CURRENT RESEARCH PROJECTS

2021

Baruch Marine Field Laboratory

North Inlet-Winyah Bay
National Estuarine Research Reserve

University of South Carolina

Belle W. Baruch Institute
for Marine & Coastal Sciences

North Inlet-Winyah Bay
National Estuarine Research Reserve

Current Research Projects
2021

Introduction

The Baruch Marine Field Laboratory (BMFL), located on Hobcaw Barony in Georgetown County, 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 more than 1,000 grant and institutionally-funded projects have taken place at BMFL. This work has contributed substantially to the more than 2,000 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 86 projects that were underway during the period from January through December 2021 in the North Inlet and Winyah Bay estuaries by faculty, staff, graduate students, and undergraduates associated with the USC and other institutions. USC is the home institution for 53 of the investigators while over 84 investigators representing at least 33 other institutions and agencies are carrying out projects through BMFL. Dozens of graduate and undergraduate students assisted scientists throughout the year to obtain hands-on training in field methods and gain experience conducting research.

This annual report lists active projects (in random order) along with a project summary that includes the title, investigators, affiliations, and an abstract. Many of the studies that involve field measurements and collections are being conducted within the North Inlet-Winyah Bay National Estuarine Research Reserve (NIWB NERR).

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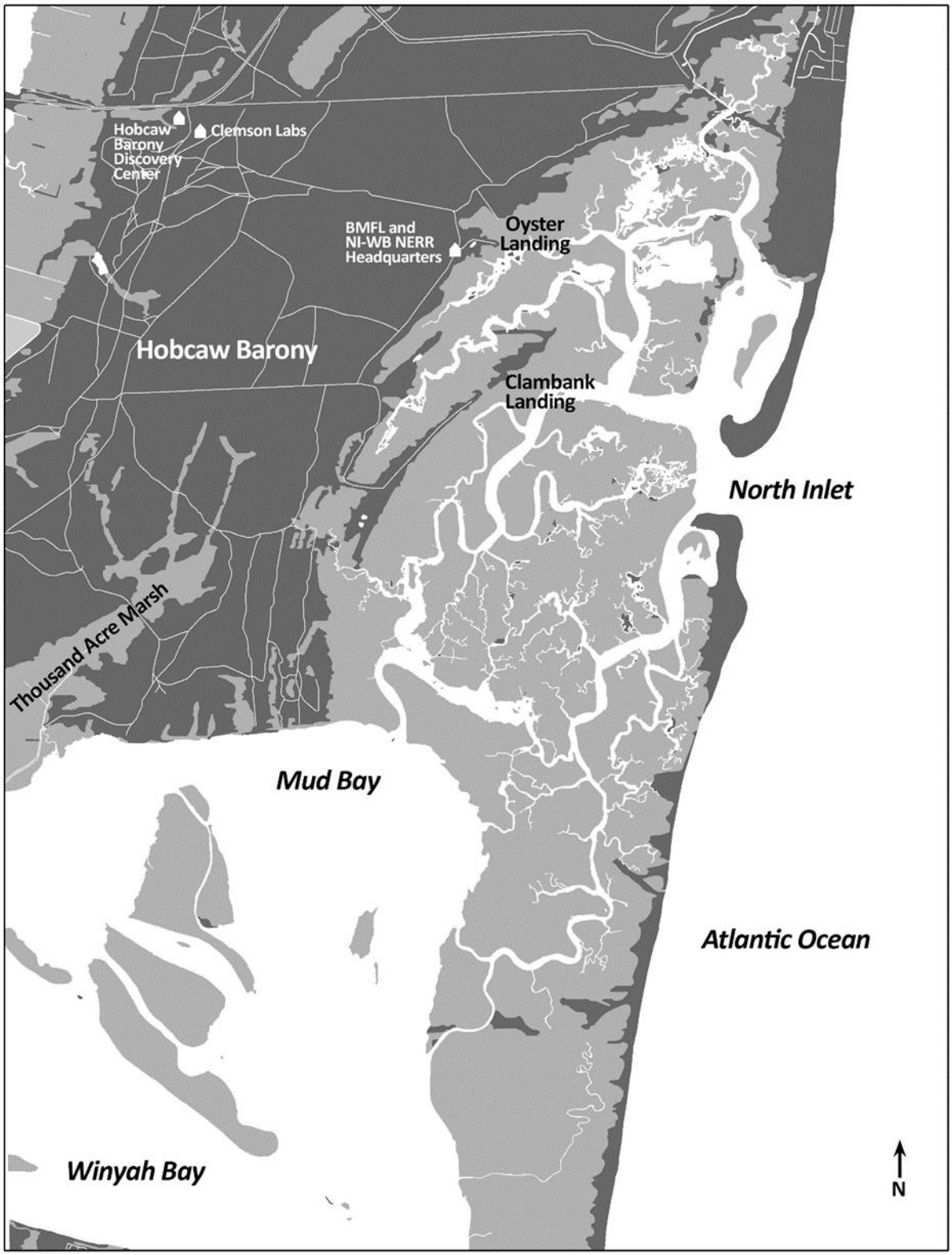

Figure 1: Map of the North Inlet-Winyah Bay estuarine system in Georgetown County, South Carolina.

Ecology, behavior, and population biology of bottlenose dolphins (*Tursiops truncatus*) in the North Inlet estuary and adjacent waters

Investigator: Robert Young

Department of Marine Science, Coastal Carolina University (SC)

This long-term project, begun in 1997, has investigated various questions related to the ecology, behavior, and population biology of bottlenose dolphins in the North Inlet and Winyah Bay (NIWB) estuaries. Using photo-ID and focal follow and transect surveys, we have identified long-term resident dolphins in the NIWB system, including several documented residents of over 20 years. NIWB dolphin abundance can exceed 100 in the summer but declines in winter as dolphins spend more time in coastal water. About 12 to 15 dolphins are core users of the North Inlet estuary, meaning they are sighted more frequently in North Inlet estuary salt marsh creeks than in Winyah Bay. These dolphins consume a significant proportion of the prey fish populations (11-14 metric tons per year) and we estimate that 3-7% of the annual primary production in North Inlet estuary is required to support them. Dolphin distribution in the North Inlet estuary has been correlated with changing patterns of salinity and prey distribution. Mothers with young calves apparently favor low current areas (tidal nodes), and salt marsh residents swim slower and expend less energy while traveling than coastal dolphins. The NIWB dolphins are part of the Northern South Carolina Estuarine System stock, managed under the Marine Mammal Protection Act. We have documented ranging movements south to Cape Romain and north along the coast to Murrells Inlet. Most recently, we developed primers for bottlenose dolphin environmental DNA (eDNA) and demonstrated its utility in identifying dolphin presence and broad patterns of distribution and abundance.

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

Investigator: Jennifer Plunket

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

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.

Quantifying seasonal vegetation controls on coastal dune volumetric change

Investigators: Peter Tereszkiewicz, Jean Ellis

Department of Geography, University of South Carolina

Coastal dunes—located on the subaerial beach—provide a formidable barrier to storm surge and flooding that protect coastal communities from economic loss. Vegetation-sediment interactions mark a keystone component to understand coastal dune growth and post storm recovery. Traditional methods of monitoring vegetation have resulted in data inconsistencies and qualitative assumptions. The short-term pilot and year-long field studies proposed here will utilize Normalized Difference Vegetation Index (NDVI) and Photochemical Reflective Index (PRI) spectral reflectance sensors to spectrally monitor dune vegetation concurrently with erosion-accretion measurements. Study results will mark a momentous advancement in coastal monitoring and management.

Examination of long-term fish and crustacean use of intertidal salt marsh creeks

Investigators: Bruce Pfirrmann, Matthew Kimball, Dennis Allen
Baruch Marine Field Laboratory, University of South Carolina

Collections of nekton (fishes, shrimps, and crabs) have been made in the Oyster Landing intertidal creek basin from 1984 to the present. The objective has been to track the composition, abundance, biomass, and length distributions of nekton and determine patterns, trends, and factors influencing changes over seasons, years, and decades. Sampling in the intertidal creek basin has consisted of three different protocols focused on intertidal creek nekton assemblages, with all three sampling sites with a 250 m stretch of the creek. From 1984-2003, this effort was based on biweekly seine hauls from an isolated intertidal creek pool (low tide). 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. High tide enclosure collections continued through 2011. In 2012 the sample site shifted to an adjacent isolated section of creek at low tide, where from 2012-2018, sampling focused on documenting shifts in the timing, size, and growth of juvenile transient species. Since 2019, our effort expanded to include the entire nekton assemblage occurring in the tidal creek at low tide. The long-term time series is 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 southeastern US.

Green porcelain crab (*Petrolisthes armatus*) larval biology and phenology

Investigator: Juliana Harding
Department of Marine Science, Coastal Carolina University (SC)

Green porcelain crab (*Petrolisthes armatus*) larval biology and phenology will be described with field collections. Weekly zooplankton tows will be used to monitor the presence and stages of crab larvae. Larval morphology will be described from field caught specimens. This information will add to the understanding of this invasive (extended geographic range) species' occurrence in the North Inlet estuary. *Petrolisthes armatus* larvae first occurred in biweekly zooplankton collections in the mid-1990s and little is known about the timing, periodicity, and duration of larval production. Modern patterns in larval occurrence can be compared to similar information from archived biweekly collections to evaluate potential changes with temperature and annual salinity trends.

Mechanisms for thermal tolerance in an estuarine cnidarian

Investigator: Adam Reitzel
Department of Biological Sciences, University of North Carolina Charlotte

Estuarine species like the starlet sea anemone (*Nematostella vectensis*) experience large fluctuations in temperature, requiring wide temperature tolerances, and at the same time, have a natural distribution along a pronounced thermal cline (Atlantic coast of North America), which may promote the evolution of different temperature optima and tolerances in populations. Previous research with *Nematostella* has shown extensive genetic variation, some of which is strongly segregated between populations, and large differences in phenotypic variation in response to both acute and chronic temperature, both of which vary with site of collection, consistent with adaptation to temperature. The North Inlet-Winyah Bay estuarine system represents the most southern location where successful collections for this species have occurred in recent decades and individuals from this site appear to have elevated thermal tolerance. We are using field-deployed temperature loggers coupled with seasonal field samples to compare mean and maximum temperatures with the growth and gene expression for this species. Results will be compared with *N. vectensis* collected from sites as far north as Nova Scotia to understand the genetic processes that allow these estuarine specialists to adapt and respond to their dynamic temperature environments.

Chemical characteristics of estuarine waters: Long-term monitoring at five sites in North Inlet estuary and Winyah Bay

Investigators: Robert Dunn, Julie Krask, J. Baker Stevens

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

As part of the National Estuarine Research Reserve System (NERRS) System-Wide Monitoring Program (SWMP), water chemistry sampling was initiated in June 1993 to monitor concentrations of suspended solids, total nitrogen, ammonium, nitrate, nitrite, total phosphorus, orthophosphate, and chlorophyll *a* at five locations within the North Inlet -Winyah Bay NERR. Water samples are collected every 30 days with ISCO automated water sampling devices 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).

