Summary, Synthesis and Relevance to Coastal Management

General Comparison of North Inlet and Winyah Bay

There are fundamental structural and functional differences between the North Inlet and Winyah Bay estuaries (Table 2). At the broadest scale, North Inlet is a barrier island-bounded, salt marsh-dominated system with such minor freshwater inflows that its waters remain highly saline most of the time. This is in sharp contrast to Winyah Bay which is mostly open water and subject to large changes in salinity due to discharges from five rivers.

Semi-diurnal tides originating from the coastal ocean control water flow and salinity in North Inlet. That tidal forcing overwhelms any freshwater introductions from the surrounding watershed or from the spillover through small creeks connecting North Inlet to the brackish portion of Winyah Bay. Although salinity at the south end of the North Inlet system can remain at intermediate levels for weeks or months during major river freshets, reduced salinities are rarely observed in the inlet area. The 30 year average salinity for the core of North Inlet at mid ebb tide is about 32; seawater is usually around 35. Periods of major rain runoff at Oyster Landing and Debidue Creek result in depressed salinities near the upland border for short periods, but tidal exchanges with the lower estuary make those short-lived events. Because almost one half of the volume of water in North Inlet at high tide leaves the inlet with a typical ebbing tide, the residence time of water in the system is short.

In Winyah Bay, a salinity gradient can be observed along the axis of the estuary throughout the year. Salinities are always highest near the mouth and nearly freshwater is usually found close to the Highway 17 bridge crossings about 25 km (15+ miles) upstream of the ocean entrance. Large river discharges force freshwater farther down the axis of the bay and salinities can be less than 15 at the ocean entrance at low tide. As the tide floods, lower salinity water is forced back up the bay and into the rivers creating rises and falls in water levels in the rivers for 10's of kilometers upstream of the bridges. Although most of Winyah Bay is shallow and the water column is well mixed, stratification occurs in the ship channel (often 10 m or more deep) as the higher density salty water at the bottom resides under the lower salinity layers creating large differences between bottom and surface salinities. Thus, salinity patterns in Winyah Bay are highly variable laterally and vertically as tides and river discharges collide and mix or stratify to form a halocline. Tidal currents near the narrow inlet (jetty) of Winyah Bay have greater velocity than those near the proportionately wider mouth of North Inlet.

These hydrological differences account for differences in water chemistry and biological communities. Because of riverborne sediment, organic, and nutrient loads, the usually salty lower

Winyah Bay is different than the salty mouth of North Inlet, an area that is comparatively less turbid and nutrient poor. Even when freshwater runoff from North Inlet's watershed is high, nothing like the sediment and nutrient enriched water characteristic of Winyah Bay is found in North Inlet. Chlorophyll levels are higher and dissolved oxygen levels are lower in Winyah Bay.

Contaminant levels are low in North Inlet and higher in Winyah Bay. Although most of the shoreline of Winyah Bay is not developed, municipal and industrial discharges in the Sampit River watershed and pollutant loading originating from many communities and agriculture in the very large, multi-state watershed contribute to degraded water and sediment quality. Airborne pollutants from local industries, vehicles, and electrical power generating plants affect both Winyah Bay and North Inlet.

The most conspicuous difference between the systems is that *Spartina alterniflora* covers more than 70% of North Inlet whereas less than 5% of Winyah Bay's total area is populated by this species. Other species of grasses, rushes, sedges, and plants occur in Winyah Bay but their occurrence is limited to fairly narrow margins and to some islands in the open water of the lower and middle bay. Higher plant diversity occurs in the upper Bay where salt marsh cordgrass does not thrive. Formerly cultivated rice fields in the upper bay have reverted to tidal marshes and the old, man-made canal systems function as tidal creeks. The proportion of Winyah Bay that is open water is much greater than in North Inlet.

The zooplankton, benthos, and motile fauna of the lower bay are similar to those in much of North Inlet, but community composition changes considerably along the salinity gradient. Because of lower salinity and large variations, the infauna is less diverse and probably less abundant in the middle and upper bay than in most of North Inlet. Winyah Bay zooplankton distribution, which is strongly controlled by water movement, is highly variable but some forms have behavioral adaptations that promote either retention within or transport seaward from that dynamic system. Zooplankton and benthos in the upper bay are very different than those close to the ocean. Most nekton, mammals, turtles, and birds can respond to changes in the water and associated prey by moving to the most suitable locations. Some nekton have narrow salinity tolerances and are only found either near the ocean or in tidal freshwater whereas others can accept large changes over short periods and remain in the same general area of the bay over a wide range of conditions. Unlike North Inlet, Winyah Bay is the base of important commercial fisheries including penaeid shrimps, blue crab, and shad. Threatened and endangered species including short-nose and Atlantic sturgeons live along the salinity gradient of the bay. Marine reptiles (e.g. loggerhead and other sea turtles) and mammals (i.e. bottlenose dolphin, East Indian manatee) occur in both systems, sometimes occurring far upstream in Winyah Bay.

The sheer size, variety of habitats and dynamic character of Winyah Bay make it a more difficult estuary to characterize and monitor than North Inlet. Accordingly, there is much more to be learned about the ecology of Winyah Bay.

While *Spartina alterniflora* covers the majority of the North Inlet marshes (left), it is limited to narrow margins of Winyah Bay and some islands of the lower bay (right).

Synthesis

» Long-Term Monitoring

Preceding sections of the Site Profile have provided results of long-term monitoring and summarized the findings of shorter-term studies conducted by hundreds of investigators over the past 40 or more years. Synthesizing all of this information is a daunting task, but in the spirit of providing some observations and thoughts and encouraging discussion, the following is offered.

The estuary of North Inlet is representative of salt marsh-dominated, barrier island-bounded estuaries in the Southeast region, but it is unusual in that (1) more than 90% of its watershed is in a natural forested state, (2) less than 10% of the bordering barrier islands are developed, (3) nutrient and contaminant levels are very low, and (4) boat traffic and pressure on living resources is low. The high rate of water exchange with the coastal ocean keeps the system well flushed. Water and habitat quality are rated outstanding by the South Carolina's environmental agencies. These conditions provide researchers with an excellent opportunity to study a relatively pristine ecosystem, one that has been minimally disturbed by historic or current human activities.

In the 1970s, investigators associated with the Baruch Institute recognized the potential value of tracking changes in key ecosystem characteristics over time. At first, the objective was to monitor the health of the estuary. The assumption was that conditions had been stable for a long time and without foreseeable threats from development or other local human activities, the estuary would likely remain stable. After a few years of collecting information on water quality, water chemistry, atmospheric variables, and key plant and animal assemblages, investigators recognized that no two years were exactly the same. By the late 1980s, it was still difficult to determine what was an average or typical year with respect to temperature, salinity, nutrients, primary production, animal reproduction and growth, and other metrics. In fall 1989, the time series measurements of all ecosystem features were punctuated by Hurricane Hugo and its impact on the uplands and high intertidal habitats. That 'once in a century' disturbance was followed by a series of ENSO events that brought increased rainfall, runoff, and decreased salinity to North Inlet through much of the 1990s. At that point in the long-term monitoring program, investigators became more convinced that regional and global scale changes in climate had impacts on the physical, chemical, and biological conditions in the estuary. Following the wet 1990s, a series of droughts affected the estuary in other ways. Many of the time series that were started in the late 1970s and early 1980s continue through the NI-WB NERR and with investigator specific funding from other sources. Collectively, these long-term time series represent what appear to be the longest continuous and comprehensive sets of measurements of ecosystem components for a non-riverine estuary anywhere in the world.

Three primary aspects of climate change and variability have been documented for the North Inlet area. Mean annual water temperature has increased by about 1°C since 1979. Mean winter water temperature has increased by about 1.7°C; with a long-term average of 11°C, that is a 15% increase in the past 32 years. Salinity in North Inlet has increased and the volume of freshwater discharged by the rivers flowing into Winyah Bay has significantly decreased. Sea level has increased by an average of nearly 3 mm yr^{-1}; it has risen by about 100 mm (4 inches) since 1978.

Temperature and salinity are key controllers of chemical reactions and the metabolism of microbes, plants, and animals. Long-term measurements of animal populations in North Inlet have revealed changes in the timing of migrations, timing of reproduction, growth rates, and abundances of some, but not all organisms. The consequences of these changes in terms of community and food web structure are unknown at this point but new experimental approaches are beginning to identify the mechanisms and rates of changes for some species. Changes in sea level combined with changes in sediment accretion on the marsh surface

are known to affect the production and survival of the salt marsh cordgrass, and researchers have speculated that major die offs of marsh could result from increasing rates of sea level rise. The result could be North Inlet and similar estuaries becoming more like open water lagoons. Such changes would have major effects on animal populations, including economically important species such as shrimps and crabs that rely on salt marshes for habitat and food.

» Modeling Studies

Long-term measurements will continue as existing data are being statistically analyzed to reveal new information that can be useful in planning and managing coastal systems and resources in the future. One powerful tool for exploring and understanding complex relationships is mathematical modeling. Models have been used throughout the North Inlet research program's history. What follows is a characterization of their use as tools to synthesize information, identify gaps in our knowledge, set priorities for future research, and, in some cases, predict responses of ecosystem services and structure. Also provided is a summary of the kinds of modeling studies that have been conducted, and some of the 'big picture' outcomes that have emerged.

The Outwelling Study's findings prompted construction of new and revisions of older models of subsystems within the estuary that examined fluxes of materials. Other models were designed to examine various ecophysiological and biogeochemical processes that take place in a systems perspective. Other models examine physical processes. Rather than describe each model individually, we have taken the approach to briefly list modeling references in chronological order within research themes for North Inlet and/or Winyah Bay.

The first formal models of material and energy flow in North Inlet and between the coastal ocean and North Inlet were described by Vernberg et al. (1977c, 1978b). These two EPA technical reports were cited in Vernberg (1993). Vernberg et al. (1976) is the precursor to the more formally presented model by Dame et al. (1977). Their closing thoughts were prophetic: "A good model is a constantly evolving entity which changes through time as man's understanding increases. There is no final model." Dame et al. (1977) proposed three subsystems: water column, intertidal zone, and a benthic subtidal zone. Each subsystem had its own compartments, e.g., the subtidal benthos had detritus, meio- and macro-omnivores, decomposers, and macroflora. There were 23 compartments total that were arranged into an input/output matrix of energy flow. Dame et al. (1977) also developed a separate, multi-compartmental, intertidal oyster community model. Both of these linear systems models helped focus future research and modeling efforts for the Outwelling Study. Summers and McKellar (1979) proposed four major subsystems (water column, intertidal marsh, subtidal benthic, and oyster reef) with forcing functions that influence material and energy exchanges, metabolism, trophic transfers, etc. Subsystem coupling and net exchange of energy with the coastal ocean were the foci. Additional iterations of this model are given in Summers et al. (1980), and Summers and McKellar (1981a,b). Dame and Patten (1981) proposed a model for energy flow within a typical oyster reef.

These earliest models served to bring structure, through compartmentalization, to simplify thinking about how a coastal estuarine system like North Inlet interacted with the adjacent ocean. The models also promoted ideas about how different compartments within North Inlet interacted before their collective outputs could be summed to test which were most important in the outwelling process. Subsequent sampling designs and measurements of various constituents of interest relevant to outwelling fluxes were made more efficient by running these models. A major outcome was that new studies were proposed and conducted based on gaps in our knowledge generated by the models. The Bly Creek Study of the marsh surface and research on oyster reefs as functioning ecosystems themselves resulted from the modeling effort. Once data were collected for these subsystems within the marsh rather than for the marsh as a whole, more detailed and comprehensive models were constructed

incorporating the newer data. For instance, a model of interactions between phytoplankton, zooplankton, nutrients and other aspects of water column dynamics was presented by Childers and McKellar (1987). For material flux measurements related to the outwelling hypothesis, Spurrier and Kjerfve (1988) used statistical models to tighten confidence intervals around measured fluxes. Kjerfve et al. (1991) modeled water flux in North Inlet. Asmus and McKellar (1989) used an input-output analysis to model fluxes of energy in North Inlet, and Childers et al. (1993b) used a tidal hydrology model to create a dynamic budget for carbon, nitrogen, and phosphorus in several subsystems of North Inlet.

While the Outwelling Study and its related follow-up multi-researcher programs were underway, additional researchers examining smaller scale, but ecologically relevant phenomena within North Inlet included models in their work. For example, Grant (1981c) modeled shorebird predation on their amphipod prey. Aller and Yingst (1985) measured diffusion from animal burrows and modeled porewater distributions. Coull (1986) discussed how changes in sampling frequency in a time-series can be modeled statistically to reduce prediction error for future harpacticoid copepod population abundance estimates. In a follow-up study, Edwards and Coull (1987) provided an example of the use of autoregressive trend analysis for this purpose. Issues related to recruitment of crustacean larvae into coastal marshes were discussed in a model by Christy (1989).

Studies of primary productivity often include physiological models of how external factors influence production rates. Coutinho and Zingmark (1987) examined the photosynthetic response of benthic macroalgae in response to changes in sunlight. Based on earlier methodological aspects of constructing photosynthesis – irradiance curves, Pinckney and Zingmark (1993b) modeled annual production of microalgae in North Inlet, an estimate that was elaborated in greater detail by Pinckney et al. (1994a). The annual productivity of the epiphytic community living on *Spartina alterniflora* was estimated by Jackson et al. (2009) using published models of photosynthesis and irradiance (P vs I) relationships.

Several researchers interested in the dynamics between nutrient salts, organic matter, and porewater fluxes in the salt marsh also used models to study this relationship. A steady-state numerical model of the vertical concentration profiles for organic matter and other components in marsh sediments was described in detail by Gardner (1990). An idealized model simulation of salt marsh sediments was constructed to calculate salt and water balances for North Inlet by Morris (1995). Gardner (2005) proposed a model of how porewater moves through the marsh into tidal creeks and how this flow may offer better growth conditions for plants at the edges of these creeks. Continuing the examination of pore water flow through the marsh, Gardner and Wilson (2006) compared two different model structures to deduce that soil compression is an important factor in this process. Wilson and Gardner (2006) also modeled the effects of the tide on groundwater flow and solute exchanges in the marsh. Stratigraphic changes in marsh sedimentation and belowground carbon storage were examined using two different models by Mudd et al. (2009). Wilson and Morris (2012) employed numerical models to study how porewater exchange is affected by tidally-driven groundwater flow exchanges in the salt marsh.

With global climate change concerns about the ability of salt marshes to maintain their position relative to sea level rise, Mudd et al. (2004) developed a one-dimensional model specifically for *Spartina alterniflora* salt marshes. It incorporated data from North Inlet on sedimentation, hydrodynamics and plant community evolution. Dame et al. (1992) had earlier created an interesting model of the spatial and temporal evolution of salt marsh estuarine ecosystems. Another study of marsh elevation was conducted by Morris et al. (2005). They combined LIDAR images into a trained artificial neural network to characterize elevation in portions of the marsh populated by different plant species, all relative to sea level.

The most recent model of water flow within North Inlet by Traynum and Styles (2008) examined

the interplay between tides, wind stress, and freshwater discharge to illustrate how flow in the interface between North Inlet and Winyah Bay is affected.

Comparative modeling studies incorporating pollution concerns have also been done. Porter et al. (1996) applied the Agricultural Non-point Source Pollution (AGNPS) model with GIS input for the Oyster Landing watershed in North Inlet. The AGNPS model was also used by Vernberg et al. (1999) to compare North Inlet and Murrells Inlet. The fecal coliform load was examined for Murrells and North Inlets to detect how a change from septic tanks to a municipal sewage system in Murrells Inlet affected water quality (Nelson et al., 2005). The regression models they utilized showed positive gains (decreased concentrations) in this parameter as a result of this intervention and no change in North Inlet's water quality, even when the new Baruch Marine Field Laboratory was constructed.

Porter et al. (2004) provided a model for how data collected during environmental monitoring programs such as the NERRS SWMP should be managed. They suggested that failure to do so effectively can compromise a long-term program's scientific integrity and future value.

Modelling efforts continue to be an integral part of understanding how various processes interact to influence important ecological and biogeochemical factors in the North Inlet-Winyah Bay landscape. Output from these models will inform future coastal development and management decisions, especially as coastal development activities and sea level continue to rise.

In summary, the research trajectory at North Inlet has been, first, discovery-type studies (e.g., what is here and how does it change over time), then one of big-picture, large spatial scale quantitative studies (e.g., testing the outwelling hypothesis) followed by modeling efforts that guided additional reductionist studies (e.g., Bly Creek, oyster reef studies). These multi-investigator programs resolved many mechanistic and physiological/metabolic questions about how the inner workings of the salt marsh translated into functional coupling with the coastal ocean. These studies were integral in identifying gaps that needed studies of physical flow, tidal effects, and how marsh sedimentation is impacted by sea-level rise. These major inquiries into how the marsh functions have been constantly punctuated and complemented by single-investigator and small-team investigations that have examined the functional and rate dynamics of primary and secondary productivity, predation and population dynamics, nutrient fluxes, pollutant impacts, and geochemistry. Other major research thrusts have examined the physiographic evolution of the salt marsh elevational landscape and dynamic temporal changes in various biotic and abiotic variables achieved mainly through long-term monitoring efforts. Scales of interest have included tidal periods, diel cycles, spring-neap asynchronies, seasonal shifts, annual average states, and even decadal trends in some climate-related variables. This monitoring continues today and likely has among the highest sampling frequency and longest duration of any similar monitoring programs at other NERR sites. The broadly-based, coordinated monitoring programs have already promoted studies of why such large community-level changes occur – especially at the seasonal and between-year scales – and an examination of the role of nutrient regeneration within the system as it drives overall marsh productivity. Researchers have only recently begun to ask whole system questions about how the marsh processes energy over long periods of time (e.g., is it net autotrophic or net heterotrophic?).

Future studies should build on the broad base of knowledge generated thus far to help resolve the coastal management-related questions of what ecological processes and functions are most necessary to protect if this salt marsh habitat and its culturally-relevant resources are to remain in a sustainably near- or relatively-pristine state. New comparative studies in the more impacted Winyah Bay will serve to emphasize how differently aquatic resources respond to perturbations, be they anthropogenically- or climate/weather-induced. The NI-WB NERR will also continue in its critical role in nurturing future generations of coastal ecologists whose job trajectories will naturally intersect with societal issues that are sure to emerge as economic

and climate-change pressures continue to impinge on the ecological value of this nation's diverse coastal habitats. Its educational programs can positively impact all future generations of learners and enlist their assistance in promoting and projecting an awareness of how the coastal environment affects our quality of life.

The NI-WB NERR will continue in its critical role in nurturing future generations of coastal ecologists.

Research Needs and Priorities

With researchers from so many different disciplines conducting work in the NI-WB NERR, it is difficult to compile a list that differentiates between what types of studies people want to do, and what types of studies need to be done. However, given the knowledge base that exists in published studies, identification of gaps in our knowledge, and the comprehensive database that has been compiled from long-term monitoring work, certain disciplinary tendencies stand out for inclusion on a list of research needs. Accomplishing the needs is another matter entirely.

All scientific research depends on the successful blending of personnel, funding, and facilities. The NI-WB NERR can offer some of each component of this triumvirate - outstanding field and laboratory facilities, several highly skilled personnel, and a modest budget. In reality, when new researchers arrive on-site, they tend to either move on relatively quickly or stay to pursue their interests more deeply over a much longer period of time. Maintaining a critical mass of investigators who generate grant funding is a key to keeping a laboratory facility running in a sustainable manner, not to mention keeping long-term, time-series measurements uninterrupted.

As for the types of research needed, theory-based, hypothesis-driven, and manipulative studies must be included. Long-term monitoring efforts and short, one-time surveys are important to maintain, but curiosity-driven research must also be encouraged, because the more research that is done, the greater the number of new questions that arise. Good science begets more good science, and ecological modeling provides direction and guidance in many cases. The following unprioritized list of needed research is offered with the hope of stimulating intellectual interest and inspiring a commitment among investigators to apply for the additional fiscal resources needed from funding agencies.

Table 13. Research needs at the North Inlet-Winyah Bay National Estuarine Research Reserve.

- Process-oriented studies on sources, sinks, and turnover rates of inorganic and organic carbon and nutrients in the water column and sediments (i.e. key ecosystem rate data are almost entirely lacking for North Inlet and Winyah Bay)
- Identification of processes that control natural hydrology of the North Inlet and Winyah Bay watersheds, including the relative roles of surface and groundwater flows, and the ecological impacts of changing hydrology associated with coastal development (increases in water use, impervious surfaces and stormwater best management practices) and climate change
- Ecological modeling efforts that utilize existing long-term data and predict the impacts of long-term climate change and/or coastal development
- Updated assessment of contaminant (including emerging contaminants of concern and pharmaceuticals) sources and sinks in sediments and organisms and their ecological impacts
- Assessment of bacterial and viral pathogen sources and sinks, including the factors that influence their survival and growth, and the ecological and human-health risks of non-human fecal pathogens.
- Genomic and metabolomic studies to quantify microbial community assemblages and their dynamics in the water column and sediments
- Identification of physical and abiotic controls and regulators of temporal (tidal, seasonal and interannual) changes in ecosystem dynamics, trophic structure, and organism abundances
- Trophic analyses of most organisms, food web dynamics and carrying capacity studies
- Recruitment of vertebrates and invertebrates (including invasive species), both transient and resident: sources of larvae, survival/mortality, settlement timing/rates, post-settlement population dynamics
- Quantifying relationships between habitat structure and primary and secondary production
- Manipulative experiments to determine whether juvenile nekton and epibenthos use the marsh in an obligatory or facultative manner, i.e., clarify the nursery role of salt marsh estuaries
- Statistical modeling of long-term data sets to establish criteria for maintaining integrity of the time-series at reduced levels of sampling and identification effort
- Phytoplankton and microzooplankton community dynamics and trophic interactions
- Multibeam sonar assessments of motile fauna movements and size composition at representative bottlenecks or thresholds into and out of the marsh
- Impact of nearshore, coastal ocean biogeochemical processes and flow on North Inlet's role in the coastal ecosystem
- High resolution bathymetric maps throughout North Inlet and Winyah Bay
- Identification of sources of sediment and organic matter and their accumulation rates on the marsh surface as sea-level changes in the future
- Determination of current rates of salt marsh carbon sequestration and identification of physical controls and ecological processes regulating carbon sequestration capacity
- Renewed/expanded sampling efforts in Winyah Bay, which has been severely under-studied with respect to hydrology, water quality, biology and ecology.
- Documentation of turtle and marine mammal use of Winyah Bay and North Inlet
- Bird surveys and studies of their energy and nutrient fluxes; what changes when migratory species are abundant?

Table 13 continued.

- Assessment of and research on archaeological sites (in conjunction with the Baruch Foundation)
- Archival research: more effective preservation, storage, and cataloging of biological specimen collections
- Development of identification keys to larval organisms via laboratory rearing efforts and genetic affinities with adult forms (e.g., DNA typing)
- Social science and economic studies on the market and nonmarket value of key coastal habitats and resources, including the integration of ecological and economic modeling to forecast socio-economic impacts of habitat degradation and overuse of coastal resources as well as the links between resource use and ecosystem sustainability

Given the NI-WB NERR's value as an un-degraded, natural site, its current though limited capabilities in technology and research infrastructure, its extensive databases and publications from site-based research, its capacity (personnel, equipment, etc.) for taking on additional research efforts, and budgetary issues, several items rise to the top tier of the list, each having equally compelling, though different, justifications. Prioritizing the list of research needs is a matter of practicality and cost. Some of the listed needs are less expensive, less labor-intensive, do not require facilities or equipment beyond what is already available, and will take less time to accomplish. Others will require a team approach for a major new research initiative that will take a considerable amount of time and funding.

» Disciplinary Priorities

What follows is an attempt to identify what might be the most important disciplinary priorities for future research efforts at the NI-WB NERR and Baruch Marine Field Laboratory. These are organized according to the sub-disciplines of science recognized by most coastal researchers.

PHYSICAL SCIENCES

Renewed sampling efforts in Winyah Bay; this estuary is severely under-sampled for toxicants, nutrients, primary producers, and all faunal categories. Also needed is a better assessment of the riverine influences on the dynamics and health of both North Inlet and Winyah Bay.

Justification Flow dominates the ecology of Winyah Bay. Freshwater discharge into Winyah Bay and flows into North Inlet will change as climate change takes place. We need to understand the influences of these inputs/outflows on water quality, chemistry, and community changes within both estuaries to understand and mitigate impacts of future climate change.

CHEMICAL SCIENCES

Identification of sources, sinks, and turnover rates of inorganic and organic nutrients and materials in the water column and sediments.

Justification Understanding chemical and microbial processes and their relationships to plant and animal ecology is essential; this requires modeling and biogeochemical expertise.

GEOLOGICAL SCIENCES

Identification of sources of sediment and organic matter and their accumulation rates on the marsh surface as sea-level changes in the future.

Justification Research regarding relationships between these forces and plant productivity is translatable and can be a model for many other at-risk coastlines, nationally and globally.

BIOLOGICAL SCIENCES

Development of relevant DNA probes to monitor changes in the microbial community in the water column and sediments.

Justification Microbial processes drive many biological patterns and trends observed in time-series observations. We need to understand how/why changes in microbial community structure are driven.

ECOSYSTEM SCIENCES

Determination of spatial and temporal variations in habitat quality for economically and ecologically important species and how the growth, reproduction, feeding, movements, and abundances of these organisms relate to the abiotic and biotic features of the habitat.

Justification In light of changing temperature, salinity, sea level and other climate-related factors, estuarine habitats are changing and affecting populations and communities. Information is needed to inform the future management of habitats and associated fauna, including those considered to be harvestable resources.

SOCIAL SCIENCES

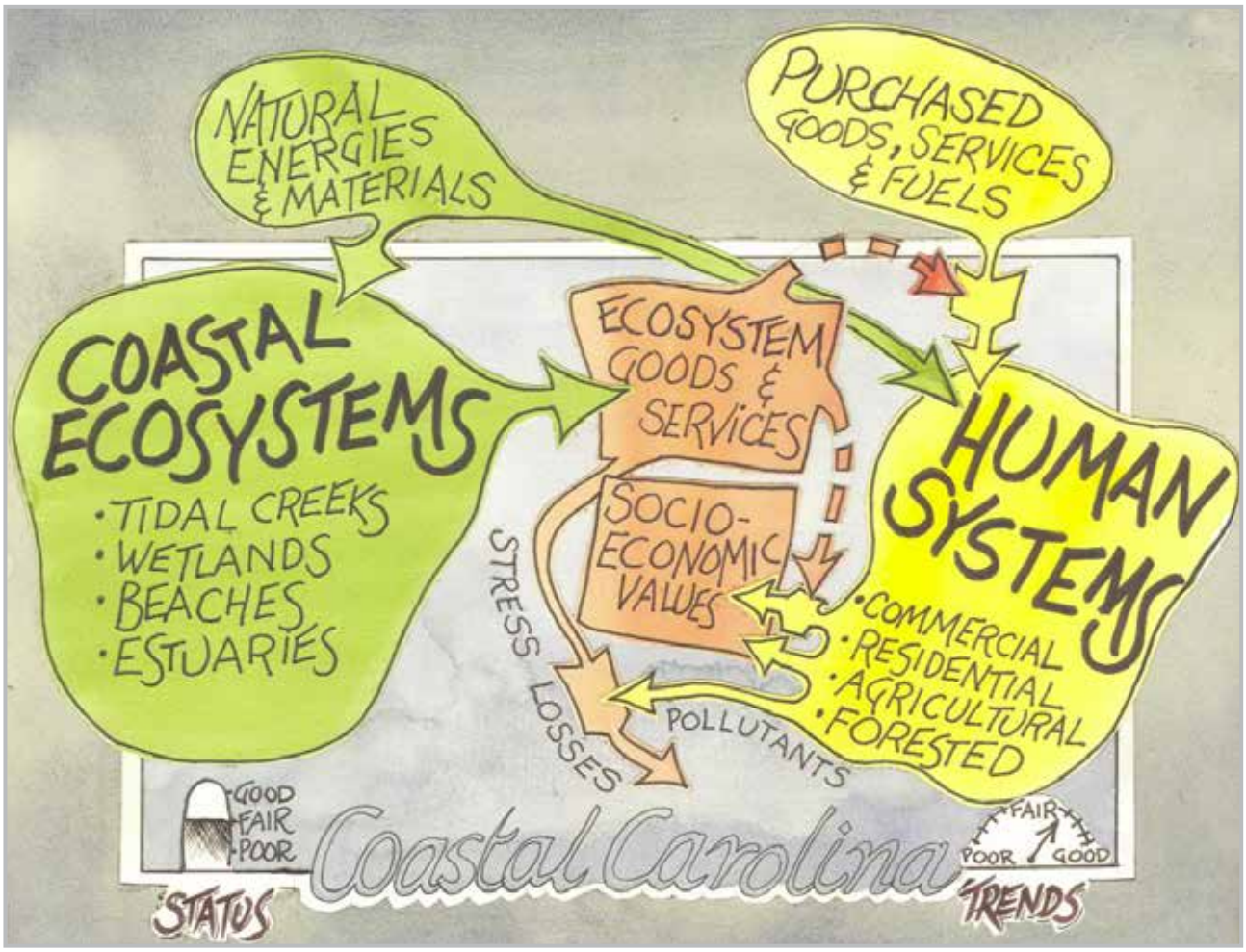
Communicating the value of research in the above disciplines to the public and all immediate stake-holders is of paramount importance in sustaining the NI-WB NERR. As social media and technology evolve, so must educational mechanisms evolve. Making the value, both economic and aesthetic/recreational, of scientific research known more broadly is key.

Justification Without public support, federally-funded efforts will wither and die. The expertise of social scientists with deep knowledge of existing societal trends and attitudes and how these are shaped is needed to support the efforts of the National Estuarine Research Reserve program. A blending of and partnerships between social and natural scientists is required to achieve this long-term objective.

Although North Inlet and, to a lesser extent, Winyah Bay have been studied by research scientists for at least four decades, the status of our knowledge remains incomplete and insufficient to provide all of the insights, projections, and recommendations that coastal managers need. The research needs and priorities listed above identify a path toward filling some major gaps in our knowledge; however, collaborations between researchers, educators and managers will be necessary to achieve our common goal for a balanced, productive, and healthy future for all coastal ecosystems.

Linking Science to Coastal Management

South Carolina's coast is known for its expansive marshes and beaches, abundant recreational opportunities, and vacation destinations. However, its coastal ecosystems and water quality are increasingly challenged by rapid development. Historically, the land areas surrounding NI-WB NERR, including Georgetown and Horry counties, have been defined by their rural character, relying upon agricultural and timber production as economic mainstays. As Myrtle Beach has been realized as a vacation and retirement destination, undeveloped landscapes throughout the Grand Strand have been converted into golf course communities, vacation resorts, and commercial establishments to support a rapidly growing tourism industry. Development, especially along scenic waterways and beachfronts, has fragmented and changed ecosystems, altered surface and groundwater hydrology, and impacted water quality. The same coastal resources that so many enjoy for their aesthetic quality, recreational amenities, and for their livelihoods are threatened by the compounded impacts of increased development and consumptive uses. Scientific research and long-term monitoring are necessary to understand the complex interactions between human systems and coastal ecosystems. Research performed by the NI-WB NERR can help improve the understanding of the impacts of increased development on coastal ecosystems, while also informing future policy and management.



The broad conceptual model of the interactions between the human systems and the coastal ecosystems. From Devoe and Sanger (2009)

» Ecosystem-Based Management

Science, monitoring, and management all play a role in the overall success of enhancing and maintaining healthy coastal ecosystems. Current environmental policies were established with the best available scientific information and prevailing politics at the time. "However, scientific discovery is rapidly evolving, new tools are always in development, and oftentimes new information negates old information. Furthermore, access to relevant information can be difficult. Therefore, past decisions may not coincide with today's best available knowledge, and may have led to adverse conditions in coastal regions" (Chasse, 2009). There remains a need for new, locally-based research and long-term monitoring to improve the understanding of how coastal systems are responding to natural phenomena and current management practices. The relatively pristine NI-WB NERR serves as a control site that researchers can use for comparative studies of similar sites in developed watersheds.

A range of research and monitoring activities at the NI-WB NERR and the USC Baruch Marine Field Laboratory, in addition to the efforts of Clemson's Baruch Institute for Coastal Ecology and Forest Science and Coastal Carolina's Center for Marine and Wetland Studies, provide information about the relative health of South Carolina's northeastern coast. These in turn provide a rational basis for updating existing and establishing new policies and best management practices that more effectively protect coastal resources.

» Aligning Research and Management

The NI-WB NERR Management Plan outlines three priority issues in which to focus research, education, and stewardship activities through 2016, including improving understanding of the:

- Impacts of coastal growth on water and habitat quality and ecological communities;
- Impacts of naturally occurring short-term, stochastic and long-term, large-scale climate events on coastal ecosystems and human communities;
- Impacts of invasive species and habitat loss on biodiversity (NI-WB NERR Management Plan, 2011).

These priority issue areas align with the NERRS Strategic Plan and the current funding priorities of the NERR System and will not likely change in the coming years. These priority issues have strong management implications and will drive research activities at the Reserve. Other locally-relevant research findings associated with these issue areas are shared with coastal decision-makers in and around the Reserve as well.

Partner research institutions and funding sources have also identified research priorities that align with the Reserve's priority issue areas. A report compiled by the South Carolina Sea Grant Consortium indicated four specific areas in which to focus future research in the South Carolina coastal zone, including improving understanding of (1) land use/land cover changes, focusing on impervious cover, (2) stormwater pond system dynamics, (3) hydrological changes and resultant pollutant loads and hydrodynamic changes, and (4) ecosystem "goods and services" (Devoe and Sanger, 2009). These research needs have been identified to understand how projected development activities will impact coastal ecosystems, human health and well-being, and account for the effects and interactions of climate change in South Carolina (Devoe and Sanger, 2009). Research findings associated with the priority areas have the ability to inform land use management practices and coastal resource protection.

Research and long-term monitoring is often pursued to answer a research question being asked by a scientist or to keep a pulse on the health of a particular system. Rarely do scientists seek the input of coastal decision-makers to identify research priorities. Coastal decision-makers often rely on healthy coastal resources to support their jobs and their communities, whether they realize it or not. Coastal decision-makers include, but are not limited to:

- Elected and appointed officials (e.g. council members or planning commissioners);

- Local government staff (e.g. planners, public works staff, stormwater engineers, and water and waste water engineers);
- State and federal government representatives (e.g. coastal management staff, ecologists and restoration practitioners, and land managers);
- Development and real estate professionals (e.g. architects, landscape architects, developers, real estate agents);
- Conservationists (e.g. land trusts and owners of large tracts of land); and
- Residential managers (e.g. property managers, homeowners associations, and landscapers).

While the scientific research needs of these varying groups are not necessarily the same, each can benefit from new and emerging research to help them manage their community, neighborhood, or watershed. Through interaction with Reserve staff, coastal decision-makers in the northeastern coast of South Carolina have identified a number of research needs that could inform their management practices and policies. This list is not fully encompassing of local research needs, but provides examples of the type of research that can inform future policy and management in and around the Reserve:

- **Water Quality Protection**
  - Pollutant removal effectiveness of existing stormwater management practices vs. low impact development practices
  - Effectiveness of stormwater pond management strategies (e.g. vegetated buffers, dredging, floating wetlands, aeration)
  - Water supply and waste water management in coastal watersheds under a changing climate
- **Habitat Protection**
  - Presence of and changes in invasive species, both aquatic and terrestrial, under existing and future conditions
  - Prioritizing coastal land conservation strategies in the light of climate change
  - Impacts of offshore wind and transmission lines on coastal ecosystems in Winyah Bay
- **Climate Change and Coastal Hazards**
  - Beach and estuarine shoreline change
  - Effectiveness of shoreline stabilization practices (e.g. groins, beach nourishment, living shorelines)
  - Sea level rise threats to stormwater management and development
  - Socio-economic vulnerability of coastal populations to hurricanes and sea level rise

» Science Communication and Translation

Scientists and decision-makers serve inherently different roles in protecting coastal ecosystems, with each having its own set of values, interests, concerns, and perspectives (Jacobs et al., 2005). In turn, scientific research findings are not typically made available in a form that is useful to decision-makers, nor are research projects typically tailored to meet the information needs of coastal decision-makers. Many grant opportunities are now requiring researchers to incorporate outreach as a component of their work, but most scientists are not trained to effectively communicate with non-scientists. Researchers often propose to present their findings to decision-makers at seminars, workshops, or conferences, where they typically convey their results through complex graphs and terminology. Additionally, they speak in terms of accuracy and highlight a number of caveats, which may undermine their credibility among non-scientists. In some cases, researchers develop products and tools, such as brochures and websites, to convey their findings, but they fail to verify their utility with their intended users, if they even know who their intended users encompass (Jacobs, 2002). The complexity of research findings to a non-scientist often makes decision-makers weary of asking clarifying questions in a public forum or basing policy on seemingly uncertain data. This results in a great deal of federal funding being spent on research without tangible or measurable societal benefits (Jacobs, 2002). Because scientists do not typically have formal training in communicating with non-scientists, natural science researchers

can benefit by partnering with social scientists and outreach specialists to ensure that their messages are properly conveyed to coastal decision-makers and the public.

