification of monogenean flatworm species. Only two previous studies have surveyed parasites of this fish and these were limited to the metazoa and one protozoan dinoflagellate. Preliminary exams have documented new protist and flatworm host records, including a provisional new species of monogenean. This project will add to our understanding of local salt marsh fish communities, document new populations of *F. luciae* in the state, and contribute to the record of *F. luciae* parasite diversity, prevalence, and intensity.

South Carolina stormwater detention ponds: Sediment accumulation and nutrient sequestration

Investigators: William Schroer[1], Dr. Claudia Benitez-Nelson[1], Dr. Erik Smith[2], and Dr. Lori Ziolkowski[1]

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2 - Baruch Marine Field Laboratory, University of South Carolina and North Inlet–Winyah Bay National Estuarine Research Reserve

Wet detention ponds are common storm water control structures employed throughout the South Carolina coastal region. These ponds receive runoff waters carrying both suspended sediments and nutrients. As sediments accumulate in these ponds, water volume is reduced leading to a decrease in runoff retention. Periodic dredging is required to maintain pond function, but dredging is costly and there is little data available to support how often pond dredging is required. This research has two main goals. The first is to quantify the rate of bulk sediment accumulation, and subsequent volume loss, using lead-210 sediment dating. The second goal is to quantify the role these ponds are playing in regional carbon, nitrogen, and phosphorus cycling. In addition to bulk nutrient and carbon analyses, biomarkers will be used to determine organic matter origin (i.e., aquatic verses terrestrial) of organic. We hypothesize that watershed development density and pond management regime will greatly influence pond water quality, sediment nutrient sequestration, and the sources of organic matter to pond sediments.

A collaborative science program for the National Estuarine Research Reserve System: Working with end users throughout the applied research process

Investigators: Dr. Dwayne E. Porter[1,2], Melissa Ide[3], and Jeremy Cothran[1]

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2 - Arnold School of Public Health, University of South Carolina
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NOAA NERRS Science Collaborative (NSC) supports integrative environmental and social research for improved community decision making. The NERRS Centralized Data Management Office, housed at the Baruch Marine Field Laboratory, is the lead for USC's involvement in the establishment and administration of the NOAA NERRS Science Collaborative (NSC). The NSC is led by researchers at the University of Michigan, Stanford University, and USC. The CDMO role is the transfer of key knowledge and lessons learned to others, potentially benefiting NERRS as well as local, state and federal coastal management decision makers and educators; and delivery of highly credible, valid and relevant scientific results and data that are both timely and universally accessible.

Tag retention, survival, and growth of two common estuarine fishes tagged with Passive Integrated Transponder (PIT) tags

Investigators: Dr. Matthew E. Kimball[1], Marvin M. Mace III[1], Eric R. Haffey[1], Kirkland Dickson[2], Robin Bulger[3], and John Tesensky[3]

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Estuarine habitats serve as critical nursery areas for numerous fish species, including early life history stages. While in the estuary, fishes often move within the mosaic of multiple interconnected habitats that include the vegetated marsh surface, marsh ponds and pools, intertidal and subtidal creeks, and open-water habitats. These movements are dictated by tidal, diel, and seasonal life-history strategies, which are largely species-specific. Historically it has been difficult to track the movement of juvenile fishes (e.g., < 100 mm TL) as they move within this habitat mosaic. Recent advances in passive integrated transponder (PIT) tagging technology have led to the development of small PIT tags (e.g., 8 mm and 12 mm) that can be used with juvenile fishes. The few studies that have tracked juvenile fish movement in estuaries yielded interesting and promising results, however, these studies generally focused on a single species of economic or recreational importance. Therefore little is known about the effectiveness of using PIT tags to track the majority of estuarine fishes. A necessary first step in this process is to examine the retention rate and survival of fishes tagged with PIT tags and determine the appropriate size tag for a given fish size. We plan to test the survival, growth, and tag retention of common estuarine fishes (e.g., pinfish and mummichog) using the flow-through sea water laboratory at the Baruch Marine Field Laboratory.

Spatial and temporal variability in the recruitment of larval and juvenile tarpon in the North Inlet and Winyah Bay estuaries

Investigators: Dr. Matthew E. Kimball[1], Marvin M. Mace III[1], Eric R. Haffey[1], Matthew P. Kennedy[2], Kirkland Dickson[3], Robin Bulger[4], and John Tesensky[4]

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4 - Rogers Fellow in Environmental Science, Cornell College, IA

Tarpon (*Megalops atlanticus*) are commonly found in offshore and inshore waters along the southeastern US Atlantic and northern Gulf of Mexico coasts. Despite this wide geographic range, limited information is available on the ecology of tarpon occurring along the Atlantic coast north of Florida. Larvae and juveniles have been reported from north Florida, Georgia, South Carolina, and North Carolina, but the timing and locations of recruitment to estuarine habitats are unknown in this region. We plan to sample multiple locations throughout the Winyah Bay and North Inlet estuaries over a four month period (May through August) to examine spatial and temporal variability of tarpon recruitment to estuarine habitats. Weekly sampling for early life history stage tarpon will take place during at multiple sites within two locations (Hobcaw Barony and the Tom Yawkey Wildlife Center) in two distinct habitats: 1) relatively deep, tidally influenced creeks/channels as they enter the estuarine system, and 2) high marsh ponds in the North Inlet estuary that may serve as estuarine nursery habitats. The results of this study will provide detailed information on the timing and spatial variability of tarpon recruitment to estuaries, as well as the potential utility of marsh pond habitats for larval and juvenile tarpon in this region.