Seasonal energetics of the blue crab (*Callinectes sapidus*)

Investigators: Blaine Griffen[1], Matthew Kimball[2], Bruce Pfirrmann[2]

1 - Department of Biology, Brigham Young University (UT)
2 - Baruch Marine Field Laboratory, University of South Carolina

The goal of this project is to examine seasonal changes in blue crab individual energetics across age classes and genders. The primary methods used involve physiological analysis of the gonads and hepatopancreas to determine seasonal patterns in size and lipid composition of these organs. This will be used to determine patterns in long-term energy storage and energy allocation towards reproduction. In addition, short-term energy reserves will be assessed using glycogen content of muscle tissues. This information will then be combined with bioenergetics growth models for this species to understand seasonal patterns in the energetics of growth and reproduction.

Transfer of a low-cost tidal wetland water level monitoring system: Hyperlocal calculations of inundation and tidal datums for understanding change and restoration planning

Investigators: Vitalii Sheremet[1], Robert Dunn[2], Megan Tyrrell[3]

1 - Department of Physical Oceanography, Woods Hole Oceanographic Institution (MA)
2 - North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina
3 - Waquoit Bay National Estuarine Research Reserve, Massachusetts Department of Conservation and Recreation

We deployed a simple and inexpensive system of water level monitoring developed by PI Sheremet; his 'Arm-and-Float' water level instrument uses a HOBO Pendant G accelerometer. These relatively inexpensive, easy to deploy loggers have been used in several types of salt marsh habitats (e.g., pools, creeks and upstream of a tidal restriction) at other NERRs. The principle of operation is based on converting the raw signal of the arm tilt into the elevation of the float relative to a fixed pivot by multiplication by the arm length. In this way, accuracy of 5-10 mm is achieved, which is adequate for calculating tidal datums. A network of 14 arm-and-float loggers was deployed across North Inlet for water level monitoring, and is part of a group of 7 Reserves spanning a range of climactic and tidal regimes which also received arm-and-float loggers. At the conclusion of this project, we will have instrumentation, locally relevant tidal datums, and enhanced understanding of the differences in inundation regime for 14 salt marsh features including creeks, pools, the marsh platform, and upstream from tidal restrictions.

Saltwater intrusion monitoring

Investigators: Alicia Wilson[1], Brooke Czwartacki[2]

1 - School of the Earth, Ocean, and Environment, University of South Carolina
2 - Land, Water, and Conservation Division, South Carolina 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 the North Inlet estuary, as part of the South Carolina Department of Natural Resources long-term coastal monitoring network. Results to date include stratigraphy from the well logs and field observations of hydraulic head and salinity. These field observations also support the development of a regional groundwater flow model.

Eddy covariance flux measurements to quantify salt marsh productivity and its response to environmental variability over multiple time scales

Investigators: Thomas O'Halloran[1], Erik Smith[2]

1 - Baruch Institute for Coastal Ecology and Forest Science, Clemson University (SC)
2 - North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

Accurate and integrative measures of marsh productivity as well as the sensitivity of marsh production to environmental variability over multiple time-scales are essential to understanding how salt marshes will respond to future environmental and anthropogenic stressors. This study is employing state-of-the-art eddy covariance flux instrumentation (IRGASON, Campbell Scientific) to generate high-frequency (30-minute interval) measurements of terrestrial-atmospheric CO_2 and CH_4 exchange at spatial scales large enough (on the order of 20,000 m^2) to capture landscape-level dynamics. The instrumentation is located with the National Estuarine Research Reserve's existing salt marsh monitoring infrastructure within the Crabhaul Creek marsh of the North Inlet estuary to leverage ongoing data collection of marsh vegetation, surface elevation and tidal inundation, salinity and pore water chemistry, and meteorological data. Results of this study will greatly improve our understanding of marsh sensitivity to environmental variability and change through the development of empirical models relating the integrated response of the salt marsh ecosystem (as gross primary production, ecosystem respiration, and net ecosystem exchange) to environmental variability over temporal scales not previously possible and at spatial scales large enough to integrate landscape-level responses.

Characterization of oyster cement

Investigators: Jonathan Wilker, Mitchell Meger

Department of Chemistry, Purdue University (IN)

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.

Public and K-12 education activities: North Inlet-Winyah Bay National Estuarine Research Reserve

Investigators: Beth Thomas, Hayley Fournier

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

Educational activities for the general public, 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, newsletters, newspapers, and the Reserve website, and the Reserve's 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 National Estuarine Research Reserve, South Carolina Department of Natural Resources, South Carolina 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: Juliana Harding[1], Dennis Allen[2]

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 goby (*Gobiosoma bosc*) crested blenny (*Hypleurochilus geminatus*), feather blenny (*Hypsoblennius hentz*), freckled blenny (*Hyposblennius ionthas*), and striped blenny (*Chasmodes bosquianus*) in Crabhaul Creek, North Inlet are being examined. Artificial nesting substrates have been and will continue to be used to describe movement and fidelity patterns of these resident fishes. Regular surveys will provide information on site fidelity and home range as well as demographics, nest substrate preferences, and habitat use patterns of resident fishes.

Using genetic techniques to understand the mechanism behind the expression of circatidal clocks in an estuarine crab

Investigators: Paola López-Duarte, Taylor Parker, Leyna Pence, Caitlin Babblerose

Department of Biological Sciences, University of North Carolina Charlotte

The use of tidal currents to achieve horizontal displacement in the water column is critical to estuarine-ocean migrations for larval and adult forms of countless species. Previous research has established that swimming activity involved in the selective-tidal stream transport in fiddler crab larvae is under endogenous control. However, the mechanism that allows organisms to keep track and accurately predict the tide, the circatidal clock, is not entirely understood. Our goal is to take advantage of recent advances in the identification of "clock genes" to better understand how organisms process information regarding tidal phase and periodicity and how that, in turn, results in the expression of tidal rhythms (12.4-hour or 24.8-hour cycles).

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

Investigators: Joshua Stone[1], Dennis Allen[2], Nayan Mallick[1], Bruce Pfirrmann[2], Matthew Kimball[2]

1 - Department of Biological Sciences, University of South Carolina
2 - 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 related to fluctuations and trends in the physical characteristics of the estuary. Information is collected for more than 50 taxonomic groups and species which are indicators of the condition and diversity of life in the estuary. Constituents include species of ecological and economic importance to the southeastern US region. Large, long-term decreases in the abundance of small (153 μm) zooplankton and changes in the timing of occurrences of some larval fishes and decapods (365 μm) have indicated responses to a long-term increase in water temperature. We have also observed responses of zooplankton populations to climatic events including El Niño-Southern Oscillation, tropical storm-related reductions in salinity, and drought. The value of these datasets continues to increase as we formulate and test new hypotheses about impacts of climate change on estuarine ecosystems and fisheries. Of note this year, the June 4th, 2021 collection marked the 1,000 sample event of this long-running time series.

Within-season patterns of larval demersal fish abundance, age, and growth in tidal creeks

Investigators: Juliana Harding[1], Dennis Allen[2]

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

Abundance, age, and growth patterns of demersal oyster reef fish larvae including the naked goby (*Gobiosoma bosc*), crested blenny (*Hypleurochilus geminatus*), feather blenny (*Hypsoblennius hentz*), freckled blenny (*Hyposblennius ionthas*), and striped blenny (*Chasmodes bosquianus*) are being examined. Regular ichthyoplankton collections will be used to describe larval fish abundance and demographics. Fish otoliths will be used to describe age and growth rates. These data will be used in combination with information about goby and blenny larvae cultured at known conditions during 2012 and 2013 to interpret patterns observed in the long-term zooplankton series (1981-present).

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

Investigator: Maeve Snyder

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

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 National Estuarine Research Reserve, South Carolina Sea Grant Consortium, the Coastal Waccamaw Stormwater Education Consortium, the Clemson University Extension Service, and the Carolina Clear Program.

Predicting ecological risk from military-derived radioactive material via sentinel species monitoring

Investigators: Sarah Donaher[1], Robert Dunn[2], Bruce Pfirrmann[3], Nicole Martinez[1]

1 - Department of Environmental Engineering and Earth Sciences, Clemson University (SC)
2 - North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina
3 - Baruch Marine Field Laboratory, University of South Carolina

Legacy nuclear sites inherently represent unplanned contamination and loss of institutional memory and therefore pose significant potential harm to human health and the environment. *Geukensia demissa* (Atlantic ribbed mussels) collected from the North Inlet-Winyah Bay National Estuarine Research Reserve will be exposed to radionuclides commonly used in radioluminescent paint at the Clemson Engineering Technologies Laboratory (CETL). This paint was frequently used to mark US Naval ships and buildings, resulting in contemporary contamination of coastal sediments with radioactive objects or paint chips near US Naval shipyards and other sites of military interest. Risk assessments on discrete radioactive material (RAM) are challenging due to large amount of uncertainty in the corrosion rates of such objects, the bioavailability of the radionuclides involved, and ultimate toxicity of these radionuclides to marine biota. Therefore, tissue accumulation, antioxidant response, and changes in gene expression will be monitored in the exposed mussels to quantify the impacts of exposure to radioluminescent paint. This information will inform a framework for the United States Navy (USN) to develop biomonitoring protocols for identifying high priority remediation sites for legacy contamination in coastal military installations.

Benthic bivalves as potential indicator species for ecosystem climate change effects

Investigators: Juliana Harding[1], Dennis Allen[2]

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

This project builds on the Baruch Institute's long-term monitoring program describing macrobenthic bivalve trends in the North Inlet estuary. The coupling of modern and historic data allows evaluation of potential changes in species richness and recruitment timing since 1982 related to increasing winter water temperatures. Modern field collections (Bly Creek, Bread and Butter Creek) describing the current status of macroinfauna will be coupled with historic macroinfaunal sample analyses to 1) quantitatively describe infaunal bivalve populations and demographics, and 2) evaluate the potential for increasing water temperatures to change these dynamics and related ecosystem services over decadal scales. This research complements previous and ongoing work describing other North Inlet estuary ecosystem trophic levels and will enhance existing descriptions and predictions of ecosystem function.

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

Investigators: James Morris[1], Karen Sundberg[2]

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

3-D subsurface modeling of a clastic paleo-shoreface deposit

Investigator: Patrick Duff

School of the Earth, Ocean, and Environment, University of South Carolina

Close examination of modern shallow marine deposits can also help us better understand similar ancient deposits, including their internal structure and relationship to other passive margin deposits. A series of Ground Penetrating Radar (GPR) lines, along with vibracore, and a UAS drone survey will be acquired near the Baruch Marine Field Laboratory on Hobcaw Barony, as one field site within the coastal plain of South Carolina to investigate the internal structure and stratigraphy of a variety of a recent shoreface deposit, as well as to serve as an experiment in the application of GPR to sedimentological and stratigraphic research.

Sediment accretion in North Inlet estuary salt marshes

Investigators: James Morris[1], Karen Sundberg[2]

1 - Department of Biological Sciences, University of South Carolina
2 - Belle W. Baruch Institute for Marine and Coastal Sciences, 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 below ground biomass due to enhanced decomposition now that below ground 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.

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

Investigators: Erik Smith, Robert Dunn, Julie Krask, J. Baker Stevens, Tracy Buck

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

As part of a National Estuarine Research Reserve (NERR) 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 8 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. 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.

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

Investigator: Juliana 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 are being quantitatively examined in North Inlet estuary tidal creeks including Town, Clambank, Crabhaul, Oyster Landing, Bly, and adjacent smaller creeks. Hard clam age structure, growth rates, biomass, and sex ratios will be evaluated seasonally 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.