» Reaching Decision-Makers through Education and Training

A number of agencies and organizations recognize the value of coastal education and training as a means to convey science-based information to coastal decision-makers (Chasse, 2009). In an effort to promote more informed and confident coastal decision-making, the NERRS established a Coastal Training Program (CTP) system-wide that is implemented in all 28 reserves and serves local decision-makers. The NI-WB NERR launched its CTP in 2003. The CTP at the NI-WB NERR provides training opportunities and technical assistance based on needs identified by local decision-makers. This information is generated in formal audience needs assessments such as one conducted by the NI-WB and ACE Basin NERRs (Pollack and Szivak, 2007), workshop evaluations, and informal discussions with stakeholders. The CTP shares current science on priority issues, increases audience understanding of the environmental, social, economic, and policy consequences of human activities, and facilitates interaction among stakeholders. The NI-WB CTP provides a variety of programs centered on land-use management, water quality protection, habitat conservation and restoration, and coastal hazards and climate change. Programs target a range of audiences, such as elected and appointed officials, developers, land-use planners, engineers, environmental non-profits, regulators, business and applied scientific groups. Typically, training programs provide opportunities for professionals to network across disciplines and develop collaborative relationships to solve complex environmental problems. The NI-WB CTP also provides a forum for professional audiences to inform local and regional science and research agendas. Programs are developed in a variety of formats, including seminars, skill-based training, participatory workshops, and field-based learning and demonstration projects. Whenever possible, training is based on local case studies to maximize the relevancy of research and monitoring occurring in South Carolina's northeastern coast.

Improving the management and use of coastal resources and services is vital to ensuring that healthy coastal ecosystems are protected and sustained. The NI-WB CTP has extensive experience developing meaningful programs that are designed to fulfill a specific local education need. Scientists are encouraged to contact the Reserve to discuss opportunities to share their research with coastal decision-makers. Table 14 lists a few examples of past trainings that have included locally-based research.

The Coastal Training Program works with partners, like Clemson Extension, to teach local decision-makers about innovative stormwater management practices.

Table 14. Examples of past Coastal Training Program trainings that have included locally-based research. For more information on past CTP events, visit: **http://www.northinlet.sc.edu/training/past_events.html**.

Isolated Wetlands: Roles, Regulations, and Rulings Workshop

Isolated wetlands are dynamic hydrologic systems that recharge groundwater, filter pollutants, and provide habitat for numerous species in the coastal zone. This half-day workshop for engineers, planners, regulators, and special interest groups highlighted the ecological role of isolated wetlands in coastal South Carolina and informed the participants about wetland regulations and recent court rulings associated with defining their jurisdiction. This training involved research faculty from USC and representatives of the US Army Corps of Engineers, the South Carolina Environmental Law Project, and the EARTHWORKS Group.

Drought and Salinity Intrusion in the Coastal Yadkin-Pee Dee Basin

Saltwater intrusion is a threat to water suppliers and conservation practices in the coastal Yadkin-Pee Dee river basin. During this half-day day workshop for water suppliers and natural resource managers, researchers presented hydrologic and climatic models that served as the basis for the development of a decision-support tool that projects how coastal drought and sea level rise may impact water supplies and coastal ecosystems in this region. Researchers from Carolinas Integrated Sciences and Assessments (CISA), SC/NC Sea Grants, the University of South Carolina, and the US Geological Survey contributed to this event. Through this workshop the researchers also received feedback on effective ways to tailor their tools to meet their intended-user's needs.

LID in Practice: Case Studies from Hobcaw Barony

Low impact development (LID) attempts to mimic the natural hydrology of a site through the use of stormwater best management practices (BMPs). This ¾ day training included classroom and field-based instruction centered on site design, meeting local regulations, pervious paving alternatives, and bioretention cells, including design, media, plants, and monitoring results. The workshop included a walking tour of BMPs at Hobcaw Barony and offered resources to help local communities implement these pollution control measures. This partnered program with the Coastal Waccamaw Stormwater Education Consortium, Carolina Clear, and Clemson's Restoration Institute included presentations by University of South Carolina and Clemson University scientists and a representative from a company that manufactures LID products.

» Lessons Learned

A number of important lessons can be distilled from the CTP's past experience. Local decision-makers turnover regularly, and it is important to repeat select training topics and concepts—either as a mantra to be repeated at the beginning of each event on the subject matter or as independent, easily-repeatable training programs or pre-packaged sessions. While this does not easily allow for new science to be conveyed, it provides a baseline of knowledge among local decision-makers. Additionally, the constant turnover of elected and appointed officials should be considered when bringing new management and policy considerations to the table, especially if it is an election year. Furthermore, local governments establish their budgets well in advance; therefore any requests for funding should be thoroughly thought through and presented many months in advance. Training experience has also affirmed the importance of couching coastal environmental issues in socioeconomic terms. While it is important to promote science-based decision-making, CTP recognizes that this tourism- and development-driven region relies on healthy coastal ecosystems to drive its economy.

» Additional Education Providers

There are a variety of other education providers that work with local government staff and officials to improve the understanding and management of coastal resources. The Coastal Waccamaw Stormwater Education Consortium (CWSEC) and the South Carolina Coastal Information Network (SCCIN) serve as overarching education groups for the northeastern coast of South Carolina. The CWSEC includes representatives from Clemson's Carolina Clear Program, Coastal Carolina University's Waccamaw Watershed Academy, Murrells Inlet 2020, the NI-WB NERR Coastal Training and Education Programs, South Carolina Sea Grant Consortium, and the Waccamaw Riverkeeper, all of which provide water quality outreach and education to local governments in Georgetown and Horry counties. Local government education is provided to stormwater managers, planners, public works staff, and locally elected and appointed officials through workshops and seminars, in addition to one-on-one technical assistance with locally appointed stormwater advisory committees. Education topics often include ways to reduce non-point source pollution and stormwater pond management. Education programs on watersheds and water quality are also provided to K-12 students who will become the decision-makers of tomorrow and indirectly influence their adult caretakers today. For more information on the CWSEC, visit: **cwsec-sc.org**. The SCCIN is also a consortium of education providers, local governments, and locally-based federal agencies from throughout coastal South Carolina. Like those involved in the CWSEC, the SCCIN members work in partnership to enhance coordination of the coastal community outreach efforts in South Carolina on a variety of environmental issues. This organization was established for the purpose of maximizing the efficient delivery of quality training and educational material to coastal decision-makers, community planners, local officials, and the public. More information on the SCCIN can be found at: **www.sccoastalinfo.org**. The education providers with both the CWSEC and the SCCIN are great at connecting coastal research to decision-makers through education materials, tools, seminars, workshops, and demonstration projects. The NI-WB and ACE Basin NERRs also coordinate and collaborate on coastal training events on topics of mutual relevance to decision-makers in their target communities.

» Integrating Scientists and Managers through Collaborative Learning

Overcoming communication barriers and meeting the research needs of coastal decision-makers is not an easy task. In order for science to be useful in a decision-making process, it has to be relevant to answering a specific policy question, must be accessible and easily understood in a management context, come from a trusted source, and be presented at an appropriate time in the decision-making process (Jacobs et al., 2005). Scientists, planners, regulators, and policy makers can all

benefit from sharing their diverse perspectives on a particular environmental concern prior to initiating a new research project or establishing new policies or guidelines. The Collaborative Learning Guide for Ecosystem Management defines an interdisciplinary approach to understand complex environmental issues, bringing together key ideas from complex systems theory, conflict theory and adult learning theory to design and implement solutions to environmental problems (Fuert, 2008). The NI-WB NERR is currently applying such processes through two NERRS Science Collaborative funded projects. One project has brought together state and local water quality researchers and municipal and county stormwater engineers and planners to design a water quality monitoring project occurring in two swashes in the Grand Strand. Another project is currently bringing together diverse opinions of engineers, planners, developers, and researchers to develop a low impact development manual for coastal South Carolina. While these projects have varying goals, they have both brought together scientific researchers with applied scientists and managers to resolve a water quality concern in coastal South Carolina. Establishing relationships in the community and with intended users is especially important for ensuring the success of these projects. Through early interaction in a project, scientists and decision-makers gain a better understanding of a management concern and can work together to protect a coastal resource which they mutually value. Such collaboration will result in greater acceptance of research findings in the end, thus, having a greater likelihood to inform policy and management practices. The Coastal Training Program and partnering education providers, due to their established relationship in the community and experience as facilitators, play a key role in the success of this type of integration and can provide similar assistance to help others bridge the gap between scientists and coastal decision-makers.

Swashes are relic tidal creeks in the Grand Strand, which now serve as conduits for stormwater into the ocean. Scientists are working with local decision-makers to better understand the role of swashes in hypoxia formation in coastal waters.

References

Abel, D. C., R. F. Young, J. A. Garwood, M. J. Travaline, and B. K. Yednock. 2007. Survey of the shark fauna in two South Carolina estuaries and the impact of salinity structure. Pp. 109-124 in C. T. McCandless, N. E. Kohler, and H. L. P. Jr., (eds.) Shark nursery grounds of the Gulf of Mexico and the East Coast waters of the United States. American Fisheries Society

Able, K.W., D.M. Allen, G. Bath-Martin, J.A. Hare, D.E. Hoss, K.E. Maranicik, P.M. Powles, D.E. Richardson, J.C. Taylor, H.J. Walsh, S.M. Warlen, and C. Wenner. 2011. Life history and habitat use of the speckled worm eel, *Myrophis punctatus*, along the east coast of the United States. Environmental Biology of Fishes 92(2): 237-259

Aelion, C.M., and M.R. Engle. 2010. Evidence for acclimation of N cycling to episodic N inputs in anthropogenically-affected intertidal marsh sediments. Soil Biology and Biochemistry 42: 1006-1008

Aelion, C.M., J.N. Shaw, and M. Wahl. 1997. Impact of suburbanization on ground water quality and denitrification in coastal aquifer sediments. Journal of Experimental Marine Biology and Ecology 213: 31-51

Agosta, K. 1985. The effect of tidally induced changes in the creek bank water table on pore water chemistry. Estuarine, Coastal and Shelf Science 21: 389-400

Allen, D.M. and D.L. Barker. 1990. Interannual variability in larval fish recruitment to estuarine epibenthic habitats. Marine Ecology Progress Series 63: 113-125

Allen, D.M., S.E. Stancyk, and W.K. Michener (eds.). 1982. Ecology of Winyah Bay, SC and Potential Impacts of Energy Development. Baruch Institute Special Publication No. 82-1. Belle W. Baruch Institute for Marine Biology and Coastal Research, University of South Carolina, Columbia, SC, 275 pp.

Allen, D.M., W.K. Michener, and S.E. Stancyk. 1984. Pollution Ecology of Winyah Bay, SC: Characterization of the Estuary and Potential Impacts of of Petroleum. Baruch Institute Special Publication No. 84-1. Belle W. Baruch Institute for Marine Biology and Coastal Research, University of South Carolina, Columbia, SC, 271 pp.

Allen, D.M., S.K. Service, and M.V. Ogburn. 1992. Factors influencing the collection efficiency of estuarine fishes. Transactions of the American Fisheries Society 121: 234-244

Allen, D.M., W.S. Johnson, and V. Ogburn-Matthews. 1995. Trophic relationships and seasonal utilization of salt-marsh creeks by zooplanktivorous fishes. Environmental Biology of Fishes 42: 37-50

Allen, D.M., D. Edwards, R.J. Feller, S.E. Hutchinson, and V. Ogburn-Matthews. 1996. Detection and analysis of unusual events in long-term zooplankton and nekton datasets from North Inlet Estuary, South Carolina, U.S.A. Oceanologica Acta 20(1): 165-175

Allen, D.M., S.S. Haertel-Borer, B.J. Milan, D. Bushek, and R.F. Dame. 2007. Geomorphological determinants of nekton use in intertidal salt marsh creeks. Marine Ecology Progress Series 329: 57-71

Allen, D.M., V. Ogburn-Matthews, T. Buck, and E.M. Smith. 2008. Mesozooplankton responses to climate change and variability in a southeastern U.S. Estuary (1981-2003). Journal of Coastal Research 55: 95-110

Allen, D.M., S.A. Luthy, J.A. Garwood, R.F. Young, and R.F. Dame. 2013. Nutrient subsidies from nekton in salt marsh intertidal creeks. Limnology and Oceanography 58: 1048-1060

Aller, R.C., and J.Y. Aller. 1998. The effect of biogenic irrigation intensity and solute exchange on diagenetic reaction rates in marine sediments. Journal of Marine Research 56: 905-936

Aller, R.C., and J.Y. Yingst. 1985. Effects of the marine deposit-feeders *Heteromastus filiformis* (Polychaeta), *Macoma balthica* (Bivalvia), and *Tellina texana* (Bivalvia) on averaged sedimentary solute transport, reaction rates, and microbial distributions. Journal of Marine Research 43: 615-645

Aller, R.C., J.Y. Yingst, and W.J. Ullman. 1983. Comparative biogeochemistry of water in intertidal *Onuphis* (Polychaeta) and *Upogebia* (Crustacea) burrows: temporal patterns and causes. Journal of Marine Research 41: 571-604

Alon, N.C., and S.E. Stancyk. 1982. Variation in life-history patterns of the grass shrimp *Palaemonetes pugio* in two South Carolina estuarine systems. Marine Biology 68: 265-276

Ansede, J.H., and D.C. Yoch. 1997. Comparison of selenium and sulfur volatilization by dimethylsulfoniopropionate lyase (DMSP) in two marine bacteria and estuarine sediments. FEMS Microbiology Ecology 23: 315-324

Apple, J.K., E.M. Smith, and T.J. Boyd. 2008. Temperature, salinity, nutrients, and the covariation of bacterial production and chlorophyll-*a* in estuarine ecosystems. Journal of Coastal Research 55: 59-75

Asmus, M.L., and H.N. McKellar Jr. 1989. Network analysis of the North Inlet salt marsh ecosystem. Pp. 206-219 in F. Wulff, J.G. Field, and K.H. Mann (eds.) Network Analysis in Marine Ecology: Methods and Applications. Springer-Verlag, Berlin

Ax, P. 1995. Two new *Promesostoma*-species (Rhabdocoela, Platyhelminthes) from the North Inlet salt marsh of Hobcaw Barony, South Carolina, USA. Microfauna Marina 10: 313-318

Baden, J. III, W.T. Batson, and R. Stalter. 1975. Factors affecting the distribution of vegetation of abandoned rice fields, Georgetown Co., South Carolina. CASTANEA, The Journal of the Southern Appalachian Botanical Club 40: 171-184

Bagwell, C.E., and C.R. Lovell. 2000a. Microdiversity of culturable diazotrophs from the rhizoplanes of the salt marsh grasses *Spartina alterniflora* and *Juncus roemerianus*. Microbial Ecology 39: 128-136

Bagwell, C.E., and C.R. Lovell. 2000b. Persistence of selected *Spartina alterniflora* rhizoplane diazotrophs exposed to natural and manipulated environmental variability. Applied and Environmental Microbiology 66: 4625-4633

Bagwell, C.E., Y.M. Piceno, A.L. Ashburne, and C.R. Lovell. 1998. Characterization of diazotroph assemblages from the rhizospheres of selected salt marsh grasses. Applied and Environmental Microbiology 64: 4276-4282

Bagwell, C.E., M. Dantzler, P.W. Bergholz, and C.R. Lovell. 2001. Host-specific ecotypic diversity of rhizoplane diazotrophs of the perennial glasswort, *Salicornia virginica* and selected salt marsh grasses. Aquatic Microbial Ecology 23: 293-300

Baker, O. E. 1999. The status of mink (*Mustela vison*) in South Carolina. South Carolina Department of Natural Resources. Furbearer Project Publication No. 99-01.

Baker, S.M., P. Baker, A. Benson, J. Nunez, E. Philips, E. and J. Williams. 2002. Biopollution by the green mussel, *Perna viridis*, in the southeastern United States. 2002 Progress Report. EPA Grant Number: R828898.

Baruch, B.M. 1957. Baruch My Own Story. Henry Holt and Company, NY.

Beckman, D.W., and J.M. Dean. 1984. The age and growth of young-of-the-year spot *Leiostomus xanthurus* (Lacepede) in South Carolina. Estuaries 7: 487-496

Behum, M.E., R.J. Brodie, and J.L. Staton. 2005. Distribution of juvenile *Uca pugnax* and *U. pugilator* across habitats in a South Carolina estuary, assessed by molecular techniques. Marine Ecology Progress Series 288: 211-220

Bell, J.L. 1988. Distribution and abundance of *Dissodactylus mellitae* Rathbun (Pinnotheridae) on *Mellita quinqueisperforata* (Leske) (Echinodermata). Journal of Experimental Marine Biology and Ecology 117: 93-114

Bell, J.L., and S.E. Stancyk. 1983. Population dynamics and reproduction of *Dissodactylus mellitae* (Brachyura: Pinnotheridae) on its sand dollar host *Mellita quinqueisperforata* (Echinodermata). Marine Ecology Progress Series 13: 141-149

Bell, S.S. 1979. Short- and long-term variations in a high marsh meiofaunal community. Estuarine and Coastal Marine Science 9: 331-350

Bell, S.S. 1980. Meiofauna-macrofauna interactions in a high salt marsh habitat. Ecological Monographs 50: 487-505

Bell, S.S. 1982. On the population biology and meiofaunal characteristics of *Manayunkia aestuarina* (Polychaeta: Sabellidae: Fabricinae) from a South Carolina salt marsh. Estuarine, Coastal and Shelf Science 14: 215-222

Bell, S.S., and B.C. Coull. 1978. Field evidence that shrimp predation regulates meiofauna. Oecologia 35: 141-148

Bell, S.S., and B.C. Coull. 1980. Experimental evidence for a model of juvenile macrofauna-meiofauna interactions. Pp. 179-192 in K. Tenore and B.C. Coull (eds.) Marine Benthic Dynamics. The Belle W. Baruch

Library in Marine Science Number 11. Univ. of South Carolina Press, Columbia, South Carolina.
Bell, S.S., and K.M. Sherman. 1980. A field investigation of meiofaunal dispersal: tidal resuspension and implications. Marine Ecology Progress Series 3: 245-249

Bell, S.S., M.C. Watzin, and B.C. Coull. 1978. Biogenic structure and its effect on the spatial heterogeneity of meiofauna in a salt marsh. Journal of Experimental Marine Biology and Ecology 35: 99-107

Benson, A. J. 2014. *Perna viridis*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=110 Revision Date: 1/8/2009

Bergin, M.E. 1981. Hatching rhythms in *Uca pugilator* (Decapoda: Brachyura). Marine Biology 63: 151-158

Bergquist, D.C., R.F. Van Dolah, G.H.M Riekerk, M.V. Levisen, S.E Crowe, L. Brock, D.I. Greenfield, D.E.Chestnut, W. McDermott, M.H. Fulton, E. Wirth and J. Harvey. 2009. The Condition of South Carolina's Estuarine and Coastal Habitats During 2005-2006: Technical Report. Charleston, SC: South Carolina Marine Resources Division. Technical Report No. 103. 74 pp.

Berke, S.K., and S.A. Woodin. 2008. Tube decoration may not be cryptic for *Diopatra cuprea* (Polychaeta: Onuphidae). Biological Bulletin 214: 50-56

Berke, S.K., M. Miller, and S.A. Woodin. 2006. Modelling the energy-mortality tradeoffs of invertebrate decorating behavior. Evolutionary Ecology Research 8: 1409-1425

Bernot, M.J., R.J. Bernot, and J.T. Morris. 2008. Nutrient cycling relative to $\delta^{15}N$ and $\delta^{13}C$ natural abundance in a coastal wetland with long-term nutrient additions. Aquatic Ecology doi:10.1007/s10452-008-9221-8

Beseres, J.J., and R.J. Feller. 2007a. Changes in the spatial distribution of subtidal macrobenthos due to predation by white shrimp (*Litopenaeus setiferus*). Estuaries and Coasts 30: 591-600

Beseres, J.J., and R.J. Feller. 2007b. Importance of predation by white shrimp *Litopenaeus setiferus* on estuarine subtidal macrobenthos. Journal of Experimental Marine Biology and Ecology 344(2): 193-205

Beseres-Pollack, J., R.M. Mroch III, and R.J. Feller. 2008. Juvenile white shrimp, *Litopenaeus setiferus*, predation on macrobenthic and zooplanktonic prey. Journal of Shellfish Research 27: 1247-1253

Bidleman, T.F., E.J. Christensen, and H.W. Harder. 1981. Chapter 24. Aerial deposition of organochlorines in urban and coastal South Carolina. Pp. 481-508 in A.A. Press (ed.), Atmospheric Input of Pollutants to Natural Waters. Eisenreich, Ann Arbor, Michigan.

Bidleman, T.F., A.A. Castleberry, W.T. Foreman, M.T. Zaranski, and D.W. Wall. 1990. Petroleum hydrocarbons in the surface water of two estuaries in the southeastern United States. Estuarine, Coastal and Shelf Science 30: 91-109

Bildstein, K.L. 1983. Age-related differences in the flocking and foraging behavior of white ibises in a South Carolina salt marsh. Colonial Waterbirds 6:45-53

Bildstein, K.L. 1984. Age-related differences in the foraging behavior of white ibises and the question of deferred maturity. Colonial Waterbirds 7: 146-148

Bildstein, K.L. 1987. Energetic consequences of sexual size dimorphism in white ibises (*Eudocimus albus*.) The Auk 104: 771-775

Bildstein, K.L. and M.W. Collopy. 1985. Escorting flight and agonistic interactions in wintering northern harriers. The Condor 87: 398-401

Bildstein, K.L., R. Christy, and P. DeCousey. 1982a. Size and structure of a South Carolina salt marsh avian community. Wetlands 2: 118-137

Bildstein, K.L., R.L. Christy, and P. DeCoursey. 1982b. Energy flow through a South Carolina shorebird community. Wader Study Group Bulletin 34: 35-37

Bildstein, K.L., W. Post, J. Johnston, and P. Frederick. 1990. Freshwater wetlands, rainfall, and the breeding ecology of white ibises in coastal South Carolina. Wilson Bulletin 102(1): 84-98

Bildstein, K.L., E. Blood, and P. Frederick. 1992. The relative importance of biotic and abiotic vectors in nutrient transport. Estuaries 15: 147-157

Billheimer, L.E., and B.C. Coull. 1988. Bioturbation and recolonization of meiobenthos in juvenile spot (Pisces) feeding pits. Estuarine Coastal Shelf Science 27: 335-340

Blood, E.R., and P.A. Smith. 1996. Water quality in two high-salinity estuaries: effects of watershed alteration. Pp. 413-444 in F.J. Vernberg, W.B. Vernberg, and T. Siewicki (eds.), Sustainable Development in the Southeastern Coastal Zone, The Belle W. Baruch Library in Marine Science, Number 20. Univ. of South Carolina Press, Columbia.

Blood, E.R., and F.J. Vernberg. 1992. Characterization of the Physical, Chemical, and Biological Conditions and Trends in Three South Carolina Estuaries: 1970 – 1985. Volume II – Winyah Bay and North Inlet Estuaries. South Carolina Sea Grant Consortium, Charleston, SC, with executive summary by M.R. DeVoe.

Blood, E.R., P. Anderson, P.A. Smith, C. Nybro, and K.A. Ginsberg. 1991. Effects of Hurricane Hugo on coastal soil solution chemistry in South Carolina. Biotropica 23: 348-355

Bollinger, M.S., and W.S. Moore. 1993. Evaluation of salt marsh hydrology using radium as a tracer. Geochimica et Cosmochimica Acta 57: 2203-2212

Boone, W.R., and D.L. Claybrook. 1977. The effect of low salinity on amino acid metabolism in the tissues of the common mud crab, *Panopeus herbstii* (Milne-Edwards). Comparative Biochemistry and Physiology 57A: 99-106

Borrero, F.J. 1987. Tidal height and gametogenesis: reproductive variation among populations of *Geukensia demissa*. Biological Bulletin 173: 160-168

Bozeman, E.L., and J.M. Dean. 1980. The abundance of estuarine larval and juvenile fish in a South Carolina intertidal creek. Estuaries 3:89-97

Borrero, F.J., and T.J. Hilbish. 1988. Temporal variation in shell and soft tissue growth of the mussel *Geukensia demissa*. Marine Ecology Progress Series 42: 9-15

Bradley, P.M., and J.T. Morris. 1990a. Physical characteristics of salt marsh sediments: ecological implications. Marine Ecology Progress Series 61: 245-252

Bradley, P.M., and J.T. Morris. 1990b. Influence of oxygen and sulfide concentration on nitrogen uptake kinetics in *Spartina alterniflora*. Ecology 71: 282-287

Bradley, P.M., and J.T. Morris. 1991a. Relative importance of ion exclusion, excretion and accumulation in *Spartina alterniflora* Loisel. Journal of Experimental Botany 42: 1525-1532

Bradley, P.M., and J.T. Morris. 1991b. The influence of salinity on the kinetics of NH_4^+ uptake in *Spartina alterniflora*. Oecologia 85: 375-380

Bradley, P.M., and J.T. Morris. 1992. Effect of salinity on the critical nitrogen concentration of *Spartina alterniflora* Loisel. Aquatic Botany 43: 149-161

Bretsch, K. and D.M. Allen. 2006. Tidal migrations of nekton in salt marsh intertidal creeks. Estuaries and Coasts 29:474-486.

Brockington, Lee G. 2006. Plantation Between the Waters – A Brief History of Hobcaw Barony. The History Press, Charleston, SC. 159 pp.

Brodie, R.J., R. Styles, S. Borgianini, J. Godley, and K. Butler. 2007. Larval mortality during export to the sea in the fiddler crab *Uca minax*. Marine Ecology Progress Series 152: 1283-1291

Brown C.E.,and S.R. Pezeshki. 2007. Threshhold for recovery in the marsh halophyte *Spartina alterniflora* grown under the combined effects of salinity and soil drying. Journal of Plant Physiology 164: 274-282

Brown, M.M., M.J. Friez, and C.R. Lovell. 2003. Expression of *nifH* genes by diazotrophic bacteria in the rhizosphere of short form *Spartina alterniflora*. FEMS Microbiology Ecology 43: 411-417

Bruce, K. 2003. Hobcaw Barony Wildlife Management Plan. Clemson University. 97 pp.

Bureau of Water. 2006. Water Classifications and Standards Regulation 61-69. South Carolina Department of Health and Environmental Control. Columbia, SC. June 2006.

Burns, R.W. 1974. Species abundance and diversity of larval fishes in a high-marsh tidal creek. Masters Thesis. Dept. of Biological Sciences. University of South Carolina.

Bushek, D., M. Heidenreich, and D. Porter. 2007. The effects of several common anthropogenic contaminants on proliferation of the parasitic oyster pathogen *Perkinsus marinus*. Marine Environmental Research 64: 535-540

Buzzelli, C., O. Akman, T. Buck, E. Koepfler, J. Morris, and A. Lewitus. 2004. Relationships among water quality parameters from the North Inlet – Winyah Bay National Estuarine Research Reserve, South Carolina. Journal of Coastal Research 45: 59-74

Caffrey, J.M. 2004. Factors controlling net ecosystem metabolism in U.S. estuaries. Estuaries 27: 90-101

Cai, W.-J., Y. Wang, J. Krest, and W.S. Moore. 2003. The geochemistry of dissolved inorganic carbon in a surficial groundwater aquifer in North Inlet, South Carolina, and the carbon fluxes to the coastal ocean. Geochimica et Cosmochimica Acta 67: 631-637

Cain, R.L. and J.M. Dean. 1976. The occurrence, abundance, and diversity of fishes in a South Carolina intertidal creek. Marine Biology 36: 369-379

Caine, E.A., and E.W.S. Hull. 1981. The Effects of Dredging Salt Marsh Creeks. Baruch Institute Technical Report No. USC-BI-81-1. University of South Carolina, Columbia, SC, 44 pp.

Carter, E.S., S.M. White, and A.M. Wilson. 2008. Variation in groundwater salinity in a tidal marsh basin, North Inlet Estuary, South Carolina. Estuarine, Coastal and Shelf Science 76: 543-552

Cavalieri, A.J. 1983. Proline and glycinebetaine accumulation by *Spartina alterniflora* Loisel. in response to NaCl and nitrogen in a controlled environment. Oecologia 57: 20-24

Cavalieri, A.J., and A.H.C. Huang. 1977. Effect of NaCl on the *in vitro* activity of malate dehydrogenase in salt marsh halophytes of the U.S. Physiologia Plantarum 41: 79-84

Cavalieri, A.J., and A.H.C. Huang. 1979. Evaluation of proline accumulation in the adaptation of diverse species of marsh halophytes to the saline environment. American Journal of Botany 66: 307-312

Cavalieri, A.J., and A.H.C. Huang. 1981. Accumulation of proline and glycinebetaine in *Spartina alterniflora* Loisel. In response to NaCl and nitrogen in the marsh. Oecologia 49: 224-228

Chandler, G.T. 1986. High-density culture of meiobenthic harpacticoid copepods within a muddy sediment substrate. Canadian Journal of Fisheries and Aquatic Sciences 43: 53-59

Chandler, G.T., and A.S. Green. 1996. A 14-day harpacticoid copepod reproduction biassay for laboratory and field contaminated muddy sediments. New Techniques in Aquatic Toxicology, Ch. 3 (NA): 23-29

Chandler, G.T., B.C. Coull, and J.C. Davis. 1994. Sediment- and aqueous-phase fenvalerate effects on meiobenthos: implications for sediment quality criteria development. Marine Environmental Research 37: 313-327

Chandler, G.T., M.R. Shipp, and T.L. Donelan. 1997a. Bioaccumulation, growth and larval settlement effects of sediment-associated polynuclear aromatic hydrocarbons on the estuarine polychaete, *Streblospio benedicti* (Webster). Journal of Experimental Marine Biology and Ecology 213: 95-110

Chandler, G.T., B.C. Coull, N.V. Schizas, and T.L. Donelan. 1997b. A culture-based assessment of the effects of chlorpyrifos on multiple meiobenthic copepods using microcosms of intact estuarine sediments. Environmental Toxicology and Chemistry 16: 2339-2346

Chasse, M. 2009. Training: National Estuarine Research Reserve. Website: http://www.nerrs.noaa.gov/CTPDefault.aspx?ID=386

Chen, Y.P., D.E. Lincoln, S.A. Woodin, and C.R. Lovell. 1991. Purification and properties of a unique flavin-containing chloroperoxidase from the capitellid polychaete *Notomastus lobatus*. Zoological Society of London 63: 231-250

Chen, Y.P., S.A. Woodin, D.E. Lincoln, and C.R. Lovell. 1996. An unusual dehalogenating peroxidase from the marine terebellid polychaete *Amphitrite ornata*. Journal of Biological Chemistry 271: 4609-4612

Chestnut, D. 1983. Feeding habits of juvenile spot *Leiostomus xanthurus* (Lacepede) in North Inlet Estuary, Georgetown, SC. 1983 Masters Thesis. Dept. of Biological Sciences. University of South Carolina.

Childers, D.L. 1994. Fifteen years of marsh flumes: a review of marsh-water column interactions in southeastern USA estuaries. Pp. 277-293, in W.J. Mitsch (ed.), Global Wetlands: Old World and New, Elsevier Science B.V.

Childers, D.L., and H.N. McKellar, Jr. 1987. A simulation of saltmarsh water column dynamics. Ecological Modelling 36: 211-238

Childers, D.L., F.H. Sklar, B. Drake, and T. Jordan. 1993a. Seasonal measurements of sediments elevation at three mid-Atlantic estuaries. Journal of Coastal Research 9: 986-1003

Childers, D.L., H.N. McKellar, R.F. Dame, F.H. Sklar, and E.R. Blood. 1993b. A dynamic nutrient budget of subsystem interactions in a salt marsh estuary. Estuarine, Coastal and Shelf Science 36: 105-131

Childers, D.L., F.H. Sklar, and S.E. Hutchinson. 1994. Statistical treatment and comparative analysis of scale-dependent aquatic transect data in estuarine landscapes. Landscape Ecology 9: 127-141

Chow, A.T., J. Dai, W.H. Conner, D.R. Hitchcock, and J.-J. Wang. 2012. Dissolved organic matter and nutrient dynamics of a coastal forested wetland in Winyah Bay, South Carolina. Biogeochemistry, published online 27 June 2012 doi: 10.1007/s10533-012-9750-z

Christian, R.R. and D.M. Allen. 2014. Linking hydrogeomorphology to food webs in intertidal creeks. Estuaries and Coasts 37 (Suppl. 1): S74-S90. DOI 10.1007/s12237-013-9657-5

Christy, J.H. 1982. Adaptive significance of semilunar cycles of larval release in fiddler crabs (Genus *Uca*): test of an hypothesis. Biological Bulletin (Woods Hole) 163: 251-263

Christy, J.H. 1989. Rapid development of megalopae of the fiddler crab *Uca pugilator* reared over sediment: implications for models of larval recruitment. Marine Ecology Progress Series 57: 259-265

Christy, J.H., and S.H. Morgan. 1998. Estuarine immigration by crab postlarvae: mechanics, reliability, and adaptive significance. Marine Ecology Progress Series 174: 51-65

Christy, J.H., and S.E. Stancyk. 1982. Tuning of larval production and flux of invertebrate larvae in a well-mixed estuary. Pp. 489-503, in V.S. Kennedy (ed.), Estuarine Comparisons. Academic Press, New York.

Christy, R.L., K.L. Bildstein, and P. DeCoursey. 1981. A preliminary analysis of energy flow in a South Carolina salt marsh: wading birds. Colonial Waterbirds 4: 96-103

Chrzanowski, T.H., and J.D. Spurrier. 1987. Exchange of microbial biomass between a *Spartina alterniflora* marsh and the adjacent tidal creek. Estuaries 10: 118-125

Chrzanowski, T.H., and L.H. Stevenson. 1979. Material fluxes through the North-Inlet-marsh system: short-term temporal fluctuations of fungi and related parameters. Mycologia 71:958-967

Chrzanowski, T.H., and L.H. Stevenson. 1980. Filamentous fungal propagules as potential indicators of sediment detritus resuspension. Botanica Marina 23: 251-256

Chrzanowski, T.H., and R.G. Zingmark. 1986. Passive filtering of microbial biomass by *Spartina alterniflora*. Estuarine, Coastal and Shelf Science 22: 545-557

Chrzanowski, T.H., and R.G. Zingmark. 1989. Bacterial abundance, biomass and secondary production along a forest-to-ocean landscape gradient. Journal of Experimental Marine Biology and Ecology 125: 253-266

Chrzanowski, T.H., L.H. Stevenson, and B. Kjerfve. 1981. Variability in total microbial biomass measurements made in cross-sections of salt-marsh creeks. Marine Geology 40: 155-170

Chrzanowski, T.H., L.H. Stevenson, and J.D. Spurrier. 1982. Transport of microbial biomass through the North Inlet ecosystem. Microbial Ecology 8: 139-156

Chrzanowski, T.H., L.H. Stevenson, and J.D. Spurrier. 1983. Transport of dissolved organic carbon through a major creek of the North Inlet ecosystem. Marine Ecology Progress Series 13: 167-174

Clements, L.A.J., and S.E. Stancyk. 1984. Particle selection by the burrowing brittlestar *Microphiopholis gracillima* (Stimpson) (Echinodermata: Ophiuroidea). Journal of Experimental Marine Biology and Ecology 84: 1-13

Clements, L.A.J., K.T. Fielman, and S.E. Stancyk. 1988. Regeneration by an amphiurid brittlestar exposed to different concentrations of dissolved organic material. Journal of Experimental Marine Biology and Ecology 122: 47-61

Clements, L.A.J., S.E. Stancyk, D.E. Lincoln, W.E. Dobson, and R.M. Showman. 1993. Uptake of free amino acids by the ophiuroid *Micophiopholis gracillima* (Stimson) (Echinodermata) during disc regeneration. Comparative Biochemistry and Physiology 105A(4): 793-802

Coen, L.D. 1995. A review of the potential impacts of mechanical harvesting on subtidal and intertidal shellfish resources. SC Dept. of Natural Resources, Marine Resources Research Institute, 46 pp + Appendices

Coller-Socha, R.D. 1994. Dioxin-contaminated sediments, a case study. U.S. Army Engineer District, Charleston, SC. DTIC document, pp. 307-314, Water Quality '94

Collins, E.S., D.B. Scott, P.T. Gayes, and F.S. Medioli. 1995. Foraminifera in Winyah Bay and North Inlet marshes, South Carolina: relationship to local pollution sources. Journal of Foraminiferal Research 25: 212-223

Collopy, M.W. and K.L. Bildstein. 1987. Foraging behavior of northern harriers wintering in southeastern salt and freshwater marshes. The Auk 104: 11-16

Conner, W.H. 1995. Woody plant regeneration in three South Carolina *Taxodium* / *Nyssa* stands following Hurricane Hugo. Ecological Engineering 4: 277-287

Conner, W.H., and L.W. Inabinette. 2003. Tree growth in South Carolina (USA) swamps after Hurricane Hugo: 1991-2001. Forest Ecology and Management 182: 371-380

Conservation Foundation, The. 1980. A reconnaissance of the structure and dynamics of the Winyah Bay ecosystem. Pp. 1-36 in The Conservation Foundation. Winyah Bay Reconnaissance Study (Technical Supplement). Washington, D.C.