Sediment accretion in North Inlet estuary salt marshes

Investigators: Dr. James Morris[1,2] and Karen Sundberg[1]

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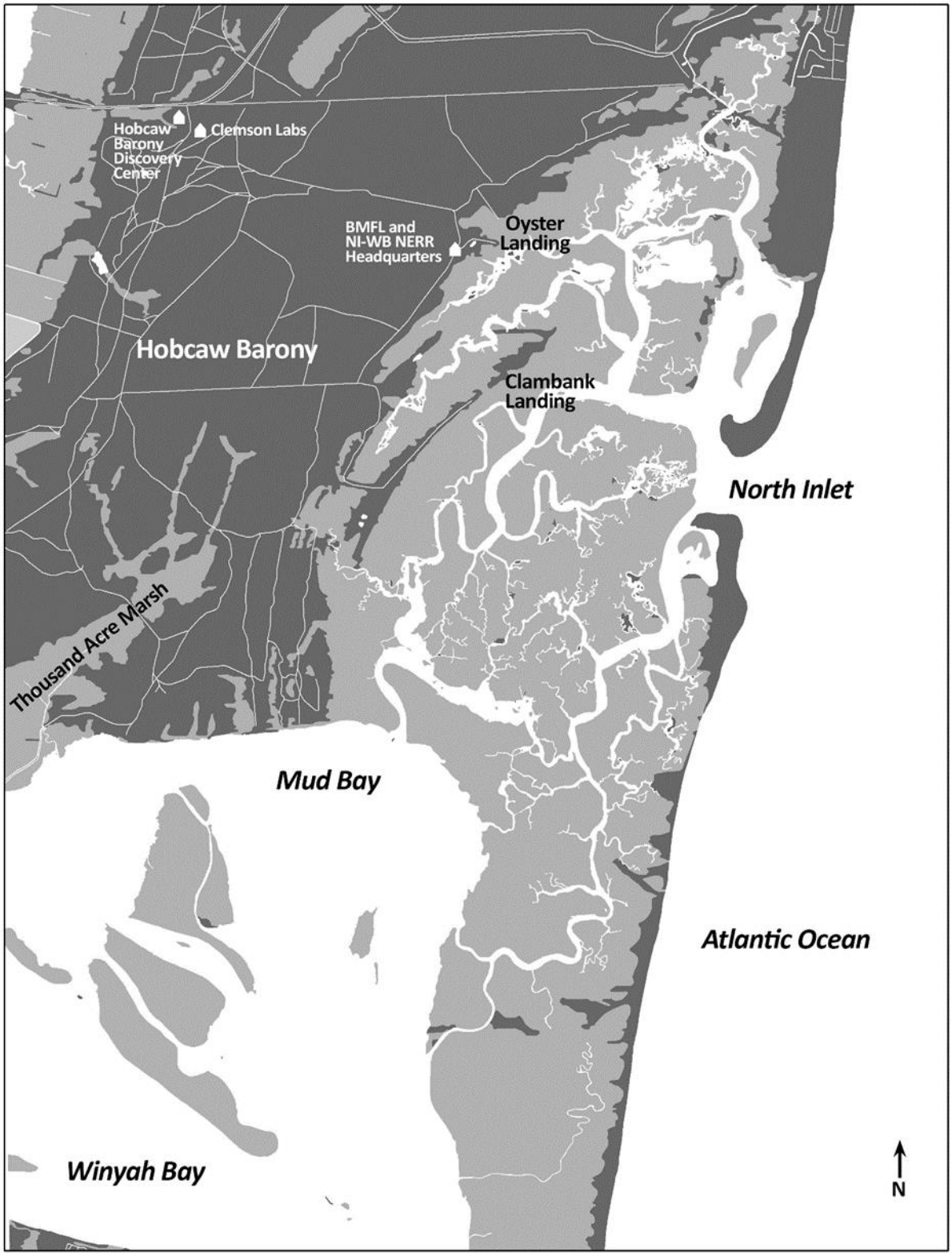
2 - Department of Biological Sciences and the Marine Science Program, University of South Carolina

The objective of this study is to understand how the elevation of the marsh surface is regulated. A major hypothesis being tested is that eutrophication initiates a sequence of changes in the sediments, beginning with a decrease in volume due to enhanced decomposition of organic matter. In fact, sediment accretion in experimentally fertilized marsh plots has increased. This is probably due to an increase in sedimentation caused by a higher density of plant stems in fertilized plots. Marsh plots were fertilized from 1996 or 2001 until 2004. A surface elevation table (SET) is used to measure marsh elevations in low and high marsh *Spartina alterniflora* plots approximately monthly. Currently we are looking at the effect of decreasing eutrophication on marsh surface elevation, and we hypothesize that there will be a decrease in volume of belowground biomass due to enhanced decomposition now that belowground production is no longer stimulated. Results of a model linking plant production and sedimentation with sea level indicate that the marsh maintains its elevation with respect to mean sea level for a range of rates of sea-level rise, up to a threshold. The elevation of the marsh platform with respect to mean sea level is inversely proportional to the rate of sea-level rise.


Hobcaw Barony Discovery Center
Clemson Labs
BMFL and NI-WB NERR Headquarters
Oyster Landing
Hobcaw Barony
Clambank Landing
North Inlet
Thousand Acre Marsh
Mud Bay
Atlantic Ocean
Winyah Bay
N

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