Experimental varying of the marsh platform and macrophyte response

Investigators: James Morris[1], Karen Sundberg[2]

1 - Department of Biological Sciences, University of South Carolina
2 - Belle W. Baruch Institute for Marine and Coastal Sciences, 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 above ground and below ground allocation patterns and quantify where the bulk of below ground 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 above ground and below ground 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.

Finding the genetic basis of developmental evolution using a marine polychaete

Investigator: Christina Zakas

Department of Biological Sciences, North Carolina State University

The goal of our research is characterizing the extent and distribution of genetic variation that contributes to early development. The estuarine polychaete *Streblospio benedicti* provides a unique opportunity to address this issue because it has two types of mothers who produce distinct offspring that differ in egg size, early development, and larval morphology. It is an ideal genetic model for understanding how transitions in the developmental programming evolve. Because early development is strongly influenced by maternal effects, we focus on finding the genetic contribution of maternal background to developmental phenotypes. We integrate aspects of population genetics, quantitative genetics, and developmental biology within a single species to identify how genomic variation influences life-history.

Petrolisthes armatus density and performance along a latitudinal gradient

Investigator: Jeb Byers

Odum School of Ecology, University of Georgia

Petrolisthes armatus is an invasive tropical crab that has spread throughout the southeastern US in the past decades. Its northern distribution seems to have remained close to the North Inlet estuary for many years, perhaps because the crab is limited by low winter temperatures. We have been latitudinally sampling the crab for the past two years to establish information on its distribution and abundance, and also to collect crabs for genetic analyses. In particular, we wish to examine whether there is any genetic differentiation in the crab within its invasive range. As the northernmost end point in our latitudinal sampling, the North Inlet estuary is an important spot to include in our analyses.

South Carolina Estuarine and Coastal Assessment Program (SCECAP)

Investigators: Andrew Tweel[1], Denise Sanger[1], Sharleen Johnson[1], David Chestnut[2], Ed Wirth[3]

1 - Marine Resources Division, South Carolina Department of Natural Resources
2 - Bureau of Water, South Carolina Department of Health and Environmental Control
3 - Hollings Marine Lab, National Centers for Coastal Ocean Science, National Oceanic and Atmospheric Administration (SC)

The South Carolina Department of Natural Resources (SCDNR) and the South Carolina Department of Health and Environmental Control (SCDHEC) have been conducting an ongoing comprehensive collaborative coastal monitoring program (South Carolina 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 August 2021, over 900 sites have been sampled statewide, with 12 located in the North Inlet estuary and an additional 38 sites located in the adjacent Winyah Bay.

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

Investigator: Juliana 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, disarticulation rates, Dermo prevalence and intensity, biomass, and reef spatial extent at sentinel sites in the Town, Clambank, Crabhaul, Debidue, and Bly Creek basins. Environmental data will be collected concurrently and integrated with the biological data. The integrated data sets will be examined in the context of available historic data and documented environmental changes across decadal time scales.

Shorebird monitoring in the North Inlet estuary

Investigators: Jennifer Plunket, Wendy Allen

North Inlet-Winyah Bay National Estuarine Research Reserve, 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 near high tide by boat and land and through the use of wildlife cameras. Species are identified and counted at sites on Hobcaw Beach, North Island, North Jones Creek, Bosun's Point, and along Clambank Causeway. Survey data is entered into a 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 help to identify key habitat areas within the reserve. 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.

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

Investigators: Isaure de Buron[1], Dennis Kyle[2], Matthew Kimball[3]

1 - Department of Biology, College of Charleston (SC)
2 - Coverdell Center, University of Georgia
3 - Baruch Marine Field Laboratory, University of South Carolina

Blood flukes are pathogenic parasites that infect the cardiovascular system of their definitive hosts. Life cycles of fish and turtles blood flukes use annelids and/or mollusks as intermediate hosts. The objectives of this project are 1) to continue the inventory of blood flukes in the North Inlet estuary and 2) to unravel life cycles of as many of these blood flukes as possible. Methods involve sampling annelids, examining them under the dissecting microscope for the presence of parasites, isolate parasites, describe their morphology and sequence parts of the COI and LSU genes. Larval flukes that infect annelids can be identified only by matching DNA sequences with adult stages found in fish. An effort will be made to survey fish captured in the North Inlet estuary for the presence of blood flukes in order to `match' them with larval stages found in annelids. Preliminary results show a high diversity of these parasites in annelids.

Atlantic brief squid (*Lolliguncula brevis*) population biology and growth rates in North Inlet estuary

Investigator: Juliana Harding

Department of Marine Science, Coastal Carolina University (SC)

Atlantic brief squid (*Lolliguncula brevis*) play an ecological role within estuarine habitats as upper level consumers. Biology, demographics, age structure, and growth rates of Atlantic brief squid are being quantitatively examined in North Inlet estuary within and across years, and subsequently evaluated in the context of environmental data. These descriptions will be integrated with parallel descriptions of other trophic levels to provide a multi-year perspective on ecosystem food web dynamics.

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

Investigators: Peter Key, James Daugomah, Grant Burdine

Hollings Marine Lab, National Centers for Coastal Ocean Science, National Oceanic and Atmospheric Administration (SC)

Long-term ecological monitoring is important to developing fundamental understandings of both biogenic and anthropogenic effects on ecosystem health. This 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. Long-term ecological monitoring data can be used not only to ascertain effects of natural and anthropogenic stressors, but also used in conjunction with GIS and advanced modeling techniques to enhance predictive capabilities. The grass shrimp (*Palaemon 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 Oyster Landing site within the North Inlet estuary is maintained as a long-term reference site for comparison to estuarine sites with other land uses. The Clambank site is also being used as a long-term monitoring reference site for Ocean Sampling Day, an international collaboration to collect water samples from the Earth's oceans and rivers.

The National Estuarine Research Reserve System Centralized Data Management Office

Investigators: Dwayne Porter[1,2], Melissa Ide[3], Jennifer Kessee[3], Amber Knowles[3], Brooks Folk[3], Lee Shutt[3], Dan Ramage[2], William Jefferson[1], Julia Britton[3], Tracy Buck[3], Jeremy Cothran[2]

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 - Centralized Data Management Office, National Estuarine Research Reserve, 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 29 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 programs, and other education, monitoring and research programs.

Developing a behavioral bioindicator of habitat health for coastal salt marshes

Investigator: Blaine Griffen

Department of Biology, Brigham Young University (UT)

The goal of this study is to compare herding behavior of sand fiddler crabs across marshes with varying levels of human disturbance to determine whether changes in crab behavior can be predictably used as an indicator of marsh health. At 25-30 marsh sites along the coast between Georgetown and Myrtle Beach that experience varying levels of human disturbance, we will measure herding behavior using a simple experiment where a predatory attack is simulated by an individual walking towards a herd. Experiments will be video recorded and later analyzed. In addition, at each site we will assess the level of human disturbance (e.g., distance to roads, infrastructure, amount of foot and road traffic, etc.).

Effect of wrack accumulation on salt marsh vegetation near Clambank Landing in the North Inlet estuary

Investigators: Richard Stalter[1], John Baden[2]

1 - Department of Biological Sciences, St. John's University (NY)
2 - US Army Corps of Engineers, Retired (NC)

In 2013 we initiated a second study of salt marsh vegetation along an elevation gradient beginning with the most flood tolerant taxon, *Sporobolus alterniflora* and ending with the least flood tolerant taxon, *S. pumilus* was covered with 15-25 cm of wrack, duplicating the natural deposition of wrack on the marsh by tides and storms. Contiguous controls were left uncovered. Generally, 6 months were needed for the wrack to decompose and be carried away from the arrays by tides. During this time the buried vegetation was killed. We have monitored the time it takes for the pre-existing vegetation to invade and cover the bare soil where the original vegetation was killed. Generally, it takes between 2 and 3 years for the original marsh taxa to invade and cover the wrack impacted sites. By 3 years the salt marsh vegetation on the wrack impacted sites is indistinguishable from the contiguous controls. We have observed that the least flood tolerant taxon, S. *pumilus* has been gradually replaced by more flood tolerant *Borrichia frutescens*, at arrays covered with wrack in an earlier study initiated in 2004. Salt marsh vegetation exists along very narrow elevation gradients. Thus, saltmarsh vegetation distribution is an excellent indicator of sea level rise. Gradual sea level rise (3.6mm/year) at this site between 2004 and 2021 accounts for *S. pumilus* being replaced by the more flood tolerant *B. frutescens*. We will continue to monitor all arrays during 2022.

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

Investigators: Robert Dunn, J. Baker Stevens, Julie Krask

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

As part of the NERR 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 and Winyah Bay waters, and provides base-line data critical for various studies of biological and physical processes in these estuaries. 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.

Examining the influence of habitat on predation within the estuarine mosaic

Investigator: Matthew Kimball

Baruch Marine Field Laboratory, University of South Carolina

This project seeks to examine fish and crab (i.e., nekton) use of estuarine habitats in the North Inlet estuary. Nekton habitat use patterns vary with the type of habitat, the stage of the tide, and during night or day, among other things. This research will seek to examine nekton use of several different habitats within the estuarine mosaic, and will employ both traditional and novel sampling techniques. Traditional predation tethering trials will be conducted in subtidal and intertidal creek habitats, and acoustic imaging will be used to observe predation and nekton habitat use in the above habitats as well as oyster reefs. Together, these observations will be used to determine the general value of such habitats to nekton.

Controls on spatial variation in porewater methane concentrations across U.S. tidal wetlands

Investigators: Erika Koontz[1], James Holmquist[1], Robert Dunn[2], Julie Krask[2]

1 - Smithsonian Environmental Research Center (MD)
2 - North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

Tidal wetlands play a critical role in carbon cycling in coastal environments and are increasingly important in management considerations due to their carbon storage potential. However, other biogeochemical processes and the extent to which they occur across varying tidal wetland characteristics affect their utility for climate change mitigation. Methanogenesis can occur in tidal wetlands, potentially leading to emission of CH_4 and offsetting the value of CO_2 removal capability. While this highlights the need to quantify CH_4 emissions across these systems, broad-scale assessments are often impractical due to the complexity of field-based CH_4 flux measurements and intensive sampling efforts required to effectively capture spatial variability. This work leverages the NERR network to quantify porewater CH_4 concentrations, which are antecedent to CH_4 emissions, across a range of spatial scales and evaluate whether several key covariates can function as proxies across different tidal wetland systems. Improved mapping and monitoring of CH_4 dynamics and associated environmental drivers will better inform management efforts and priorities for mitigating climate impacts.

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

Investigators: George Voulgaris[1], William Jefferson[2]

1 - School of the Earth, Ocean, and Environment, University of South Carolina
2 - Belle W. Baruch Institute for Marine and Coastal 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.