Costello, J. and S.E. Stancyk. 1983. Tidal influence upon appendicularian larvae in North Inlet estuary, South Carolina. Journal of Plankton Research 5(2): 263-277

Couch, C.A. 1989. Carbon and nitrogen stable isotopes of meiobenthos and their food resources. Estuarine Coastal and Shelf Science 28: 433-441

Coull, B.C. 1973. Estuarine meiofauna: a review: trophic relationships and microbial interactions. Pp. 499-512 in L.H. Stevenson and R.R. Colwell (eds.) Estuarine Microbial Ecology, Univ. of South Carolina Press, Columbia, South Carolina

Coull, B.C. 1975. Three new harpacticoid copepods from the North Inlet estuary, Georgetown, South Carolina, U.S.A. Crustaceana 29: 113-126

Coull, B.C. 1976. A revised key to *Stenhelia (Delavalia)* (Copepoda: Harpacticoida) including a new species from South Carolina, U.S.A. Zoological Journal of the Linnean Society 59: 353-364

Coull, B.C. 1977. Marine Flora and Fauna of the Northeastern United States. Copepoda: Harpacticoida. NOAA Technical Report, NMFS Circular 399, 41 pp.

Coull, B.C. 1985a. The use of long-term biological data to generate testable hypotheses. Estuaries 8: 84-92

Coull, B.C. 1985b. Long-term variability of estuarine meiobenthos: an 11 year study. Marine Ecology Progress Series 24: 205-218

Coull, B.C. 1986. Long-term variability of meiobenthos: value, synopsis, hypothesis generation and predictive modeling. Hydrobiologia 142: 271-279

Coull, B.C. 1988. Ecology of the marine meiofauna. Pp. 18-38 in R.P. Higgins and H. Thiel (eds.) Introduction to the Study of Meiofauna. Smithsonian Institution Press, Washington, D.C.

Coull, B.C. 1990. Are members of the meiofauna food for higher trophic levels? Transactions of the American Microscopical Society 109: 233-246

Coull, B.C., and S.S. Bell. 1979. Perspectives of marine meiofaunal ecology. Pp. 189-216, in R.J. Livingston (ed.) Ecological Processes in Coastal and Marine Systems. Plenum Publishing Corporation

Coull, B.C., and G.T. Chandler. 1992. Pollution and meiofauna: field, laboratory, and mesocosm studies. Oceanography and Marine Biology Annual Review 30:191-271

Coull, B.C., and B.W. Dudley. 1985. Dynamics of meiobenthic copepod populations: a long-term study (1973-1983). Marine Ecology Progress Series 24: 219-229

Coull, B.C., and B.W. Dudley. 1976. Delayed naupliar development of meiobenthic copepods. Biological Bulletin 150:38-46

Coull, B.C., and R.J. Feller. 1988. Site-to-site variability in abundance of meiobenthic copepods along a tidal gradient over 24 hours. Hydrobiologia 167/168: 477-483

Coull, B.C., and J.W. Fleeger. 1977. Long-term temporal variation and community dynamics of meiobenthic copepods. Ecology 58: 1136-1143

Coull, B.C., and J. Grant. 1981. Encystment discovered in a marine copepod. Science 212: 342-344

Coull, B.C., and M.A. Palmer. 1984. Field experimentation in meiofaunal ecology. Hydrobiologia 118: 1-19

Coull, B.C., and W.B. Vernberg. 1970. Harpacticoid copepod respiration: *Enhydrosoma propinquum* and *Longipedia helgolandica*. Marine Biology 5: 341-344

Coull, B.C., and W.B. Vernberg. 1975. Reproductive periodicity of meiobenthic copepods: seasonal or continuous? Marine Biology 32: 289-293

Coull, B.C., S.S. Bell, A.M. Savory, and B.W. Dudley. 1979. Zonation of meiobenthic copepods in a southeastern United States salt marsh. Estuarine and Coastal Marine Science 9: 181-188

Coull, B.C., G.R.F. Hicks, and J.B.J. Wells. 1981. Nematode/copepod ratios for monitoring pollution: a rebuttal. Marine Pollution Bulletin 12: 378-381

Coull, B.C., M.A. Palmer, and P.E. Meyers. 1989. Controls on the vertical distribution of meiobenthos in mud: field and flume studies with juvenile fish. Marine Ecology Progress Series 55: 133-139

Coutinho, R. 1987. Ecology of macroalgae in North Inlet Estuary, South Carolina. Ph.D. dissertation, Univ. of South Carolina, Columbia. 228 pp.

Coutinho, R., and R.G. Zingmark. 1987. Diurnal photosynthetic responses to light by macroalgae. Journal of Phycology 23: 336-343

Cowart, J.D., K.T. Fielman, S.A. Woodin, and D.E. Lincoln. 2000. Halogenated metabolites in two marine polychaetes and their planktotrophic and lecithotrophic larvae. Marine Biology 136: 993-1002

Cowley, G.T. 1973. Variations in soil fungus populations in a South Carolina salt marsh. Contrib. No. 34 of the Belle W. Baruch Coastal Research Institute. Pp. 441-454, in L.H. Stevenson & R.R. Colwell (eds.), Estuarine Microbial Ecology, The Belle W. Baruch Library in Marine Science, Number 1, Univ. South Carolina Press, Columbia, SC

Cowley, G.T., and T.H. Chrzanowski. 1980. Yeasts in the habitat and nutrition of *Uca pugilator*. Botanica Marina XXIII: 397-403

Crabtree, R. & Middaugh, D. 1982. Oyster shell size and the selection of spawning sites by *Chasmodes bosquianus*, *Hypleurochilus geminatus*, *Hypsoblennius ionthas* (Pisces, Blenniidae) and *Gobiosoma bosci* (Pisces, Gobiidae) in two South Carolina estuaries. Estuaries 5: 150-155

Creed, E.L., and B.C. Coull. 1984. Sand dollar (*Mellita quinquesperforata* (Leske)) and sea pansey (*Renilla reniformis* (Cuvier)) effects on meiofaunal abundance. Journal of Experimental Marine Biology and Ecology 77: 1-10

Crosby, M.P. 1989. A Report to the Belle W. Baruch Foundation Trustees on the Results of Pollution Surveys Conducted at Hobcaw Barony, June 1989.

Crosby, M.P., C.F. Roberts, and P.D. Kenny. 1991. Effects of immersion time and tidal position on *in situ* growth rates of naturally settled eastern oysters, *Crassostrea virginica* (Gmelin, 1791). Journal of Shellfish Research 10(1): 95-103

D'Andrea, A.F., S.E. Stancyk, and G.T. Chandler. 1996. Sublethal effects of cadmium on arm regeneration in the burrowing brittlestar, *Microphiopholis gracillima*. Ecotoxicology 5: 115-133

Dame, R.F. 1972. The ecological energies of growth, respiration and assimilation in the intertidal American oyster *Crassostrea virginica*. Marine Biology 17: 243-250

Dame, R.F. 1979. The abundance, diversity, and biomass of macrobenthos on North Inlet, South Carolina, intertidal oyster reefs. Proceedings of the National Shellfisheries Association 69: 6-10

Dame, R.F. 1982. The flux of floating macrodetritus in the North Inlet estuarine ecosystem. Estuarine, Coastal and Shelf Science 15: 337-344

Dame, R.F. 1989. The importance of *Spartina alterniflora* to Atlantic coast estuaries. Aquatic Sciences 1: 639-660

Dame, R.F., and L.R. Gardner. 1993. Nutrient processing and the development of tidal creek ecosystems. Marine Chemistry 43: 175-183

Dame, R.F., and P. D. Kenny. 1986. Variability of *Spartina alterniflora* primary production in the euhaline North Inlet estuary. Marine Ecology Progress Series 32: 71-80

Dame, R.F., and S. Libes. 1993. Oyster reefs and nutrient retention in tidal creeks. Journal of Experimental Marine Biology and Ecology 171: 251-258

Dame, R.F., and B.C. Patten. 1981. Analysis of energy flows in an intertidal oyster reef. Marine Ecology Progress Series 5: 115-124

Dame, R.F., and D. Stillwell. 1984. Environmental factors influencing macrodetritus flux in North Inlet estuary. Estuarine, Coastal and Shelf Science 18: 721-726

Dame, R.F., and F.J. Vernberg. 1978. The influence of constant and cyclic acclimation temperatures on the metabolic rates of *Panopeus herbstii* and *Uca pugilator*. Biological Bulletin 154: 188-197

Dame, R., F. Vernberg, R. Bonnell, and W. Kitchens. 1977. The North Inlet marsh-estuarine ecosystem: a conceptual approach. Helgolander wiss. Meeresunters. 30: 343-356

Dame, R., R. Zingmark, H. Stevenson, and D. Nelson. 1980. Filter feeder coupling between the estuarine water column and benthic subsystems. Pp. 521-526, in V.S. Kennedy (ed.) Estuarine Perspectives. Academic Press, New York.

Dame, R.F., R.G. Zingmark, and E. Haskin. 1984. Oyster reefs as processors of estuarine materials. Journal of Experimental Marine Biology and Ecology 83: 239-247

Dame, R.F., T.G. Wolaver, and S.M. Libes. 1985. The summer uptake and release of nitrogen by an intertidal oyster reef. Netherlands Journal of Sea Research 19: 265-268

Dame, R. F., T. Chryzanoski, K. Bildstein, B. Kjerfve, H. N. McKellar, D. Nelson, J. Spurrier, S. E. Stancyk, H. Stevenson, F. J. Vernberg, and R. Zingmark. 1986. The outwelling hypothesis in North Inlet, South Carolina. Marine Ecology Progress Series 33: 217-229

Dame, R.F., J.D. Spurrier, and T.G. Wolaver. 1989. Carbon, nitrogen, and phosphorus processing by an oyster reef. Marine Ecology Progress Series 54: 249-256

Dame, R.F., T.G. Wolaver, T.M. Williams, J.D. Spurrier, and A.B. Miller. 1990. The Bly Creek ecosystem study: phosphorus transport within a euhaline salt marsh basin, North Inlet, South Carolina. Netherlands Journal of Sea Research 27: 73-80

Dame, R.F., J. Spurrier, T. Williams, B. Kjerfve, R. Zingmark, T. Wolaver, T. Chrzanowski, H.N. McKellar, and F.J. Vernberg. 1991. Annual material processing by a salt marsh-estuarine basin in South Carolina, USA. Marine Biology Progress Series 72: 153-166

Dame, R.F., D.L. Childers, and E.T. Koepfler. 1992. A geohydrodynamic continuum theory for the spatial and temporal evolution of marsh-estuarine ecosystems. Netherlands Journal of Sea Research 30: 63-72

Dame, R.F., E. Koepfler, and L. Gregory. 2000a. Benthic-pelagic coupling in marsh-estuarine ecosystems. Pp. 369-390, in M.P. Weinstein and D.A. Kreeger (eds.) Concepts and Controversies in Tidal Marsh Ecology. Kluwer Academic Publishers, Dordrecht/Boston/London

Dame, R., D. Bushek, D. Allen, D. Edwards, L. Gregory, A. Lewitus, S. Crawford, E. Koepfler, C. Corbett, B. Kjerfve, and T. Prins. 2000b. The experimental analysis of tidal creeks dominated by oyster reefs: the premanipulation year. Journal of Shellfish Research 19: 361-369

Dame, R., D. Bushek, D. Allen, A. Lewitus, D. Edwards, E. Koepfler, and L. Gregory. 2002. Ecosystem response to bivalve density reduction: management implications. Aquatic Ecology 36: 51-65

Dang, H., and C.R. Lovell. 2000. Bacterial primary colonization and early succession on surfaces in marine waters as determined by amplified *r*RNA gene restriction analysis and sequence analysis of 16S rRNA. Applied Environmental Microbiology 66: 466-475

Dang, H., and C.R. Lovell. 2002a. Numerical dominance and phylotype diversity of marine *Rhodobacter* during early colonization of submerged surfaces in coastal marine waters as determined by 16S rDNA sequence analysis and fluorescence in situ hybridization. Applied and Environmental Microbiology 68: 496-504

Dang, H., and C.R. Lovell. 2002b. Seasonal dynamics of particle-associated and free-living marine *Proteobacteria* in a salt marsh tidal creek as determined using fluorescence *in situ* hybridization. Environmental Microbiology 4: 287-295

Davis, D., M.D. Gamble, C.E. Bagwell, P.W. Bergholz, and C.R. Lovell. 2011. Responses of salt marsh grass rhizosphere diazotroph assemblages to changes in marsh elevation, edaphic conditions and plant host species. Microbial Ecology 61: 386-398

Day, J.W., R.R. Christian, D.M. Boesch, A. Yanez-Arencibia, J. Morris, R.R. Twilley, L. Naylor, L. Schaffner, and C. Stevenson. 2008. Consequences of climate change on the ecogeomorphology of coastal wetlands. Estuaries and Coasts 31: 477-491

De Santo, T.L., S.G. McDowell, and K.L. Bildstein. 1990. Plumage and behavioral development of nestling white ibises. Wilson Bulletin 102(2): 226-238

De Santo, T.L., J.W. Johnston, and K.L. Bildstein. 1997. Wetland feeding site use by White Ibises (*Eudocimus albus*) breeding in coastal South Carolina. Colonial Waterbirds 20(2): 167-176

Decker, R.A., and B.D. Griffen. 2012. Correlating context-specific boldnessand physiological condition of female sand fiddler crabs (*Uca pugilator*). Journal of Ethology DOI 10.1007/s10164-012-0338-9

DeCoursey, P. 1977. Vertical migration of larval *Uca* in North Inlet Estuary. Pp. 45-47 In Vernberg, F.J., R. Bonnell, B.C. Coull, R.F. Dame, P. DeCoursey, W. Kitchens, B. Kjerfve, L.H. Stevenson, W.B. Vernberg, and R. Zingmark. 1977. The Dynamics of an Estuary as a Natural Ecosystem. I. EPA Technical Report EPA-600/3-77-016. Gulf Breeze, FL.

DeLorenzo, M.E., A.J. Lewitus, G.I. Scott, and P.E. Ross. 2001. Use of metabolic inhibitors to characterize ecological interactions in an estuarine microbial food web. Microbial Ecology 42: 317-327

Devoe, R. and D. Sanger. 2009. Final Report and Prospectus: Development of a Conceptual Model for an Integrated Coastal Demographic-Economic-Environmental Prediction and Forecasting Initiative. SC Sea Grant Consortium

DiPinto, L.M. 1996. Trophic transfer of a sediment-associated organophosphate pesticide from meiobenthos to bottom feeding fish. Archives of Environmental Contamination and Toxicology 30: 459-466

DiPinto, L.M., and B.C. Coull. 1997. Trophic transfer of sediment-associated polychlorinated biphenyls from meiobenthos to bottom-feeding fish. Environmental Toxicology and Chemistry 16: 2568-2575

DiPinto, L.M., B.C. Coull, and G.T. Chandler. 1993. Lethal and sublethal effects of the sediment-associated PCB Aroclor 1254 on a meiobenthic copepod. Environmental Toxicology and Chemistry 12: 1909-1918

Dobson, W.E., S.E. Stancyk, L.A. Clements, and R.H. Showman. 1991. Nutrient translocation during early disc regeneration in the brittlestar *Microphiopholis gracillima* (Stimpson) (Echinodermata: Ophiuroidea). Biological Bulletin 180: 167-184

Donachy, J.E., and N. Watabe. 1986. Effects of salinity and calcium concentration onarm regeneration by *Ophiothrix angulata* (Echinodermata: Ophiuroidea). Marine Biology 91: 253-257

Dorsch, J.E., and T.F. Bidleman. 1982. Natural organics as fluorescent tracers of river-sea mixing. Estuarine, Coastal and Shelf Science 15: 701-707

Duncan, T. and T.J. Shaw. 2003. The mobility of rare earth elements and redox sensitive elements in the groundwater/seawater mixing zone of a shallow coastal aquifer. Aquatic Geochemistry 9(3): 233-255

Dykstra, M.J., J.F. Levine, E.J. Noga, J.H. Hawkins, P. Gerdes, W.J.Hargis, Jr., H.J. Grier, and D. T. Strake. 1989. Ulcerative mycosis: a serious menhaden disease of the southeastern coastal fisheries of the United States. Journal of Fish Diseases 12:175-178

Ebeling, D.E. 1982. Biomass, zonation, and seasonal succession of benthic intertidal macroalgae on oyster beds in the North Inlet Estuary, South Carolina. Master of Science thesis, University of South Carolina, Columbia. 46 pp.

Eddins, S.G.N. 2001. Calculation of terrestrial inputs to particulate organic carbon in an anthropogenically impacted estuary in the southeastern United States. Water, Air and Soil Pollution 127: 227-241

Eddins, S.G.N., S. Tsakovski, V. Simeonov, and D.F. Williams. 1999. Evaluation of bottom sediment data from the Winyah Bay estuarine system. Toxicological and Environmental Chemistry 70: 461-472

Edwards, D, and B.C. Coull. 1987 Autoregressive trend analysis: an example using long-term ecological data. Oikos 50: 95-102

Edwards, D., R.J. Feller, S.E. Stancyk, and B.C. Coull. 1995. On seasonal and interannual zooplankton and benthos dynamics. Pp. 117-136, in B.F. Keegan et al. (eds.), Change in marine benthos: The case for long-term studies. European Economic Community, Brussels, Belgium.

Eiser, W.C., and B. Kjerfve. 1986. Marsh topography and hypsometric characteristics of a South Carolina salt marsh basin. Estuarine, Coastal and Shelf Science 23:595-605

Ellis, M.J., and B.C. Coull. 1989. Predation on meiobenthos: field experiments using juvenile spot (Pisces). Journal of Experimental Marine Biology and Ecology 130: 19-32

Ember, L.M., D.F. Williams, and J.T. Morris. 1987. Processes that influence carbon isotope variations in salt marsh sediments. Marine Ecology Progress Series 36: 33-42

Erkenbrecher, C.W., and L.H. Stevenson. 1975. The influence of tidal flux on microbial biomass in salt marsh creeks. Limnology and Oceanography 20: 618-625

Erkenbrecher, C.W., and L.H. Stevenson. 1977. Factors related to the distribution of microbial biomass in salt-marsh creeks. Marine Biology 40: 121-125

Erkenbrecher, C.W., Jr., and L.H. Stevenson. 1978. The transport of microbial biomass and suspended material in a high-marsh creek. Canadian Journal of Microbiology 24: 839-846

Erkenbrecher, C.W., and L.H. Stevenson. 1980. Tidal and diel fluctuations in the temporal concentrations of chlorophyll a and pheophytin at a station monitoring a high-marsh creek. Journal of Experimental Marine Biology and Ecology 48: 253-261

Eskin, R., and B.C. Coull. 1984. *A priori* determination of valid control sites: an example using marine meiobenthic nematodes. Marine Environmental Research 12: 161-172

Eskin, R.A., and B.C. Coull. 1987. Seasonal and three-year variability of meiobenthic nematode populations at two estuarine sites. Marine Ecology Progress Series 41: 295-303

Eskin, R.A., and M.A. Palmer. 1985. Suspension of marine nematodes in a turbulent tidal creek: species patterns. Biological Bulletin 169: 615-623

Evans, M.R., S.-J. Larsen, G.H.M. Riekerk, and K.G. Burnett. 1996. Patterns of immune response to environmental bacteria in natural populations of the red drum, *Sciaenops ocellatus* (Linnaeus). Journal of Experimental Marine Biology and Ecology 208: 87-105

Eyster, L.S. 1979. Reproduction and developmental variability in the opisthobranch *Tenellia pallid*. Marine Biology 51: 133-140

Eyster, L.S. 1980. Distribution and reproduction of shell-less opisthobranchs from South Carolina. Bulletin of Marine Science 30: 580-599

Eyster, L.S., and S.E. Stancyk. 1981. Reproduction, growth and trophic interactions of *Doriopsilla pharpa* Marcus in South Carolina. Bulletin of Marine Science 31: 72-82

FAO. 2014. *Penaeus monodon* (Fabricus, 1798). FAO, Fisheries and Aquaculture Department. http://www.fao.org/fishery/culturedspecies/Penaeus_monodon/en. Accessed 2014

Feller, R.J. 1984a. Dietary immunoassay of *Ilyanassa obsolete*, the eastern mud snail. Biological Bulletin 166: 96-102

Feller, R.J. 1984b. Serological tracers of meiofaunal food webs. Hydrobiologia (Special Edition) 118: 119-125

Feller, R.J. 1986. Immunological detection of *Mercenaria mercenaria* in a predator and preparation of size-class specific antibodies. The Veliger 28: 341-347

Feller, R.J., and B.C. Coull. 1995. Non-selective ingestion of meiobenthos by juvenile spot (*Leiostomus xanthurus*) (Pisces) and their daily prey ration. Vie et Milieu 45: 49-59

Feller, R.J., and E.D. Gallagher. 1982. Antigenic similarities among estuarine soft-bottom benthic taxa. Oecologia 52: 305-310

Feller, R.J., and R.M. Warwick. 1988. Energetics. Pp.181-196 in Higgins, R.P. and H. Theil (eds.). Introduction to the Study of Meiofauna. Smithsonian Institution Press, Washington, D.C.

Feller, R.J., B.C. Coull, and B.T. Hentschel. 1990. Meiobenthic copepods – tracers of where juvenile *Leiostomus xanthurus* (Pisces) feed. Canadian Journal of Fisheries and Aquatic Sciences 47(10): 1913-1919

Feller, R.J., S.E. Stancyk, B.C. Coull, and D. Edwards. 1992. Recruitment of polychaetes and bivalves: Long-term assessment of predictability in a soft-bottom habitat. Marine Ecology Progress Series 87: 227-238

Feurt, C. 2008. Collaborative Learning Guide for Ecosystem Management. Wells National Estuarine Research Reserve: Wells, Maine. UNH/NOAA Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) Project. http://www.wellsreserve.org/sup/downloads/collaborative_learning_guide.pdf

Fielman, K.T., S.A. Woodin, M.D. Walla, and D.E. Lincoln. 1999. Widespread occurrence of natural halogenated organics among temperate marine infauna. Marine Ecology Progress Series 181: 1-12

Fielman, K.T., S.A. Woodin, and D.E. Lincoln. 2001. Polychaete indicator species as a source of natural halogenated organic compounds in marine sediments. Environmental Toxicology and Chemistry 20: 738-747

Findlay, S.E.G. 1981. Small-scale spatial distribution of meiofauna on a mud- and sandflat. Estuarine and Coastal Marine Science 12: 472-484

Findlay, S.E.G. 1982. Influence of sampling scale on apparent distribution of meiofauna on a sandflat. Estuaries 5: 322-324

Finelli, C.M., N.D. Pentcheff, R.K. Zimmer-Faust, and D.S. Wethey. 1999. Odor transport in turbulent flows: Constraints on animal navigation. Limnology and Oceanography 44: 1056-1071

Finelli, C.M., D.S. Wethey, N.D. Pentcheff, and R.K. Zimmer. 2000. Physical constraints on ecological processes: A field test of odor-mediated foraging. Ecology 81: 784-797

Finley, R.J. 1976. Hydraulics and dynamics of North Inlet, South Carolina, 1974-75. Final Report, September, 191 pp. Accession Number ADA033419, Corps of Engineers, Online Information for the Defense Community http://oai.dtic.mil/oai

Firth, L. B., A. M. Knights, and S. S. Bell. 2011. Air temperature and winter mortality: implications for the persistence of the invasive mussel, *Perna viridis* in the intertidal zone of the south-eastern United States. Journal of Experimental Marine Biology and Ecology 400: 250-256

Flavier, A.B., and R.G. Zingmark. 1993. Macroalgal recruitment in a high marsh creek of North Inlet Estuary, South Carolina. Journal of Phycology 29: 2-8

Fleeger, J. 1980. Community structure of an estuarine meiobenthic copepod assemblage. Estuarine and Coastal Marine Science 10: 107-118

Fleeger, J.W. 1979. Population dynamics of three estuarine meiobenthic harpacticoids (Copepoda) in South Carolina. Marine Biology 52: 147-156

Fleeger, J.W., and M.A. Palmer. Secondary production of the estuarine meiobenthic copepod, *Microarthridion littorale*. Marine Ecology Progress Series 7: 157-162

Fletcher, M., D. Porter, L. Leonard, M. Moss, M. Durako, J. Dorton, L.J. Pietrafesa, E. Buckley, and L. Xie. 2006. Adaptive integration of sub-regional coastal ocean observing systems: a case study of the Coastal Ocean Research and Monitoring Program (CORMP) and the Carolinas Coastal Ocean Observing and Prediction System (Caro-COOPS). Proceedings, Oceans '06 Marine Technological Society/IEEE Conference, Boston, MA, September 18-21, 2006. 6 pp.

Fortner, A.R., M. Sanders, and S.W. Lemire. 1996. Polynuclear aromatic hydrocarbon and trace metal burdens in sediment and the oyster, *Crassostrea virginica* Gmelin, from two high-salinity estuaries in South Carolina. Pp. 445-475, in F.J. Vernberg, W.B. Vernberg, and T. Siewicki (eds.) Sustainable Development in the Southeastern Coastal Zone. Belle W. Baruch Library in Marine Science, No. 20. Univ of South Carolina Press, Columbia, SC

Fox, R.S., and E.E. Ruppert. 1985. Shallow-Water Marine Benthic Macroinvertebrates of South Carolina., The Belle W. Baruch Library in Marine Science, No. 14, Univ. of S. Carolina Press, 329 pp.

Frederick, P.C. 1985. Mating Strategies of White Ibis (*Eudocimus albus*). PhD diss, University of North Carolina, Chapel Hill, NC

Frederick, P.C. 1987a. Extrapair copulations in the mating system of white ibis (*Eudocimus albus*). Behaviour 100: 170-201

Frederick, P. 1987b. Responses of male white ibises to their mate's extra-pair copulations. Behavioral Ecology and Soiobiology 21: 223-228

Frederick, P. 1987c. Chronic tidally-induced nest failure in a colony of white ibises. The Condor 89: 413-419

Freeman, H.W. 1970. Belle.W. Baruch Foundation fish survey of Atlantic Coast estuaries along the northeast border of Hobcaw Barony. Report to the Belle W. Baruch Foundation, 112 pp.

Fulton, M.H., G.I. Scott, A. Fortner, T.F. Bidleman, and B. Ngabe. 1993. The effects of urbanization on small high salinity estuaries of the southeastern United States. Archives of Environmental Contamination and Toxicology 25: 476-484

Fulton, M.H., G.T. Chandler, and G.I. Scott. 1996. Urbanization effects on the fauna of a southeastern U.S.A. bar-built estuary. Pp. 477-504 in F.J. Vernberg, W.B. Vernberg, and T. Siewicki (eds.) Sustainable Development in the Southeastern Coastal Zone. Belle W. Baruch Library in Marine Science, No. 20. Univ of South Carolina Press, Columbia

Gamble, M.D., and C.R. Lovell. 2011. Infaunal burrows are enrichment zones for *Vibrio parahaemolyticus*. Applied and Environmental Microbiology 77: 3703-3714

Gamble, M.D., C.E. Bagwell, J. LaRocque, P.W. Bergholz, and C.R. Lovell. 2010. Seasonal variability of diazotroph assemblages associated with the rizosphere of the saltmarsh cordgrass, *Spartina alterniflora*. Microbial Ecology 59: 253-269

Gandy, E.L., and D.C. Yoch. 1988. Relationship between nitrogen-fixing sulfate reducers and fermenters in salt marsh sediments and roots of *Spartina alterniflora*. Applied and Environmental Microbiology 54: 2031-2036

Gardner, L.R. 1973a. The effect of hydrologic factors on the pore water chemistry of intertidal marsh sediments. Southeastern Geology 15: 17-28

Gardner, L.R. 1973b. Chemical models for sulfate reduction in closed anaerobic marine environments. Geochimica et Cosmochimica Acta 37: 53-68

Gardner, L.R. 1975. Runoff from an intertidal marsh during tidal exposure: Recession curves and chemical characteristics. Limnology and Oceanography 20: 81-89

Gardner, L.R. 1990. Simulation of the diagenesis of carbon, sulfur, and dissolved oxygen in salt marsh sediments. Ecological Monographs 60: 91-111

Gardner, L.R. 2005. A modeling study of the dynamics of pore water seepage from intertidal marsh sediments. Estuarine, Coastal and Shelf Science 62: 691-698

Gardner, L.R. and M. Bohn. 1990. Geomorphic and hydraulic evolution of tidal creeks on a subsiding beach-ridge plain, North Inlet, SC. Marine Geology 34: M91-M97.

Gardner, L.R., and C. Gorman. 1984. The summertime net transport of dissolved oxygen, salt and heat in a salt marsh basin, North Inlet, S.C. Estuarine, Coastal and Shelf Science 19: 331-339

Gardner, L.R., and B. Kjerfve. 2006. Tidal fluxes of nutrients and suspended sediments at the North Inlet – Winyah Bay National Estuarine Research Reserve. Estuarine, Coastal and Shelf Science 70: 682-692

Gardner, L.R. and D.E. Porter. 2001. Stratigraphy and geologic history of a southeaster salt marsh basin, North Inlet, South Carolina, USA. Wetlands Ecology and Management 9: 371-385

Gardner, L.R., and W.W. Reeves. 2002. Seasonal patterns in the soil water balance of a *Spartina* marsh site at North Inlet, South Carolina, USA. Wetlands 22: 467-477

Gardner, L.R., and A.M. Wilson. 2006. Comparison of four numerical models for simulating seepage from salt marsh sediments. Estuarine, Coastal and Shelf Science 69: 427-437

Gardner, L.R., P. Sharma, and W.S. Moore. 1987. A regeneration model for the effect of bioturbation by fiddler crabs on ^{210}Pb profiles in salt marsh sediments. Journal of Environmental Radioactivity 5: 25-36

Gardner, L.R., T.G. Wolaver, and M. Mitchell. 1988. Spatial variations in the sulfur chemistry of salt marsh sediments at North Inlet, South Carolina. Journal of Marine Research 46: 815-836

Gardner, L.R., L. Thombs, D. Edwards, and D. Nelson. 1989. Time-series analyses of suspended sediment concentrations at North Inlet, South Carolina. Estuaries 12: 211-221

Gardner, L.R., W.K. Michener, B. Kjerfve, and D.A. Karinshak. 1991. The geomorphic effect of Hurricane Hugo on an undeveloped coastal landscape at North Inlet, South Carolina. Journal of Coastal Research 81: 181-186

Gardner, L.R., W.K. Michener, T.M. Williams, E.R. Blood, B. Kjerfve, L.A. Smock, D.J. Lipscomb, and C. Gresham. 1992a. Disturbance effects of hurricane Hugo on a pristine coastal landscape: North Inlet, South Carolina, USA. Netherlands Journal of Sea Research 30: 249-263

Gardner, L.R., B.R. Smith, and W.K. Michener. 1992b. Soil evolution along a forest- salt marsh transect under a regime of slowing rising sea level, southeastern United States. Geoderma 55: 141-157.

Gardner, L.R., B. Kjerfve, and D.M. Petrecca. 2006. Tidal fluxes of dissolved oxygen at the North Inlet – Winyah Bay National Estuarine Research Reserve. Estuarine, Coastal and Shelf Science 67: 450-460

Gayes, P.T. 1991. Post-hurricane Hugo nearshore side scan sonar survey; Myrtle Beach to Folly Beach, South Carolina. Journal of Coastal Research 8: 95-111 (Special Issue)

Gettys, K.L., J.F. Hancock, and A.J. Cavalieri. 1980. Salt tolerance of in vitro activity of leucine aminopeptidase, peroxidase, and malate dehydrogenase in the halophytes *Spartina alterniflora* and *S. patens*. Botanical Gazette 141: 453-457

Gibbons, J.W., Lovich, J.E., Tucker, A.D., Fitzsimmons, N.N., Greene, J.L. 2001. Demographic and ecological factors affecting conservation and management of the diamondback terrapin (*Malaclemys terrapin*) in South Carolina. Chelonian Conservation and Biology. 4: 66-74

Gielazyn, M.L., S.E. Stancyk, and W.W. Piegorsch. 1999. Experimental evidence of subsurface feeding by the burrowing ophiuroid *Amphipholis gracillima* (Echinodermata). Marine Ecology Progress Series 184: 129-138

Godley, J., and R.J. Brodie. 2007. Effect of summer storms on early life stages of *Uca minax*, *U. pugnax*, and *U. pugilator* in North Inlet Estuary, South Carolina, USA. Marine Ecology Progress Series 342: 197-204

Goni, M.A., and L.R. Gardner. 2003. Seasonal dynamics in dissolved organic carbon concentrations in a coastal water-table aquifer at the forest-marsh interface. Aquatic Geochemistry 9: 209-232

Goni, M.A., and K.A. Thomas. 2000. Sources and transformations of organic matter in surface soils and sediments from a tidal estuary (North Inlet, South Carolina, USA). Estuaries 23: 548-564

Goni, M.A., M.J. Teixeira, and D.W. Perkey. 2003. Sources and distribution of organic matter in a river-dominated estuary (Winyah Bay, SC, USA). Estuarine, Coastal and Shelf Science 57: 1023-1048

Goni, M.A., M.W. Cathey, Y.H. Kim, and G. Voulgaris. 2005. Fluxes and sources of suspended organic matter in an estuarine turbidity maximum region during low discharge conditions. Estuarine, Coastal and Shelf Science 63: 683-700

Goni, M.A., G. Voulgaris, and Y.H. Kim. 2009. Composition and fluxes of particulate organic matter in a temperate estuary (Winyah Bay, South Carolina, USA) under contrasting physical forcings. Estuarine, Coastal and Shelf Science 85: 273-291

Grant, J. 1981a. Factors affecting the occurrence of intertidal amphipods in reducing sediments. Journal of Experimental Marine Biology and Ecology 49: 203-216

Grant, J. 1981b. Dynamics of competition among estuarine sand-burrowing amphipods. Journal of Experimental Marine Biology and Ecology 49: 255-265

Grant, J. 1981c. A bioenergetic model of shorebird predation on infaunal amphipods. Oikos 37: 53-62

Grant, J. 1983. The relative magnitude of biological and physical sediment reworking in an intertidal community. Journal of Marine Research 41: 673-689

Grant, J. 1984. Sediment microtopography and shorebird foraging. Marine Ecology Progress Series 19: 293-296

Green, A.S., and G.T. Chandler. 1994. Meiofaunal bioturbation effects on the partitioning of sediment-associated cadmium. Journal of Experimental Marine Biology and Ecology 180: 59-70

Green, A.S., G.T. Chandler, and E.R. Blood. 1993. Aqueous-, porewater-, and sediment-phase cadmium: toxicity relationships for a meiobenthic copepod. Environmental Toxicology and Chemistry 12: 1497-1506

Green, A.S., G.T. Chandler, and B.C. Coull. 1995. Age-specific survival analysis of an infaunal meiobenthic harpacticoid copepod, *Amphiascus tenuiremis*. Marine Ecology Progress Series 129: 107-112

Green, A.S., G.T. Chandler, and W.W. Piegorsch. 1996. Life-stage-specific toxicity of sediment-associated chlorpyrifos to a marine, infaunal copepod. Environmental Toxicology and Chemistry 15: 1182-1188

Griffen, B.D., and H. Mosblack. 2011. Predicting diet and consumption rate differences between and within species using gut ecomorphology. Journal of Animal Ecology 80: 854-863

Griffen, B.D., B.J. Toscano, and J. Gatto. 2012. The role of individual behavior type in mediating indirect interactions. Ecology 93: 1935-1943

Grove, M.W., and S.A. Woodin. 1996. Conspecific recognition and host choice in a pea crab *Pinnixa chaetopterana*. Biological Bulletin 190: 359-366

Grove, M.W., C.M. Finelli, S.A. Woodin, and D.S. Wethey. 2000. The effects of pea crabs on the pumping activity and growth rates of *Chaetopterus variopedatus*. Journal of Experimental Marine Biology and Ecology 246: 31-52

Guentzel, J.L., and Y. Tsukamoto. 2001. Processes influencing mercury speciation and bioconcentration in the North Inlet–Winyah Bay Estuary, South Carolina, USA. Marine Pollution Bulletin 42: 615-619

Gulbransen, D. J., K. J. McGlathery, M. Marklund, J. N. Norris, and C. F. D. Gurgel. 2012. *Gracilaria vermiculophylla* (rhodophyta, gracilariales) in the Virginia coastal bays, USA: cox1 analysis reveals high genetic richness of an introduced macroalga. Journal of Phycology 48: 1278–1283

Gulka, G., C.M. Doscher, and N. Watabe. 1980. Toxicity and molt-accelerating effects of diflubenzuron on the barnacle, *Balanus eburneus*. Bulletin of Environmental Contamination and Toxicology 25: 477-481

Gutierrez, C.K., G.Y. Matsui, D.E. Lincoln, and C.R. Lovell. 2009. Production of the phytohormone indole-3-acetic acid by estuarine species of the genus *Vibrio*. Applied and Environmental Microbiology 75: 2253-2258

Guttman, N., and M. Plantico. 1987. "Drought History and Chance of Recurrence" in Climate Report G-30: Southeast Drought Symposium Proceedings, March 4-5, 1987 (Scott F. Sidlow, Editor) South Carolina Department of Natural Resources Water Resources Division (Formerly South Carolina Water Resources Commission), Columbia, South Carolina

Haertel-Borer, S.S., D.M. Allen, and R.F. Dame. 2004. Fishes and shrimps are significant sources of dissolved inorganic nutrients in intertidal marsh creeks. Journal of Experimental Marine Biology and Ecology 311: 79-99

Hall, M. 1979. The species composition and abundance cycle of the phytoplankton in North Inlet Estuary, South Carolina, with special reference to tidal effects. M.S. Thesis, Univ. of South Carolina, Columbia. 61 pp.

Han, K., S.A. Woodin, D.E. Lincoln, and B. Ely. 2001. *Amphitrite ornata*, a marine worm, contains two dehaloperoxidase genes. Marine Biotechnology 3: 287-292

Harden, S.L., and D.F. Williams. 1989. Stable carbon isotopic evidence for sources of particulate organic carbon found in sea foam. Estuaries 12: 49-56

Harder, H.W., E.C. Christiansen, J.R. Matthews, and T.F. Bidleman. 1980. Rainfall input of toxaphene to a South Carolna estuary. Estuaries 3: 142-147

Hartman, M.J. 2003. Population dynamics and trophic interactions of *Petrolisthes armatus*, an invasive decapod crustacean. Ph.D. Dissertation. University of South Carolina, Columbia. 178 pp.

Hartman, M.J., and S.E. Stancyk. 2000. Distribution of an invasive anomuran decapod, *Petrolisthes armatus*, in the North Inlet-Winyah Bay National Estuarine Research Reserve on the South Carolina coast. American Zoologist 40: 1047-1047

Hartman, M.J., S.E. Stancyk, and A.M. Lohrer. 2002. Native predators and the success of a newcomer, *Petrolisthes armatus*, the green porcelain crab to an oyster reef ecosystem in North Inlet, SC. Integrative and Comparative Biology 42: 1241-1241

Hauswaldt, S.J. and T.C. Glenn. 2005. Population genetics of the diamondback terrapin (*Malaclemys terrapin*). Molecular Ecology. 14: 723-732

Heard, R.W., W.W. Price, D.M. Knott, R.A. King, and D.M. Allen. 2006. A taxonomic guide to the mysids of the South Atlantic Bight. NOAA Professional Papers Series. NMFL 4. U.S. Dept. of Commerce. Seattle. 37 pp.

Heatwole, D. W., and S.E. Stancyk. 1982. Spawning and functional morphology of the reproductive system in the ophiuroid, *Hemipholis elongata* (Say). International Echinoderms Conference, Tampa Bay, 14-17 September 1981. J.M. Lawrence, ed. (A.A. Balkema, Rotterdam.) pp. 469- 474

Hein, J. L. 2012. *Anguillicoloides crassus*, an invasive parasite of the American eel, *Anguilla rostrata*: Population dynamics in South Carolina estuaries and health impacts on the host. Master of Science Thesis, College of Charleston, 152 pp.

Hersh, S. and D. Duffield. 1990. Distinction between northwest Atlantic offshore and coastal Bottlenose dolphins based on hemoglobin profile and morphometry. In The Bottlenose Dolphin, pp. 129-139. San Diego, Academic Press.

Hicks, G.R.F., and B.C. Coull. 1983. The ecology of marine meiobenthic harpacticoid copepods. Oceanography and Marine Biology Annual Review 21: 67-175

Higgins, R.P., and J.W. Fleeger. 1980. Seasonal changes in the population structure of *Echinoderes coulli* (Kinorhyncha). Estuarine and Coastal Marine Science 10: 495-505

Hilbish, T.J. 1981. Latitudinal variation in freezing tolerance of *Melampus bidentatus* (Say) (Gastropoda: Pulmonata). Journal of Experimental Marine Biology and Ecology 52: 283-197

Hilbish, T.J. 1987. Response of aquatic and aerial metabolic rates in the ribbed mussel *Geukensia demissa* (Dillwyn) to acute and prolonged changes in temperature. Journal of Experimental Marine Biology and Ecology 105: 207-218

Hilbish, T.J., and F.J. Vernberg. 1987. Quantitative genetics of juvenile growth and shape in the mud crab *Eurypanopeus depressus*. Biological Bulletin 173: 461-473

Hinde, R.M., C.A. Wenner, J. Smith, and D. Calder. 1981. Benthic and Nektonic Studies of Winyah Bay for the Proposed Channel Deepening Project and Dredging of the Western Turning Basin. US Corps of Engineers, Charleston, SC. Contract Report DACW60-80-C-0029, 141 pp.

Hirschboeck, K.K. 1991. Climate and floods in National Water Summary 1988-1989 Hydrologic Events and Floods and Droughts: U.S. Geological Survey Water Supply Paper 2375, Hydrology: 67-88

Hogue, E.W. 1978. Spatial and temporal dynamics of a subtidal estuarine gastrotrich assemblage. Marine Biology 49: 211-222

Holland, A.F., and J.M. Dean. 1977a. The community ecology of intertidal macrofauna inhabiting sandbars in the North Inlet area of South Carolina, U.S.A. pp. 423-438, in B.C. Coull (ed.) The Ecology of Marine Benthos. The Belle W. Baruch Library in Marine Science Number 6, Univ. of South Carolina Press, Columbia, South Carolina

Holland, A.F., and J.M. Dean. 1977b. The biology of the stout razor clam, *Tagelus plebeius* II. Some aspects of the population dynamics. Chesapeake Science 18:188-196.

Holland, A.F., and T.T. Polgar. 1976. Seasonal changes in the structure of an intertidal community. Marine Biology 37: 341-348

Holland, A.F., R.G. Zingmark, and J.M. Dean. 1974. Quantitative evidence concerning the stabilization of sediments by marine benthic diatoms. Marine Biology 27: 191-196

Holle, R., Vaisala Consultant for NOAA. June 2012. Lightning Fatalities by State, 1959-2011. Source: Storm Data, a monthly publication from the National Weather Service. http://www.erh.noaa.gov/iln/lightning/2012/LightningFatalities.pdf

Horn, T.D. 1978. The distribution of *Echinoderes coulli* (Kinorhyncha) along an interstitial salinity gradient. Transactions of the American Microscopical Society 97(4): 586-589

Hoskins, D.L., S.E. Stancyk, and A.W. Decho. 2003. Utilization of algal and bacterial extracellular polymeric secretions (EPS) by the deposit-feeding brittlestar, *Amphipholis gracillima* (Echinodermata). Marine Ecology Progress Series 247: 93-101

Houser, D.S. and D.M. Allen. 1996. Zooplankton dynamics in an intertidal salt-marsh basin. Estuaries 19(3): 659-673

Hutcheson, M.S. 1974. The effect of temperature and salinity on cadmium uptake by the blue crab, *Callinectes sapidus*. Chesapeake Science 15: 237-242

Hutchinson, S.E., and F.H. Sklar. 1993. Lunar periods as grouping variables for temporally fixed sampling regimes in a tidally dominated estuary. Estuaries 16: 789-798

Hutchinson, S.E., F.H. Sklar, and C. Roberts. 1995. Short term sediment dynamics in a southeastern U.S.A. *Spartina* marsh. Journal of Coastal Research 11: 370-380

Hwang, Y.-H., and J.T. Morris. 1991. Evidence for hygrometric pressurization in the internal gas space of *Spartina alterniflora*. Plant Physiology 96: 166-171

Hwang, Y.-H., and J.T. Morris. 1992. Fixation of inorganic carbon from different sources and its translocation in *Spartinal alterniflora* Loisel. Aquatic Botany 43: 137-147

Iacarella, J.C., and B. Helmuth. 2011. Experiencing the salt marsh environment through the foot of *Littorina irrorata*: Behavioral responses to thermal and dessication stresses. Journal of Experimental Marine Biology and Ecology 409: 143-153

Ivester, M.S. 1980. The distribution of meiobenthic copepods along a sediment gradient: factor and niche analysis. Bulletin of Marine Science 30: 634-645

Ivester, M.S., and B.C. Coull. 1977. Niche fractionation studies of two sympatric species of *Enhydrosoma* (Copepoda, Harpacticoida). Mikrofauna Meeresboden 61: 137-151

Jackson, G., R. Zingmark, A.J. Lewitus, R.G. Tymowski, and J. Stuckey. 2006. Spatial and temporal dynamics of epiphytic microalgae on the cordgrass, *Spartina alterniflora*, in North Inlet Estuary, South Carolina. Estuaries and Coasts 29: 1212-1221

Jackson, G., R.G. Zingmark, and A.J. Lewitus. 2009. Modeling epiphytic community production. Marine Ecology Progress Series 387: 61-70

Jackson, M.G.O. 2004. Ecology of the epiphytic microalgal community in North Inlet estuary, SC. Ph.D. dissertation, Univ. South Carolina, Columbia

Jacobs, K. 2002. Connecting Science, Policy, and Decisionmaking: A Handbook for Researchers and Science Agencies. National Oceanic and Atmospheric Administration. Office of Global Programs. http://ciceet.unh.edu/resources/jacobs-2002.pdf

Jacobs, K., Garfin, G. and M. Lenart. 2005. "More than Just Talk: Connecting Science and Decisionmaking. Environment 47 (9): 6–21 http://perceval.bio.nau.edu/downloads/grail/climate_seminar/section1/Jacobs_Garfin_Lenart05.pdf

Johnson, W., A.J. Lewitus, and M. Fletcher. 2006. Linking bacterioplankton community structures to environmental state variables and phytoplankton assemblages in two South Carolina salt marsh estuaries. Aquatic Microbial Ecology 45:129-145

Johnson, W.S., and D.M. Allen. 2012. Zooplankton of the Atlantic and Gulf coasts: A Guide to their Identification and Ecology. Second edition. Johns Hopkins Univ. Press. Baltimore. 452 pp.

Johnson, W.S., D.M. Allen, M.V. Ogburn-Matthews, and S.E. Stancyk. 1990. Short-term predation responses of adult bay anchovies *Anchoa mitchilli* to estuarine zooplankton availability. Marine Ecology Progress Series 64: 55-68

Johnston, J.W., and K.L. Bildstein. 1990. Dietary salt as a physiological constraint in white ibis breeding in an estuary. Physiological Zoology 63(1): 190-207

Jones, C.M. 1999. Concentrations and dynamics of dissolved organic carbon in a coastal aquifer, North Inlet, South Carolina. MS Thesis, Dept. Geological Sciences, Univ. South Carolina, Columbia

Jost, J., and B. Helmuth. 2007. Morphological and ecological determinants of body temperature of *Geukensia demissa*, the Atlantic ribbed mussel, and their effects on mussel mortality. Biological Bulletin 213: 141-151

Kamermans, P., H.W. Van der Veer, J.IJ. Witte, and E.J. Adrianns. 1999. Morphological differences in *Macoma balthica* (Bivalvia, Tellinacea) from a Dutch and three southeastern United States estuaries. Journal of Sea Research 41: 213-224

Kana, T.W., E.J. Hayter, and P.A. Work. 1999. Mesoscale sediment transport at southeastern U.S. tidal inlets: conceptual model applicable to mixed energy settings. Journal of Coastal Research 15: 303-313

Kawaguchi, T., A.J. Lewitus, C.M. Aelion, and H.N. McKellar. 1997. Can urbanization limit iron availability to estuarine algae? Journal of Experimental Marine Biology and Ecology 213: 53-69

Kawaguchi, T., D. Porter, D. Bushek, and B. Jones. 1999. Mercury in the American oyster *Crassostrea virginica* in South Carolina, USA, and public health concerns. Marine Pollution Bulletin 38: 324-327

Kawasaki, N., and R. Benner. 2006. Bacterial release of dissolved organic matter during cell growth and decline: Molecular origin and composition. Limnology and Oceanography 51: 2170-2180

Kennish, M.J. 2004. NERRS research and monitoring initiatives. Journal of Coastal Research 45: 1-8

Kiehn, W.M., and J.T. Morris. 2009. Relationships between *Spartina alterniflora* and *Littoraria irrorata* in a South Carolina salt marsh. Wetlands 29: 818-825

Kiehn, W.M., and J.T. Morris. 2010. Variability in dimethylsulfoniopropionate (DMSP) concentrations in *Spartina alterniflora* and the effect on *Littoraria irrorata*. Marine Ecology Progress Series 406: 47-55

Kihslinger, R.L., and S.A. Woodin. 2000. Foraging behavior, risk and organic enrichment. Marine Ecology Progress Series 201: 233-239

Kim, Y.H., and G. Voulgaris. 2005. Effect of channel bifurcation on residual estuarine circulation: Winyah Bay, South Carolina. Estuarine, Coastal and Shelf Science 65: 671-686

King, G.M. 1988. Patterns of sulfate reduction and the sulfur cycle in a South Carolina salt marsh. Limnology and Oceanography 33: 376-390

Kingsley, R.J., and N. Watabe. 1984. CA-ATPase localization and inhibition in the gorgonian *Leptogorgia virgulata* (Lamark) (Coelenterata: Gorgonacae). Journal of Experimental Marine Biology and Ecology 93: 157-167

Kirwan, M.L., G.R. Guntenspergen, and J.T. Morris. 2009. Latitudinal trends in *Spartina alterniflora* productivity and the response of coastal marshes to global change. Global Change Biology doi: 10.1111/j.1365-2486.2008.01834.x

Kirwan, M.L., G.R. Guntenspergen, A. D'Alpaos, J.T. Morris, S.M. Mudd, and S. Temmerman. 2010. Limits on the adaptability of coastal marshes to rising sea level. Geophysical Research Letters 37, L23401, doi: 10.1029/2010GL045489

Kjerfve, B. 1986. Circulation and salt flux in a well mixed estuary. Pp. 22-29 in J. Van de Kreeke (ed.). Physics of Shallow Estuaries and Bays. Springer-Verlag, Berlin, 280 pp.

Kjerfve, B., and H.N. McKellar, Jr. 1980. Time series measurements of estuarine material fluxes. Pp. 341-357, in V.S. Kennedy (ed.) Estuarine Perspectives. Academic Press, New York.

Kjerfve, B., and C. Medeiros. 1989. Current vanes for measuring tidal currents in estuaries. Estuarine, Coastal and Shelf Science 28: 87-93

Kjerfve, B., and T.G. Wolaver. 1988. Sampling optimization for studies of tidal transport in estuaries. American Fisheries Society Symposium 3: 26-33

Kjerfve, B., L.H. Stevenson, J.A. Proehl, T.H. Chrzanowski, and W.M. Kitchens. 1981. Estimation of material fluxes in an estuarine cross section: a critical analysis of spatial measurement density and errors. Limnology and Oceanography 26: 325-335

Kjerfve, B., L.B. Miranda, and E. Wolanski. 1991. Modelling water circulation in an estuary and intertidal marsh system. Netherlands Journal of Sea Research 28: 141-147

Kjerfve, B., W.K. Michener, and L.R. Gardner. 1994. Impacts of climate change in estuary and delta environments. Pp. 31-43 in Pernetta, J., R. Leemans, D. Elder, and S. Humphrey (eds.) Impacts of climate change on ecosystems and species: marine and coastal ecosystems. IUCN, The World Conservation Union, Gland, Switzerland, A Marine Conservation and Development Report, 108 pp.

Kjerfve, B., G.M.E. Perillo, L.R. Gardner, J.M. Rine, G.T.M. Dias, and F.R. Mochel. 2002. Chapter Twenty. Morphodynamics of muddy environments along the Atlantic coasts of North and South America. Pp. 479-532, in T. Healy, Y. Wang, and J.-A. Healy (eds.) Muddy Coasts of the World: Processes, Deposits and Function. Elsevier Science B.V.

Klosterhaus, S.L., L.M. DiPinto, and G.T. Chandler. 2003. A comparative assessment of azinphosmethyl bioaccumulation and toxicity in two estuarine meiobenthic harpacticoid copepods. Environmental Toxicology and Chemistry 22: 2960-2968

Knott, D. M., E. L. Wenner and R. A. King. 2008. A preliminary assessment of the occurrence of the invasive Asian green mussel, *Perna viridis*, in South Carolina. Marine Resources Research Institute, Marine Resources Division, South Carolina Department of Natural Resources, 24 pp.

Kovatch, C.E., N.V. Schizas, G.T. Chandler, B.C. Coull, and J.M. Quattro. 2000. Tolerance and genetic relatedness of three meiobenthic populations exposed to sediment-associated contaminant mixtures: role of environmental history. Environmental Toxicology and Chemistry 19: 912-919

Kratz, T.K., B.J. Benson, E.R. Blood, G.L. Cunningham, and R.A. Dahlgren. 1991. The influence of landscape position on temporal variability in four North American ecosystems. The American Naturalist 138: 355-378

Krest, J.M., W.S. Moore, L.R. Gardner, and J.T. Morris. 2000. Marsh nutrient export supplied by groundwater discharge: evidence from radium measurements. Global Biogeochemical Cycles 14: 167-176

Kucklick, J.R., and T.F. Bidleman. 1994a. Organic contaminants in Winyah Bay, South Carolina I: pesticides and polycyclic aromatic hydrocarbons in subsurface and microlayer waters. Marine Environmental Research 37: 63-78

Kucklick, J.R., and T.F. Bidleman. 1994b. Organic contaminants in Winyah Bay, South Carolina II: using natural fluorescence to follow atrazine levels and river mixing. Marine Environmental Research 37: 79-91

Kucklick, J.R., S.K. Sivertsen, M. Sanders, and G.I. Scott. 1997. Factors influencing polycyclic aromatic hydrocarbon distributions in South Carolina estuarine sediments. Journal of Experimental Marine Biology and Ecology 213: 13-29

Kutcher, T.E., Garfield, N.H., and Raposa, K.B. 2005. A recommendation for a comprehensive habitat and land use classification system for the National Estuarine Research Reserve System. Report for the Estuarine Reserves Division, NOAA/NOS/OCRM, Silver Spring, MD, 26 pp.

LaCount, M.W., E.L. Zhang, Y.P. Chen, K.P. Han, M.M. Whitton, D.E. Lincoln, S.A. Woodin, and L. Lebioda. 2000. The crystal structure and amino acid sequence of dehaloperoxidase from *Amphitrite ornate* indicate common ancestry with globins. Journal of Biological Chemistry 275: 18712-18716

LaRocque, J., P.W. Bergholz, C.E. Bagwell, and C.R. Lovell. 2004. Influence of host plant-derived and abiotic environmental parameters on the composition of the diazotroph assemblage associated with roots of *Juncus roemerianus*. Antonie van Leeuwenhoek 68: 249-261

LaSalle, M.W., M.C. Landin, and J.G. Sims. 1991. Evaluation of the flora and fauna of a *Spartina alterniflora* marsh established on dredged material in Winyah Bay, South Carolina. Wetlands 11: 191-208

Lawrenz, E. 2011. Spectral irrandiance and phytoplankton community composition in blackwater estuaries. Ph.D. dissertation, Univ. of South Carolina, Columbia, 210 pp.

Lawrenz, E., and T.L. Richardson. 2011. How does the species used for calibration affect chlorophyll a measurements by in situ fluorometry? Estuaries and Coasts 34: 872-883

Lawrenz, E., J.L. Pinckney, M.L. Ranhofer, H.L. MacIntyre, and T.L. Richardson. 2010. Spectral irradiance and phytoplankton community composition in a blackwater-dominated estuary, Winyah Bay, South Carolina, USA. Estuaries and Coasts 33: 1186-1201

Lebioda, L., M.W. LaCount, E. Zhang, Y.P. Chen, K. Han, M.M. Whitton, D.E. Lincoln, and S.A. Woodin. 1999. An enzymatic globin from a marine worm. Nature 401: 445

Lehnert, R.L. and D.M. Allen. 2002. Nekton use of subtidal oyster shell habitat in a southeastern U.S. estuary. Estuaries 25: 1015-1024.

Levy, R.V., and B.C. Coull. 1977. Feeding groups and size analysis of marine meiobenthic nematodes from South Carolina, USA. Vie et Milieu XXVII (B): 1-12

Lewitus, A.J., D.L. White, R.G. Tymowski, M.E. Geesey, S.N. Hymel, and P.A. Noble. 2005. Adapting the CHEMTAX method for assessing phytoplankton taxonomic composition in southeastern US estuaries. Estuaries 28: 160-172

Lewitus, A.J., E.T. Koepfler, and J.T. Morris. 1998. Seasonal variation in the regulation of phytoplankton by nitrogen and grazing in a salt-marsh estuary. Limnology and Oceanography 43: 636-646

Lewitus, A.J., T. Kawaguchi, G.R. DiTullio, and J.D.M. Keesee. 2004. Iron limitation of phytoplankton in an urbanized vs. forested southeastern U.S. salt marsh estuary. Journal of Experimental Marine Biology and Ecology 298: 233-254

Li, Y., J.T. Morris, and D.C. Yoch. 1990. Chronic low level hydrocarbon amendments stimulate plant growth and microbial activity in salt-marsh microcosms. Journal of Applied Ecology 27: 159-171

Lincoln, D.E., K.T. Fielman, R.L. Marinelli, and S.A. Woodin. 2005. Bromophenol accumulation and sediment contamination by the polychaetes *Notomastus lobatus* (Capitellidae) and *Thelepus crispus* (Terebellidae). Biochemical Systematics and Ecology 33: 559-570

Lohrer, A.M., and J.J. Wetz. 2003. Dredging-induced nutrient release from sediments to the water column in a southeastern saltmarsh creek. Marine Pollution Bulletin 46: 1156-1163

Long, E.R. 2000. Spatial extent of sediment toxicity in U.S. estuaries and marine bays. Environmental Monitoring and Assessment 64: 391-407

Long, E.R., A. Robertson, D.A. Wolfe, J. Hameedi, and G.M. Sloane. 1996. Estimates of the spatial extent of sediment toxicity in major U.S. estuaries. Environmental Science & Technology 30: 3585-3592

Long, E.R., and 9 others. 1998. Magnitude and Extent of Sediment Toxicity in Selected Estuaries of South Carolina and Georgia. NOAA Technical Memorandum NOS ORCA 128, Silver Spring, MD, 289 pp.

Long, M.E. 2006. Quantifying blue crab (*Callinectes sapidus*) predation on periwinkle (*Littoraria irrorata*) abundance. M.S. Thesis, Univ. of South Carolina, Columbia

Lonsdale, D.J. and B.C. Coull. 1977. Composition and seasonality of zooplankton in North Inlet, South Carolina. Chesapeake Science 18(3): 272-283

Lovell, C.R. 2005. Belowground interactions among salt marsh plants and microorganisms. Pp. 61-83, in E. Kristensen, J.E. Kosta, and R.H. Hease (eds.) Interactions Between Macro- and Microorganisms in Marine Sediments. Coastal and Estuarine Studies, Volume 60. American Geophysical Union, Washington, D.C.

Lovell, C.R., and D.A. Davis. 2012. Specificity of salt marsh diazotrophs for vegetation zones and plant hosts. Frontiers in Terrestrial Microbiology 3:84, DOI 10.3389/fmicb.2012.00084

Lovell, C.R., T.M. Phillips, and C.C. Steward. 1999. Activity of marine sediment bacterial communities exposed to increasing concentrations of 4-bromophenol, a polychaete secondary metabolite. Marine Ecology Progress Series 179: 241-246

Lovell, C.R., Y.M. Piceno, J.M. Quattro, and C.E. Bagwell. 2000. Molecular analysis of diazotroph diversity in the rhizosphere of the smooth cordgrass, *Spartina alterniflora*. Applied and Environmental Microbiology 66: 3814-3822

Lovell, C.R., C.E. Bagwell, M. Czako, L. Marton, Y.M. Piceno, and D.B. Ringelberg. 2001a. Stability of a rhizosphere microbial community exposed to natural and manipulated environmental variability. FEMS Microbiology Ecology 38: 69-76

Lovell, C.R., M.J. Friez, J.W. Longshore, and C.E. Bagwell. 2001b. Recovery and phylogenetic analysis of *nifH* sequences from diazotrophic bacteria associated with dead aboveground biomass of *Spartina alterniflora*. Applied and Environmental Microbiology 67: 5308-5314

Lovell, C.R., P.V. Decker, C.E. Bagwell, M. Friez, and G.Y. Matsui. 2008. Analysis of a diverse assemblage of diazotrophic bacteria from *Spartina alterniflora* using DGGE and clone library screening. Journal of Microbiological Methods 73:160-171

Luckenbach, M. 1984a. Settlement and early post-settlement survival of *Mulinia lateralis* (Bivalvia). Marine Ecology Progress Series 17: 245-250

Luckenbach, M.W. 1984b. Biogenic structure and foraging by five species of shorebirds (Charadrii.) Estuarine, Coastal and Shelf Science 19: 691-697

Luckenbach, M.W. 1986. Sediment stability around animal tubes: the roles of biotic and hydrodynamic processes. Limnology and Oceanography 31: 779-787

Luckenbach, M. 1987. Effects of adult infauna on new recruits: Implications for the role of biogenic refuges. Journal of Experimental Marine Biology and Ecology 105: 197-206

Lunetta, J.E., and W.B. Vernberg. 1971. Fatty acid composition of parasitized and nonparasitized tissue of the mud-flat snail, *Nassarius obsolete* (Say). Experimental Parasitology 30: 244-248

Mackin, J.E., and R.C. Aller. 1984. Ammonium adsorption in marine sediments. Limnology and Oceanography 29: 250-257

MacRae, A., and S.A. Woodin. 1984. A photographic method for quantifying surface defecation. Marine Ecology Progress Series 19: 233-236

Marinelli, R., and B.C. Coull. 1987. Structural complexity and juvenile fish predation on meiobenthos: an experimental approach. Journal of Experimental Marine Biology and Ecology 108: 67-81

Maroney, L.A. 2005. Sources and distribution of terrestrially-derived high molecular weight dissolved organic matter in a subterranean estuary (North Inlet, South Carolina) and in Winyah Bay and the South Carolina coast. MS Thesis, Dept. Geological Sciences, Univ. South Carolina, Columbia. 178 pp.

Marshall, K.R., and B.C. Coull. 1996. PAH effects on removal of meiobenthic copepods by juvenile spot (*Leiostomus xanthurus*: Pisces). Marine Pollution Bulletin 32: 22-26

Marte, C.L. 1980. The food and feeding habit of *Penaeus monodon* Fabricius collected from Makato River, Aklan, Philippines (Decapoda Natantia). Crustaceana 38: 225-236

Martof, B.S., W.M. Palmer, J.R. Bailey, and J.R. Harrison III. 1980. Amphibians and Reptiles of the Carolinas and Virginia. The University of North Carolina Press. Chapel Hill. 264 pp.

Matsui, G.Y., D.B. Ringelberg, and C.R. Lovell. 2004. Sulfate reducing bacteria in tubes constructed by the marine infaunal polychaete *Diopatra cuprea*. Applied and Environmental Microbiology 70: 7053-7065

Maxwell, M.K. 2008. Distribution, movement, and growth of neonate Atlantic sharpnose sharks, *Rhizoprionodon terraenovae,* in a South Carolina estuary and nearby coastal ocean waters. Masters Thesis. Coastal, Marine, and Wetlands Studies. Coastal Carolina University.

McCann, J.A., L.N. Arkin, and J.D. Williams. 1996. Nonindigenous aquatic and selected terrestrial species of Florida. Report to U.S. Fish and Wildlife Service, Washington, DC.

McCraith, B.J., L.R. Gardner, D.S. Wethey, and W.S. Moore. 2003. The effect of fiddler crab burrowing on sediment mixing and radionuclide profiles along a topographic gradient in a southeastern salt marsh. Journal of Marine Research 61: 359-390

McDonald, J. 1982. Divergent life history patterns in the co-occurring intertidal crabs *Panopeus herbstii* and *Eurypanopeus depressus* (Crustacea: Brachyura: Xanthidae). Marine Ecology Progress Series 8: 173-180

McMahon, P.B., D.F. Williams, and J.T. Morris. 1990. Production and carbon isotopic composition of bacterial CO_2 in deep coastal plain sediments of South Carolina. Ground Water 28: 693-702

Mendelssohn, I.A., and J.T. Morris. 2002. Eco-physiological controls on the productivity of *Spartina alterniflora* Loisel. Pp. 59-80, in M.P. Weinstein and D.A. Kreeger (eds.), Concepts and Controversies in Tidal Marsh Ecology, Kluwer Academic Publishers, Dordrecht/Boston/London

Michener, W.K., and P.D. Kenny. 1991. Spatial and temporal patterns of *Crassostrea virginica* (Gmelin) recruitment: relationship to scale and substratum. Journal of Experimental Marine Biology and Ecology 154: 97-121

Michener, W.K., R. J. Feller, and D. Edwards. 1986. Development, management, and analysis of a long-term ecological research information base: Example for marine macrobenthos. Pp. 173-188, in American Society for Testing and Materials (ed.), New Approaches to Monitoring Aquatic Ecosystems.

Middaugh, D.P. 1981.Reproductive ecology and spawning periodicity of the Atlantic silverside, *Menidia menidia*. Copeia 4: 766-776.

Miller, J.L. and L.R. Gardner. 1981. Sheet flow in a salt-marsh basin, North Inlet, South Carolina. Estuaries 4: 234-237.

Millero, F.J. 1993. What is PSU? Oceanography 6: 67.

Mirkes, D.Z., W.B. Vernberg, and P.J. DeCoursey. 1978. Effects of cadmium and mercury on the behavioral responses and development of *Eurypanopeus depressus* larvae. Marine Biology 47: 143-147

MMC (Marine Mammal Commission). 2004. Annual Report to Congress – 2003. Marine Mammal Commission, 4340 East-West Highway, Room 905, Bethesda, Maryland. 264 pp.

Montagna, P.A. 1982. Sampling design and enumeration statistics for bacteria extracted from marine sediments. Applied and Environmental Microbiology 43: 1366-1372

Montagna, P.A. 1983. Live controls for radioisotope tracer food chain experiments using meiofauna. Marine Ecology Progress Series 12: 43-46

Montagna, P.A. 1984a. *In situ* measurement of meiobenthic grazing rates on sediment bacteria and edaphic diatoms. Marine Ecology Progress Series 18: 119-130

Montagna, P.A. 1984b. Competition for dissolved glucose between meiobenthos and sediment microbes. Journal of Experimanetal Marine Biology and Ecology 76: 177-190

Montagna, P.A., B.C. Coull, T.L. Herring, and B.W. Dudley. 1983. The relationship between abundances of meiofauna and their suspected microbial food (diatoms and bacteria). Estuarine, Coastal and Shelf Science 17: 381-394

Moore, M.H. 2012. A tangle net study on relative abundance and habitat preference of elasmobranchs in North Inlet Estuary, South Carolina. Masters Thesis. Coastal, Marine, and Wetlands Studies. Coastal Carolina University.

Moore, P.A., M.J. Weissburg, J.M. Parrish, R.K. Zimmer-Faust, and G.A. Gerhardt. 1993. Spatial distributions of odors in simulated benthic boundary layer flows. Journal of Chemical Ecology 20: 255-279

Moore, R.H., and R.R. Reis. 1983. Analysis of spatial and temporal variations in biomass and community structure of motile organisms in Town Creek, a South Carolina tidal pass. Contributions in Marine Science 26: 111-125

Moore, W.S. 1999. The subterranean estuary: a reaction zone of ground water and sea water. Marine Chemistry 65: 111-125

Morris, J.T. 1988. Ch. 41, Pathways and controls of the carbon cycle in salt marshes. Pp. 497-510, in D.D. Hook and 12 others (eds.) The Ecology and Management of Wetlands. Vol. 1: Ecology of Wetlands, Croom Helm, London & Sydney, Timber Press, Portland, Oregon

Morris, J.T. 1989. Modelling light distribution within the canopy of the marsh grass *Spartina alterniflora* as a function of canopy biomass and sun angle. Agricultural and Forest Meterology 46: 349-361

Morris, J.T. 1995. The mass balance of salt and water in intertidal sediments: Results from North Inlet, South Carolina. Estuaries 18: 556-567

Morris, J.T. 2000. Ch. 5, Effects of sea level anomalies on estuarine processes. Pp. 107-127, in J. Hobbie (ed.), Estuarine Science: A Synthetic Approach to Research and Practice. Island Press, Washington, DC, USA

Morris, J.T. 2004. Effects of changes in sea level and productivity on the stability of intertidal marshes. Pp. 121-127, in Lasserre, P., P. Viaroli, and P. Campostrini (eds.), Lagoons and Coastal Wetlands in the Global Change Context: Impacts and Management Issues. Proceedings of the International Conference. Venice, 26-28 April 2004. UNESCO, ICAM Dossier.

Morris, J.T. 2010. Ch. 2. *Spartina* distribution and spread. Competition among marsh macrophytes by means of vertical geomorphological displacement. Pp. 109-115 in D.R.Ayres, D.W. Kerr, S.D. Ericson, and P.R. Olofson (eds.), Proceedings of the Third International Conference on Invasive *Spartina*. San Francisco, November 8-10, 2004.

Morris, J.T., and P.M. Bradley. 1999. Effects of nutrient loading on the carbon balance of coastal wetland sediments. Limnology and Oceanography 44: 699-702

Morris, J.T., and B.C. Coull. 1992. Population dynamics, numerical production, and potential predation impact on a meiobenthic copepod. Canadian Journal of Fisheries and Aquatic Sciences 49: 609-616

Morris, J.T., and B. Haskin. 1990. A 5-yr record of aerial primary production and stand characteristics of *Spartina alterniflora*. Ecology 71: 2209-2217

Morris, J.T., and G.J. Whiting. 1985. Gas advection in sediments of a South Carolina salt marsh. Marine Ecology Progress Series 27: 187-194

Morris, J.T., and G.J. Whiting. 1986. Emission of gaseous carbon dioxide from salt-marsh sediments and its relation to other carbon losses. Estuaries 9: 9-19

Morris, J.T., B. Kjerfve, and J.M. Dean. 1990. Dependence of estuarine productivity on anomalies in mean sea level. Limnology and Oceanography 35: 926-930

Morris, J.T., C. Haley, and R. Krest. 1996. Effects of sulfide concentrations on growth and dimethylsulfoniopropionate (DMSP) concentration in *Spartina alterniflora*. Pp. 87-95 in R. Kiene, P. Visscher, M. Keller, and G. Kirst (eds.) Biological and Environmental Chemistry of DMSP and related Sulfonium Compounds. Plenum Press, New York, USA.

Morris, J.T., P.V. Sundareshwar, C.T. Nietch, B. Kjerfve, and D.R. Cahoon. 2002. Responses of coastal wetlands to rising sea level. Ecology 83: 2869-2877

Morris, J.T., D. Porter, M. Neet, P.A. Noble, L. Schmidt, L.A. Lapine, and J.R. Jensen. 2005. Integrating LIDAR elevation data, multi-spectral imagery and neural network modeling for marsh characterization. International Journal of Remote Sensing 26: 5221-5234

Mudd, S.M., S. Fagherazzi, J.T. Morris, and D.J. Furbish. 2004. Ch. 9. Flow, sedimentation and biomass production on a vegetated salt marsh in South Carolina: toward a predictive model of marsh morphologic and ecologic evolution. Pp. 165-188 in Fagherazzi, S., M. Marani, and L.K. Bluml (eds.) The Ecogeomorphology of Tidal Marshes, Coastal Estuarine Studies, Vol. 59, American Geophysical Union, Washington, D.C.

Mudd, S.M., S.M. Howell, and J.T. Morris. 2009. Impact of dynamic feedbacks between sedimentation, sea-level rise, and biomass production on near-surface marsh stratigraphy and carbon accumulation. Estuarine, Coastal and Shelf Science 82: 377-389

Mudd, S.M., A. D'Alpaos, and J.T. Morris. 2010. How does vegetation affect sedimentation on tidal marshes? Investigating particle capture and hydrodynamic controls on biologically mediated sedimentation. Journal of Geophysical Research 115: doi:10.1029/2009JF001566,2010

Murphy, S., and G. Voulgaris. 2006. Identifying the role of tides, rainfall and seasonality in marsh sedimentation using long-term suspended sediment concentration data. Marine Geology 227: 31-50.

Mwamba, M.J., and R. Torres. 2002. Rainfall effects on marsh sediment redistribution, North Inlet, South Carolina, USA. Marine Geology 189: 267-287

National Invasive Species Council. 2008. 2008-2012 National Invasive Species Management Plan, 35 pp.

NAS. 2014. Nonindigenous Aquatic Species USGS. http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=1209. Accessed 2014.

National Ocean Economics Program [Internet]. Living marine resources commercial landings data [2010]. http://www.oceaneconomics.org.

National Oceanic and Atmospheric Administration. 2011. Fisheries Economics of the United States, 2009. NOAA Technical Memorandum NMFS-F/SPO-118.