Decapod crustacean population dynamics and fishery trends in the North Inlet-Winyah Bay estuarine system

Investigators: Robert Dunn, Julie Krask, J. Baker Stevens

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

Despite the economic and ecological importance of decapod crabs within estuarine ecosystems, fisheries for blue and stone crabs in South Carolina currently have relatively little management. To better understand the status of crab populations within the waters of North Inlet-Winyah Bay National Estuarine Research Reserve (NIWB NERR), we will conduct quarterly trap-based surveys to collect data on blue and stone crabs. Although blue crabs have been extensively studied elsewhere, there is relatively little information regarding their recent population dynamics in estuaries of S.C. For example, the most recent estimates of multiple blue crab vital rates are decades old, and environmental conditions along our coast have likely changed since previous data were collected. The goal of this survey is to estimate crab abundance (catch per unit effort), sex ratio, size distribution, length-weight relationships, and reproductive condition, within NIWB NERR, as well as spatial and temporal variation in these parameters. We will also conduct monthly counts of crab pot buoys within the Reserve to estimate fishing effort in individual creeks and understand spatio-temporal variation in fishing effort.

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

Investigators: Richard Stalter[1], Joseph Rachlin[2], John Baden[3]

1 - Department of Biological Sciences, St. John's University (NY)
2 - Department of Biology, Lehman College (NY)
3 - US Army Corps of Engineers, Retired (NC)

The vascular flora present in three abandoned rice fields of the Winyah Bay estuary at the Baruch Marine Field Laboratory, Georgetown County, South Carolina identified in 1968-1969 was compared with the vascular flora present in 1987-1991, and 2013-2015. Twenty vascular plant species were identified in 1968-1969 and 22 in 2013-2015 at the most saline marsh, Thousand Acre Rice Field. Forty-seven taxa were reported at Airport marsh in 1968-1969 and 27 in 2013-2015. Fifty-six taxa were reported at Alderly marsh in 1968-1969, while only 41 were identified here in 2013-2015. A parsimony algorithm was used to evaluate the distribution and co-occurrence of vascular brackish marsh species in 3 abandoned rice fields sampled at three intervals, 1968-1969, 1987-1991, and 2013- 2015. There was a shift in the flora at the two least saline sites, Alderly marsh and Airport marsh from 1968-1969 to 1987-1991 and 2013-2015. Three factors, rising sea level, an increase in water salinity, plus the invasion of *Phragmites australis* may explain the shift in vegetation in Alderly marsh and Airport marsh, the two least saline marshes. There was a shift in the flora at the most saline site, Thousand Acre Rice Field, from 1967-1969 to 1987-1991 and 2013-2015 after the marsh was savaged by Hurricane Hugo in 1989. The invasion of non-native *P. australis* at all sites and the increase in water salinity at all sites best explains the reduction in vascular plant species at Airport and Alderly marshes over the 47-year collecting period.

South Carolina BioDiscovery Biofouling Project

Investigators: Beth Thomas, Hayley Fournier

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

The South Carolina BioDiscovery Project is a STEM (science-technology-engineering-math)-based citizen science education initiative initiated in 2019 and designed to provide hands-on exploration of biofouling communities that colonize in fresh and saltwater environments, connecting students and teachers along a watershed and/or across the state through the collection of biodiversity monitoring and water quality data via an online data portal where teachers, students and citizen science volunteers share their findings through a network of sampling locations across the state. Project activities address South Carolina State Science Standards for grades 1-12 and engage STEM skills through the design of biofouling equipment, incorporation of data collection technology, calculation of biodiversity and water quality indicators, and engagement in the scientific process. NIWB NERR will serve as a partner hub location for the project and education staff and volunteers will conduct monthly monitoring of the fouling discs and share these activities via a variety of virtual outreach programs for K12 and public audiences and will submit monthly data via an online date portal. The saltwater monitoring location at Oyster Landing offers online access to water quality information, including real-time readings, and NOAA tide gauge and other citizen science monitoring data such as the SE Phytoplankton Monitoring Network, and a freshwater location at the pond dock at the USC BMFL Kimbel complex will offer additional data on freshwater fouling communities and convenient access to the outdoor classroom shelter for conducting field sampling activities with K12 and public groups.

Investigation into the occurrence of juvenile common snook (*Centropomus undecimalis*), a subtropical estuarine sport fish, in saltmarshes beyond their established range

Investigators: Philip Stevens[1], Matthew Kimball[2], Garrett Elmo[2,3], Kyle Williams[4], Jared Ritch[1], Derek Crane[3]

1 - Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission
2 - Baruch Marine Field Laboratory, University of South Carolina
3 - Department of Biology, Coastal Carolina University (SC)
4 - Tequesta Field Laboratory, Florida Fish and Wildlife Conservation Commission

Given recent trends of warming water temperatures and shifting fish distributions, detecting range expansion is important for resource management and planning. The subtropical common snook (*Centropomus undecimalis*; hereafter referred to as snook) is an estuarine species that historically extended from the tropics to southern portions of Florida and Texas, but this range has been expanding for the past decade. We collected juvenile snook (n = 16; size range = 96–210 mm standard length [SL]) in saltmarshes of South Carolina, which is well outside their usual range but not unprecedented. Growth rates of juvenile snook in South Carolina (0.72 mm SL da^{-1}) were similar to those reported for Florida during a cold period, but faster than rates reported for Florida during a recent period of mild winters (0.49 mm SL da^{-1}). Based on collection and estimated hatch dates, and supported by winter water temperature records, juvenile snook overwintered for at least 1 year allowing them to grow to sizes that are typical for emigration from nursery habitats to open estuarine shorelines. Continued work is needed to determine whether there is potential for ongoing range expansion of snook to the region, and a strategy is proposed to focus on future research.

Phytoplankton monitoring - community science project

Investigators: Jennifer Plunket, Maeve Snyder

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

Community scientists will monitor the North Inlet estuary and surrounding coastal waters for potentially harmful phytoplankton. The National Phytoplankton Monitoring Network (PMN) is a community-based network of volunteers that monitor marine phytoplankton and harmful algal blooms (HABs). The PMN enhances the US's ability to respond to and manage the growing threat posed by HABs by collecting important data on species composition and distribution in coastal waters and creating working relationships between volunteers and professional marine biotoxin researchers. The North Inlet-Winyah Bay NERR Phytoplankton monitoring project will monitor the North Inlet estuary and surrounding coastal waters for potentially harmful phytoplankton. Participants will collect and assess samples twice a month. Results will be reported to the National Phytoplankton Monitoring Network.

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

Investigators: Robert Dunn, J. Baker Stevens, Julie Krask

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

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 (CDMO), and made available in near real time on the CDMO website. 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.

Oyster Landing Creek as essential fish habitat for juvenile transient fishes?

Investigators: Annamaria Deitz[1], Juliana Harding[1], Matthew Kimball[2], Bruce Pfirrmann[2]

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

Estuaries provide important nursery habitat for juvenile transient nekton. Integrated seasonal descriptions of abundance, growth, age, and energy flow are required for a comprehensive assessment of organism-habitat interactions. These interactions aid in establishing a baseline for ecosystem-based management, Essential Fish Habitat (EFH), in particular. Biweekly juvenile transient fish collections from Oyster Landing Creek are being used to quantitatively evaluate seasonal trends in abundance, demographics, age, and standard biological condition indices. *Leiostomus xanthurus* (spot) and *Mugil curema* (white mullet) are being analyzed. The integration of environmental and biological data types at an annual scale will provide information for multiple EFH levels for these fishes. These data will provide necessary context for North Inlet estuary to potentially serve as a reference estuary for EFH evaluations in other locations using these same juvenile transient nekton species.

Salt marsh seasons phenology monitoring - community science project

Investigator: Jennifer Plunket

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

Phenology is the study of the timing of seasonal plant and animal life-cycle events, including the flowering of plants, ripening of fruit, the emergence of insects, and migration of birds. Life-cycle events influence the abundance and distribution of organisms, which affects food webs, ecosystem services, and global cycles of water and carbon. The timing, duration and intensity of these events are sensitive to seasonal and long-term changes in temperature and precipitation. Monitoring phenological events can aid in the assessment of the vulnerability of species, populations, and ecological communities to ongoing climate change. Volunteers with the Salt Marsh Season Phenology Community Science Project will record observations of plant phenology and wildlife activity for selected species at designated salt marsh monitoring trails. Volunteers will visit designated monitoring sites along the trails on a weekly basis. Following a written protocol, the phenological stages (e.g., leaf break, flower buds) will be recorded for marked plants within the site. Volunteers will also listen and watch for selected bird species and conduct a visual inspection for insect species. Over time this will provide information for research on how species are adjusting to shifts in season and sea level rise occurring as the climate changes.

Assessment of leptocephali and juvenile recruitment of three sympatric species, the Atlantic tarpon (*Megalops atlanticus*) and ladyfish (*Elops saurus*; *Elops smithi*), along the South Carolina coast

Investigators: Derek Crane[1], Garrett Elmo[1,2], Matthew Kimball[2]

1 - Department of Biology, Coastal Carolina University (SC)
2 - Baruch Marine Field Laboratory, University of South Carolina

Estuarine arrival of larval fishes plays an important role in the development and growth of individuals and year classes of fish. Investigating larval recruitment and the factors that affect recruitment (e.g., water quality, climate, and currents) is essential to understanding the early life histories of Atlantic tarpon (*Megalops atlanticus*) and ladyfish (*Elops saurus; Elops smithi*). To investigate the timing of recruitment for these species we sampled three locations in South Carolina (North Inlet estuary, Tom Yawkey Wildlife Heritage Preserve, and Kiawah Island), May through November 2019, and sampled one location in South Carolina (North Inlet estuary), April through November 2020. High marsh pools and managed impoundments were sampled using a modified plankton net and a cast net to sample the early life stages of these fishes. Analysis of variance was used to determine if size at arrival, duration of arrival, and densities differed among species and study sites. Distribution of catches was plotted across sites and time to visualize arrival patterns of the three species.

Quantifying the impacts of recreational harvest on mobile oyster reef fauna

Investigators: Robert Dunn[1], Mercer Brugler[2], Mary Margaret Pelton[3]

1 - North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina
2 - Department of Natural Sciences, University of South Carolina Beaufort
3 - Department of Biological Sciences, University of South Carolina

This project aims to investigate the effects of fishery harvest (`oyster picking') on oyster reef faunal biodiversity. At four oyster reef locations within North Inlet, which span a range of fishery harvest, we have deployed oyster shellbaskets buried into the reef matrix. Shellbaskets are made of the bottom of a plastic basket holding loose, weathered oyster shells, and shellbaskets are left in the field for ~4 weeks and then swapped. Mobile fauna that inhabit oyster reefs colonize the shells and sediment that accumulate within the basket. After 4 weeks in the field, these organisms are sieved from the shells and mud. At the time of shellbasket retrieval, environmental DNA (eDNA) water samples are also collected from on the reef, off the reef, and from a water bath holding the shellbasket. This BACI design will provide baseline information regarding the effects of recreational oyster harvest on the community of organisms inhabiting reefs. Ultimately, this project will contribute to the implementation of ecosystem-based management via enhanced understanding of the effects of a culturally important recreational fishery on target and non-target ecosystem components.

Painted bunting (*Passerina ciris*) breeding survey

Investigators: Jennifer Plunket, Wendy Allen

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

The project goal is to estimate the number of painted buntings utilizing the edges of North Inlet estuary marshes as nesting habitat during the breeding season. A point count method is utilized that involves 5 minutes of listening for calling male buntings at fixed intervals along a prescribed route. Summer 2021 marked the fourth year of this survey. The plan is to continue this breeding bird survey of painted buntings each year so that changes in numbers can be detected for this species of high concern in South Carolina. The point count methodology is consistent with North American Breeding Bird Surveys and a population assessment of painted buntings conducted in the southeast, 2007-2009, thus allowing for comparisons with other studies.