Nelson, A.L., and B.C. Coull. 1989. Selection of meiobenthic prey by juvenile spot (Pisces): an experimental study. Marine Ecology Progress Series 53: 51-57

Nelson, K.A., G.I. Scott, and P.F. Rust. 2005. A multivariable approach for evaluating major impacts on water quality in Murrells and North Inlets, South Carolina. Journal of Shellfish Research 24: 1241-1251

Newell, C.L. 2006. 2005 Shellfish Growing Area Status Report: Including Classification Trends for Report Years 1986 through 2005. Shellfish Sanitation Program. South Carolina Department of Health and Environmental Control, Bureau of Water. Columbia, SC. January 2006. Online web address: http://www.scdhec.net/environment/water/docs/sftrend.pdf

Ngabe, B., T.F. Bidleman, and G.I. Scott. 2000. Polycyclic aromatic hydrocarbons in storm runoff from urban and coastal South Carolina. The Science of the Total Environment 255: 1-9

NOAA/NWS Climate Prediction Center. 2007. ENSO Impacts on the U.S. http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff

Noble, P.A., R.G. Tymowski, M. Fletcher, J.T. Morris, and A.J. Lewitus. 2003. Contrasting patterns of phytoplankton community pigment composition in two salt marsh estuaries in southeastern United States. Applied and Environmental Microbiology 69: 4129-4143

North Inlet-Winyah Bay National Estuarine Research Reserve (NI-WB NERR). 2011. NI-WB NERR Management Plan 2011-2016. North Inlet-Winyah Bay NERR, Georgetown, SC. 151pp.

O'Hara, J. 1973a. The effect of temperature and salinity on the toxicity of cadmium to the fiddler crab, *Uca pugilator*. Fishery Bulletin 71: 149-153

O'Hara, J. 1973b. Cadmium uptake by fiddler crabs exposed to temperature and salinity stress. Journal of the Fisheries Research Board of Canada 30: 846-848

Odum, E.P. 1969. The strategy of ecosystem development. Science 164: 262-270

Ogburn-Matthews, V. and D.M. Allen. 1993. Interactions among some dominant estuarine nekton species. Estuaries 16: 840-850

Ogburn, M.V., D.M. Allen, W.K. Michener. 1988. Fishes, shrimps, and crabs of the North Inlet Estuary, SC: a four-year seine and trawl survey. Baruch Institute Technical Report. No.88-1. Belle.W.Baruch Institute for Marine Biology and Coastal Research, University of South Carolina. 299 pp.

Ornes, W.H., and D.I. Kaplan. 1989. Macronutrient status of tall and short forms of *Spartina alterniflora* in a South Carolina saltmarsh. Marine Ecology Progress Series 55: 63-72

Osenga, G.A., and B.C. Coull. 1983. *Spartina alterniflora* Loisel root structure and meiofaunal abundance. Journal of Experimental Marine Biology and Ecology 67: 221-225

Otte, M.L., and J.T. Morris. 1994. Dimethylsulphoniopropionate (DMSP) in *Spartina alterniflora* Loisel. Aquatic Botany 48: 239-259

Otte, M.L., G. Wilson, J.T. Morris, and B.M. Moran. 2004. Dimethylsulphoniopropionate (DMSP) and related compounds in higher plants. Journal of Experimental Botany 55: 1919-1925

Palmer, M.A. 1980. Variation in life history patterns between intertidal and subtidal populations of the meiobenthic copepod, *Microarthridion littorale*. Marine Biology 60: 159-165

Palmer, M.A. 1984. Invertebrate drift: behavioral experiments with intertidal meiofauna. Marine Behavior and Physiology 10: 235-253

Palmer, M.A. 1986. Hydrodynamics and structure: interactive effects on meiofaunal dispersal. Journal of Experimental Marine Biology and Ecology 104: 53-68

Palmer, M.A. 1988. Epibenthic predators and marine meiofauna: separating predation, disturbance, and hydrodynamic effects. Ecology 69: 1251-1260

Palmer, M.A., and R.R. Brandt. 1981. Tidal variation in sediment densities of marine benthic copepods. Marine Ecology Progress Series 4: 207-212

Palmer, M.A., and B.C. Coull. 1980. The prediction of development rate and the effect of temperature for the meiobenthic copepod, *Microarthridion littorale* (Poppe). Journal of Experimental Marine Biology and Ecology 48: 73-83

Palmer, M.A., and G. Gust. 1985. Dispersal of meiofauna in a turbulaent tidal creek. Journal of Marine Research 43: 179-210

Palmer, M.A., and R. Malloy. 1986. Water flow and the vertical distribution of meiofauna: a flume experiment. Estuaries 9: 225-228

Pape-Lindstrom, P.A., R.J. Feller, S.E. Stancyk, and S.A. Woodin. 1997. Sublethal predation: field measurements of arm tissue loss from the ophiuroid *Microphiopholis gracillima* and immunological identification of its predators in North Inlet, South Carloina. Marine Ecology Progress Series 156: 131-140

Patchineelam, S.M., and B. Kjerfve. 2004. Suspended sediment variability on seasonal and tidal time scales in the Winyah Bay estuary, South Carolina, USA. Estuarine, Coastal and Shelf Science 59: 307-318

Patchineelam, S.M., B. Kjerfve, and L.R. Gardner. 1999. A preliminary sediment budget for the Winyah Bay estuary, South Carolina, USA. Marine Geology 162: 133-144

Pearse, J. 1977. Radiocarbon tracing of migrating benthic diatoms. M.S. Thesis, Univ. of South Carolina, Columbia. Cited in Pinckney and Zingmark (1991)

Pennings, S.C., C.-K. Ho, C.S. Salgado, K. Wieski, N. Dave, A.E. Kunza, and E.L. Wason. 2009. Latitudinal variation in herbivore pressure in Atlantic Coast salt marshes. Ecology 90 (1): 183-195.

Pernet, B., and L. McArthur. 2006. Feeding by larvae of two different developmental modes in *Streblospio benedicti* (Polychaeta: Spionidae). Marine Biology 149(4): 803-811

Petit, D.R. and K.L. Bildstein. 1986. Development of formation flying in juvenile white ibises. The Auk 103: 244-246

Petit, D.R. and K.L. Bildstein. 1987. Effect of group size and location within the group on the foraging behavior of white ibises. The Condor 89: 602-609

Phillips, J.D. 1991. Fluvial sediment delivery to a coastal plain estuary in the Atlantic drainage of the United States. Marine Geology 98: 121-134

Phillips, T.M., and C.R. Lovell. 1999. Distributions of total and active bacteria in biofilms lining tubes of the onuphid polychaete *Diopatra cuprea*. Marine Ecology Progress Series 163: 169-176

Piceno, Y.M., and C.R. Lovell. 2000a. Stability of natural bacterial communities: I. Nutrient addition effects on rhizosphere diazotroph assemblage composition. Microbial Ecology 39: 32-40.

Piceno, Y.M., and C.R. Lovell. 2000b. Stability of natural bacterial communities: II. Plant resource allocation effects on rhizosphere diazotroph assemblage composition. Microbial Ecology 39: 41-48.

Piceno, Y.M., P.A. Noble, and C.R. Lovell. 1999. Spatial and temporal assessment of diazotroph assemblage composition in vegetated salt marsh sediments using denaturing gradient gel electrophoresis analysis. Microbial Ecology 38(2): 157-167

Pillay, S., L.R. Gardner, and B. Kjerfve. 1992. The effect of cross-sectional velocity and concentration variations on suspended sediment transport rates in tidal creeks. Estuarine, Coastal and Shelf Science 35: 331-345

Pimentel, D., R. Zuniga and D. Morrison. 2005. Update on the environmental and economic cost associated with alien-invasive species in the United States. Ecological Economics 52: 273-288

Pinckney, J.L. 1992. Ecology of benthic intertidal microalgal communities in North Inlet Estuary, South Carolina. Ph.D. dissertation, Univ. of South Carolina, Columbia

Pinckney, J., and R.G. Zingmark. 1991. Effects of tidal stage and sun angles on intertidal benthic microalgal productivity. Marine Ecology Progress Series 76:81-89

Pinckney, J., and R.G. Zingmark. 1993a. Biomass and production of benthic microalgal communities in estuarine habitats. Estuaries 16: 887-897

Pinckney, J., and R.G. Zingmark. 1993b. Modeling the annual production of intertidal benthic microalgae in estuarine ecosystems. Journal of Phycology 29:396-407

Pinckney, J., and R.G. Zingmark. 1993c. Photophysiological responses of intertidal benthic microalgal communities to in situ light environments: Methodological considerations. Limnology and Oceanography 38: 1373-1383

Pinckney, J., Y. Piceno, and C.R. Lovell. 1994a. Short-term changes in the vertical distribution of benthic algal biomass in intertidal muddy sediments. Diatom Research 9: 143-153

Pinckney, J., R. Papa, and R. Zingmark. 1994b. Comparison of high-performance liquid chromatographic, spectrophotometric and fluorometric methods for determining chlorophyll-a concentrations in estuarine sediments. Journal of Microbiological Methods 19: 59-66

Pitts, G.Y., and G.T. Cowley. 1974. Mycoflora of the habitat and midgut of the fiddler crab, *Uca pugilator*. Mycologia 66: 669-675

Pollack, J. and R.W. Szivak. 2007. Training Needs Assessment of Professional Decision Makers in the Coastal Counties of South Carolina. North Inlet-Winyah Bay and ACE Basin National Estuarine Research Reserve Coastal Training Programs, February 2007. 24 pp.

Pollack, J.B., C.P. Buzelli, and R.J. Feller. 2009. The predatory role of white shrimp (*Litopenaeus setiferus*) in seasonal declines of subtidal macrobenthos. Hydrobiologia 627: 117-128. DOI 10.1007/s10750-009-9719-7

Pollack, J.B., R.M. Mroch III, and R.J. Feller. 2008. Juvenile white shrimp *Litopenaeus setiferus* predation on macrobenthic and zooplanktonic prey. Journal of Shellfish Research 27: 1247-1253

Porter, D.E., W.H. Jefferson, V. Ogburn-Matthews, and D.S. Taylor. 1994. Development of a multi-participant database management program for marine resources research and management. Special Report No. 35, Atlantic States Marine Fisheries Commission, Proceedings of the Workshop on the Collection and Use of Trawl Survey Data for Fisheries Management. December, 1994. Pp. 137-144.

Porter, D.E., W.K. Michener, T. Siewicki, D. Edwards, and C. Corbett. 1996. Geographic information processing assessment of the impacts of urbanization on localized coastal estuaries: a multidisciplinary approach. Pp. 355-387 in F.J. Vernberg, W.B. Vernberg, and T. Siewicki (eds.) Sustainable Development in the Southeastern Coastal Zone. Belle W. Baruch Library in Marine Science, No. 20. Univ of South Carolina Press, Columbia

Porter, D.E., D. Edwards, G. Scott, B. Jones, and W.S. Street. 1997. Assessing the impacts of anthropogenic and physiographic influences on grass shrimp in localized salt-marsh estuaries. Aquatic Botany 58: 289-306

Porter, D.E., T. Small, D. White, M. Fletcher, A. Norman, D. Swain, and J. Friedman. 2004. Data management in support of environmental monitoring, research, and coastal management. Journal of Coastal Research SI 45: 9-16

Potthoff, M.T. and D.M. Allen. 2003. Site fidelity, home range, and tidal migrations of juvenile pinfish, *Lagodon rhomboides*, in salt marsh creeks. Environmental Biology of Fishes 67: 231-240

Powell, W.E. 1985. Groundwater flow patterns beneath a forest-high marsh transect at North Inlet, South Carolina. M.S. Thesis, Dept. Geological Sciences, Univ. of South Carolina, Columbia, 216 pp.

Prichard, D.W. 1956. The dynamic structure of a coastal plain estuary. Journal of Marine Research 15: 33-42

Pulliam, B, B. Haskins, M. Spinks, and W. Allen. 1996. Snowy plover observed at North Island, Georgetown County, South Carolina. The Chat 60: 109-113

Rama, and W.S. Moore. 1996. Using the radium quartet for evaluating groundwater input and water exchange in salt marshes. Geochemica Et Cosmochimica Acta 60(23) 4645-4652

Ranhofer, M.L. 2009. Utilization of dissolved organic phosphorus by estuarine phytoplankton. Ph.D. Dissertation, Univ. of South Carolina, Columbia, 108 pp. (3366821)

Ranhofer, M.L., E. Lawrenz, J.L. Pinckney, C.R. Benitez-Nelson, and T.R. Richardson. 2009. Cell-specific alkaline phosphatase expression by phytoplankton from Winyah Bay, South Carolina, USA. Estuaries and Coasts 32: 943-957

Rawson, P.D., and T.J. Hilbish. 1991. Genotype-environment interaction for juvenile growth in the hard clam *Mercenaria mercenaria* (L.). Evolution 45: 1924-1935

Reis, R.R. and J.M.Dean. 1981. Temporal variation in the utilization of an intertidal marsh creek by the bay anchovy (*Anchoa mitchilli*). *Estuaries* 4: 16-23

Richardson, T.L., E. Lawrenz, J.L. Pinckney, R.C. Guajardo, E.A. Walker, H.W. Paerl, and H.L. MacIntyre. 2010. Spectral fluorometric characterization of phytoplankton community composition using the Algae Online Analyser. Water Research 44: 2461-2472

Richmond, C.E., and S.A. Woodin. 1996. Short-term fluctuations in salinity: effects on planktonic invertebrate larvae. Marine Ecology Progress Series 133: 167-177

Richmond, C.E., and S.A. Woodin. 1999. Environmental stress and benthic invertebrates: individual, population and community effects. Marine Biology 134: 259-267

Richmond, C.E., D.S. Wethey, and S.A. Woodin. 2007. Climate change and increased environmental variability: demographic responses in an estuarine harpacticoid copepod. Ecological Modelling 209: 189-202

Roach, M.P., Y.P. Chen, S.A. Woodin, D.E. Lincoln, C.R. Lovell, and J.H. Dawson. 1997. *Notomastus lobatus* chloroperoxidase and *Amphitrite ornate* dehaloperoxidase. Both contain histidine as their proximal heme iron ligand. Biochemistry 36: 2197-2202

Robinson, C.A., T.J. Heincelman, D.P. Foy, and H.L. Jett, III. 2000. The impact of salinity on distribution of macro-invertebrates in Mud Bay, Winyah Bay, South Carolina. Marine and Aquatic Research Experience student program, Marine Science Program, Univ. of South Carolina (unpublished)

Ruppert, E., and R. Fox. 1988. Seashore Animals of the Southeast. A Guide to Common Shallow-water Invertebrates of the Southeastern Atlantic Coast. Univ. South Carolina Press, Columbia, South Carolina, 429 pp.

Sanders, F.J., T.M. Murphy, and M.D. Spinks. 2004. Winter abundance of the American oystercatcher in South Carolina. Waterbirds 27 (1): 83-88

Sanders, F.J., T.M. Murphy, M.D. Spinks, and J.W. Coker. 2008. Breeding season abundance and distribution of American oystercatchers in South Carolina. Waterbirds 31(2): 268-273

Sanders, M. 1995. Distribution of polycyclic aromatic hydrocarbons in oyster (*Crassostrea virginica*) and surface sediment from two estuaries in South Carolina. Archives of Environmental Contamination and Toxicology 28: 397-405

Sandifer, P.A., J.V. Miglarese, D.R. Calder, et al. 1980. Ecological characterization of the Sea Island coastal region of South Carolina and Georgia. Vol. III: Biological features of the characterization area. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-79/42. 620 pp.

Sanger, D.M., A.F. Holland, and G.I. Scott. 1999. Tidal creek and salt marsh sediments in South Carolina coastal estuaries: II. Distribution of organic contaminants. Archives of Environmental Contamination and Toxicology 37: 458-471

Sanger, D.M., M.D. Arendt, Y. Chen, E.L. Wenner, A.F. Holland, D. Edwards, and J. Caffrey. 2002. A synthesis of water quality data: National Estuarine Research Reserve's System-Wide Monitoring Program (1995-2001). National Estuarine Research Reserve Technical Report Series 2002: 3, South Carolina Department of Natural Resources, Marine Resources Division, Contribution No. 500

Sanger, D., and 13 others. 2008. Support for Integrated Ecosystem Assessments of NOAA's National Estuarine Research Reserves System (NERRS), Volume I. The Impacts of Coastal Developmenton the Ecology and Human Well-being of Tidal Creek Ecosystems of the US Southeast. NOAA Technical Memorandum NOS NCCOS 82, 76 pp.

Sanudo-Wilhelmy, S.A., A. Tovar-Sanchez, N.S. Fisher, and A.R. Flegal. 2004. Examining dissolved toxic metals in U.S. estuaries. Environmental Science and Technology, 15 January, pp. 34a-38a.

Sauer, G.R., and N. Watabe. 1984. Zinc uptake and its effects on calcification in the scales of the mummichog, *Fundulus heteroclitus*. Aquatic Toxicology 5: 51-66

Sauer, G.R., and N. Watabe. 1988. The effects of heavy metals and metabolic inhibitors on calcium uptake by gills and scales of *Fundulus heteroclitus in vitro*. Comparative Biochemistry and Physiology 91C(2): 473-478

Sauer, G.R., and N. Watabe. 1989. Ultrastructural and histochemical aspects of zinc accumulation by fish scales. Tissue and Cell 21: 935-943

SC DNR. 2005. South Carolina's Comprehensive Wildlife Conservation Strategy. http://www.dnr.sc.gov/cwcs/index.html

SC DNR. 2014. Titan acorn barnacle (*Megabalanus coccopoma*) https://www.dnr.sc.gov/marine/sertc/InvSpp/Megabalanus%20profile%20for%20website.pdf Accessed 2014.

SCECAP. www.dnr.sc.gov/marine/scecap

SCFC. 2012. Forestry researchers: Laurel wilt pest now spreading into Georgetown County. South Carolina Forestry Commission news release. http://www.state.sc.us/forest/b012012.htm

Schaffer, P.L. 1979. The population ecology of *Heteromastus filiformis* (Polychaeta: Capitellidae). PhD dissertation, Univ. of South Carolina, 191 pp.

Schizas, N.V., G.T. Street, B.C. Coull, G.T. Chandler, and J.M. Quattro. 1999. Molecular population structure of the marine benthic copepod *Microarthridion littorale* along the southeastern and Gulf coasts of the USA. Marine Biology 135: 399-405

Schizas, N.V., G.T. Chandler, B.C. Coull, S.L. Klosterhaus, and J.M. Quattro. 2001. Differential survival of three mitochondrial lineages in a marine copepod exposed to a mixture of pesticides. Environmental Science and Technology 35: 535-538

Schizas, N.V., B.C. Coull, G.T. Chandler, and J.M. Quattro. 2002. Sympatry of distinct mitochondrial DNA lineages in a copepod inhabiting estuarine creeks in the southeastern USA. Marine Biology 140: 585-594

Scholz, D.S., L.A. Matthews, and R.J. Feller. 1991. Detecting selective digestion of meiobenthic prey by juvenile spot, *Leiostomus xanthurus* (Pisces), using immunoassays. Marine Ecology Progress Series 72: 59-67

Schwing, F.B. and B. Kjerfve. 1980. Longitudinal characterization of a tidal marsh creek separating two hydrographically distinct estuaries. Estuaries 3: 236-241.

Scott, G.I., and D.R. Lawrence. 1982. The American oyster as a coastal zone pollution monitor. Estuaries 5: 40-46

Scott, S.M. 2010. *Spartina alterniflora* productivity and salt marsh stability relative to marsh platform elevation. M.S. Thesis, University of South Carolina, Columbia, SC (http://scholarcommons.sc.edu/etd/402)

Sellner, B.W. 1973. Primary production and the release of dissolved organic matter from natural communities of estuarine phytoplankton. M.S. Thesis, Univ. of South Carolina, Columbia. 40 pp.

Sellner, B.W. 1976. Survival and metabolism of the harpacticoid copepod *Thompsonula hyaenae* (Thompson) fed on different diatoms. Hydrobiologia 50: 233-238

Sellner, K.G., R.G. Zingmark, and T.G. Miller. 1976. Interpretations of the 14C method of measuring the total annual production of phytoplankton in a South Carolina estuary. Botanica Marina 21: 119-125

SERTC. 2014. Southeastern Regional Taxonomic Center. http://www.dnr.sc.gov/marine/sertc/

Service, S.K., and R.J. Feller. 1992. Long-term trends of subtidal macrobenthos in North Inlet, South Carolina. Hydrobiologia 231: 13-40

Service, S.K., R.J. Feller, B.C. Coull, and R. Woods. 1992. Predation effect of three fish species and a shrimp on macrobenthos and meiobenthos in microcosms. Estuarine, Coastal and Shelf Science 34: 277-293

Settlemyre, J.L., and L.R. Gardner. 1975. Low-tide storm erosion in a salt marsh. Southeastern Geology 16: 205-212

Settlemyre, J.L., and L.R. Gardner. 1977. Suspended sediment flux through a salt marsh drainage basin. Estuarine, Coastal and Shelf Science 5: 653-663

Sharma, P., L.R. Gardner, W.S. Moore, and M.S. Bollinger. 1987. Sedimentation and bioturbation in a salt marsh as revealed by ^{210}Pb, ^{137}Cs, and ^{7}Be studies. Limnology and Oceanography 32: 313-326

Shenker, J.M. and J.M. Dean. 1979. The utilization of an intertidal marsh creek by larval and juvenile fishes: abundance, diversity, and temporal variation. Estuaries 2: 154-163

Shepherd, P., T. Crockett, T.L. De Santo, and K.L. Bildstein. 1991. The impact of Hurricane Hugo on the breeding ecology of wading birds at Pumpkinseed Island, Hobcaw Barony, South Carolina. Colonial Waterbirds 14(2): 150-157

Sherman, K.M., and B.C. Coull. 1980. The response of meiofauna to sediment disturbance. Journal of Experimental Marine Biology and Ecology 46: 59-71

Shoemaker, A.H., H.J. Porter, B. Boothe, R.E. Petit, and L.S. Eyster. 1978. Marine mollusks. Pp. 123-135, in Zingmark, R.G. (ed.) An Annotated Checklist of the Biota of the Coastal Zone of South Carolina. Univ. of South Carolina Press, Columbia, South Carolina. 364 pp.

Sikora, W.B. 1977. The ecology of *Palaemonetes pugio* in a southeastern salt marsh ecosystem with particular emphasis on production and trophic relationships. PhD dissertation, Univ. of South Carolina, Columbia, SC. 122 pp.

Simpson, R.G., D.M. Allen, S.A. Luthy, and K.A. Foley. 2006. Fishes of North Inlet: an Identification Guide. Baruch Institute Special Publication. University of South Carolina. 131 pp.

Sizemore, R.K., and L.H. Stevenson. 1970. Method for the isolation of proteolytic marine bacteria. Applied Microbiology 20: 991-992

Sizemore, R.K., and L.H. Stevenson. 1974. Environmental factors associated with proteolytic activity of estuarine bacteria. Life Sciences 15: 1425-1432

Sizemore, R.K., L.H. Stevenson, and B.H. Hebeler. 1973. Distribution and activity of proteolytic bacteria in estuarine sediments. Pp. 133-143, in L.H. Stevenson & R.R. Colwell (eds.), Estuarine Microbial Ecology, The Belle W. Baruch Library in Marine Science, Number 1, Univ. South Carolina Press, Columbia, SC.

Smith, C. 2012. Comparison of large nekton between a pristine and urbanized estuary and between two National Estuarine Research Reserve systems in South Carolina. Masters Thesis. Coastal, Marine, and Wetlands Studies, Coastal Carolina University.

Smith, D.L., and B.C. Coull. 1987. Juvenile spot (Pisces) and grass shrimp predation on meiobenthos in muddy and sandy substrates. Journal of Experimental Marine Biology and Ecology 105: 123-126

South Carolina Population Projections 2006-2035 [Internet]. Columbia (SC): South Carolina Budget and Control Board, Office of Research and Statistics, c2002-2010 [cited 2010 March 30]. Available from: http://www.sccommunityprofiles.org/census/projection.php.

South Carolina State Climatology Office. http://www.dnr.state.sc.us/climate/sco/

Southerland, H.A., and A.J. Lewitus. 2004. Physiological responses of estuarine phytoplankton to ultraviolet light-induced fluoranthene toxicity. Journal of Experimental Marine Biology and Ecology 298: 303-322

Spurrier, J.D., and B. Kjerfve. 1988. Estimating the net flux of nutrients between a salt marsh and a tidal creek. Estuaries 11: 10-14

Stalter, R. 1973. Transplantation of salt marsh vegetation II, Georgetown, South Carolina. CASTANEA 38: 132-139.

Stalter, R., and J. Baden. 1994. A twenty year comparison of vegetation of three abandoned rice fields, Georgetown County, South Carolina. CASTANEA 59: 69-77

Stalter, R., and W.T. Batson. 1969. Transplantation of salt marsh vegetation, Georgetown, South Carolina. Ecology 50: 1087-1089

Stancyk, S.E., and R.J. Feller. 1986. Transport of non-decapod larvae in estuaries: an overview. Bulletin of Marine Science 39: 257-268

Stancyk, S.E., and P.L. Schaffer. 1977. The salinity tolerance of *Ophiothrix angulata* (Say) (Echinodermata: Ophiuroidea) in latitudinally separate populations. Journal of Experimental Marine Biology and Ecology 29: 35-43

Stancyk, S.E., H.M. Golde, P.A. Pape-Lindstrom, and W.E. Dobson. 1994. Born to lose. I. Measures of tissue loss and regeneration by the brittlestar *Microphiopholis gracillima* (Echinodermata: Ophiuroidea). Marine Biology 118: 451-462

Staton, J.L. 2002. Meiofauna – An estuarine "canary"? pp. 3, 6 Baruch Briefs, Spring Issue. Belle W. Baruch Institute for Marine and Coastal Ecology, Univ. of South Carolina, Columbia, South Carolina.

Staton, J.L., N.V. Schizas, G.T. Chandler, B.C. Coull, and J.M. Quattro. 2001. Ecotoxicology and population genetics: the emergence of "Phylogeographic and Evolutionary Ecotoxicology." Ecotoxicology 10: 217-222

Staton, J.L., N.V. Schizas, S.L. Klosterhaus, R.J. Griffitt, G.T. Chandler, and B.C. Coull. 2002. Effect of salinity variation and pesticide exposure on an estuarine harpacticoid copepod, *Microarthridion littorale* (Poppe), in the southeastern US. Journal of Experimental Marine Biology and Ecology 278: 101-110

Staton, J.L., L.C. Wickliffe, L. Garlitska, S.M. Villanueva, and B.C. Coull. 2005. Genetic isolation discovered among previously described sympatric morphs of a meiobenthic copepod. Journal of Crustacean Biology 25: 551-557

Stauble, D.K., W.C. Seabergh, and L.Z. Hales. 1991. Effects of hurricane Hugo on the South Carolina coast. Journal of Coastal Research 8: 129-162 (Special Issue)

Stevenson, L.H. 1978. A case for bacterial dormancy in aquatic systems. Microbial Ecology 4:127-133

Stevenson, L.H., T.H. Chrzanowski, and C.W. Erkenbrecher. 1979. ATP: Conceptions and misconceptions. Pp. 99-116, in J.W. Costerton and R.R. Colwell (eds.), Native Aquatic Bacteria: Enumeration, Activity, and Ecology. Am. Soc. Test. Materials, Philadelphia.

Stevenson, L.H., T.H. Chrzanowski, and B. Kjerfve. 1980. Short-term fluxes through major outlets of the North Inlet marsh in terms of adenosine 5'-triphosphate. Pp. 355-369 in P. Hamilton and K.B. McDonald (eds.) Estuarine and wetland processes with emphasis on modelling. Plenum Press.

Stevenson, L.H., C.A. Wilson, and T.H. Chrzanowski. 1981. The assay of adenosine 5'-triphosphate extracted from salt marsh microbiota. Canadian Journal of Microbiology 27: 633-635

Steward, C.C., and C.R. Lovell. 1992. Improved method for recovery and quantification of assimilated radiolabel from sediment bacteria. Journal of Microbiology Methods 16:221-230

Steward, C.C., and C.R. Lovell. 1997. Respiration and assimilation of 4-bromophenol by estuarine sediment bacteria. Microbial Ecology 33:198-205

Steward, C.C., J. Pinckney, Y. Piceno, and C.R. Lovell. 1992. Bacterial numbers and activity, microbial biomass and productivity and meiofaunal distribution in sediments naturally-contaminated with biogenic bromophenols. Marine Ecology Progress Series 90: 61-71

Strawbridge, S., B.C. Coull, and G.T. Chandler. 1992. Reproductive output of a meiobenthic copepod exposed to sediment-associated fenvalerate. Archives of Environmental Contamination and Toxicology 23: 295-300

Styles, R., and C.C. Teague. 2007. Evaluation of a UHF radar surface current mapping system in an intertidal salt marsh. Journal of Atmospheric and Oceanic Technology 24: 2120-2127

Sullivan, M.J., and C.A. Currin. 2000. Community structure and functional dynamics of benthic microalgae in salt marshes. Pp. 81-106, in M.P. Weinstein and D.A. Kreeger (eds.) Concepts and Controversies in Tidal Marsh Ecology, Kluwer Academic Publishers, Dordrecht/Boston/London ISBN 0-7923-6019-2

Summers, J.K., and H.N. McKellar, Jr. 1979. A simulation model of estuarine subsystem coupling and carbon exchange with the sea – 1. Model structure. Pp. 323-366, in S.E. Jorgensen (ed.) State-of-the-Art in Ecological Modelling, Volume 7. Proceedings of the Conference on Ecological Modelling, Copenhagen, Denmark, 28 August – 2 September 1978. Pergamon Press, Oxford.

Summers, J.K., and W.M. Kitchens. 1980. A simulation model of estuarine subsystem coupling and carbon exchange with the sea. II. North Inlet model structure, output and validation. Ecological Modelling 11:101-140

Summers, J.K., and H.N. McKellar, Jr. 1981a. A sensitivity analysis of an ecosystem model of estuarine carbon flow. Ecological Modelling 13: 283-301

Summers, J.K., and H.N. McKellar, Jr. 1981b. The role of physical forcing functions in an estuarine model of carbon exchange with the sea. ISEM Journal 3: 71-101

Summers, J.K., W.M. Kitchens, H.N. McKellar, Jr., and R.F. Dame. 1980. A simulation model of estuarine subsystem coupling and carbon exchange with the sea. II. North Inlet model structure, output and validation. Ecological Modelling 11: 101-140

Sundareshwar, P.V., and J.T. Morris. 1999. Phosphorus sorbtion characteristics of intertidal marsh sediments along an estuarine salinity gradient. Limnology and Oceanography 44(7): 1693-1701

Sundareshwar, P.V., J.T. Morris, P.J. Pellechia, H.J. Cohen, D.E. Porter, and B.C. Jones. 2001. Occurrence and ecological implications of pyrophosphate in estuaries. Limnology and Oceanography 46: 1570-1577

Sundareshwar, P.V., J.T. Morris, E.K. Koepfler, and B. Fornwalt. 2003. Phosphorus limitation of coastal ecosystem processes. Science 299: 563-565

Sutton, C.C., P.T.Sutton, D. Allen, and W.B. Allen. 1986. First South Carolina record of Sabine's Gull. The Chat 50(2): 53-54

Swenson, G.J., I.M. Hagenbuch, J.L. Pinckney, and R.A. Long. 2012. Fluorometric estimation of surface associated microbial abundance. Journal of Microbiological Methods 88: 297-303

Thibodeau, P.M. 1997. Groundwater flow dynamics across the forest-marsh interface: North Inlet, South Carolina. PhD Dissertation, Dept. Geological Sciences, Univ. South Carolina, Columbia.

Thomas, M.C. 2007. Two Asian ambrosia beetles recently established in Florida (Curculionidae: Scolytinae). Dept. Plant Industry, Florida Department of Agriculture and Consumer Services. http://www.doacs.state.fl.us/pi/enpp/ento/twonewxyleborines.html. Accessed 2014.

Tibbetts, J.H. 2007. Knocking back biological invaders. Coastal Heritage 21: 3-11. South Carolina Sea Grant Consortium.

Tiner, R.W. 1977. An Inventory of South Carolina's Coastal Marshes. Technical Report No. 23, Marine Resources Center, Charleston, SC. 33 pp.

Torres, R., M.J. Mwamba, and M.A. Goni. 2003. Properties of intertidal marsh sediment mobilized by rainfall. Limnology and Oceanography 48: 1245-1253

Torres, R., M.A. Goni, G. Voulgaris, C.R. Lovell, and J.T. Morris. 2004. Effects of low tide rainfall on intertidal zone material cycling. Pp. 93-114, in Fagherazzi, S., M. Marani, and L.K. Blum. (eds.) Coastal and Estuarine Studies, American Geophysical Union, Vol. 59

Toscano, B.J., and B.D. Griffen. 2012. Predatory crab size diversity and bivalve consumption in oyster reefs. Marine Ecology Progress Series 445: 65-74

Traynum, S., and R. Styles. 2007. Flow, stress and sediment resuspension in a shallow tidal channel. Estuaries and Coasts 30: 94-101

Traynum, S., and R. Styles. 2008. Exchange flow between two estuaries connected by a shallow tidal channel. Journal of Coastal Research 24: 1260-1268

Tufford, D.L., C.L. Samarghitan, H.N. McKellar, Jr., D.E. Porter, and J.R. Hussey. 2003. Impacts of urbanization on nutrient concentrations in small southeastern coastal streams. Journal of the American Water Resources Association, April: 301-312

U.S. Department of Agriculture. 1997. Summary Report: 1997 National Resources Inventory (revised December 2000), Natural Resources Conservation Service, Washington, DC, and Statistical Laboratory, Iowa State University, Ames, Iowa. 89 pp.

Ullman, W.J., and R.C. Aller. 1979. Dissolved iodine flux from estuarine sediments and implications for the enrichment of iodine at the sediment water interface. Geochimica et Cosmochimica Acta 44: 1177-1184.

Ullman, W.J., and R.C. Aller. 1982. Diffusion coefficients in nearshore marine sediments. Limnology and Oceanography 27: 552-556

Ullman, W.J., and R.C. Aller. 1983. Rates of iodine remineralization in terrigenous near-shore sediments. Geochimica et Cosmochimica Acta 47: 1423-1432

UNESCO. 1985. United Nations Educational, Scientific and Cultural Organization. The International System of Units (SI) in Oceanography. Unesco technical papers in marine science 45. International Association for the Physical Sciences of the Ocean (IAPSO) Publication Scientifique No. 32, Grenoble, France. Pp. 40-44

Van Dolah, R.F., D.M. Knott, E.L. Wenner, T.D. Matthews, and M.P. Katuna. 1984. Benthic and sedimentological studies of the Georgetown ocean dredged material disposal site. Technical Report No. 59, 97 pp. SC Marine Resources Center, Charleston, SC.

Van Dolah, R.F., J.L. Hyland, A.F. Holland, J.S. Rosen, and T.R. Snoots. 1999. A benthic index of biotic integrity for assessing habitat quality in estuaries of the southeastern USA. Marine Environmental Research 48: 269-283

Van Dolah, R.F., P.C. Jutte, G.H.M. Riekerk, M.V. Levinsen, S. Crowe, A. Lewitus, D.E. Chestnut, W. McDermott, D. Bearden, and M.H. Fulton. 2002. The Condition of South Carolina's Estuarine and Coastal Habitats during 2001-2002. SCECAP. Technical Report. SC DNR Marine Resources Division. 73 pp.

Van Dolah, R.F., G.H.M. Riekerk, D.C. Bergquist, J. Felber, D.E. Chestnut, and A.F. Holland. 2008. Estuarine habitat quality reflects urbanization at large spatial scales in South Carolina's coastal zone. Science of the Total Environment 390:142-154

Vennewitz, M. 1977. Biomass, productivity and associated environmental variables of the net- and nanno-phytoplankton in the North Inlet Estuary, South Carolina. M.S. Thesis, Univ. of South Carolina, Columbia.

Vernberg, F.J. 1981. Comparative studies of tropical and temperate zone coastal systems. Bulletin of Marine Science 31: 801-808

Vernberg, F.J. 1993. Salt-marsh processes: a review. Environmental Toxicology and Chemistry 12: 2167-2195

Vernberg, F.J. 1996. Ecology of southeastern salt marshes. Pp. 117-133 in F.J. Vernberg, W.B. Vernberg, and T. Siewicki (eds.) Sustainable Development in the Southeastern Coastal Zone. The Belle W. Baruch Library in Marine Science, Number 20. Univ. of South Carolina Press, Columbia.

Vernberg, F.J., R.F. Dame, Jr., and R.D. Bonnell. 1976. Estuarine ecosystem studies with special emphasis on the North Inlet estuary, South Carolina. Anais da Academia Brasileira de Ciencias 47: 75-87

Vernberg, F.J., M.S. Guram, and A. Savory. 1977a. Survival of larval and adult fiddler crabs exposed to Aroclor 1016 and 1254 and different temperature-salinity combinations. Pp. 37-50, in F.J. Vernberg, A. Calabrese, F.P. Thurberg, and W.B. Vernberg (eds.) Physiological Responses of Marine Biota to Pollutants. Academic Press, New York.

Vernberg, F.J., P.J. DeCoursey, M. Kelly, and D.M. Johns. 1977b. Effects of sublethal concentrations of cadmium on adult *Palaemonetes pugio* under static and flow-through conditions. Bulletin of Environmental Contamination and Toxicology 17: 16-24

Vernberg, F.J., and 9 others. 1977c. The Dynamics of an Estuary as a Natural Ecosystem. I. U.S. Environmental Protection Agency Technical Report, EPA-600/3077-016, Gulf Breeze, Florida.

Vernberg, F.J., M.S. Guam, and A.M. Savory. 1978a. Metabolic response to thermal changes of the adult fiddler crab *Uca pugilator* and the effect of PCBs. Marine Biology 48: 135-141

Vernberg, F.J., W. Kitchens, H.N. McKellar, Jr., J.K. Summers, and R. Bonnell. 1978b. The Dynamics of an Estuary as a Natural Ecosystem. II. U.S. Environmental Protection Agency Technical Report, EPA-600/3-78-092, Gulf Breeze, Florida.

Vernberg, F.J., W.B. Vernberg, E. Blood, A. Fortner, M. Fulton, H. McKellar, W. Michener, G. Scott, T. Siewicki, and K. El Figi. 1992. Impact of urbanization on high salinity estuaries in the southeastern United States. Netherlands Journal of Sea Research 30: 239-248

Vernberg, F.J., and 10 others. 1999. Coastal development impacts on land-coastal waters. Pp. 613-622 in E. Ozhan (ed.) MEDCOAST 99 - EMECS 99Joint Conference, Land-Ocean Interactions: Managing Coastal Ecosystems. Antalya, Turkey.

Vernberg, W.B. 1977. Energetics of zooplankton. Pp. 50-5 in Vernberg, F.J., R. Bonnell, B.C. Coull, R.F. Dame, P. DeCoursey, W. Kitchens, B. Kjerfve, L.H. Stevenson, W.B. Vernberg, and R. Zingmark. 1977. The Dynamics of an Estuary as a Natural Ecosystem. I. EPA Technical Report EPA-600/3-77-016. Gulf Breeze, Florida.

Vernberg, W.B., and B.C. Coull. 1974. Respiration of an interstitial ciliate and benthic energy relationships. Oecologia 16: 259-264

Vernberg, W.B., and B.C. Coull. 1975. Multiple factor effects of environmental parameters on the physiology, ecology and distribution of some marine meiofauna. Cahiers de Biologie Marine XVI: 721-732

Vernberg, W.B., and B.C. Coull. 1981. Meiofauna. Pp. 147-177 in F.J. and W.B. Vernberg (eds.) Functional Adaptations of Marine Organisms. Academic Press, Inc. ISBN 0-12-718280-2

Vernberg, W.B., and J. O'Hara. 1972. Temperature-salinity stress and mercury uptake in the fiddler crab, *Uca pugilator*. Journal of the Fisheries Research Board of Canada 29: 1491-1494

Vernberg, W.B., and D.D. Jorgenson. 1977. Light, time of day and metabolism in larvae of *Uca pugilator*. Pp. 48-49 in Vernberg, F.J., R. Bonnell, B.C. Coull, R.F. Dame, P. DeCoursey, W. Kitchens, B. Kjerfve, L.H. Stevenson, W.B. Vernberg, and R. Zingmark. 1977. The Dynamics of an Estuary as a Natural Ecosystem. I. EPA Technical Report EPA-600/3-77-016. Gulf Breeze, Florida.

Vernberg, W.B., B.C. Coull, and D.D. Jorgensen. 1977. Reliability of laboratory metabolic measurements of meiofauna. Journal of the Fisheries Research Board of Canada 34: 164-167

Viscido, S.V., and D.S. Wethey. 2002. Quantitative analysis of fiddler crab flock movement: Evidence for "selfish herd" behavior. Animal Behavior 63: 735-741

Viscido, S.V., M. Miller, and D.S. Wethey. 2001. The response of a selfish herd to an attack from outside the group perimeter. Journal of Theoretical Biology 208: 315-328

Viscido, S.V., M. Miller, and D.S. Wethey. 2002. The dilemma of the selfish herd: The search for a realistic movement rule. Journal of Theoretical Biology 217: 183-194

Vitousek, P., and W. Reiners. 1975. Ecosystem succession and nutrient retention: a hypothesis. BioScience 25: 376-381

Vo, M., D.E. Porter, G.T. Chandler, H. Kelsey, S.P. Walker, and B.E. Jones. 2004. Assessing photoinduced toxicity of polycyclic aromatic hydrocarbons in an urbanized estuary. Ecology and Society 9(5): 3. The Resilience Alliance. http://www.ecologyandsociety.org/vol9/iss5/art3

Vogel, R.L., B. Kjerfve, and L.R. Gardner. 1996. Inorganic sediment budget for the North Inlet salt marsh, South Carolina, U.S.A. Mangroves and Salt Marshes 1:23-35

Voulgaris, G., and S.T. Meyers. 2004a. Temporal variability of hydrodynamics, sediment concentration and sediment settling velocity in a tidal creek. Continental Shelf Research 24: 1659-1683

Voulgaris, G., and S.T. Meyers. 2004b. Net effect of rainfall activity on salt-marsh sediment distribution. Marine Geology 207: 115-129.

Waccamaw Regional Council of Governments Demographics & Statistics [Internet]. Georgetown (SC): Waccamaw Regional Council of Governments, c2003-2010 [cited 2010 April 5]. http://www.wrcog.org/demograph.htm.

Wahl, M.H., H.N. McKellar, Jr., and T.M. Williams. 1996. The effects of coastal development on watershed hydrography and the transport of organic carbon. Pp. 389-411 in F.J. Vernberg, W.B. Vernberg, and T. Siewicki (eds.) Sustainable Development in the Southeastern Coastal Zone, The Belle W. Baruch Library in Marine Science, Number 20. Univ. of South Carolina Press, Columbia.

Wahl, M.H., H.N. McKellar, and T.M. Williams. 1997. Patterns of nutrient loading in forested and urbanized coastal streams. Journal of Experimental Marine Biology and Ecology 213: 111-131

Walker, S.P. and N. Garfield. 2006. Recommended guidelines for adoption and implementation of the NERRS comprehensive habitat and land use classification system. Report for the Estuarine Reserves Division, NOAA/NOS/OCRM, Silver Spring, MD, 18 pp.

Wargo, C.A., and R. Styles. 2007. Along channel flow and sediment dynamics at North Inlet, South Carolina. Estuarine, Coastal and Shelf Science 71(3-4): 669-682

Waring, G.T., J.M. Quintal, and C.P. Fairfield, (eds.) 2002. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2002. NOAA Tech. Memo. NMFS-NE-169. 318 pp.

Warren, D.M. 2007. Shellfish Management Area 05, Shellfish Sanitation Program, 2007 Annual Update [Data Through December 2006]. C. Gorman and D.M. Pearson (eds.). South Carolina.

Wason, E.L. and S.C. Pennings. 2008. Grasshopper (orthoptera: tettigoniidae) species composition and size across latitude in Atlantic coast salt marshes. Estuaries and Coasts 31: 335-343.

Webster, W.D., J.F. Parnell, and W.C. Biggs, Jr. 1985. Mammals of the Carolinas, Virginia, and Maryland. The University of North Carolina Press. Chapel Hill. 255 pp.

Weiland, R.T., T. Chrzanowski, and L.H. Stevenson. 1979. Influence of freshwater intrusion on microbial biomass in salt-marsh creeks. Estuaries 2: 126-129

Weinstein, J.E. 1995. Seasonal responses of the mixed-function oxygenase system in the American oyster, *Crassostrea virginica* (Gmelin 1791), to urban-derived polycyclic aromatic hydrocarbons. Comparative Biochemistry and Physiology 112C: 299-307

Weinstein, J.E. 1996. Anthropogenic impacts on salt marshes – a review. Pp. 135-170, in F.J. Vernberg, W.B. Vernberg, and T. Siewicki (eds.) Sustainable Development in the Southeastern Coastal Zone. Belle W. Baruch Library in Marine Science, No. 20. Univ of South Carolina Press, Columbia

Weinstein, J.E. 1997. Fluoranthene-induced histological alterations in oysters, *Crassostrea virginica*: seasonal field and laboratory studies. Marine Environmental Research 43: 201-218

Wenner, E.L., and M. Geist. 2001. The National Estuarine Research Reserves program to monitor and preserve estuarine waters. Coastal Management 29: 1-17

Wenner, E.L., W.P. Coon,III, M.H. Shealy, Jr., P.A. Sandifer. 1981. Species assemblages, distribution, and abundance of fishes and decapod crustaceans from the Winyah Bay estuarine system, SC. South Carolina Sea Grant Consortium, Technical Report. SC-SG-81-3. 61 pp.

Wenner, E., D. Sanger, M. Arendt, A.F. Holland, and Y. Chen. 2004. Variability in dissolved oxygen and other water-quality variables within the National Estuarine Research Reserve System. Journal of Coastal Research 45: 17-38

Wethey, D.S., S.M. Lindsay, S.A. Woodin, and R.L. Marinelli. 2001. Population consequences of intermediate disturbance: Enhancement of recruitment by browsing predation. Pp. 141-157, in S.A. Woodin (ed.) Organism-Sediment Interactions. The Belle W. Baruch Library in Marine Science, No. 21. Univ. of South Carolina Press, Columbia, South Carolina

Wetz, M.S., A.J. Lewitus, E.T. Koepfler, and K.C. Hayes. 2002. Impact of the Eastern oyster *Crassostrea virginica* on the microbial community structure in a salt marsh estuary. Aquatic Microbial Ecology 28: 87-97

White, D.L., D. Bushek, D.E. Porter, and D. Edwards. 1998. Geographic Information Systems (GIS) and kriging: analysis of spatial and temporal distributions of the oyster pathogen *Perkinsus marinus* in a developed and an undeveloped estuary. Journal of Shellfish Research 17: 1473-1476

White, D.L., D.E. Porter, and A.J. Lewitus. 2004. Spatial and temporal analyses of water quality and phytoplankton biomass in an urbanized versus a relatively pristine salt marsh estuary. Journal of Experimental Marine Biology and Ecology 298: 255-273

Whiting, G.J., and D.L. Childers. 1989. Subtidal advective water flux as a potentially important nutrient input to southeastern USA saltmarsh estuaries. Estuarine, Coastal and Shelf Science 28: 417-431.

Whiting, G.J., H.N. McKellar, Jr., B. Kjerfve, and J.D. Spurrier. 1985. Sampling and computational design of nutrient flux from a southeastern U.S. salt marsh. Estuarine, Coastal and Shelf Science 21: 273-286

Whiting, G.J., E.L. Gandy, and D.C. Yoch. 1986. Tight coupling of root-associated nitrogen fixation and plant photosynthesis in the salt marsh grass *Spartina alterniflora* and carbon dioxide enhancement of nitrogenase activity. Applied and Environmental Microbiology 52: 108-113

Whiting, G.J., H.N. McKellar, Jr., B. Kjerfve, and J.D. Spurrier. 1987. Nitrogen exchange between a southeastern USA salt marsh ecosystem and the coastal ocean. Marine Biology 95: 175-182

Whiting, G.J., H.N. McKellar, Jr., J.D. Spurrier, and T.G. Wolaver. 1989. Nitrogen exchange between a portion of vegetated salt marsh and the adjoining creek. Limnology and Oceanography 34: 463-473

Wilbur, A.E., and T.J. Hilbish. 1989. Physiological energetic of the ribbed mussel *Geukensia demissa* (Dilwyn) in response to increased temperature. Journal of Experimental Marine Biology and Ecology 131: 161-170

Wilde, S.B., D. Edwards, E. Smith, E. Wenner, and D.L. White. 2007. The effect of climatological cycles and storm events on water quality in the National Estuarine Research Reserve systems of the southeastern U.S. Final Report submitted to the NOAA/UNH Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) under Grant No. NA05-998. 30 pp.

Williams, T.M., T.G. Wolaver, R.F. Dame, and J.D. Spurrier. 1992. The Bly Creek ecosystem study – organic carbon transport within a euhaline salt marsh basin, North Inlet, South Carolina. Journal of Experimental Marine Biology and Ecology 163: 125-139

Williams-Howze, J. 1996. The biology and morphology of the marine harpacticoid copepod *Heteropsyllus nunni* Coull, during encystment diapause. Hydrobiologia 320: 179-189

Williams-Howze, J., and B.C. Coull. 1992. Are temperature and photoperiod necessary cues for encystment in the marine benthic harpacticoid copepod *Heteropsyllus nunni* Coull? Biological Bulletin 182: 109-116

Wilson, A.M., and L.R. Gardner. 2006. Tidally driven groundwater flow and solute exchange in a marsh: numerical simulations. Water Resources Research 42: W01405, doi:10.1029/2005WR004302, 2006

Wilson, A.M., and J.T. Morris. 2012. The influence of tidal forcing on groundwater flow and nutrient exchange in a salt marsh-dominated estuary. Biogeochemistry 108: 27-38

Wilson, C.A., and L.H. Stevenson. 1980. The dynamics of the bacterial population associated with a salt marsh. Journal of Experimental Marine Biology and Ecology 48: 123-138

Wilson, C.A., L.H. Stevenson, and T.H. Chrzanowski. 1981. The contribution of bacteria to the total adenosine triphosphate extracted from the microbiota in the water of a salt-marsh creek. Journal of Experimental Marine Biology and Ecology 50: 183-195

Wirth, E.F., M.H. Fulton, G.T. Chandler, P.B. Key, and G.I. Scott. 1998. Toxicity of sediment associated PAHs to the estuarine crustaceans, *Palaemonetes pugio* and *Amphiascus tenuiremis*. Bulletin of Environmental Contamination and Toxicology 61: 637-644

Wolaver, T.G., and L.R. Gardner. 1983. Salt marsh sediment interstitial iron and sulfate concentrations along a height gradient from tidal creeks to the high marsh in North Inlet, South Carolina. Abstract. Estuaries 6: 296-297

Wolaver, T.G., and J.D. Spurrier. 1988. The exchange of phosphorus between a euhaline vegetated marsh and the adjacent tidal creek. Estuarine, Coastal and Shelf Science 26: 203-214

Wolaver, T.G., W. Johnson, and M. Marozas. 1984. Nitrogen and phosphorus concentrations within North Inlet, South Carolina – speculation as to sources and sinks. Estuarine, Coastal and Shelf Science 19: 243-255

Wolaver, T., G. Whiting, B. Kjerfve, J. Spurrier, H. McKellar, R. Dame, T. Chrzanowski, R. Zingmark, and T. Williams. 1985. The flume design – a methodology for evaluating material fluxes between a vegetated salt marsh and the adjacent tidal creek. Journal of Experimental Marine Biology and Ecology 91: 281-291

Woodin, S.A. 2007. Behavioral cues, recruitment and relative mobility: rocky shores versus sediments. Bulletin of Marine Science 81: 181-189

Woodin, S.A., and R. Marinelli. 1991. Biogenic habitat modification in marine sediments: the importance of species composition and activity. Zoological Society of London 63: 231-250

Woodin, S.A., M.D. Walla, and D.E. Lincoln. 1987. Occurrence of brominated compounds in soft-bottom benthic organisms. Journal of Experimental Marine Biology and Ecology 107: 209-217

Woodin, S.A., R.L. Marinelli, and D.E. Lincoln. 1993. Biogenic brominated aromatic compounds and recruitment of infauna. Journal of Chemical Ecology 19: 517-530

Woodin, S.A., S.M. Lindsay, and D.S. Wethey. 1995. Process-specific recruitment cues in marine sedimentary systems. Biological Bulletin 189: 49-58

Woodin, S.A., S.M. Lindsay, and D.E. Lincoln. 1997. Biogenic bromophenols as negative recruitment cues. Marine Ecology Progress Series 157: 303-306

Woodin, S.A., R.L. Marinelli, and S.M. Lindsay. 1998. Process-specific cues for recruitment in sedimentary environments: geochemical signals? Journal of Marine Research 56: 535-558

Woodin, S.A., D.S. Wethey, and N. Volkenborn. 2010. Infaunal hydraulic ecosystem engineers: cast of characters and impacts. Integrative and Comparative Biology 50: 176-187

Yoch, D.C., and G.J. Whiting. 1986. Evidence for NH_4^+ switch-off regulation of nitrogenase activity by bacteria in salt marsh sediments and roots of the grass *Spartina alterniflora*. Applied and Environmental Microbiology 51: 143-149

Yoon, K.S., Y.P. Chen, C.R. Lovell, D.E. Lincoln, L.W. Knapp, and S.A. Woodin. 1994. Localization of the chloroperoxidase of the capitellid polychaete *Notomastus lobatus*. Biological Bulletin 187: 215-222

Young, B.L. 1991. *Spartina* axil zones: preferred settlement sites of barnacles. Journal of Experimental Marine Biology and Ecology 151: 71-82

Young, R. F. and H. D. Phillips. 2002. Primary production required to support bottlenose dolphins in a salt marsh estuarine creek system. Marine Mammal Science 18(2): 358-373

Zeeman, S.I. 1982. Phytoplankton photosynthesis and its relation to light intensity in a turbid estuary and the nearshore coastal ocean. Ph.D. Dissertation. University of South Carolina, Columbia

Zeeman, S.I. 1985. The effects of tropical storm Dennis on coastal phytoplankton. Estuarine, Coastal and Shelf Science 20: 403-418

Zhang, E., Y.P. Chen, M.P. Roach, D.E. Lincoln, C.R. Lovell, S.A. Woodin, J.H. Dawson, and L. Lebioda. 1996. Crystallization and initial spectroscopic characterization of the heme-containing dehaloperoxidase from the marine polychaete *Amphitrite ornate*. Acta Cryst. D52: 1191-1193

Zimmer-Faust, R.K., C.M. Finelli, N.D. Pentcheff, and D.S. Wethey. 1995. Odor plumes and animal navigation in turbulent water flow: a field study. Biological Bulletin 188: 111-116

Zimmerman, K.M., S.E. Stancyk, and L.A.J. Clements. 1987. Substrate selection by the burrowing brittlestar *Microphiopholis gracillima* (Stimpson) (Echinodermata: Ophiuroidea). Marine Behavior and Physiology 13: 239-255

Zingmark, R.G. 1977. Studies on the phytoplankton and microbenthic algae in the North Inlet Estuary, SC. Pp. 35-39, in Vernberg, F.J. et al. (eds.) The Dynamics of an Estuary as a Natural Ecosystem. USEPA EPA-600/3-77-016. Gulf Breeze, FL, 86 pp.

Zingmark, RG. 1978. (ed.) An Annotated Checklist of Biota of the Coastal Zone of South Carolina. Belle W. Baruch Institute for Marine Biology and Coastal Research. University of South Carolina Press, Columbia. 364 pp.

Zingmark, R.G., G.W. Wohlgemuth, G.L. Wagner, R.E. Vennewitz, R.R. Reis, D.E. Hall, D.E. Ebeling, and D.C. Brown. 1977. Ecology of macroalgae in a temperate salt marsh at a site in North Inlet, SC. Journal of Phycology (suppl) 13: 77

Zobrist, E.C., and B.C. Coull. 1992. Meiobenthic interactions with macrobenthic larvae and juveniles: an experimental assessment of the meiofaunal bottleneck. Marine Ecology Progress Series 88: 1-8

Zobrist, E.C., and B.C. Coull. 1994. Meiofaunal effects on growth and survivorship of the polychaete *Streblospio benedicti* Webster and the bivalve *Mercenaria mercenaria* (L.). Journal of Experimental Marine Biology and Ecology 175: 167-179

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Appendix A

Supplemental Background Information

Appendix A – Supplemental Background Information

This appendix provides additional background information on some topics presented in the Site Profile. These entries provide definitions of terms and explain process and relationships among environmental variables.

ENVIRONMENTAL SETTING

» Water Quality in North Inlet

pH and Redox Potential (page 58)

As sediments change from oxidizing to reducing conditions, they experience changes in their electrochemical redox potential (Eh). Metallic electrodes are used to measure the redox potential in much the same way that pH is routinely measured. The depth in the sediment where this oxic/anoxic transition occurs is usually quite visible to the naked eye as the place where sediment color changes from light brown to darker shades or black. Sulfides produced within the redox layer are toxic to most organisms, but burrowing species such as clams and some macrobenthic worms can survive there by making oxygenated water flush through their burrows. Most of the biomass of benthic infauna occurs within the oxic zone above the redox layer. Anaerobic bacteria live within the redox layer and promote the breakdown and remineralization of buried organic matter. The redox status of the sediments also determines the relative abundance of nitrogen species (ammonium, nitrite and nitrate ions). This dark layer beneath the muddy and sandy surfaces of the salt marsh is thus critically important to the ecological balance of the estuarine environment. Changes in pH can also affect how pollutants and chemical contaminants react in the water and with flora and fauna.

Sediments and Turbidity (page 58)

Input of sediments to estuaries comes from both land (deforestation, farming practices, surface mining, river runoff, dust, etc.) and from the ocean during flooding tides and storm events. Creek bank erosion adds sediments to the water as well. These sediments can settle to and accumulate on the bottom and thereby help the marsh grow vertically in response to sea level rise. Turbidity caused by suspended particulate matter, inorganic and organic, is an optical property of water that can be measured electronically by assessing changes in transparency over a fixed distance at some depth in the water. Turbidity blocks sunlight entering the water and thus can reduce rates of photosynthesis by photoautotrophs. Suspended particles cause the water to become turbid, especially during summer, and thus make visual predators work harder to find prey while simultaneously affording those prey a refuge from their predators. Suspended sediments also carry attached bacteria (ingested by filter-feeders and deposit-feeding worms) and chemical species bound electrostatically or by strong chemical bonds. Because suspended organic sediments carry carbon, researchers sometimes use measurements of particulate organic carbon (POC) as a surrogate measurement for organic suspended sediments (OSS). Technically, however, these two measurements are not the same. Sediments, including larger sand particles, are frequently re-suspended by wind, rain, and currents, but can be bound in a mucus-like layer (microbial biofilm) that inhibits re-suspension at relatively low current velocities.

Although not directly addressing North Inlet *per se*, Kana et al. (1999) provide an overview of mesoscale (years to decades) sediment transport for southeastern U.S. tidal inlets like North Inlet. Their conceptual model explains how sediment transport occurs in four inlet domains: main ebb channels, ebb-tidal deltas, shoal-bypassing zones, and recurved spits. Much of the sand moving in and out of inlets is recycled back into inlet channels, completing the “inlet transport loop”.

Dissolved Oxygen (page 63)

Despite its critical importance to most life and to water quality, technically speaking oxygen, like water, is not a true "nutrient" like C, N, and P. Depending on wind speed and current velocity, oxygen diffuses from the air at various rates and dissolves in water, regardless of whether it is fresh or salty. If the water is undersaturated, oxygen will diffuse from the air into the water. If it is supersaturated (> 120% of normal saturated concentration), oxygen will diffuse from water to air. The amount that dissolves depends on how much is already present in the water, and the rate of dissolution is temperature-dependent. Cold water holds more O_2 in dissolved form than warm water. Photosynthesis by autotrophs in the water releases oxygen gas that dissolves in the water and increases its O_2 concentration. Respiration by heterotrophs (and autotrophs) consumes dissolved oxygen and causes its concentration to decline over time. When thermoclines or pycnoclines develop and restrict vertical mixing of the water column, hypoxic (levels of DO < 28% of saturated values) conditions can develop in the layer of water above the sediment. Dissolved oxygen concentration is usually measured in units of mg per liter (mg L^{-1}) or as percent of saturation under prevailing conditions. Stagnation, elevated temperature and high loads of organic matter in the water are conditions that promote hypoxia and possibly anoxia as bacteria multiply and require more oxygen to decompose the extra load. This is called a high biological oxygen demand (BOD) situation. Some chemical processes in the sediment also consume dissolved oxygen. When, over a set period of time, an aquatic ecosystem produces more oxygen via photosynthesis than it consumes by respiration, the net ecosystem metabolism (NEM) is positive, or autotrophic. If respiration exceeds photosynthesis, NEM is negative or heterotrophic during that time period.

» Water Chemistry in North Inlet

Nitrogen and Phosphorus (page 67)

The availability of N and P and other macro- and micronutrients is often determined by the physical and chemical properties of sediments and porewater, as most N and P is bound to clay minerals, metal complexes, and humic acids in marsh grass environments. The composition and behavior of these organic complexes is incompletely known, so it is challenging to determine how much of either the dissolved or particulate pools of organic matter are actually available. Particulate and dissolved phases of these nutrients are defined and sampled only as an operational artifact. Concentrations of each form depend on both mechanical separation of the two phases using filters and analytical chemical differentiations. However, standardized methods have been agreed upon so that data are comparable from study to study. The advent of auto-analyzers has made nutrient analyses almost routine, but there are still many methodological difficulties encountered.

In oxygen-limited environments denitrifying bacteria use nitrate as an electron acceptor rather than O_2 and NO_3^- is reduced in a cascade first to NO_2^- and then to NO, N_2O, and finally to N_2 gas. Thus this process removes nitrogen from soil and can ameliorate pollution from nitrate-laden fertilizer, for instance, and possibly prevent eutrophication of receiving waters.

Biogeochemical cycles include not just chemical "species", but biological species as well. Every herbivore, carnivore, omnivore and every prey organism (plant, animal, bacterium, etc.) contains chemical elements that come from the food we eat. Metabolic wastes, excreta, and feces return these constituents to the environment. Food webs are an integral part of most, if not all, biogeochemical cycles. Hence every time a fish eats something here and defecates or excretes somewhere else, it is moving nutrients around. For example, migrating birds bring nutrients to the NI-WB NERR from elsewhere and take some with them when they leave. Their foraging activities in freshwater ecosystems move nutrients from there to North Inlet where some get deposited as excreta.

Sulfur (page 79)

Although sulfur is an essential component in virtually all living organisms, most of the attention to sulfur in the NI-WB NERR has been directed at sulfate reducing bacteria that live in the sediments along with a host of fermenters and methanogens. Organic sulfides, primarily dimethyl sulfide, and hydrogen sulfide, H_2S, cause the familiar rotten egg odor of anoxic marine sediments. The hydrogen sulfide gas is a by-product of sulfate reducing bacteria that use hydrogen and organic compounds produced by plant roots, for example, as electron donors and sulfate ions as electron acceptors. Many anaerobes also produce pyrite (fool's gold or iron sulfide, FeS_2) that can be seen in the sediments. Sulfate reduction is also fueled by metabolically-produced carbon dioxide or methane. Sulfur is thus an integral part of biogeochemical cycles in the salt marsh, and the activities of sulfate reducers, methanogens, and fermenters are closely coupled in the anaerobic layer beneath the marsh surface. Thickness of this layer is greater in the high marsh than in the low marsh where the longer duration of tidal inundation and higher plant densities bring more dissolved oxygen to the sediments.

Carbon (page 80)

All organic matter (OM) contains carbon, hence whether OM occurs in dissolved (DOM) or particulate (POM, living or dead) forms, the non-carbon portion can be burned off or oxidized until all that remains is the carbon. Thus measured amounts of dissolved organic carbon (DOC) and particulate organic carbon (POC) reveal the presence of organic materials of which the C was previously a part. Because most OM also contains other elements like N and P, it is often the case that nutrient-oriented studies also collect data on the C content of the OM. Is carbon a "nutrient"? Definitely, because, as a building block for living organisms, carbon uptake is essential for the growth of new tissues, including reproductive products. There are many reservoirs for carbon, and studies of the carbon cycle in any ecosystem attempt to measure not only the amounts of C in each type of reservoir, but also the magnitudes and rates of C flux between reservoirs. Every time a piece of plant material falls to the ground and starts to decompose, the carbon in that tissue changes forms as part of this flux. Plants and other autotrophs like phytoplanktonic algae ultimately get their carbon from the atmosphere directly through uptake of inorganic CO_2 gas or, in aquatic ecosystems, through uptake of dissolved inorganic carbon dioxide, DIC. When organic matter (detritus, fecal material) sinks to the bottom, much of the carbon in it is stored temporarily in the sediments where microbes and benthic fauna utilize the energy contained in these organic substances for their own growth and metabolism. Some carbon also gets mineralized and stored as, for instance, carbonates. Some carbon-rich compounds are reactive or easily decomposed (the "labile" component), while other compounds or parts of the labile ones are decay-resistant, i.e., they are "refractory" and do not break down easily. All predator-prey interactions involve carbon and energy flow, as do most parts of biogeochemical cycles. The carbon cycle, besides it major role in buffering seawater's pH, is thus intimately linked to the chemo-autotrophic uptake of energy and its subsequent conversions from more concentrated, energy-rich, forms to less concentrated forms. The energy contained in OM as carbohydrates, lipids and such, unfortunately, does not recycle. Lastly, a disproportionate supply of carbon and increased (or decreased) residence times in some reservoirs (atmospheric carbon dioxide, withdrawals of coal, oil and natural gas from underground reservoirs) can have profound consequences for life on Earth.

ECOLOGICAL/BIOLOGICAL SETTING

North Inlet's Major Biota

» Primary Producers

At the base of the food web are the primary producers, autotrophic organisms that take up carbon dioxide and produce oxygen and sugars as they photosynthesize and participate in the carbon and other biogeochemical cycles. For a coastal salt marsh like North Inlet (and many others throughout the southeastern US), salt marsh cordgrass (*Spartina alterniflora*) dominates the visible landscape. Many other primary producers also contribute significantly to the salt marsh food web, including phytoplankton, microphytobenthos, macroalgae, and other vascular plants.

Phytoplankton (page 130)

Phytoplankton is a general term for photosynthetic single-celled organisms occurring in the water column. These taxonomically diverse cells span a range of sizes from micrometers to millimeters. A proxy for the biomass of total phytoplankton in the water is obtained by measuring the concentration of a volumetric water sample's chlorophyll *a* (also abbreviated as chl-*a*) pigment. However, not all phytoplankton cells or species have the same amount of this pigment. Other techniques, e.g., HPLC (high pressure liquid chromatography), are used to quantify other types of pigments in a sample. Some of these pigments are taxon-specific, and ratios between the amounts of these pigments can be used to characterize the structure and composition of the total phytoplankton community. Laborious cell counts and visual identifications of species also provide valuable information, but microscopy is very tedious and the taxonomy of the unicellular primary producers is difficult. Fluorometric methods can also be used to estimate phytoplankton biomass, and other cell sorting techniques are available to count and characterize phytoplankton cells. However, for quantitative monitoring purposes, measures of chlorophyll *a* are usually made to estimate the amounts of phytoplankton in the water.

Benthic Microalgae (page 136)

Benthic microalgae (BMA) or microphytobenthos are generally called edaphic because they are associated with sediments, epipelic if they live freely on and migrate (motile forms) within the sediment, or epipsammic if they live attached to sand grains and have no or reduced motility. BMA also live attached to plant stems as part of an epiphytic community. They are difficult to sample quantitatively, they are a challenge to identify microscopically and, as a consequence, their ecological roles are not well known. In addition, compared with phytoplankton and vascular plants, their productivity is more difficult to measure. These small cells, despite their motility, are easily resuspended and mobilized by currents and become part of the phytoplankton community quite frequently. Their populations may also be inextricably linked with bacterial biofilms on surfaces, adding yet more complexity for studying their functional interactions within the carbon cycle. BMA are also difficult to culture in the laboratory. Thus benthic microalgae have been difficult to "remove" from the ecosystem and isolate for research purposes.

The vertical migration of the BMA community is a common phenomenon that can be the subject of field experiments conducted by students. Because chlorophyll-*a* is so easily measured spectrophotometrically, students can readily measure changes in the vertical distribution of BMA biomass within the time constraints of relatively short field studies possible in the laboratory or field portions of ecologically-oriented classes. It is a great hands-on practicum experience for students to test hypotheses about what factors might control BMA vertical migration on a sandy beach or in a muddy salt marsh.

Macroalgae (page 139)

A subtidal macroalgal community persists throughout the year in North Inlet and becomes most prominent during winter when water clarity is greatest and maximum insolation is much lower than during summertime. The intertidal macroalgae populate sediments and shallow benthic structures (e.g., oyster reefs). Many organisms incorporate macroalgae as part of their cryptic behaviors (e.g., decorator crabs) or utilize it as part of their burrow infrastructure (e.g., the tubes of *Diopatra*, a polychaete worm). The macroalgae, although adapted to living in places where current velocities may be high, almost continuously slough off considerable biomass that becomes part of the water column community of primary producers.

Vascular Plants (page 140)

A majority of North Inlet's low marsh is dominated almost exclusively by *Spartina alterniflora* with a mix of about eight species occurring in the high marsh areas. Stresses include high (and occasionally low) temperatures, intense sunlight during summer, freshwater runoff variations from droughts to floods, waterlogging of soils, soil porosity, permeability, and compressibility, nutrient concentration variations, salinity variations in both overlying and groundwaters, sediment anoxia and hypoxia, sulfide buildup, changes in redox potential, fossorial invertebrates (burrowers and diggers), insect and marine invertebrate grazers, and strong, often violent, storm events. Rhizosphere microbial communities may also stress some plants in the salt marsh. Some of the questions addressed by researchers concern not just the plants' physiologies, but also their abilities to withstand slow, gradual sea-level rise that, without sediment subsidies to the marsh surface, would result in mass die-offs of this hardy vegetation. As evidenced by the presence of large tree root structures beneath marsh sediments, sea-level rise also causes the salt marsh to migrate slowly landward. Thus the youngest part of the salt marsh lies close to the upland forest.

» **Benthos** (page 156)

Aquatic animals that live within, on the surface of, or in association with the bottom are members of a group called the benthos. Some of the larger common estuarine benthic animals are snails, oysters, clams, sand worms, and fiddler crabs. Benthic organisms differ in their size, feeding habits, sediment preferences, reproductive behavior, means of locomotion, and coloration. Those that live within the bottom (infauna) are typically sampled using small coring tubes or metallic devices which grab a known volume of sediment. The animals are then recovered by washing the sediment away through a sieve whose wire or nylon mesh (usually 0.5 or 1.0 mm) retains the animals for examination. Animals that live attached to or upon the bottom (epifauna) are sampled quantitatively using cores, by scraping them off hard surfaces of known area (quadrats), or by using suction devices. The epifaunal benthos (soft corals, sponges, hydroids, bryozoans, etc.) may also be collected using a dredge, a metal device with a net attached that is dragged along the bottom in much the same fashion as a shrimp trawl, for instance. The estuarine benthos is a very diverse community. It is comprised by thousands of species that range from fist-sized bivalve molluscs (clams, oysters) and nearly meter-long worms to smaller, more familiar invertebrates like snails and shrimplike crustaceans and finally to microscopic forms like ciliates and bacteria that live neatly on the surface of sand grains and amongst other fine particles that make up the sediment. An intermediate-sized group of microscopic animals is called, collectively, the meiobenthos. Meiobenthic organisms will go through a 0.5 mm mesh but are retained by a 0.063 mm mesh. Most meiofauna are just barely visible to the naked eye. These animals live interstitially within the sediment fabric or plow through unconsolidated sediments and detrital material that lies upon or just below the sediment surface. They do not construct burrows but crawl around amongst and between sand grains. Numerically common meiobenthic invertebrates include nematode worms and tiny crustaceans called harpacticoid copepods and ostracods. Bottom-feeding, young juvenile fishes like spot and flounders individually eat hundreds to thousands of meiobenthic-sized prey each day. Almost all commercially valuable

fishes, shrimps and crabs feed upon benthic animals during or after the early stages of their lives, and many benthic animals themselves are desirable foodstuffs for people, e.g., clams, oysters. Wading birds of many kinds also eat large numbers of small benthic animals.

Besides their key roles in estuarine food webs, the benthic organisms contribute to basic ecosystem functions in other ways as well. These include sediment re-working (called bioturbation) that serves to enhance rates of nutrient remineralization (breakdown of organic matter into its constitutive components – nitrates, phosphates - that are then re-cycled in the ecosystem), oxygenation of the sediment, removal of suspended particles from the water (e.g., filter-feeding by clams and oysters), and stimulation of benthic algal growth via their contribution of nitrogen-bearing waste products (especially ammonia) to this portion of the habitat. Benthic animals reproduce and spawn in two general ways: via release of eggs or larvae that drift with currents and later settle to the bottom or via release of larvae that stay in the vicinity of where they were born. Benthic animals feed in diverse ways as well. Some ingest sediment particles and digest the bacteria attached to the particles (deposit-feeders). There can be up to a thousand bacteria attached to a single grain of sand. Many marine worms feed in this manner. Other worms and animals like clams and oysters actually filter food suspended in the overlying water (filter- or suspension-feeders). This feeding mode is most common among animals that can't move around very much if at all. Many other types of benthos are highly motile and either scavenge for food or behave as predators. Many of the larger benthic crustaceans get their food this way - crabs and shrimp, for example. There are some worms, e.g., nemerteans, that plow their way through the sediments beneath the sediment surface in search of prey.

Measures of sediment and water quality in an area often include assessments of the benthic community present in the vicinity. Generally speaking, the higher the number of species present, the healthier the habitat. Degraded habitats have considerably lower numbers of benthic species and/or much lower numbers of individuals, but there are sometimes large numbers of a very few pollution-tolerant species because nothing else can survive under the degraded conditions present. These are often called "indicator species" because they are almost always found in or associated with degraded habitats. Interestingly, these same indicator species are also found in natural, un-degraded, habitats.

Definitions of benthos according to size

The life spans of benthic fauna seem to correlate well with their sizes (see classifications below) and range from months to years for macrobenthos, from weeks to several months for meiobenthos, and from hours to a few days for microbenthos.