Seasonal microbial dynamics in the North Inlet-Winyah Bay estuarine system

Investigators: Xuefeng Peng[1], Bruce Pfirrmann[2], William Strosnider[2], James Pinckney[3]

1 - School of the Earth, Ocean, and Environment, University of South Carolina
2 - Baruch Marine Field Laboratory, University of South Carolina
3 - Department of Biological Sciences, University of South Carolina

Microbial communities play a major role in determining ecosystem functions. Technological advances in DNA sequencing and bioinformatics have enabled the discovery of new lineages and functions of life and how they are shaped by the environment. Nevertheless, it remains challenging to link the composition and activity of microbial communities to the physical environment they are an integral part of. Decades of environmental monitoring at four stations in the North Inlet-Winyah Bay National Estuarine Research Reserve (NIWB NERR) make them an ideal location to study the interactions between microbial communities and the physical environment with seasonal dynamics. The NIWB NERR has been home to many ecological studies in coastal ecosystems, but little is known about the microbial communities in the NIWB NERR due to the paucity of microbial investigations to date. The main objectives of this project include: 1) Determine the microbial community composition and functions at the genome level using shotgun metagenomics; 2) Identify links and feedback between microbial communities and the physical environment by analyzing the microbial data along with the physicochemical data collected from the long-term environmental monitoring at the NIWB NERR; and 3) Cultivate representative fungal strains from the NIWB NERR that play a major role carbon and nitrogen cycling.

Response to COVID-19 field research and education disruptions: Creating virtual field experiences in coastal and estuarine science

Investigators: Robert Hougham[1], William Strosnider[2], Katherine Ryker[3], Damon Gannon[4], Zoe Goodrow[1], Emily Baumann[3], Bruce Pfirrmann[2], J. Kyle Houser[2], Matthew Kimball[2]

1 - Upham Woods Outdoor Learning Center, University of Wisconsin-Madison
2 - Baruch Marine Field Laboratory, University of South Carolina
3 - School of the Earth, Ocean, and Environment, University of South Carolina
4 - University of Georgia Marine Institute

The pandemic has dramatically impacted the educational landscape in the United States and globally, radically limiting enriching educational experiences for undergraduates and high school students. There is a pressing need to develop educational content and experiences that not only mitigate the loss of in-person learning, but also outdoor, field-based learning. Field stations are uniquely pressed with not only serving as laboratories, but also educational venues that need to fully consider both the research as well as the educational front when they reopen their doors to a world changed by COVID-19 as recently noted in *Science*. We are addressing this problem by bringing accessible, engaging, and rigorous science experiences to learners virtually by developing a suite of estuarine field experiences polished for distance-delivery in undergraduate programs that use marine field laboratories from New York to Texas. These experiences will consist of 10 modules, each focusing on a particular estuarine ecology topic and feature research projects, datasets, prompts, and worksheets to support science learning. The modules will also be modified for delivery to high school students as virtual modules usable by outdoor education centers and schools. It is critical to address this educational shortfall rapidly as the COVID-19 limitation of field experiences persisted into much of 2021, de-coupling a cohort of future scientists and stewards from critical educational engagement.

Keystone chemicals: Identifying general and universal molecules of fear

Investigators: Marc Weissburg[1], Lee Smee[2], Julia Kubanek[1], Benjamin Belgrad[2]

1 - School of Biological Sciences, Georgia Institute of Technology
2 - Dauphin Island Sea Lab (AL)

Many prey species adjust their behavior and morphology in the presence of predators to avoid being consumed which can affect numerous community-wide interactions. In aquatic environments, prey often rely on waterborne chemical cues to recognize predators. Although numerous prey species are consumed by the same types of predators, it is unknown the extent chemical cues are unique for specific predator-prey combinations or if some compounds are universally recognized as “molecules of fear” by species. Here, we perform a series of bioassays on two important prey species that share common predators, but have different responses to these predators. While eastern oysters (*Crassostrea virginica*) will change their morphology and increase their shell strength in the presence of predators, mud crabs (*Panopeus herbstii*) alter their behavior and become less active. Bioassays involve extracting urine from common predators, including other crab species and fish that were fed either oysters or mud crabs, and creating several cue mixtures unique to each predator species - diet combination. These mixtures are then regularly applied to cultures of our prey species to cause changes in their morphology and behavior. Compounds within these mixtures are identified through NMR spectroscopy and mass spectrometry-based metabolomics and correlated to the strength of the prey species' response to that mixture. By using metabolomics this work is expected to identify a number of waterborne cues where other approaches have historically failed, and also advance our understanding of the chemical nature of a wide range of ecological interactions.

Listen In: Acoustic monitoring of estuarine communities facing ecosystem change

Investigators: Matthew Kimball[1], Robert Dunn[2], Eric Montie[3]

1 - Baruch Marine Field Laboratory, University of South Carolina
2 - North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina
3 - Department of Natural Sciences, University of South Carolina Beaufort

Passive acoustics (hydrophones) are effective for monitoring underwater soundscapes across a range of biological complexity (shrimp, fish, mammals), while active acoustics (sonar) can noninvasively quantify patterns of organismal abundance, distribution, and behavior across complementary spatial and temporal scales. By combining acoustic data with traditional environmental monitoring, scientists and managers can identify key habitats for protection and measure how ecological communities respond to environmental changes (e.g., storm events, coastal development, eutrophication) in a cost-effective and low-impact manner. This project will bring together academic leaders in bioacoustics, estuarine ecology, and fisheries ecology with managers and staff from three NERRs that "book-end" the entire southeastern coast of the United States. Our goal is to develop the framework for a new acoustic monitoring program that can be integrated within long-term monitoring (e.g., SWMP), targeted research (e.g., hurricane impacts), stewardship (e.g., protected area designations) and education programs (e.g., TOTE) of NERRs throughout the region. This framework holds great potential to address priority management needs of regional NERRs associated with climate change, water quality, and habitat restoration. The project will also engage state fishery managers in each region as end-users to ensure the designed framework informs their efforts to manage coastal habitats, species, and fishery resources.

The extraordinary visual systems of snapping shrimp and the armor that protects them

Investigators: Alexandra Kingston[1], Daniel Speiser[2]

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2 - Department of Biological Sciences, University of South Carolina

Snapping shrimp (Decapoda: Alpheidae) are an exciting system in which to study integrative neurobiology because they have armor, termed the orbital hood, that protects them from supersonic high-amplitude pressure waves, better known as shock waves. This is the only armor, natural or engineered, known to protect an animal from shock waves. The morphology of the orbital hood may be key to its protection, but it may also create challenges for the visual system situated beneath it. The visual system of snapping shrimp functions faster than that of any other aquatic animal. We aim to learn how orbital hoods protect snapping shrimp from shock waves and why snapping shrimp have evolved such fast vision.

Evaluation of grazing rates of *Ilyanassa obsoleta* on microbenthic organisms in the North Inlet estuary

Investigators: Brittany DeArmitt[1], James Pinckney[2], Juliana Harding[3], Joshua Stone[2]

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2 - Department of Biological Sciences, University of South Carolina
3 - Department of Marine Science, Coastal Carolina University (SC)

The purpose of this experiment is to perform a time study that evaluates the grazing rates of the Eastern mudsnai, *Ilyanassa obsoleta*, and their effect on microalgae abundance and composition. As an obligate omnivore, *I. obsoleta* has been observed to eat mostly diatoms in the North Inlet Estuary. Their grazing pressures on the microalgal community ultimately translate to an overall ecological effect since the bottom of the marine food chain is targeted. The monthly grazing rates will be calculated from the months of May 2021 through December 2021. The relationship between atmospheric temperature and grazing rates will be evaluated as well. The monthly grazing rates will be compared to determine if grazing rates significantly differ between months. It is hypothesized that the monthly grazing rate will be highest in the month of August, when summer is at its peak and temperatures and light exposure are typically highest. It is hypothesized that the grazing rates will have a concave relationship with temperature.

Elucidating the mechanisms of dissolved oxygen impairment in the Waccamaw River, SC

Investigators: Curtis Szewczyk[1], Erik Smith[2], Claudia Benitez-Nelson[1]

1 - School of Earth, Ocean, and Environment, University of South Carolina
2 - North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

The occurrence of low dissolved oxygen (DO) is a widespread concern for aquatic systems, especially within coastal zones. The blackwater, carbon-rich Waccamaw River, is an example of a body plagued with annual DO impairment during summers. The goal of this research is to investigate how increasing temperatures and nutrient loading can impact the rate at which microbial respiration consumes DO, thus further exacerbating DO impairment in these waters. Additionally, the potential for sites of varying organic matter (OM) lability to vary in their sensitivity to these proposed mechanisms of DO impairment will be explored. Sample collection will occur within the Waccamaw River, nearby forested wetlands (mostly terrestrial, refractory OM), and stormwater detention ponds (mostly aquatic, labile OM) to explore any quality-sensitivity relationship in the OM pools. Samples will be incubated for 5-days across different temperature and nutrient addition treatments and DO will be tracked over this incubation period. Findings from this work will inform stormwater managers and scientists concerned with DO impairment, and with ongoing climate change leading to higher temperatures and more extreme precipitation events, this information may prove vital. We expect that warming will lead to higher rates of DO consumption across sites, but those characterized by more refractory organic matter will show higher sensitivity, using Q10 temperature coefficient measurements. Additionally, nutrient loading to our carbon-rich systems may support higher rates of respiration. Overall, this research will be insightful for the understanding of DO impairment in coastal regions and its potential mechanisms.

Research to operationalize the use of UAS in wetland monitoring in support of the NOS/NERRS science mission

Investigators: Erik Smith[1], Jenny Davis[2], Brandon Puckett[3], Justin Ridge[4]

1 - North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina
2 - Beaufort Laboratory, National Centers for Coastal Ocean Science, NOAA (NC)
3 - North Carolina National Estuarine Research Reserve, North Carolina Department of Environmental Quality
4 - Duke Marine Laboratory, Duke University (NC)

A core mission of NOAA's National Ocean Service includes stewardship of sensitive coastal habitats like those of the National Estuarine Research Reserve System (NERRS). To fulfill this mission, the NERRS has made substantial investments in monitoring tidal wetlands for change detection. To date this has largely involved labor-intensive ground-based sampling conducted at relatively course temporal and spatial scales. The current project is a coordinated effort among the National Ocean Service's National Centers for Coastal Ocean Science (NCCOS), NERRS, and Duke University to develop protocols for the collection of high-resolution wetland monitoring data based on imagery acquired by Unoccupied Aerial Systems (UAS), which can complement and expand current national monitoring efforts. Project goals include assessing the efficacy of UAS-based imagery for estimating common monitoring parameters (e.g., percent cover), delineating boundaries/ecotones, generating digital elevation models, and estimating vegetative biomass. UAS image collection and field sampling for the North Inlet-Winyah Bay NERR component of the work will leverage the Reserve's long-term marsh monitoring efforts in the Crab Haul Creek basin of the North Inlet estuary. The work involves a systematic analysis of the impacts of image collection practices and data processing techniques on the accuracy of image-based products. This effort will result in the production of standardized protocols and best practices for the incorporation of UAS in wetland monitoring in the NERRS and beyond. Anticipated outcomes include expansion of technical UAS capacity within NOS/NERRS and improved ability to detect and quantify change in wetland habitats.