Macrobenthos: Bottom-dwelling animals that are retained by a 0.5 mm mesh. Major members of this group include polychaete and oligochaete worms, bivalves, and small crustaceans (amphipods, isopods, cumaceans). Burrowing and motile worms dominate this group in soft sediments (mud, sand), whereas harder substrates (rocky) are dominated by attached forms such as mussels, barnacles, and oysters. Macrobenthos abundance typically ranges between hundreds of animals per square meter on the open coast beaches to tens of thousands per square meter in muddy subtidal areas.

Meiobenthos: Metazoans which pass through a 0.5 mm mesh but are retained by a 0.063 mm mesh. Major members include nematode worms, harpacticoid copepods, ostracods, turbellarian flatworms, foraminiferan protozoans, and representatives from minor phyla such a kinorhynchs, gastrotrichs, and pycnogonids. Temporary members of the meiofauna include juvenile forms of the macrobenthos as well, especially polychaetes, oligochaetes, and bivalves. Some insect larvae also fall into the meiofaunal size classification. The meiofauna can be extremely abundant, with

over a million individuals per square meter in some muddy intertidal and subtidal habitats. The submerged sediments on a sandy beach may harbor up to a few thousand individuals beneath an area the size of a footprint.

Microbenthos (sometimes also called Nanobenthos): These animals pass through a 0.063 mm mesh but are larger than 0.002 mm. Included are small rotifers, ciliates, flagellates, amoebae and some juvenile forms of animals that are meiobenthic in size as adults, e.g., harpacticoid copepod nauplii. This diverse community of algae, bacteria, and "animalcules" is poorly known and difficult to identify and sample quantitatively despite their widespread occurrence in virtually all marine and estuarine shallow-water habitats. We do not know exactly how abundant the microbenthos is in most habitats, but it is probably safe to say that this size-class of animals is the most abundant of all bottom-dwellers except for algae, bacteria and viruses. It must be noted that bacterial communities are present in abundance in all benthic habitats and are particularly important in the ecosystem for their role as food for sediment-eating animals (deposit-feeders) and as remineralizers (recyclers) of organic matter and as promoters of all biogeochemical cycles known, e.g., carbon, nitrogen, phosphorus, etc.

Habitats/Setting

The kinds and varieties of benthic animals present in an area depends mostly upon physical characteristics of the habitat and the nature of the substrate. As mentioned above, soft-bodied forms numerically dominate muddy and sandy bottoms, while hard-bodied forms attach to and numerically dominate hard (e.g., pilings) or rocky bottoms. Besides sediment grain size, tides are another major factor that limits where certain benthic animals can thrive. Nearer the forest border and throughout the salt marsh, the intertidal benthos must withstand periodic exposure to the air (and rain!) and the wide temperature variations that ensue, whereas the subtidal benthos is subject to much less variation in the physical components of the habitat because they are constantly covered by seawater.

Unvegetated Mud and Sand Flats*:* A trip to the mud flat at low tide reveals evidence for the presence of many different types of benthos visible by virtue of their tube structures (e.g., *Diopatra cuprea*, a polychaete worm that decorates its tubes with shell bits and algae), feeding marks from sand anemones, holes from which bivalves project their siphons during high tide, mounds of sandy defecation products that may form coiled structures (from hemichordate acorn worms), and many other "signs" and "shows". Virtually every pockmark or small structure can be associated with a benthic organism. Mud flats are among the most densely populated, dynamic and interesting places on the planet, yet most who see them from a distance simply regard them as lifeless areas. Far from it – they are teeming with life.

Oyster Reef*:* Many of the individual oysters in the reef are oriented upright such that a person walking on them would be likely to cut their feet or ankles on the edges of the shells. Oyster harvesters typically wear rugged thick boots. These tasty animals obtain food by extracting algae and other particles from suspension in the water column, hence intertidal oysters feed only when submerged by the tide. Subtidal oysters often grow larger than intertidal oysters because they can feed longer. The presence of a large aggregation of hard substrate (the oysters' shells) attracts a diverse community of fishes and invertebrates that use the convoluted structures as more or less permanent habitat. So attractive is this habitat that many researchers use empty oyster shells as collection devices, placing trays full of them onto creek bottoms. When the trays are collected a week or two later, they are found to contain diverse animals that cannot be collected any other way. This suggests that hard substrate is in short supply in the area.

Creek bottoms (shell hash) and tidal pools: The dredge is a heavy metallic device with a net attached that is dragged behind a boat, scooping up the large animals and plants and shell material that lie on the bottom. The epibenthic sled moves across the bottom on skids and collects small animals living near or in association with the bottom. A variety of fishes, shrimps, and crabs are collected in this manner.

» **Zooplankton** (page 170)

Sampling zooplankton

Zooplankton (i.e., not viruses, bacteria, phytoplankton) range in size from about 20 microns (1/50th of 1 mm) to >2000 mm (if the large jellyfishes are included), but those sampled with zooplankton nets are mostly from 0.2 – 20 mm. This size category is referred to as the mesozooplankton and it is dominated by copepods, an important holoplanktonic group of crustaceans that are typically smaller than 2 mm long. Different size mesh nets are used to capture different size fractions of the zooplankton, and a 153-micron mesh is often used to collect copepods and small invertebrate larvae. However, the straining efficiency of such fine mesh nets decreases quickly when high densities of diatoms and detritus clog the mesh and create a head pressure that is sensed by larger zooplankton in front of the tow path. Thus, fine mesh nets are not suitable for collecting zooplankton more than a few millimeters long. Larger mesh sizes (e.g. 365-micron) do a better job at collecting these larger forms, but most of the copepods pass through that mesh. To more fully characterize the wide size range of zooplankton, at least two mesh sizes are needed, and the 153- and 365-micron mesh nets are adequate for sampling the full range of mesozooplankton in estuaries. Mesh sizes of 750-microns and 1000-microns (1 mm) are sometimes used to sample large decapod and fish larvae and jellyfishes.

Many different strategies can be used to collect zooplankton. Conically shaped nets attached to a ring (usually 30, 50, or 1000 cm diameter) are commonly towed, but these usually sample only one depth within the water column. When tidal currents are strong enough to fully extend and open the nets, plankton nets can be deployed from an anchored boat. Specially rigged “opening-closing” nets can sample discrete levels in the water column by lowering them to the desired depth in a closed position and sliding a weight down the cable to a triggering mechanism which opens the net mouth; this can be followed by another weight to close the mouth. Similarly, the entire water column can be evenly sampled by using a single trigger designed to open the net near the bottom, then lifting the net toward the surface, timing the ascent to ensure equal filtering time near the bottom, mid-water and surface. Another technique for sampling very close to the bottom involves using an epibenthic sled which consists of a rectangular metal frame with skis or skids that keep the net within a few centimeters of the bottom during the tow. In the long-term zooplankton sampling program in North Inlet, large mesozooplankton were collected with an epibenthic sled fitted with a 365-micron net and small mesozooplankton were collected with a modified opening (single trigger) net fitted with a 153-micron mesh net. The fine-mesh net was deployed for 1 minute at each of three levels from an anchored boat during the ebbing tide. The sled was towed along the axis of the creek in the same direction as the ebbing tide for 5 minutes.

In order to determine changes in the abundance and distribution of zooplankton over time and between locations, sampling must be quantitative. We need to know how much water is filtered by the net so that the total number of individuals in the sample can be expressed as a density or number per cubic meter of water. The amount of water filtered between even carefully timed tows can vary quite a bit. A flowmeter mounted inside the mouth of a net is used for this purpose. In the lab, various categories of zooplankton are counted under a microscope and the determination of their densities allows for direct comparisons to be made between collections made at different stages of the tide, time of year, season, or locations. In order

to statistically compare abundances, multiple collections or replicate samplings must be made. For the long-term study, two identical 153-micron nets were used at the same time to obtain two replicate samples. The 365-micron mesh sled was towed three consecutive times to obtain quasi-replicate samples. Abundances from these replicates were used to calculate an average (mean) density as well as a measure of the variation (standard error) in abundance at that time and place. These values make it possible to statistically compare samples from different times and places. High variability in abundance is typical of the plankton and much of it can be attributed to patchiness in the distribution of organisms in both space and time. Another reason for high variability in the numbers between replicate net tows is the fact that it is impossible to sample the exact same volume of water twice. Although acoustic and digital photographic methods have been developed and are useful for counting at broad taxonomic levels especially in clearer waters, zooplankton sampling with nets is still the most acceptable method for use in more turbid estuarine waters.

» **Nekton** (page 184)

Sampling the nekton

Scientists use many devices and techniques to measure and describe distributions of nekton in estuaries. Because of the wide range of sizes, shapes, swimming capabilities, and general abundance among fishes, no single type of collection gear can be used to characterize all the nekton. Furthermore, any characterization is biased both by the kind and spatial and temporal extent of sampling conducted. Familiar devices include seines, trawls, gill nets, and traps. These and other techniques used by scientists to understand the nekton of North Inlet are described in the table below. Certain gear and approaches have been developed for particular habitats or groups of fishes. Even slight modifications in size, mesh, or the way a certain gear type is used can make a difference in what is caught. A medium mesh seine can provide a good indication of the occurrence of adult silversides in a shore zone, but could completely miss the much more abundant juveniles when adults are not there. Changes in the influence of current, speed of towing, clarity of the water, temperature, or time of day can affect catches at any location. Because time and personnel are often limited, surveys are usually restricted to the use of one or two gear types which are deployed the same way every time they are used. Scientists cannot determine how much of an observed change between sampling dates is due to technique, environmental conditions, or the movement of the animals to other locations. The tendency of many of the nekton to occur in schools or patches also complicates assessments of abundance. Gobies, blennies, and speckled worm eels are likely among the most abundant nekton in North Inlet, but, because of their cryptic habits, few are collected with nets that skim over the bottom where these fishes live. As is the case in most efforts to describe nature, our efforts are far from precise, but new technology (such as electronic systems that can identify, count, and measure nekton moving through a field of sensors) will likely enable us to be more quantitative in the future. In the meantime, multiple gear types (see table below) and deployment strategies (different tides, time of day, months, habitat types, and locations) will continue to be used to characterize nekton in an estuary.

Most frequently used gear and deployment techniques used by researchers to sample nekton in North Inlet

Seine

- a panel of nylon net of uniform mesh of ⅛ in to ½ in
- usually about 3 ft deep and 20 -50 ft long, sometimes with a 'bag' in the middle
- bottom line with lead weights and surface line with floats or floating line
- pulled perpendicular to the bottom in shallow water with one person on each end; foot in loop in bottom line and hand on top line or with a pole that keeps the end of the net spread
- most effective if hauled onto a smooth sloped shoreline
- advantage: collects in water too shallow to use a boat to tow a net
- disadvantage: moves too slow to capture faster swimmers and if pulling causes bottom line to lift or if used on irregular bottom, nekton easily escape underneath; not useful on rough bottom with snags (Allen et al. 1992)

Trawl

- a tapered net with larger mesh (1-2 in) in the broad body in front and smaller mesh (½ – ⅛ in) in the more constricted tail end
- usually about 3 ft high and 15 ft across the mouth tapering to a 1 x 1 ft bag end
- bottom line across mouth weighted with leads and or chain, floats on top line
- pulled by a boat with lines extending to 1 x 3 ft wood/metal doors that are rigged to ride perpendicular to the bottom and spread the mouth of the net when pulled forward
- advantage: collects in deeper channels and sounds, weighted trawls take nekton on or just above the bottom, floating trawls collect midwater or at the surface; effort can be standardized by distance covered; can capture some of largest demersal fish in the system
- disadvantages: fast swimmers and nekton elsewhere in the water column are missed; retention of small animals low due to large mesh in body of net.

Beam trawl

- a fairly short tapered, trawl-like net with uniform mesh (¼ – 1 in) mounted on a rigid (metal) rectangular frame mouth
- usually about 1.5 ft high and 5 ft across the mouth
- pulled by boat but a small one can be hauled by hand; especially effective for small flatfishes

Blocknet

- funnel shaped net with mouth dimensions comparable to mouth of creek to be sampled, slow taper to narrow tail end
- mesh size uniform at ⅛ to ½ in
- suspended in rigid frame secured to posts and set perpendicular to bottom, extra flanking walls to force all water and animals into the net mouth
- usually used starting at high tide to passively catch nekton leaving a creek with the ebb
- disadvantages: labor intensive, most nekton die during confinement
- advantages; very effective in collecting all animals occupying the habitat thus more quantitative than other techniques

Gill net

- panel of monofilament mesh from 1 - 6 or more in, 20 -100's of feet long, and 3 -8 ft high
- set perpendicular to bottom with leaded bottom line and floating upper line
- either staked in shallow water or tended from boat in which case it is held in place by large weights on either end, floats as markers on top
- set for 15 min to many hours
- advantages: collects larger, faster swimming fishes not collected by other gear
- disadvantages: as entanglement gear that snags fish under the gill plates, it usually means mutilation and death of the fish; a variation called a trammel net is less damaging; entangled oyster clumps, crabs, and debris are tedious to remove; net repairs are constant

Trap

- wire or plastic enclosures with funnels designed for easy entry and more difficult exit
- mesh and overall size selected for size of targeted species
- often baited and deployed for 30 min to a day or more
- disadvantages: selective since many species will not enter or be retained in traps
- advantages; can be used in pools and other areas where pulling nets is not possible

Habitat tray

- wire mesh trays (often 2 x 2 ft) with short sides and open tops
- usually filled with shell and set on bottom in deeper areas to sample structure dwelling nekton that will not enter traps
- quickly lifted from above by a pulling single line that terminates in a bridle attached to corners of tray
- effective for sampling small demersal animals which tend to hide in the rubble when lifted

Lift net

- rectangular nylon net that is buried in the bottom and lifted to entrap nekton on marshes
- vertical sides tall enough so that area remains surrounded at high tide; no top
- bottom edge with chain is permanently installed deep in mud, walls tucked into groove
- ropes connected to top center of opposite side panels, routed through top of poles
- lifted from afar at specified depth of coverage; secure in extended position, await low tide
- remove catch from basins with tops at marsh levels
- advantages: very good technique for quantitatively sampling marsh surface at different levels of flooding
- disadvantages: very labor intensive, requires removable boardwalks to approach nets

Longline

- nylon mainline with perpendicular monofilament or wire leaders that terminate in hooks with bait
- lines are usually 30- 150 ft long, set along the bottom or at specific depths regulated by floats
- set in deeper waters by boat, soaked for 15 min to hours
- advantages: only means of catching largest fishes besides hook and line, effort can be standardized
- disadvantages: labor intensive, potentially dangerous with large sharks and rays

SUMMARY, SYNTHESIS AND RELEVANCE TO COASTAL MANAGEMENT

General comparison of North Inlet and Winyah Bay

Mathematical models are used globally to predict the weather, estimate stock market ups and downs, chart hurricane paths in the days ahead, track animal migrations, calculate allowable catches for fisheries, and for thousands of other things that affect our daily lives. They rely on good data inputs and the quality of their predictions is often quite accurate. Uncertainties in the input data, however, make model predictions less reliable. The same is true for models of ecological processes. Arguably, one of the goals of ecological modeling is prediction. If X changes, what will happen to Y? A major challenge in modeling biogeochemical processes in estuarine ecosystems has been that physical (abiotic) forcings are highly variable in both magnitude and space over time, hence model input data have high uncertainties. To get around this, a reductionist approach has been used to isolate discrete, more easily measurable parts of the ecosystem to gain accuracy and then to assemble these parts into the larger whole.

Appendix B

USC Baruch and NI-WB NERR Archived and Web Published Databases

USC Baruch and NI-WB NERR Archived and Web Published Databases:
Biological Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection and end date (if different than rest of sites or main database)
BARUCH DATA ARCHIVES: LTER MACRO Jan 1981 through Jan 1992							
LTER MACROBENTHOS (MACRO)	Macrobenthos	Taxa, abundance (per m2), biomass estimates	2 - 10.3 cm cores	10 to 18 days (approx. biweekly)	1	BB, DD	BB: 01/20/1981 - 01/31/1992 DD: 01/20/1981 - 01/08/1985
LTER MACROBENTHOS (MACRO)	Sediment/Water Interface temperature	degrees celsius	mercury filled thermometer	10 to 18 days (approx. biweekly)	1	BB, DD	BB: 01/20/1981 - 01/31/1992 DD: 01/20/1981 - 01/08/1985
BARUCH DATA ARCHIVES: OLFISH Jan 1984 through Mar 2003							
OYSTER LANDING FISH (OLFISH)	NEKTON (fish, shrimp, and crab) in Low Tide Pool	Taxa, abundance, length (mm SL), weight (g)	2 tows with a 1/4" bag seine at low tide -> 1 tow	10 to 18 days (approx. biweekly)	1	OL	01/04/1984 - 03/31/2003
OYSTER LANDING FISH (OLFISH)	Water parameters in Low Tide Pool	Water temp	mercury thermometer -> Hydrolab datalogger	10 to 18 days (approx. biweekly)	1	OL	01/04/1984 - 03/31/2003
OYSTER LANDING FISH (OLFISH)	Physical parameters in Low Tide Pool	Air Temp	mercury filled thermometer	10 to 18 days (approx. biweekly)	1	OL	01/04/1984 - 03/31/2003
OYSTER LANDING FISH (OLFISH)	Water parameters in Low Tide Pool	Dissolved Oxygen	DO meter -> titrations -> Hydrolab datalogger	10 to 18 days (approx. biweekly)	1	OL	01/04/1984 - 03/31/2003
OYSTER LANDING FISH (OLFISH)	Water parameters in Low Tide Pool	Turbidity	Secchi disk	10 to 18 days (approx. biweekly)	1	OL	02/28/1991 - 03/31/2003
OYSTER LANDING FISH (OLFISH)	Water parameters in Low Tide Pool	Salinity	Refractometer -> Hydrolab datalogger	10 to 18 days (approx. biweekly)	1	OL	01/04/1984 - 03/31/2003
OLFISH LOW TIDE SEINE EFFICIENCY Study	fish, shrimp, crab collection efficiency	taxa, abundance, length (mm SL), weight (g)	15 tows with a 1/4" bag seine + Rotenone & dipnets	once per season	1	OL	05/01/1984 - 03/16/1988
OYSTER LANDING FISH POOL BATHYMETRY	Change in Low Tide Pool Volume	bathymetry	2 meter grids over pool	yrs	1	OL	02/22/1991

USC Baruch and NI-WB NERR Archived and Web Published Databases: Biological Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection and end date (if different than rest of sites or main database)
BARUCH DATA ARCHIVES: LTER MOTILE EPIBENTHOS Jan 1981 through Dec 2003							
LTER EPIBENTHOS (EPI)	Motile epibenthic macrozooplankton & Larval fish	Taxa, life stage, length, abundance (per m3)	3 sequential 365 µm net sled tows, 2 to 30 cm off the creek bottom, tow with the ebbing tide	10 to 18 days (approx. biweekly)	2 -> 1	BB, DD -> BB	DD:01/20/1981 - 01/04/1985
BARUCH DATA ARCHIVES: LTER SPARTINA 1984 through 2011							
Spartina	fertilization effects	height	census	monthly	1 - 6 in sm scale location	GI	04/30/1980
Spartina	Primary Productivity	height	census	monthly	2 - 6@ OL, 3@ GI	OL, GI	06/30/1982
Spartina	Below ground Productivity	root biomass	sand core	monthly sum	1	GI	02/28/1990
Spartina	porewater major ions	Cl-, SO4-, Na+, K+, Mg+, Ca+	porewater peepers	monthly	2 - 2@ OL, 3@ GI	OL, GI	07/31/1990
Spartina	Below ground Reserves	above ground dry biomass	marsh core	yearly	2 - 6@ OL, 3@ GI	OL, GI	06/30/1982
Spartina	porewater salinity	g/L Cl-	silver titration	monthly	2 - 2@ OL, 3@ GI	OL, GI	11/30/1989
Spartina	porewater nutrients	ammonia, PO4	colorimetric analysis	monthly	2 - 2@ OL, 3@ GI	OL, GI	11/30/1989
Spartina	porewater sulfide	Sulfide	colorimetric analysis	monthly	2 - 2@ OL, 3@ GI	OL, GI	11/30/1989
Spartina	Marsh elevation	cm	SET	monthly	1	GI	02/29/1992
BARUCH DATA: LTER Microbial ATP 1981 through 1985							
LTER Microbial ATP	adenosine 5'-triphospate (ATP)	nanograms per milliliter	3 -20 ml aliquots from a single 1 liter water sample	once per day at 10 am	3	CB, OL, TC	03/17/1981 - 03/31/1985

USC Baruch and NI-WB NERR Archived and Web Published Databases: Biological Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection and end date (if different than rest of sites or main database)
BARUCH DATA: CREEK Project 1996-2000; Testing the Role fo Oyster Reefs in the structure and function of tidal creeks							
CREEK Project: Role of Oyster Reefs	Oyster Biomass	grams dry body Wt per cubic meter per creek	Measuring reef area and quantifying oyster biomass in square meter quadrates	Approx 1 time per year	Four Creeks each in Clambank & Town Creeks	Creek Codes: 1, 2, 3, 4, 5, 6, 7, 8	1996 - 2000
CREEK Project: Role of Oyster Reefs	Water Chemistry, Water Quality, Chlorophyll a, and Suspended Sediment	Chlorophyll a (CHLA), Total Suspended Solids (SUSSol), Inorganic Susp. Solids (ISS), Organic Susp. Solids (OSS), Water Temp. (TEMP), Salinity (SAL), Total Nitrogen Filtered (TNF), Total Phosphorus Filtered (TPF), Dissolved Organic Carbon (DOC), Ammonia (NH4), Nitrate (NO3), & Orthophosphate (PO4)	colorimetric analysis on technicon autoanalyser, acetone extraction and fluorometer & combustion at 450 C on glass fiber filters	One liter of water taken one meter below water surface weekly at each creek	Four Creeks each in Clambank & Town Creeks	Creek Codes: 1, 2, 3, 4, 5, 6, 7, 8	03/19/1997 - 02/23/2000
CREEK Project: Role of Oyster Reefs	Nekton (fish, shrimp, and crab)	Species abundance (#/m^3) and biomass (g/m^3) collection data and species list for bank-full high tides only.	Block nets set at early morning slack high tide; low tide pools seined	Seasonal	Four Creeks each in Clambank & Town Creeks	Creek Codes: 1, 2, 3, 4, 5, 6, 7, 8	3/221997 - 11/03/1998
CREEK Project: Role of Oyster Reefs	Oyster Growth and Survival	Increase in Length and Number alive	Four plastic mesh bags with 25 oysters each set out in each creek at same tidal elevation	Seasonal	Four Creeks each in Clambank & Town Creeks	Creek Codes: 1, 2, 3, 4, 5, 6, 7, 8	1997 - 1999

USC Baruch and NI-WB NERR Archived and Web Published Databases: Biological Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection and end date (if different than rest of sites or main database)
CREEK Project: Role of Oyster Reefs	Microzooplankton	Replicate and abundance data, means and standard deviations for heterotrophic and phototrophic nanoflagellates, ciliates, chlorophyll a, and NH4.	Replicated morning mid-ebb water samples incubated for 72hr	19 March, 17 July, and 29 August 1997 (pre-manipulation year), and monthly from March through September 1998 (first post-manipulation year)	Four Creeks each in Clambank & Town Creeks	Creek Codes: 1, 2, 3, 4, 5, 6, 7, 8	1997 - 1998
CREEK Project: Role of Oyster Reefs	Phytoplankton Pigments	Species Abundance of phytoplankton	High Performance Liquid Chromatorgraphy (HPLC)	Pre-manip yr: Seasonally; Post-Manipulation yr: monthly	Four Creeks each in Clambank & Town Creeks	Creek Codes: 1, 2, 3, 4, 5, 6, 7, 8	1997 - 1999
CREEK Project: Role of Oyster Reefs	Internal Creek Habitat Survey	Amount of habitat that was oyster reef or shell, mud, sand and slope characteristics	Survey using tape measure and quadrates; 16 categories from mud to dense shell	once	Four Creeks each in Clambank & Town Creeks	Creek Codes: 1, 2, 3, 4, 5, 6, 7, 8	Dec-93
BARUCH DATA: Coastal Intensive Site Network (CISNet) Molecular to landscape-scale monitoring of estuarine eutrophication							
CISNet Project: Phytoplankton Pigment Monitoring	Phytoplankton Pigments	Species Abundance of phytoplankton	High Performance Liquid Chromatorgraphy (HPLC)	sesaonally	5 locations: North Inlet and ACE Basin	Creek Codes: NI or ACE (1, 2, 3, 4, 5)	7/27/1999 - 9/18/2001
CISNet Project: Water Quality Monitoring	Water Quality & Water Chemistry	Water temperature, salinity, dissolved oxygen, light, pH, nitrogen, phosphorus, suspended solids, carbon, silicate, & chlorophyll a	triplicate 1-liter water samples, approx mid-way between daytime high and low tide stage	varying intervals from spring through early fall each year	5 locations: North Inlet and ACE Basin	Creek Codes: NI or ACE (1, 2, 3, 4, 5)	7/27/1999 - 9/18/2001

USC Baruch and NI-WB NERR Archived and Web Published Databases:
Biological Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection and end date (if different than rest of sites or main database)
BARUCH DATA: LTER MEIOBENTHOS 1972 through 1995 (managed onsite & in process of archival and web publication)							
LTER MEIO (meiobenthos)	Meiobenthos	Taxa, abundance (per 10 cm2)	4-4.4cm, 3.48cm, 2.66cm diameter cores -> 2-2.66cm diameter cores	Monthly -> 10 to 18 days (approx. biweekly)	2	DD, BB	09/06/1968
LTER MEIO (meiobenthos)	Physical parameters for Meio	Air temperature	mercury filled thermometer	Monthly -> 10 to 18 days (approx. biweekly)	2	DD, BB	01/19/1977
LTER MEIO (meiobenthos)	Physical parameters for Meio	Surface Water temperature	Salinometer (or Refractometer) -> Hydrolab datalogger	Monthly -> 10 to 18 days (approx. biweekly)	2	DD, BB	01/19/1977
LTER MEIO (meiobenthos)	Physical parameters for Meio	Sediment-Water Interface (Surface Sediment) temperature	mercury filled thermometer	Monthly -> 10 to 18 days (approx. biweekly)	2	DD, BB	09/06/1968
LTER MEIO (meiobenthos)	Physical parameters for Meio	Redox (Eh) of sediment	platinum electrode -> visually	Monthly -> 10 to 18 days (approx. biweekly)	2	DD, BB	09/06/1968
LTER MEIO (meiobenthos)	Physical parameters for Meio	Surface Water Salinity	Salinometer (or Refractometer) -> Hydrolab datalogger	Monthly -> 10 to 18 days (approx. biweekly)	2	DD, BB	09/06/1968
LTER MEIO (meiobenthos)	Physical parameters for Meio	sediment grain size	Phi series sieves & pipette analysis	Monthly -> 10 to 18 days (approx. biweekly)	2	DD, BB	09/06/1969
LTER MEIO (meiobenthos)	Physical parameters for Meio	sediment organic content	wet dichromate method	Monthly -> 10 to 18 days (approx. biweekly)	2	DD,BB	09/06/1969

USC Baruch and NI-WB NERR Archived and Web Published Databases:

Biological Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection and end date (if different than rest of sites or main database)
BARUCH DATA: NERR High Tide Nekton 1994 through 2011 (managed onsite & in process of archival and web publication)							
OL High Tide Fish	Nekton (fish, shrimp, and crab)	Taxa, abundance, length (mm SL), weight (g)	1/4" Funnel Net Deployed at Slack High; Animals collected at Low Tide	Monthly -> 10 to 18 days (approx. biweekly)	1	OI	08/17/1990
OL High Tide Fish	High Tide Bottom Water parameters	High Tide Water temp, Dissolved Oxygen, & Salinity	Hydrolab datalogger	Monthly -> 10 to 18 days (approx. biweekly)	1	OI	08/17/1990
OL High Tide Fish	Water parameters in Low Tide pool	High Tide Turbidity	Secchi disk	Monthly -> 10 to 18 days (approx. biweekly)	1	OI	08/17/1990
BARUCH DATA: LTER seine & trawl survey 1981 through 1984 (Paperback publication completed; in process of archival and web publication)							
LTER Seine & Trawl survey	fish, shrimp, crab	taxa, abundance, length, weight	2 beach hauls with 1/4" bag seine & 1-13 min Otter trawl in creek channel	10 to 18 days (approx. biweekly)	2	DD, BB	01/20/1981 - 11/07/1984
BARUCH DATA: LTER Zooplankton Monitoring 1981 through 2008 (in process of archival and web publication)							
LTER ZOOPLANKTON (ZPK)	Zooplankton	Taxa, life, stage, abundance (per m3)	153 µm paired nets, suspended into ebbing tide for 3 min Total (1 min each @ bottom, middle, surface waters)	10 to 18 days (approx. biweekly)	2 -> 1	DD, BB -> BB	DD:01/20/1981 - 01/04/1985
LTER ZOOPLANKTON (ZPK)	Physical parameters collected for zpk	depth at time of zpk	0.25 m increment marked rope used for ZPK collections	10 to 18 days (approx. biweekly)	2 -> 1	BB, DD -> BB	DD:08/26/1981 - 01/04/1985

USC Baruch and NI-WB NERR Archived and Web Published Databases: Meteorological Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection and end date (if different than rest of sites or main database)
BARUCH DATA ARCHIVES: LTER MET Jun 1982 through Apr 1996							
LTER MET (meteorological)	air temperature	degrees Celsius	YSI 703 Dual element epoxy coated thermistor	hrly ave. based on 1 sec samples from previous hour	1	OL	06/03/1982 - 04/29/1996
LTER MET (meteorological)	wind direction	1-360 degrees (no correction for magnetic declination)	Windmark III wind vane	Before 09/21/1989 hrly ave. based on 30 sec samples -> hrly ave. based on 1 sec samples from previous hour	1	OL	6/3/1982 - 04/29/1996
LTER MET (meteorological)	wind speed	meters/second	Windmark III 3cup anemometer	hrly ave. based on 1 sec samples from previous hour	1	OL	6/3/1982 - 04/29/1996
LTER MET (meteorological)	maximum hrly wind speed	meters/second	Windmark III 3cup anemometer	hrly maximum based on 1 sec samples from previous hour	1	OL	01/01/1993 - 04/29/1996
LTER MET (meteorological)	barometric pressure	940-1040 millibars	YSI 2014 pressure transducer	hrly ave. based on 1 sec samples from previous hour	1	OL	6/3/1982 - 04/29/1996
LTER MET (meteorological)	solar radiation	400-700 nm wavelengths (µE/M2/Sec or micromoles/M2/Sec	LI-COR LI190SB Quantum Sensor	hrly ave. based on 1 sec samples from previous hour	1	OL	10/5/1994 - 04/29/1996
LTER MET (meteorological)	solar radiation	(Langleys/min or mV/cal per cm-2 per min-1)	Eppley black and white 8-48 radiometer measuring 280-2800 nm wavelengths	hrly ave. based on 1 sec samples from previous hour	1	OL	6/3/1982 - 04/29/1996
BARUCH DATA ARCHIVES: LTER RAINDAZE Apr 1978 through Dec 2001							
RAINDAZE (meteorological)	precipitation	rainfall (mm & inches) {does not measure snowfall}	Belfort 5-780 tipping bucket -> NWS approved Dip-stick gauges -> Sierra-Misco & Campbell Scientific Tipping buckets	By event: Begin Date&Hr - End Date&Hr OR during a 24 hour period	1	OL	04/01/1978 - 12/31/2001

USC Baruch and NI-WB NERR Archived and Web Published Databases: Meteorological Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection and end date (if different than rest of sites or main database)
BARUCH DATA ARCHIVES: LTER NWS Dec 1986 through Mar 1996							
National Weather Service	Current & Min & Max Air Temperature	degrees Celsius	Visual inspection of thermometer OR Weekly charts: 2hr resolution	Daily at 1000 for previous 24hrs OR Interpreted from charts for 0000 to 2400 time period	1	OL	12/01/1986 - 02/04/1996
National Weather Service	Min & Max Barometric Press	millibars	Qualimetric weekly chart driven sensors: 2hr resolution	Min & Max Values derived from 0000 to 2400 time period	1	OL	10/10/1989 - 03/03/1996
National Weather Service	Min & Max Relative Humidity	percent saturation	Qualimetric weekly chart driven sensors: 2hr resolution	Min & Max Values derived from 0000 to 2400 time period	1	OL	12/29/1986 - 03/03/1996
National Weather Service	Precipitation	millimeters	Visual inspection of rain gauge OR Weekly charts: 2hr resolution	Daily at 1000 for previous 24hrs OR Interpreted from charts for 0000 to 2400 time period	1	OL	12/01/1986 - 03/03/1996
BARUCH DATA ARCHIVES: NIW NERR MET July 1997 through Dec 2004							
NERR MET (meteorological)	Air temperature	Degrees C	Campbell Scientific HMP35 Temperature and Humidity Probe with Thermistor -> Platinum Resistance Temp. Detector	15 min instan; hrly & daily ave based on 5 sec samples	1	OL	7/2/1997 - 12/31/12004
NERR MET (meteorological)	Wind direction	1-360 degrees (no correction for magnetic declination)	R.M. Young Wind Sentry 03001-5 Anemometer and Vane Set	15 min instan; hrly & daily ave based on 5 sec samples	1	OL	4/3/1998 - 12/31/2004
NERR MET (meteorological)	Wind speed	meters/second	R.M. Young Wind Sentry 03001-5 Anemometer and Vane Set	15 min instan; hrly & daily ave based on 5 sec samples	1	OL	4/3/1998 - 12/31/2004
NERR MET (meteorological)	Barometric pressure	940-1040 millibars	CS105 Barometric Pressure Sensor using Barocap silicon capacitive press. Sensor	15 min instan; hrly & daily ave based on 5 sec samples	1	OL	8/15/1997 - 12/31/2004

USC Baruch and NI-WB NERR Archived and Web Published Databases: Meteorological Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection and end date (if different than rest of sites or main database)
NERR MET (meteorological)	Relative humidity	percent saturation	Campbell Scientific HMP35 Temperature and Relative Humidity (RH) Probe with Capacitive RH sensor -> HUMICAP 180 capacitive RH sensor	15 min instan; hrly & daily ave based on 5 sec samples	1	OL	7/2/1997 - 12/31/2004
NERR MET (meteorological)	Solar radiation	280-2800 nm wavelengths (Langleys/min or mV/cal per cm-2 per min-1)	Eppley black and white 8-48 pyranometer	15 min instan; hrly & daily ave based on 5 sec samples	1	OL	6/30/1998 - 12/31/2004
NERR MET (meteorological)	Precipitation	rainfall (in mm) does not measure snowfall	Sierra-Misco 2500-8 tipping bucket	15 min instan; hrly & daily totals	1	OL	7/2/1997 - 12/31/2004
CDMO: NIW NERR SWMP Meteorological Data Jan 2001 through Dec 2010							
NERR MET (meteorological)	Air temperature	Degrees C	Campbell Scientific HMP35 Temperature and Humidity Probe with Thermistor -> Platinum Resistance Temp. Detector	15 min instan; hrly & daily ave based on 5 sec samples	1	OL	
NERR MET (meteorological)	Relative humidity	percent saturation	Campbell Scientific HMP35 Temperature and Relative Humidity (RH) Probe with Capacitive RH sensor -> HUMICAP 180 capacitive RH sensor	15 min instan; hrly & daily ave based on 5 sec samples	1	OL	
NERR MET (meteorological)	Barometric pressure	940-1040 millibars	CS105 Barometric Pressure Sensor using Barocap silicon capacitive press. Sensor	15 min instan; hrly & daily ave based on 5 sec samples	1	OL	
NERR MET (meteorological)	Wind speed	meters per second	R.M. Young Wind Sentry 03001-5 Anemometer and Vane Set	15 min instan; hrly & daily ave based on 5 sec samples	1	OL	
NERR MET (meteorological)	Wind direction	1-360 degrees (no correction for magnetic declination)	R.M. Young Wind Sentry 03001-5 Anemometer and Vane Set	15 min instan; hrly & daily ave based on 5 sec samples	1	OL	
NERR MET (meteorological)	Precipitation	15 minute rainfall (millimeters) does not measure snowfall	Sierra-Misco 2500-8 tipping bucket	15 min instan; hrly & daily totals	1	OL	
NERR MET (meteorological)	Total Photosynthetic Active Radiation (PAR)	millimoles per square meter per 15 minutes	LI-190SB (LICOR) Quantum Terrestrial Radiation Sensor; 400-700 nm wavelengths	15 min instan; hrly & daily ave based on 5 sec samples	1	OL	