Detecting impacts from climate change across multiple scales: A national synthesis of tidal marshes

Investigators: Chris Peter[1], Erik Smith[2], Robert Dunn[2]

1 - Great Bay National Estuarine Research Reserve, New Hampshire Fish and Game Department
2 - North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

Building upon two NERRS Science Collaborative catalyst projects that established a prototype methodology for standardizing, visualizing, and analyzing tidal marsh monitoring data, this project proposes a detailed, national-scale synthesis of tidal marsh responses to climate change, specifically changes in marsh vegetation community responses to sea level rise (SLR). National Estuarine Research Reserves (NERRs) are uniquely situated to address this topic, given our decade-long monitoring focused on understanding effects of changing sea levels and inundation regimes on coastal habitats. Accelerated rates of SLR and shifts in marsh vegetation communities have occurred nationwide, however a dedicated nationwide synthesis has yet to be conducted. Using a variety of NERR datasets, the researchers will quantify climate-induced shifts in marsh integrity and resilience at local to national scales that document ecological responses and inform best management practices. Additionally, shifts in species ranges and patterns of diversity across latitudes and biogeographic regions will be investigated. The proposed work will provide: 1) insight on how climate change is affecting marshes nationwide, 2) NERRs-specific templates and automated tools for data analysis and visualization, 3) transferable utility to other organizations with marsh monitoring datasets, 4) transferable utility to other coastal habitats (seagrass, mangroves), and 5) a framework for guiding and facilitating other national-level research.

Oyster drill (*Urosalpinx cinerea*) population dynamics in North Inlet estuary

Investigator: Juliana Harding

Department of Marine Science, Coastal Carolina University (SC)

Atlantic oyster drills (*Urosalpinx cinerea*) play an ecological role within tidal creek oyster reef habitats. Oyster drill population dynamics, distribution, age structure, and growth rates are being quantitatively examined in North Inlet estuary tidal creeks (e.g., Town, Clambank, Debidue, Bly, Crabhaul, Oyster Landing) and combined with measurements of ambient environmental variables. The resulting population descriptions will provide information on oyster drill population dynamics and applied to quantitative descriptions of oyster drill and oyster (*Crassostrea virginica*) population biology and demographics in the context of environmental conditions across multi-year time scales.

Downstream from Myrtle Beach: An analysis of water quality at Winyah Bay

Investigators: Terra Pettit-Bacovin, Sheri Strickland

Department of Chemistry, Converse College (SC)

Impaired water bodies have negative impacts on the health of dependent ecosystems. The downstream effects of human density in Myrtle Beach on the Waccamaw River and Winyah Bay may have long lasting consequences if left unaddressed. The recent Title 303(d) listings of several locations across Winyah Bay for various pollutants highlights the need for continuous evaluation of water quality. Samples from the Waccamaw River, and several sites representing Winyah Bay with respect to Hobcaw Barony will be analyzed over the course of the summer. The following physical and chemical criteria will be obtained from each sample collection: air/water temperature, site conditions, water odor/color, pH, dissolved oxygen, conductivity, bacteria levels, and phosphorous levels. Analysis of samples for impairment parameters will be SCDHEC approved methods that meet their standards of water quality assessment. The intention is that the data collected during this project will be used to supplement a formal Total Maximum Daily Load that will help to protect South Carolina waters from further impairment.

Using phytoplankton nutrient uptake rates to estimate dissolved inorganic nitrogen loading to estuaries

Investigators: James Pinckney[1], Erik Smith[2]

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2 - North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

Documenting long term nutrient loading trends in low inflow estuaries has proven difficult due to multiple non-point source inputs. The purpose of this research was to estimate the magnitude of dissolved inorganic nitrogen (DIN) loading needed to support the observed phytoplankton standing stocks over daily to decadal time scales in a high salinity estuary with limited riverine input. We used empirically derived limiting nutrient uptake rates and long-term monitoring data that incorporates the tidal, seasonal, and annual variability in semi-continuous measurements of phytoplankton and limiting nutrient (dissolved inorganic nitrogen, DIN) concentrations. DIN uptake rates (DIN_{UR}) and phytoplankton biomass (chl *a*) were used to calculate a DIN utilization rate (DIN_{PH}) that we propose is a measure of the DIN loading necessary to support phytoplankton growth in this estuary. We conclude that DIN loading has increased in recent years (2015 - 2020) with 2020 having the highest rate over the measurement record (19 years). We estimate that the long-term median amount of DIN required to support phytoplankton standing stocks is ca. 0.5 mmol l^{-1} y^{-1} or 74 tons of N y^{-1} for the North Inlet estuary tidal prism. Our approach is applicable to a variety of low inflow estuarine ecosystems and offers an alternative way to quantitatively compare phytoplankton N loading budgets within and across low inflow estuaries.

Investigation of high-energy storm events and their impact on carbon storage in tidal wetlands of South Carolina

Investigators: Kelly Lazar, Gavin Gleasman

Department of Environmental Engineering and Earth Sciences, Clemson University (SC)

The disturbances which tropical storms impose on coastal carbon cycling in tidal wetlands are currently unidentified. High-energy storms have the potential to either disturb the storage of carbon with increased erosion or inhibit carbon storage through increased deliverance of organic matter accompanied by an increase in post-storm sedimentation. The objective of the proposed research is to discern the effects high-energy storm events impose on the ability of tidal wetlands to sequester carbon during storm events by utilizing in-situ CO2 flux measurements and analyzing a historical sediment record through paleotempestological methods, to ultimately improve carbon budgets for South Carolina's coastal wetlands.

Role of salinity in perfluorooctane sulfonate (PFOS) bioconcentration between aquatic species and the differential regulation of transporters in *Fundulus heteroclitus*

Investigators: Tyler Davis, Bill Baldwin, Peter van den Hurk, Charlie Rice

Department of Environmental Toxicology, Clemson University (SC)

Salinity is a physiochemical property of water that can potentially enhance PFOS accumulation due to the presence of ions such as Ca^{+} and Mg^{2+} in the water; however, the difference in PFOS bioconcentration between freshwater and saltwater fish is not well studied. An estuarine fish species, *Fundulus heteroclitus* (mummichog), is known for its adaptation to both hypertonic and hypotonic environments, which makes it an ideal organismal model to determine differences in the bioconcentration of PFOS in saltwater compared to freshwater in the same species. *F. heteroclitus* were adapted to both saltwater (23-26 ppt) and freshwater (moderately hard water; 0.143 ppt) conditions for 30 days before being treated with PFOS for 20 days to determine if bioconcentration of PFOS is higher in the liver, gills, and muscle of saltwater mummichogs compared to freshwater-acclimated mummichogs.

Juvenile brown shrimp (*Farfantepenaeus aztecus*) use of salt marsh intertidal creeks as nursery habitat

Investigators: Kaitlin Glover[1], Matthew Kimball[2], Bruce Pfirrmann[2], Mary Margaret Pelton[1], Robert Dunn[3]

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2 - Baruch Marine Field Laboratory, University of South Carolina
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Designation of essential fish habitat requires a detailed understanding of how species-specific vital rates vary across habitats and biogeographical regions. This is especially true for species like the economically important brown shrimp (*Farfantapenaeus aztecus*) which occurs in multiple habitat types across a wide geographic range (southeastern US Atlantic and Gulf of Mexico [GoM] coasts) and exhibits variation in vital rates to small-scale variability in habitat conditions. As juveniles, brown shrimp occupy a suite of interconnected habitats within the estuarine mosaic before migrating offshore as adults. In the southeastern US, intertidal creeks make up a substantial proportion of available habitat within the estuarine mosaic, yet habitat-specific vital rates, including growth, are currently unavailable. We therefore sought to 1) estimate growth rates of juvenile brown shrimp in intertidal creek habitat within a high salinity, southeastern US estuary, the North Inlet estuary in South Carolina, and 2) compare our estimated rates with those from other habitats in northern GoM estuaries where tidal conditions differ dramatically from our study site. Juvenile brown shrimp collected over a 10-week period (May-July 2021) ranged from 25-95 mm TL, and appeared to emigrate from the intertidal creek to deeper waters beginning at ~ 65 mm TL. Daily growth rates ranged from 0.45-2.30 mm day^{-1}, with the highest rates estimated early in the study period. Despite differences in estimation method, salt marsh habitat type, and region, estimated growth rates from the North Inlet estuary were nearly identical to those from northern GoM estuaries. Collectively, our results suggest that despite differences in habitat geomorphology, spatial extent, and temporal availability, intertidal creeks may provide juvenile brown shrimp with similar nursery function.

Monitoring change in salt marsh vegetation distribution and biomass using UAS-derived multispectral imagery in North Inlet estuary, South Carolina

Investigators: Brittany Morse, Erik Smith

North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

Coastal marsh responses to increasing rates of sea level rise and episodic storm events are spatially variable, depending on a range of local factors. The National Estuarine Research Reserve System (NERRS) uses a suite of standardized ground-based measurements to track marsh response to sea level rise across the different estuaries represented by the NERRS. To increase both the temporal frequency and spatial resolution of its marsh monitoring program, The North Inlet – Winyah Bay NERR is now supplementing these ground-based efforts with data collection from Uncrewed Aerial Systems (UAS) and analysis workflows developed in a collaborative effort among the six Southeastern and Caribbean NERRs. Beginning in 2020, a UAS (DJI Matrice 200 v2) equipped with a multispectral sensor (MicaSense Altum) was flown on a bimonthly to monthly basis to collect data on vegetation community distributions and biomass across the marsh platform of the landward-most creek basin of the North Inlet estuary. Of all indices tested, the Normalized Difference Vegetation Index (NDVI) produced the strongest predictive relationship with live biomass, based on comparisons with clipped vegetation harvested seasonally across the elevation gradient. This relationship was then used to quantify spatially-explicit seasonal growth curves and biomass distributions as a function of marsh elevation. Integrating the use of UAS into monitoring protocols greatly expands the scale and resolution of assessment, enabling an improved understanding of salt marsh vegetation dynamics.

Zooplankton trait response to climate change: the case of North Inlet estuary, South Carolina

Investigators: Nayan Mallick, Joshua Stone

Department of Biological Sciences, University of South Carolina

Rising temperatures due to anthropogenic climate change is adversely affecting aquatic biota in multifaced ways. Change in body size, a dominant trait controlling ecosystem function, is one of the pervasive consequences of elevated temperature. We investigated change in body size of two mesozooplankton groups, copepoda and chaetognatha, from spring to early summer (March – July) for two decades (1981-1990 and 2010- 2019). Biweekly mesozooplankton samples were collected using 153 μm mesh net from the North Inlet estuary, a designated NERR site. Over the last four decades (1981-2020) temperature increased about 1.5°C in this estuary. Interannual variability in body size anomaly was evident for both the taxa examined, but chaetognatha showed strong variability among years (Adj R^2: 0.51, $p = 0.01$) in first decade (1981-1990). Body size of both taxa was significantly larger (Mann Whitney U test, $p < 0.001$) in the latest decade (2010-2019) compared to first decade. For both the taxa, body size on average decreased significantly seasonally from spring to early summer during the latest decade. Temperature was negatively correlated with body size of both groups, but more strong a stronger relationship was observed for copepods (Adj R^2: 0.31, $p < 0.001$). These findings have important ramifications for predator populations especially larval fish as their feeding is limited by gape size.

The BMFL–University of Dayton ETHOS Service Collaborative

Investigators: William Strosnider[1], Jordan Wilson[2], Jai'Viana Harris[2], Ancy Johnson[2], Ashley Kush[2], Brianna Moen[2], Kelly Bohrer[3], Scott Schneider[3]

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3 - The ETHOS Center, University of Dayton (OH)

Beginning in 2021, the Baruch Marine Field Lab (BMFL) established a partnership with the University of Dayton's ETHOS (Engineers in Technical Humanitarian Opportunities of Service Learning) Center, becoming a host site for undergraduate and graduate engineering students participating in the ETHOS program. With an overall goal of engaging with underrepresented communities to promote multiculturalism and environmental justice in Georgetown County, specific initiatives undertaken by participating students to-date include: 1) providing technical assistance to expand the food production capacity of regional food gardens within the county and 2) supporting the re-opening and proper memorialization of the historic African-American Myrtle Grove Cemetery in Georgetown's West End. While in residence at BMFL, ETHOS students have also engaged in "Greening BMFL projects" including decreasing the CO^2 footprint of the seawater system, designing, and implementing rainwater collection, composting, and raised bed gardening.

Visual ecology of the green porcelain crab *Petrolisthes armatus*

Investigators: Madison Janakis, Daniel Speiser

Department of Biological Sciences, University of South Carolina

Conditions for visual signaling in aquatic environments vary drastically depending on local factors such as depth, sediment type and weather conditions. Tidal creeks, for example, are challenging environments for visual signaling due to frequent high levels of turbidity. High turbidity increases light scattering, which lowers the contrast of images and reduces sighting distances. Tidal creeks can also be spectrally narrow, which decreases the ability of animals to distinguish color signals. Given these challenges, how do the inhabitants of tidal creeks reliably send and receive visual signals? We hypothesize that animals use polarized signals and polarization-sensitive vision to enhance the reliability of visual communication in turbid, spectrally narrow environments such as tidal creeks. To explore this hypothesis, we are investigating the visual ecology of *Petrolisthes armatus*, an invasive porcelain crab (Decapoda, Anomura, Porcellanidae) abundant in the North Inlet estuary. *P. armatus* has a pair of maxillipeds (feeding appendages) with iridescent turquoise spots which they can voluntarily hide or reveal. These spots reflect polarized light and we propose porcelain crabs use them for interspecific visual signaling. We are currently investigating how the polarization of these visual signals may increase the distance at which *P. armatus* can communicate visually in the turbid tidal creeks in which they live.

Long-term changes in fish assemblage diversity and abundance in the Winyah Bay estuary

Investigators: Matthew Kimball, Bruce Pfirrmann

Baruch Marine Field Laboratory, University of South Carolina

The lack of research on fish assemblages in the Winyah Bay estuary is limiting our ability to detect, examine, and understand the local and regional impacts of climate change on the ecological structure and function of the North Inlet-Winyah Bay estuarine ecosystem in South Carolina. Over the last 35 years we have detected significant changes in larval and juvenile fish assemblages in the North Inlet estuary. However, no such examination has yet occurred for fish assemblages in the Winyah Bay estuary; in fact, only two studies have focused on fish assemblages in the Winyah Bay estuary. Seasonal juvenile fish assemblages were only (and last) examined in for two full years in 1977-1978. Therefore, the objective of this research is to examine the juvenile fish assemblages of the Winyah Bay estuary following the same sampling methods employed back in late 1970s. Using a 20 ft otter trawl net of the same specifications, fishes will be collected monthly (one 20-minute trawl) at each of the nine sample sites covering the bay and rivers for two full calendar years. This is a unique opportunity to exactly replicate the methods and protocols of a prior study that will allow for a 1:1 comparison with the historic collections from over 40 years prior.

Spatial and temporal variation in salt marsh crab communities

Investigators: Robert Dunn[1], Nadya Gutierrez[2]

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2 - Department of Biological and Environmental Sciences, Georgia College & State University

Salt marshes provide habitat for numerous species of decapod crustaceans, in particular those commonly referred to as fiddler crabs (*Uca* spp.), mud crabs (*Panopeus* spp.), and those in the genus *Sesarma*. Marsh crabs can be highly abundant and perform numerous ecosystem functions, including bioturbating marsh sediments, consuming algae and detritus, and serving as a link within food webs between primary producers and upper-level consumers. Long-term crab population monitoring will provide insight on the ability of crabs to affect marsh vegetation both directly and by interacting with sea level rise. Crab species vary in size, diet, and behavior, which may affect their impacts on vegetation and marsh geomorphology. This project will use pitfall trap-based sampling for mobile fauna, paired with non-invasive burrow counts and physical measurements of environmental parameters (sediment characteristics, elevation, and porewater chemistry).

Assessing performance of in situ fluorescence sensors for predicting phytoplankton chlorophyll concentrations across diverse aquatic ecosystems

Investigators: Camille Wheeler[1], Erik Smith[2]

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Effectively monitoring chlorophyll in aquatic ecosystems is important for various reasons. Chlorophyll serves as a proxy for phytoplankton biomass, an important measure of ecosystem trophic status as well as a priority water quality indicator. In addition, spikes in chlorophyll levels can be a warning sign of Harmful Algal Blooms, an increasing public health concern. High frequency, in situ chlorophyll monitoring has the potential to provide a more comprehensive characterization of chlorophyll variability, and thus the factors that may drive this variability, than conventional discrete water sampling. This study investigated chlorophyll variability in two contrasting estuarine systems: North Inlet estuary, a high salinity, ocean dominated estuary, and Winyah Bay, a river dominated system. Sampling was conducted using both high-frequency (every 15 minutes) sampling with an in situ fluorescence sensor on a continuously deployed YSI EXO2 datasonde, and monthly grab samples collected 13 times over a full tidal cycle. Grab samples were returned to the laboratory, extracted, and quantified by standard fluorometric methods. Laboratory-based comparison between sensor measured chlorophyll and extracted chlorophyll yielded strong correlations under controlled conditions ($R^2 = 0.892$ for North Inlet, $R^2 = 0.808$ for Winyah Bay), providing confidence in interpretation of time-series measurements in these two systems. Results showed that the North Inlet estuary has distinct tidal and seasonal variability, while the Winyah Bay estuary is largely dominated by stochastic variability driven by variable river inputs. Continuously deployed in situ chlorophyll fluorescence sensors allow for an understanding of phytoplankton temporal dynamics not possible with traditional grab sampling methods.

Guiding successful applications of floating treatment wetlands in brackish coastal ponds

Investigators: William Strosnider[1], Sarah White[2], Amy Scaroni[3], Matthew Kimball[1], Levi McKercher[4], Tyler Gobert[5], Andrea Landaverde[2], Clare Escamilla[2]

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3 - Department of Forestry and Conservation Science, Clemson University (SC)
4 - Department of Biological Sciences, University of South Carolina
5 - Environmental Engineering Program, Saint Francis University (PA)

Floating treatment wetlands (FTWs) are a low cost, low maintenance option for removing nutrients from eutrophic ponds, however their use in brackish waters is limited. Therefore, this project aims to deploy FTWs at various scales in brackish waters to assess plant survivability, nutrient removal rates, and water quality improvements following installation. Many plant species will be screened across several nutrient and salinity concentrations at greenhouse and mesocosm scale to determine those species suitable for field scale FTW application. Field-scale FTWs will be constructed and applied to several brackish, coastal retention ponds of varying trophic status near Mt. Pleasant, SC, where nutrient concentrations and water quality parameters will be rigorously monitored pre- and post-FTW application to assess any changes in response to FTW deployment. A multitude of workshops and trainings will be provided to pond management professionals, local conservation officers, and all others who are interested in using FTWs as a tool to improve retention pond water quality. Anticipated benefits resultant of this project include improved understanding of the suitability of FTWs for nutrient removal in brackish waters, increased public engagement in urban water quality restoration efforts, and training for several graduate and undergraduate students.

Using marsh organs to investigate the interactive effects of sea level rise and eutrophication on plant-microbe interactions within the *Spartina* root zone.

Investigators: Johanna L'Heureux[1], Julia Feldman[1], Jen Bowen[1], Karen Sundberg[2], Robert Dunn[3]

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2 - Belle W. Baruch Institute for Marine and Coastal Sciences, University of South Carolina
3 - North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

To better understand how salt marsh carbon dynamics will respond to environmental change, we must look to the communities of microbes within marsh sediments that are known to regulate biogeochemical reactions. Belowground microbial communities are especially influenced by vegetation because photo-assimilated carbon is secreted out of roots, greatly impacting microbial structure and activity within the rhizosphere. One way to assess how rhizodeposits exhibit control on microbes within the rhizosphere is through the application of stable isotope probing (SIP), which allows for labelled photosynthate to be traced into the microbes that consume the rhizodeposits. To understand the effects of sea level rise and nutrient enrichment on *Spartina alterniflora* rhizodeposit production and microbial community composition, I performed a $^{13}CO_2$ labeling experiment at North Inlet-Winyah Bay NERR using marsh organs - platforms in the field containing planters at different elevations. *S. alterniflora* plants in the marsh organs were labeled for five consecutive days for three hours each day before being harvested. Preliminary analyses reveal that leaf, root, and sediment samples from labeled pots are significantly enriched with ^{13}C. Additionally, analyses of porewater samples showed that environmental conditions in pots differed between treatments. By identifying microbes that are enriched with ^{13}C and comparing them across treatments, we will gain a better understanding of how sea level rise and fertilizer runoff are affecting carbon cycling in salt marshes.

Variability in sediment organic matter concentrations along a tidal inundation gradient in Crabhaul Creek, North Inlet estuary

Investigators: Erik Smith[1], Claudia Benitez-Nelson[2], Heather Kish[2], Brittany Morse[1,] Julie Krask[1]

1 - North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina
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Salt marshes are known to bury and store substantial amounts of organic carbon and thus play a critical role in global carbon cycling and the sequestration of atmospheric CO_2. The degree to which marsh sediment organic carbon concentrations vary over small spatial scales within individual marshes, and how this may be changing over time as a result of increasing sea level rise rates, remains poorly known. To address this knowledge gap, small-scale spatial variability in sediment organic carbon concentrations is being quantified along gradients of tidal inundation and marsh vegetation community composition from creek bank to upland forest edge. This project is leveraging the NERR's long-term monitoring infrastructure in the Crab Haul Creek basin of the North Inlet estuary. Triplicate sediment cores were collected adjacent to the 53 permanent NERR monitoring plots in summer of 2020 and sectioned at 0-10, 10-20 and 20-30 cm depth intervals. Sediment samples are being analyzed for bulk density, organic carbon, total nitrogen and phosphorus, percent organic matter, and sediment grain size. Sampling in 2020 for sediment bulk density, organic carbon and grain size analysis repeats identical efforts conducted in the summer of 2010. Comparisons between years will allow an assessment of potential change over a decade of increasing tidal inundation along the marsh elevation gradient. Results of this study will improve understanding of variability in marsh carbon storage, the factors that influence this variability, and potentially how this is changing over short-term increases in sea level. This information is essential for informing strategic initiatives involving the value of marshes in carbon emission reduction scenarios.

Using acoustic imaging to quantify diel nekton oyster reef habitat use

Investigators: Matthew Kimball[1], Robert Dunn[2], Caitlin O'Brien[3], Nathan Adams[4]

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Oyster reefs provide valuable structured habitat in coastal zones, but due to the high turbidity of estuaries in the southeast US, characterizing the faunal community that utilize oyster reefs typically requires direct capture (often lethal). High-resolution acoustic imaging sonars allow for non-destructive sampling to estimate relative abundance and body size of fish communities. However, collection of data from acoustic imaging files requires substantial processing time in the laboratory following deployment of acoustic imaging gear in the field. We compared five alternative data examination protocols that could be applied to acoustic imaging files collected on shallow, intertidal oyster reefs. We identified a protocol (analyzing randomly chosen three of five minutes of image recordings) that simultaneously reduces parameter estimation bias and processing time. To demonstrate the utility of this sampling technique and of our selected data examination protocol, we investigated diel differences in nekton use of fringing oyster reef habitats. We found no difference between day and night in the relative abundance, mean body size, or size spectra of the fish community inhabiting fringing oyster reefs. Active acoustic imaging can be an effective, non-destructive method to characterize nekton communities in shallow, turbid estuarine habitats and can be used to test hypotheses regarding the ecology of these ecosystems.

Dynamic camouflage in the grass shrimp *Palaemonetes vulgaris*

Investigators: Nicholas Steichmann, Daniel Speiser

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Camouflage's effectiveness is limited to environments which match the subject's approach to concealment. Two approaches to camouflage are background matching and transparency. Neither method is effective under all conditions, so to stay concealed in variable environments, many organisms change their appearance in response to environmental cues. We are investigating what cues cause decapod crustaceans to change their approach to camouflage and the physiological methods they use to change their appearance. We are addressing these questions using the grass shrimp, *Palaemonetes vulgaris*, which is abundant in the North Inlet estuary. Grass shrimp are mostly transparent with pigment-packed organs termed chromatophores distributed throughout their carapace. These chromatophores expand and contract as grass shrimp experience different light conditions. Like most decapod crustaceans, grass shrimp have a pair of main eyes with superposition optics. Unlike most decapods, they also have an accessory eye with apposition optics positioned at the margin of each main eye. In other shrimp species, the accessory eyes have neural connections to endocrine organs in the eyestalks containing hormones that control pigment distribution within the chromatophores. Using environmental light recordings, behavioral experiments, electrophysiology, and neurohistological approaches, we are testing how the main and accessory eyes of grass shrimp contribute to their dynamic camouflage responses to shifting environmental conditions.

Bridging the gap between quadrats and satellites: Assessing utility of drone-based imagery to enhance emergent vegetation biomonitoring

Investigators: Brandon Puckett[1], Erik Smith[2]

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North Inlet-Winyah Bay National Estuarine Research Reserve, University of South Carolina

The National Estuarine Research Reserve System (NERRS) has made a huge investment to monitor tidal wetlands. Through these efforts, important processes at intermediate spatial (i.e., marsh platform) and fine temporal (i.e., storm events) scales may be missed. Unmanned Aerial Systems (UAS, i.e., drones) can improve tidal wetland monitoring by providing high spatial resolution and coverage, with customizable sensors, at user-defined times. Based on a needs assessment and discussions with NERRS end users, the research team will conduct a regionally coordinated effort in tidal wetlands in all NERRs in the Southeast/Caribbean to develop a UAS-based tidal wetlands monitoring protocol. The team will assess the efficacy of UAS-based imagery for estimating common monitoring parameters (e.g., percent cover), delineating boundaries/ecotones, generating digital elevation models, and estimating biomass. Lastly, the team will communicate project findings to end users and strategize project expansion. There are four primary outputs: 1) UAS-based tidal wetlands monitoring protocol, 2) protocol implementation to generate monitoring products, 3) archive of high-resolution imagery, and 4) strategy for project expansion. Anticipated outcomes include expansion of technical capacity to utilize UAS, improved NERRS-wide understanding of UAS capabilities, and a first-of-its-kind cross-reserve regional collaboration. The project serves as a critical first step for improving tidal wetlands monitoring.

Understanding the effects of environmental variability on penaeid shrimp population dynamics in the southeast United States

Investigators: Robert Dunn[1], Matthew Kimball[2], Joshua Stone[3], Juliana Harding[4], Maeve Snyder[1], Bruce Pfirrmann[2]

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2 - Baruch Marine Field Laboratory, University of South Carolina
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4 - Department of Marine Science, Coastal Carolina University (SC)

Shrimp reside in estuaries during multiple life-stages, and because shrimp life history occurs on an annual scale, populations are sensitive to changes in environmental conditions and available habitat. Two species, white and brown shrimp, constitute the bulk of commercial shrimp landings along the southeast U.S. Atlantic coast. Commercial shrimp landings have been highly variable over the past two decades with the effects of environmental factors on shrimp abundance remaining unclear. To better understand changes in shrimp abundance in response to environmental variability due to changing climate conditions, weather events, and habitat modifications, we will utilize ongoing, long-term data collections within estuaries across South Carolina and Georgia, conduct additional sampling for shrimp and benthic infauna, and implement manipulative laboratory and field experiments targeting brown and white shrimp and their benthic infaunal prey. These efforts will leverage NERR System Wide Monitoring Program environmental data and infrastructure. Using a multi-faceted research approach based on iterative guidance from end users, we will explore the importance of different estuarine habitat types and variable environmental conditions on shrimp populations, information which is critical to future management of this multi-million-dollar fishery.

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

Investigators: Dwayne Porter[1,2], Melissa Ide[3], Jeremy Cothran[2], Jennifer Kesee[3], Amber Knowles[3], Brooks Folk[3], Lee Shutt[3], Dan Ramage[2], Julia Britton[3], Tracy Buck[3]

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The NOAA NERRS Science Collaborative (NSC) supports integrative environmental and social research for improved community decision making. The NERRS Centralized Data Management Office (CDMO), housed at the Baruch Marine Field Laboratory, is the lead for the University of South Carolina's (USC) 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.

Urbanization affects dissolved organic matter concentration and quality in a southeastern United States watershed

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Dissolved organic matter (DOM) is essential to a variety of biogeochemical processes, including remineralization and dissolved oxygen (DO) consumption. In the summer of 2021, 20 sites were sampled across the Winyah Bay watershed to explore how DOM concentration, composition, and lability vary with location and land cover. Average initial dissolved organic carbon (DOC) and nutrient concentrations varied, with urban stormwater ponds having significantly lower concentrations than forested uplands. Low complexity DOM, defined by the absorption coefficient at 355 nm, was more characteristic of ponds relative to uplands. DOM lability (180-d DOC loss) was lowest in uplands (19%) and highest in ponds (30±2%), with decay rates averaging -0.03 to -0.06±0.01 µM DOC d^{-1}, respectively. Combined, these results and indices reveal that urban areas export DOM that is structurally less complex and more readily remineralized than forested sites. Additionally, calculations suggest that high concentrations of forested terrestrial-derived DOM could significantly impact DO conditions, especially during large rain events predicted to become more frequent and intense with changes in climate. Ongoing work assesses interannual and seasonal shifts in DOM, focusing closely on the more bioavailable DOM pool.

Construction of biodegradable floating treatment wetland utilizing wood and bamboo

Investigators: William Strosnider[1], Travis Tasker[2], Levi McKercher[1], Sam Downs[1], Tyler Gobert[2], Kendra Zaruba[2], Lily Currie[2]

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2 - Environmental Engineering Program, Saint Francis University (PA)

The purpose of this research is to develop new designs for floating treatment wetlands (FTWs) that utilize natural and biodegradable materials to support plant growth and improve water quality. In this work, we designed and built biodegradable and durable wood and bamboo floating rafts embedded with coir fiber mats, which are subsequently planted with *Pontederia cordata*. Multiple iterations of these FTWs have been deployed in Kimbel Pond and continue to be monitored to determine the longevity of the floating mats. The benefits and success of constructing FTWs out of more natural, biodegradable, and ubiquitous materials could reduce the costs of FTWs and allow for more resilient plant and biological communities.

Expanding collections of the Chesapeake Bay Barcode Initiative (CBBI): The first comprehensive genetic library for fish and invertebrates of the Mid-Atlantic US

Investigators: Matthew Ogburn[1], Robert Aguilar[1], Scott Smith[2]

1 - Smithsonian Environmental Research Center (MD)
2 - Division of Marine Fisheries, North Carolina Department of Environmental Quality

DNA barcoding is a powerful tool to investigate biodiversity, phylogenetic relationships, food webs, wildlife forensics, and ecosystem services. The ecological utility of genetic reference libraries is greatly improved when they are validated, possess vouchers and detailed metadata, and are regionally based. Although the Chesapeake Bay (CB) is the largest estuary in the United States and a major focus of early fisheries research, there has been minimal genetic sequencing effort and a paucity of museum collections in the last century. Since 2012, we have been compiling the first comprehensive barcode libraries for fish (*COI* and 12*S*) and invertebrates (*COI*) of the greater CB/mid-Atlantic region, collectively known as the Chesapeake Bay Barcode Initiative (CBBI). Associated with each sequence are photographic, tissue, DNA, and museum vouchers and detailed metadata. All vouchers are housed in the Smithsonian National Museum of Natural History's collections and sequences and metadata are publicly available via GenBank and BOLD. In May–June 2021, in order to address specific taxonomic questions and expand collections regionally, we conducted targeted sampling at and around the Baruch Marine Field Laboratory for freshwater prawns (*Macrobrachium* spp.) and Marsh Killifish (*Fundulus confluentus*), which was highly successful. Additionally, BMFL provided material for sequencing from their ongoing trawl and seine surveys (e.g., Leatherjacket *Oligoplites saurus*, Highfin Goby *Gobionellus oceanicus*, Irish Pompano *Diapterus auratus*). These collections increased the taxonomic and geographic breadth of the CBBI and helped address biogeographic uncertainty regarding native and introduced estuarine species.

Evaluation of juvenile nekton growth and intertidal creek nursery function

Investigators: Juliana Harding[1], Dennis Allen[2], Robert Young[1]

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2 - Baruch Marine Field Laboratory, University of South Carolina

Intertidal creeks provide important nursery habitat for a variety of juvenile transient nekton. Demographics and growth rates were evaluated for selected nekton collected from similar creeks within the North Inlet estuary within years and across years during 2006-2008. The same sites will be sampled seasonally to describe demographics and growth for young of the year spot (*Leiostomus xanthurus*) and pinfish (*Lagodon rhomboides*). These ubiquitous estuarine species represent different trophic levels and may be good indicator species for food web function. Fish standard length (mm) and biomass (g dry tissue) will be quantified. Otoliths will be used to describe within year growth rates and recruitment periodicity for both species. Creek-specific fish metrics will be used for within and across year comparisons of nekton growth in the North Inlet estuary intertidal creeks. These comparisons will provide valuable context for North Inlet estuary tidal creek habitat value and trophic dynamics at different spatial and temporal scales that can be applied to similar estuarine nursery habitats.

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