USC Baruch and NI-WB NERR Archived and Web Published Databases: Water Chemistry Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection and end date (if different than rest of sites or main database)
BARUCH DATA ARCHIVES: LTER Daily Water Sample (DWS) Water Chemistry 1978 through JUNE 30, 1993							
LTER DWS (Water Chemistry)	Particulate organic carbon (POC)	microgram atoms/liter	Beckman 915A TOC analyzer -> after 01/23/1981 Oceanigraphics International TOC analyzer	once per day at 10 am	3	CB, OL, TC	04/14/1981 - 04/15/1987
LTER DWS (Water Chemistry)	Total organic carbon (TOC)	microgram atoms/liter	Beckman 915A TOC analyzer -> after 01/23/1981 Oceanigraphics International TOC analyzer	once per day at 10 am	1	TC	09/01/1978 - 08/17/1989
LTER DWS (Water Chemistry)	Dissolved organic carbon (DOC)	microgram atoms/liter	Beckman 915A TOC analyzer -> after 01/23/1981 Oceanigraphics International TOC analyzer -> after 10/02/89 Shimadzu TOC-500 analyzer	once per day at 10 am	4	CB, OL, TC, DB*	01/28/1980 DB=11/12/1985 - 11/16/1988
LTER DWS (Water Chemistry)	total solids (TSS), inorganic sediment (ISS), organic sediment (OSS)	milligrams per liter	combustion at 450 C on glass fiber filters	once per day at 10 am	4	CB, OL, TC, DB*	02/12/1981 DB=11/12/1985 - 11/16/1988
LTER DWS (Water Chemistry)	chlorophyll (CHLa) & Phaeophytin	Chlorophyll a & Phaeophytin -> Chlorophyl a	acetone extraction and fluorometer	once per day at 10 am	4	CB, OL, TC, DB*	09/08/1978 DB=11/12/1985 - 11/16/1988
LTER DWS (Water Chemistry)	nitrate+nitrite (NN)	microgram atoms/liter	colorimetric analysis on technicon autoanalyser	once per day at 10 am	4	CB, OL, TC, DB*	06/16/1980 DB=11/12/1985 - 11/16/1988
LTER DWS (Water Chemistry)	orthophosphate (OP)	microgram atoms/liter	colorimetric analysis on technicon autoanalyser	once per day at 10 am	4	CB, OL, TC, DB*	06/16/1980 DB=11/12/1985 - 11/16/1988
LTER DWS (Water Chemistry)	ammonia (NH4)	microgram atoms/liter	colorimetric analysis on technicon autoanalyser	once per day at 10 am	4	CB, OL, TC, DB*	06/16/1980 DB=11/12/1985 - 11/16/1988
LTER DWS (Water Chemistry)	total nitrogen whole (TNW) & filtered (TNF)	microgram atoms/liter	colorimetric analysis on technicon autoanalyser	once per day at 10 am	4	CB, OL, TC, DB*	06/16/1980 DB=11/12/1985 - 11/16/1988
LTER DWS (Water Chemistry)	total phosphorus whole (TPW) and filtered (TPF)	microgram atoms/liter	colorimetric analysis on technicon autoanalyser	once per day at 10 am	4	CB, OL, TC, DB*	06/16/1980 DB=11/12/1985 - 11/16/1988

*DB data collected but not included in archived dataset

USC Baruch and NI-WB NERR Archived and Web Published Databases: Water Chemistry Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection and end date (if different than rest of sites or main database)
BARUCH DATA ARCHIVES: NIW NERR Estuarine Surface Water Chemistry Jun 1993 through Dec 2004 (2002-2004 not available online)							
NERR WCHEM (Water Chemistry)	Dissolved organic carbon (DOC)	milligrams per liter	Shimadzu TOC-500 analyzer	every 20 day every 2hr4min for 25 hrs	3 -> 2 -> 4	CB, OL, TA -> OL, TA -> CB, DC, OL, TA	CB=06/02/1993-12/30/1995; 12/19/2001 DC=03/08/1998 OL=06/02/1993 TA=04/18/1994
NERR WCHEM (Water Chemistry)	total solids (TSS), inorganic sediment (ISS) & organic sediment (OSS)	milligrams per liter	combustion at 450 C on glass fiber filters	every 20 day every 2hr4min for 25 hrs	3 -> 2 -> 4	CB, OL, TA -> OL, TA -> CB, DC, OL, TA	CB=06/02/1993-12/30/1995; 8/19/2001 DC=03/08/1998 OL=06/02/1993 TA=04/18/1994
NERR WCHEM (Water Chemistry)	chlorophyll (CHLa)	micrograms per liter	acetone extraction and fluorometer	every 20 day every 2hr4min for 25 hrs	3 -> 2 -> 4	CB, OL, TA -> OL, TA -> CB, DC, OL, TA	CB=06/02/1993-12/30/1995; 12/19/2001 DC=03/08/1998 OL=06/02/1993 TA=04/18/1994
NERR WCHEM (Water Chemistry)	nitrate+nitrite (N-N)	micromoles per liter	colorimetric analysis on technicon autoanalyser	every 20 day every 2hr4min for 25 hrs	3 -> 2 -> 4	CB, OL, TA -> OL, TA -> CB, DC, OL, TA	CB=06/02/1993-12/30/1995; 12/19/2001 DC=03/08/1998 OL=06/02/1993 TA=04/18/1994
NERR WCHEM (Water Chemistry)	orthophosphate (OP)	micromoles per liter	colorimetric analysis on technicon autoanalyser	every 20 day every 2hr4min for 25 hrs	3 -> 2 -> 4	CB, OL, TA -> OL, TA -> CB, DC, OL, TA	CB=06/02/1993-12/30/1995; 12/19/2001 DC=03/08/1998 OL=06/02/1993 TA=04/18/1994
NERR WCHEM (Water Chemistry)	ammonia (NH4)	micromoles per liter	colorimetric analysis on technicon autoanalyser	every 20 day every 2hr4min for 25 hrs	3 -> 2 -> 4	CB, OL, TA -> OL, TA -> CB, DC, OL, TA	CB=06/02/1993-12/30/1995; 12/19/2001 DC=03/08/1998 OL=06/02/1993 TA=04/18/1994
NERR WCHEM (Water Chemistry)	total nitrogen whole (TNW) & filtered (TNF)	micromoles per liter	colorimetric analysis on technicon autoanalyser	every 20 day every 2hr4min for 25 hrs	3 -> 2 -> 4	CB, OL, TA -> OL, TA -> CB, DC, OL, TA	CB=06/02/1993-12/30/1995; 12/19/2001 DC=03/08/1998 OL=06/02/1993 TA=04/18/1994
NERR WCHEM (Water Chemistry)	Nitrite (NO2)	micromoles per liter	colorimetric analysis on technicon autoanalyser	every 20 day every 2hr4min for 25 hrs	4	CB, DC, OL, TA	3/22/2003 for all sites
NERR WCHEM (Water Chemistry)	total phosphorus whole (TPW) & filtered (TPF)	micromoles per liter	colorimetric analysis on technicon autoanalyser	every 20 day every 2hr4min for 25 hrs	3 -> 2 -> 4	CB, OL, TA -> OL, TA -> CB, DC, OL, TA	CB=06/02/1993-12/30/1995; 12/19/2001 DC=03/08/1998 OL=06/02/1993 TA=04/18/1994

USC Baruch and NI-WB NERR Archived and Web Published Databases: Water Chemistry Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection and end date (if different than rest of sites or main database)
CDMO System-Wide Monitoring Program (SWMP) NUTRIENT DATA: NIW NERR January 1, 2002 to September 30, 2010							
NERR WCHEM (Water Chemistry)	nitrate+nitrite (NN)	milligrams per liter	colorimetric analysis on technicon autoanalyser	20 day every 2hr4min for 25 hrs + 2 reps @ end (13+2)	4	CB, DC, OL, TA	01/01/2002 for all sites
NERR WCHEM (Water Chemistry)	Nitrate (NO3)	milligrams per liter	colorimetric analysis on technicon autoanalyser	20 day every 2hr4min for 25 hrs + 2 reps @ end (13+2)	4	CB, DC, OL, TA	01/01/2002 for all sites
NERR WCHEM (Water Chemistry)	Nitrite (NO2)	milligrams per liter	colorimetric analysis on technicon autoanalyser	20 day every 2hr4min for 25 hrs + 2 reps @ end (13+2)	4	CB, DC, OL, TA	3/22/2003 for all sites
NERR WCHEM (Water Chemistry)	orthophosphate (OP)	milligrams per liter	colorimetric analysis on technicon autoanalyser	20 day every 2hr4min for 25 hrs + 2 reps @ end (13+2)	4	CB, DC, OL, TA	01/01/2002 for all sites
NERR WCHEM (Water Chemistry)	chlorophyll a (Chla)	milligrams per liter	acetone extraction and fluorometer	20 day every 2hr4min for 25 hrs + 2 reps @ end (13+2)	4	CB, DC, OL, TA	01/01/2002 for all sites
NERR WCHEM (Water Chemistry)	ammonium (NH4)	milligrams per liter	colorimetric analysis on technicon autoanalyser	20 day every 2hr4min for 25 hrs + 2 reps @ end (13+2)	4	CB, DC, OL, TA	01/01/2002 for all sites
BARUCH DATA: NIW NERR Estuarine Surface Water Chemistry Jan 2005 to Sep 2012 (managed onsite & not part of SWMP)							
NERR WCHEM (Water Chemistry)	total nitrogen whole (TNW) & filtered (TNF)	micromoles per liter	colorimetric analysis on technicon autoanalyser	20 day every 2hr4min for 25 hrs + 2 reps @ end (13+2)	4	CB, DC, OL, TA	01/01/2005
NERR WCHEM (Water Chemistry)	total phosphorus whole (TPW) & filtered (TPF)	micromoles per liter	colorimetric analysis on technicon autoanalyser	20 day every 2hr4min for 25 hrs + 2 reps @ end (13+2)	4	CB, DC, OL, TA	01/01/2005
NERR WCHEM (Water Chemistry)	total solids (TSS), inorganic sediment (ISS) & organic sediment (OSS)	milligrams per liter	combustion at 450 C on glass fiber filters	20 day every 2hr4min for 25 hrs + 2 reps @ end (13+2)	4	CB, DC, OL, TA	01/01/2005
NERR WCHEM (Water Chemistry)	chlorophyll a (Chla)	micrograms per liter	acetone extraction and fluorometer	20 day every 2hr4min for 25 hrs + 2 reps @ end (13+2)	4	CB, DC, OL, TA	01/01/2005
NERR WCHEM (Water Chemistry)	Dissolved organic carbon (DOC)	milligrams per liter	Shimadzu TOC-500 analyzer	20 day every 2hr4min for 25 hrs + 2 reps @ end (13+2)	4	CB, DC, OL, TA	01/01/2005
NERR WCHEM (Water Chemistry)	water wavelength absorbance	absorbance @ 355	550-250 nm Spectrophotometer	20 day every 2hr4min for 25 hrs + 2 reps @ end (13+2)	2	OL & TA	OL=03/26/2006 TA=03/25/2010

USC Baruch and NI-WB NERR Archived and Web Published Databases: Water Quality Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection (and end date if different than rest of sites or main database)
BARUCH DATA ARCHIVES: Daily Water Sample (DWS) Water Quality 1979 THROUGH JUNE 30, 1993							
LTER DWS (Water Chemistry)	salinity	parts per thousand	refractometer	once per day at 10 am	4	CB, OL, TC, DB*	08/27/79 DB=11/12/1985 - 11/16/1988
LTER DWS (Water Chemistry)	Water Temperature	degrees Celsius	Hand Held Mercury Filled Thermometer	once per day at 10 am	4	CB, OL, TC, DB*	09/13/1979 DB=11/12/1985 - 11/16/1988
LTER DWS (Water Chemistry)	Water Clarity	Secchi Disk	2M PVC Pole with Secchi Disk mounted at end; Pole marked at 10cm increments	once per day at 10 am	4	CB, OL, TC, DB*	02/25/1982 DB=11/12/1985 - 11/16/1988
LTER DWS (Water Chemistry)	Sediment (Water) Color	Sediment Color from Filtered Water Sample	Sediment Filter Color compared to Munsell Chart; code written down	once per day at 10 am	4	CB, OL, TC, DB*	06/1988 DB=11/12/1985 - 11/16/1988
*DB data collected but not included in archived dataset							
BARUCH DATA ARCHIVES: LTER MET JUNE 1982 THROUGH APRIL 1996							
LTER MET	Water Physicals	Water Temp (degrees Celsius)	YSI 070/44018/NA/RN/300 plastic coated thermistor	hrly ave. based on 1 sec samples from previous hour	1	OL	01/01/1993 - 04/29/1996
LTER MET	Water Physicals	Water level @ 0.0-3.0 meters (corrected for barometric pressure)	Enviro-Labs water level sensor -> Kellar PSI PT108V-50-15PSI VENTED Water level sensor	6 min & hrly instantaneous	1	OL	01/01/1993 - 04/29/1996
LTER MET	Water Physicals	Conductivity @ 0.0-2.0 millivolts per centimeter	YSI Conductivity Sensor (glass cond. cell and temp. compensator) -> RoseMont 1181T-00-02-99 water conductivity probe	hrly ave. based on 1 sec samples from previous hour	1	OL	01/01/1993 - 04/29/1996
BARUCH DATA ARCHIVES: NIW NERR Estuarine Surface Water Chemistry Jun 2, 1993 to Dec 2001							
NERR WCHEM (Water Chemistry)	salinity	parts per thousand	refractometer	every 20 day every 2hr4min for 26 hrs	3 -> 2 -> 4	CB, OL, TA -> OL, TA -> CB, DC, OL, TA	CB=06/02/1993-12/30/1995; 12/19/2001 DC=03/08/1998 OL=06/02/1993 TA=04/18/1994
NERR WCHEM (Water Chemistry)	Sediment (Water) Color	Sediment Color from Filtered Water Sample	Sediment Filter Color compared to Munsell Chart; code written down	every 20 day every 2hr4min for 26 hrs	3 -> 2 -> 4	CB, OL, TA -> OL, TA -> CB, DC, OL, TA	CB=06/02/1993-12/30/1995; 12/19/2001 DC=03/08/1998 OL=06/02/1993 TA=04/18/1994

USC Baruch and NI-WB NERR Archived and Web Published Databases: Water Quality Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection (and end date if different than rest of sites or main database)
BARUCH DATA ARCHIVES: NIW NERR Estuarine Water Quality Oct 25,1993 to Dec 31, 2002							
NERR WatQual (Water Quality)	salinity	parts per thousand	YSI or Hydrolab water quality sensor	every 30 min	3 -> 4	CB, OL, TA -> CB, DC, OL, TA	CB=10/25/1993-6/30/1995; 8/17/2001 DC=03/05/1998 OL=10/25/1993 TA=04/15/1994
NERR WatQual (Water Quality)	specific conductivity	millisiemens per cm	YSI or Hydrolab water quality sensor	every 30 min	3 -> 4	CB, OL, TA -> CB, DC, OL, TA	CB=10/25/1993-6/30/1995; 8/17/2001 DC=03/05/1998 OL=10/25/1993 TA=04/15/1994
NERR WatQual (Water Quality)	Water Temperature	degrees Celsius	YSI or Hydrolab water quality sensor	every 30 min	3 -> 4	CB, OL, TA -> CB, DC, OL, TA	CB=10/25/1993-6/30/1995; 8/17/2001 DC=03/05/1998 OL=10/25/1993 TA=04/15/1994
NERR WatQual (Water Quality)	dissolved oxygen	mg/L and % saturation	YSI or Hydrolab water quality sensor	every 30 min	3 -> 4	CB, OL, TA -> CB, DC, OL, TA	CB=10/25/1993-6/30/1995; 8/17/2001 DC=03/05/1998 OL=10/25/1993 TA=04/15/1994
NERR WatQual (Water Quality)	pH		YSI or Hydrolab water quality sensor	every 30 min	2 -> 4	-> OL, TA -> CB, DC, OL, TA	CB=8/17/2001 DC=03/08/1998 OL=01/08/1997 TA=01/22/1996
NERR WatQual (Water Quality)	turbidity	NTU	YSI or Hydrolab water quality sensor	every 30 min	2 -> 4	-> OL, TA -> CB, DC, OL, TA	CB=8/17/2001 DC=03/08/1998 OL=01/08/1997 TA=01/22/1996
NERR WatQual (Water Quality)	Depth	meters	YSI or Hydrolab water quality sensor	every 30 min	3 -> 4	CB, OL, TA -> CB, DC, OL, TA	CB=06/02/1993-12/30/1995; 12/19/2001 DC=03/08/1998 OL=06/02/1993 TA=04/18/1994

USC Baruch and NI-WB NERR Archived and Web Published Databases: Water Quality Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning of data collection (and end date if different than rest of sites or main database)
BARUCH DATA ARCHIVES: Motile Epibenthos Biweekly Water Physicals Jan 18, 1981 to Dec 2003							
LTER/NERR Biweekly Epibenthos Water Physicals	salinity	parts per thousand	Conductivity meter -> YSI or Hydrolab water quality sensor	every 10-18 day (biweekly)	3 -> 1	DD, BB -> BB	DD=01/18/1981- 12/18/1984 BB=01/18/1981
LTER/NERR Biweekly Epibenthos Water Physicals	Water Temperature	degrees Celsius	Conductivity meter -> YSI or Hydrolab water quality sensor	every 10-18 day (biweekly)	3 -> 2	DD, BB -> BB	DD=01/18/1981- 12/18/1984 BB=01/18/1981
LTER/NERR Biweekly Epibenthos Water Physicals	dissolved oxygen	mg/L	YSI or Hydrolab water quality sensor	every 10-18 day (biweekly)	3 -> 2	BB	BB=09/23/1993
LTER/NERR Biweekly Epibenthos Water Physicals	Light	micromoles per meter^2 per second	LI-COR LI-193SB Underwater Spherical Quantum Sensor	every 10-18 day (biweekly)	3 -> 2	DD, BB -> BB	DD=01/18/1981- 12/18/1984 BB=01/18/1981
LTER/NERR Biweekly Epibenthos Water Physicals	Tide velocity	meters per second	Marsh McBirney Model 201D Portable Water Current Meter	every 10-18 day (biweekly)	3 -> 2	DD, BB -> BB	DD=01/18/1981- 12/18/1984 BB=01/18/1981

USC Baruch and NI-WB NERR Archived and Web Published Databases: Rescued and Archived Data

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning and end Date of data collection
Forest-Marsh-Tidal Creek Groundwater Dynamics	Groundwater water level (Head pressure)	Piezometer readings	15 minute datalogger readings at different piezometer depths along transects	10 to 15 days	3 (Transects)	Transects across CrabHaul Creek; Codes: B, C, D	03/16/1994 - 05/02/1996
Forest-Marsh-Tidal Creek Groundwater Dynamics	Station Elevations	Topographic elevations	1993: TopCon Total Station and Prism Reflector; 1996: Leveling Telescope	1 time 1993; 1 time in 1996	3 (Transects)	Transects across CrabHaul Creek; Codes: B, C, D	1993 & 1996
Forest-Marsh-Tidal Creek Groundwater Dynamics	Water Level Groundtruthing	Dipstick Measurements	PVC pipe with two wires protruding from holes in a rubber stopper at the bottom end, sounded when immersed in water	bimonthly	3 (Transects)	Transects across CrabHaul Creek; Codes: B, C, D	1994 - 1996
Forest-Marsh-Tidal Creek Groundwater Dynamics	Botanical Zonation along Transects	Plant identifications, heights, and communities	Measured and documented along transects	once in summer	3 (Transects)	Transects across CrabHaul Creek; Codes: B, C, D	June - August 1993
Forest-Marsh-Tidal Creek Groundwater Dynamics	Hydraulic conductivities	Slug Test	Recorded time between slug was inserted into piezometer and when water returned to ambient level	Once only for 292 of 306 piezometers	3 (Transects)	Transects across CrabHaul Creek; Codes: B, C, D	unknown
Forest-Marsh-Tidal Creek Groundwater Dynamics	Groundwater salinities	Salinity	piezometer well water salinity measured by optical refractometer	bimonthly	3 (Transects)	Transects across CrabHaul Creek; Codes: B, C, D	1994 - 1996
NADP (National Atmospheric Deposition Program)	Precipitation Chemistry	Sulfate, Nitrate, Ammonium, Chloride, Calcium, Magnesium, Potassium, and Sodium, Acidity (pH)	Samples collected with strict clean-handling procedures and sent to Analytical Laboratory for analysis	Weekly	1	OL	01/08/2002

USC Baruch and NI-WB NERR Archived and Web Published Databases: Historical Data Needing Rescue, Archival and Web Publication

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning and end Date of data collection
Oyster Growth	Oyster Growth	Shell length & width (mm); Weight (grams)	40 oysters per Replicate; 3 Reps per depth; 2 depth levels: 1 & 3ft below water surface	bimonthly	2	OL & CB	11/1984 - 03/1987
Oyster Spat Recruitment	Number of Oyster Larvae Settled onto Mid and Low Intertidal & Subtidal plates	Abundance (#/225cm2) of Spat on Top and Bottom of Plate	6 plates per site; 2 plates each at 3 different depths	Every 12 to 16 days	3 -> 1	OL, OM, TC -> TC	04/01/82 - 1986
Oyster Spat Recruitment	Number of Spat Settled onto Plates at Differing Days of Deployment	Number of Spat on Top and Bottom of Plate	2 replicate plates per level at three levels	3, 7, 10, 14 days	1	TC	April 1986 - October 1986
LTER Spartina	sediment temp	degrees Celsius	tempmentor	20 minutes	2 OL,GI	OL, GI	unknown
LTER Decomposition	LTER intersite litterbag decomposition	weight loss of bag contents + animal taxa	decomposition bags	annual	2	OL, GI	1991 - 1995
LTER Ibis Feeding	Number of White Ibis Feeding	Life Stage and Number by Hour in 65 ha plot	Visual Census from Spotting Scope at Clambank Tower	Weekly & Biweekly	1	Bly	6/15/1984 - 7/26/1989
LTER Ibis Feeding	Vegetation Cover	% Coverage by Subtrate in 65 ha feeding plot	Field Inspection; Quadrate Analysis	Weekly & Biweekly	1	Bly	6/15/1984 - 7/26/1989
LTER Ibis Feeding	Substrate Cover	% Coverage by Subtrate in 65 ha feeding plot	Field Inspection; Quadrate Analysis	Weekly & Biweekly	1	Bly	6/15/1984 - 7/26/1989
LTER 48 Hour Zooplankton/Fish Study	Zooplankton	Surface & Bottom Abundance	Stationary boat using 153 micron Nets & centrifical pump	Every Hour for 48 Hours	1	BB	Two studies: June 4-5, 1985 & August 6-8, 1986

USC Baruch and NI-WB NERR Archived and Web Published Databases: Historical Data Needing Rescue, Archival and Web Publication

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning and end Date of data collection
LTER 48 Hour Zooplankton/Fish Study	Motile Epizooplankton	Surface & Bottom Abundance	365 micron mesh Sled towed behind a boat	Every Hour for 48 Hours	1	BB	Two studies: June 4-5, 1985 & August 6-8, 1986
LTER 48 Hour Zooplankton/Fish Study	Zooplanktivorous Fish	Surface & Bottom Abundance	Otter Trawl with 1/4 inch bag liner & Surface Trawl	Every Hour for 48 Hours	1	BB	Two studies: June 4-5, 1985 & August 6-8, 1986
LTER 48 Hour Zooplankton/Fish Study	Water Physicals	Water Temperature, Salinity, Water Velocity & Light Penetration	Salinometer, Marsh McBirney Current Meter, LI-Cor Quantum Sensor	Every Hour for 48 Hours	1	BB	Two studies: June 4-5, 1985 & August 6-8, 1986
LTER 48 Hour Zooplankton/Fish Study	Zooplanktivorous Fish Gut Contents	Zooplankton Species Abundance and Volume in Guts	Dissection and Visual Identifications and measurements via microscope	Every Hour for 48 Hours	1	BB	Two studies: June 4-5, 1985 & August 6-8, 1986
LTER Biweekly Zooplankton/Fish Study	Zooplankton	Surface, Midwater, & Bottom Abundance	Stationary boat using 153 micron Nets	Every 10 to 18 days	1	BB	06/28/1985 - 02/11/1987
LTER Biweekly Zooplankton/Fish Study	Motile Epizooplankton	Epibenthic Abundance	365 micron mesh Sled towed behind a boat	Every 10 to 18 days	1	BB	06/28/1985 - 02/11/1987
LTER Biweekly Zooplankton/Fish Study	Zooplanktivorous Fish	Surface & Bottom Abundance	1/4 inch Surface Trawl & Otter Trawl with 1/4 inch bag liner	Every 10 to 18 days	1	BB	06/28/1985 - 02/11/1987
LTER Biweekly Zooplankton/Fish Study	Water Physicals	Water Temperature, Salinity, Water Velocity & Light Penetration	Salinometer, Marsh McBirney Current Meter, LI-Cor Quantum Sensor	Every 10 to 18 days	1	BB	06/28/1985 - 02/11/1987
LTER Biweekly Zooplankton/Fish Study	Zooplanktivorous Fish Gut Contents	Zooplankton Species Abundance and Volume in Guts	Dissection and Visual Identifications and measurements via microscope	Every 10 to 18 days	1	BB	06/28/1985 - 02/11/1987
Blycreek Ecosystem Flux Study	Marsh Flume, Creek Transect, Oyster Flume, or Marsh Weir Carbon	Total Organic Carbon (TOC), Particulate organic carbon (POC), Dissolved Inorganic carbon (DIC), & Dissolved organic carbon (DOC)	Wet Persulfate Digestion & Oceanographic Carbon Analyzer	Every 10 days	4	BC, MF, OF, MW	04/15/1983 - 06/19/1984

USC Baruch and NI-WB NERR Archived and Web Published Databases: Historical Data Needing Rescue, Archival and Web Publication

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning and end Date of data collection
Blycreek Ecosystem Flux Study	Marsh Flume, Creek Transect, Oyster Flume, or Marsh Weir Suspended Sediments	total solids (TSS) & inorganic sediment (ISS)	combustion at 450 C on glass fiber filters	Every 10 days	4	BC, MF, OF, MW	04/15/1983 - 06/19/1984
Blycreek Ecosystem Flux Study	Marsh Flume, Creek Transect, Oyster Flume, or Marsh Weir Water Parameters	salinity	refractometer	Every 10 days	4	BC, MF, OF, MW	04/15/1983 - 06/19/1984
Blycreek Ecosystem Flux Study	Marsh Flume, Creek Transect, Oyster Flume, or Marsh Weir Chlorophyll a	chlorophyll (CHLa) & Phaeophytin	acetone extraction and fluorometer	Every 10 days	4	BC, MF, OF, MW	04/15/1983 - 06/19/1984
Blycreek Ecosystem Flux Study	Marsh Flume, Creek Transect, Oyster Flume, or Marsh Weir Microbial biomass	Microbial ATP (adenosine 5'-triphospate) nanograms per milliliter	3 -20 ml aliquots from a single 1 liter water sample	Every 10 days	4	BC, MF, OF, MW	04/15/1983 - 06/19/1984
Blycreek Ecosystem Flux Study	Marsh Flume, Creek Transect, Oyster Flume, or Marsh Weir Nutrient Chemistry	nitrate-nitrite (N-N)	colorimetric analysis on technicon autoanalyser	Every 10 days	4	BC, MF, OF, MW	04/15/1983 - 06/19/1984
Blycreek Ecosystem Flux Study	Marsh Flume, Creek Transect, Oyster Flume, or Marsh Weir Nutrient Chemistry	orthophosphate (OP)	colorimetric analysis on technicon autoanalyser	Every 10 days	4	BC, MF, OF, MW	04/15/1983 - 06/19/1984
Blycreek Ecosystem Flux Study	Marsh Flume, Creek Transect, Oyster Flume, or Marsh Weir Nutrient Chemistry	ammonia (NH4)	colorimetric analysis on technicon autoanalyser	Every 10 days	4	BC, MF, OF, MW	04/15/1983 - 06/19/1984
Blycreek Ecosystem Flux Study	Marsh Flume, Creek Transect, Oyster Flume, or Marsh Weir Nutrient Chemistry	total nitrogen whole (TNW) & filtered (TNF)	colorimetric analysis on technicon autoanalyser	Every 10 days	4	BC, MF, OF, MW	04/15/1983 - 06/19/1984
Blycreek Ecosystem Flux Study	Marsh Flume, Creek Transect, Oyster Flume, or Marsh Weir Nutrient Chemistry	total phosphorus whole (TPW) & filtered (TPF)	colorimetric analysis on technicon autoanalyser	Every 10 days	4	BC, MF, OF, MW	04/15/1983 - 06/19/1984
Blycreek Ecosystem Flux Study	Flux Study at Marsh Flume, Oyster Reef, and Creek Transect	All above plus POC, PN, DON, PP, DOP, DO, H20 Discharge with incoming and outgoing tide	See documentation at Field Laboratory or Baruch's website	Half Hourly every 21st tidal cycle	4	BC, MF, OF, MW	04/15/1983 - 06/19/1984

USC Baruch and NI-WB NERR Archived and Web Published Databases:
Historical Data Needing Rescue, Archival and Web Publication

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning and end Date of data collection
Forest Rainfall Chemistry	Rainfall, Throughfall, Stemflow, Litter water, Stream Flow, and Soil water Nutrients	Total Nitrogen	colorimetric analysis on technicon autoanalyser	Every Precipitation/ Storm Event	6	TF, LY, GD, SF, BU, & SR	5/23/82 - 10/09/1992
Forest Rainfall Chemistry	Rainfall, Throughfall, Stemflow, Litter water, Stream Flow, and Soil water Nutrients	Total Phosphorous	colorimetric analysis on technicon autoanalyser	Every Precipitation/ Storm Event	6	TF, LY, GD, SF, BU, & SR	5/23/82 - 10/09/1992
Forest Rainfall Chemistry	Rainfall, Throughfall, Stemflow, Litter water, Stream Flow, and Soil water Nutrients	ammonia (NH4)	colorimetric analysis on technicon autoanalyser	Every Precipitation/ Storm Event	6	TF, LY, GD, SF, BU, & SR	5/23/82 - 10/09/1992
Forest Rainfall Chemistry	Rainfall, Throughfall, Stemflow, Litter water, Stream Flow, and Soil water Nutrients	nitrate-nitrite (N-N)	colorimetric analysis on technicon autoanalyser	Every Precipitation/ Storm Event	6	TF, LY, GD, SF, BU, & SR	5/23/82 - 10/09/1992
Forest Rainfall Chemistry	Rainfall, Throughfall, Stemflow, Litter water, Stream Flow, and Soil water Nutrients	orthophosphate (OP)	colorimetric analysis on technicon autoanalyser	Every Precipitation/ Storm Event	6	TF, LY, GD, SF, BU, & SR	5/23/82 - 10/09/1992
Forest Rainfall Chemistry	Rainfall, Throughfall, Stemflow, Litter water, Stream Flow, and Soil water Nutrients	Sulfate	colorimetric analysis on technicon autoanalyser	Every Precipitation/ Storm Event	6	TF, LY, GD, SF, BU, & SR	5/23/82 - 10/09/1992
Forest Rainfall Chemistry	Rainfall, Throughfall, Stemflow, Litter water, Stream Flow, and Soil water Nutrients	Cations: Chloride, Sodium (Na), Potassium (K), Calcium (Ca) & Magnesium (Mg)	Flame Atomic Adsorption Analysis	Every Precipitation/ Storm Event	6	TF, LY, GD, SF, BU, & SR	5/23/82 - 10/09/1992
Forest Rainfall Chemistry	Rainfall, Throughfall, Stemflow, Litter water, Stream Flow, and Soil water Nutrients	pH	pH meter	Every Precipitation/ Storm Event	6	TF, LY, GD, SF, BU, & SR	5/23/82 - 10/09/1992

USC Baruch and NI-WB NERR Archived and Web Published Databases: Historical Data Needing Rescue, Archival and Web Publication

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning and end Date of data collection
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Motile epibenthic macrozooplankton & Larval fish	Taxa, life stage, length, abundance (per m3)	3 Sequential 365 µm net sled tows, 2 to 30 cm off the creek bottom, tow with the ebbing tide	48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Zooplankton	Taxa, life, stage, abundance (per m3)	2 Sequential Oblique tows, boat moving against current	48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Fish, shrimp, and crab	Taxa, life, stage, abundance	16ft headrope Otter (Shrimp) 1 1/2 in. to 1 1/4 in. Trawl; towed against current along designated tow path & Gill nets	48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Physical parameters collected for Epi and Zpk	Surface & Bottom water temperature	Salinometer	Hourly: 48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Physical parameters collected for Epi and Zpk	Surface & Bottom salinity	Salinometer	Hourly: 48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Physical parameters collected for Epi and Zpk	water velocity	Marsh McBirney Model 201D Portable Water Current meter (m/sec) 50cm Increments: Surface to Bottom	Hourly: 48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Physical parameters collected for Epi and Zpk	vertical visibility	Secchi disk	Hourly: 48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Physical parameters collected for Epi and Zpk	depth at time of zpk	0.25 m increment marked rope	Hourly: 48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Surface & Bottom Nutrient Data	nitrate-nitrite (N-N)	colorimetric analysis on technicon autoanalyser	Hourly: 48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982

USC Baruch and NI-WB NERR Archived and Web Published Databases: Historical Data Needing Rescue, Archival and Web Publication

Core database group name	Core Parameters measured	Variables collected	Collection protocol	Collection Frequency	Number of sites - See map	Site designation code	Beginning and end Date of data collection
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Surface & Bottom Nutrient Data	orthophosphate (OP)	colorimetric analysis on technicon autoanalyser	Hourly: 48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Surface & Bottom Nutrient Data	ammonia (NH4)	colorimetric analysis on technicon autoanalyser	Hourly: 48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Surface & Bottom Nutrient Data	total nitrogen whole (TNW) & filtered (TNF)	colorimetric analysis on technicon autoanalyser	Hourly: 48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Surface & Bottom Nutrient Data	total phosphorus whole (TPW) & filtered (TPF)	colorimetric analysis on technicon autoanalyser	Hourly: 48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Surface & Bottom Carbon Data	Total organic carbon (TOC) & Dissolved organic carbon (DOC)	Beckman 915A TOC analyzer -> after 01/23/1981 Oceanigraphics International TOC analyzer	Hourly: 48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
Estuarine Characterization & Petroleum Impact of Winyah Bay, SC	Surface & Bottom Phytoplankton Pigments	chlorophyll (CHLa) & Phaeophytin	acetone extraction and fluorometer	Hourly: 48 Hr, 3 Week, and 6 weeks	3 -> 14	SJ, NMF, WB -> PR, SR, PD, WR, US, BI, TA, PS, MS, TC, EP, MB, SB, MN	August 1980 - September 1982
CREEK Project: Role of Oyster Reefs	Creek Geomorphology	elevations of marsh surfaces and creeks	Total Station?	Over the course of 6 months?	Four Creeks each in Clambank & Town Creeks	Creek Codes: 1, 2, 3, 4, 5, 6, 7, 8	1997
CREEK Project: Role of Oyster Reefs	Oyster Disease	unknown	unknown	unknown	Four Creeks each in Clambank & Town Creeks	Creek Codes: 1, 2, 3, 4, 5, 6, 7, 8	1997 - 1999
NADP (National Atmospheric Deposition Program)	Precipitation Chemistry	Sulfate, Nitrate, Ammonium, Chloride, Calcium, Magnesium, Potassium, and Sodium, Acidity (pH)	Samples collected with strict clean-handling procedures and sent to Analytical Laboratory for analysis	Weekly	1	OL	01/08/2002

Appendix C

Vascular Plant List for Hobcaw Barony and Adjacent Estuarine Habitats

Vascular Plant List for Hobcaw Barony and Adjacent Estuarine Habitats

Source: John M. Barry. 1966. A Survey of the Native Vascular Plants of the Baruch Plantation. B.S. Honor's Project. University of South Carolina. Edited 1998 by John Baden, Army Corps of Engineers, Wilmington, NC, and Dick Stalter, Dept. Biol. Sciences, St. John's University Taxonomic verifications: Integrated Taxonomic Information System (http://www.itis.gov) by Ginger Ogburn-Matthews, BMFL. 2006.

Species	Common Name	Synonym Name
Pinaceae		
Pinus palustris	longleaf pine	
Pinus taeda	loblolly pine	
Pinus serotina	pond pine, marsh pine, pocosin pine	
Taxodiaceae		
Taxodium distichum	bald or swamp cypress	
Taxodium ascendens	pond cypress	
Cupressaceae		
Juniperus virginiana	red cedar juniper, eastern red cedar	
Juniperus virginiana var. silicicola	coast juniper, southern red cedar, coastal red cedar	
Typhaceae		
Typha angustifolia	narrow-leaf cat-tail	
Typha domingensis	southern cat-tail	
Alismataceae		
Sagittaria lancifolia	bulltongue arrowhead	
Poaceae		
Arundinaria gigantea	giant cane	
Arundo donax	giant reed	
Phragmites australis	common reed	*Phragmites communis*
Distichlis spicata	saltgrass, marsh spikegrass, seashore saltgrass	
Chasmanthium laxum	slender woodoats, spike uniola	*Uniola laxa*
Uniola paniculata	seaoats	
Poa annua	annual blue grass, walk grass	
Melica mutica	onion grass, twoflower melic grass	
Elymus virginicus	Virginia wild rye	
Sphenopholis obtusata	prairie wedge grass, prairie wedgescale	
Aristida Purpurascens var virgata	arrowfeather threeawn	*Aristida virgata*
Sporobolus indicus var. indicus	smutgrass	*Sporobolus poiretii*
Sporobolus virginicus	seashore dropseed	
Cynodon dactylon	Bermuda grass	
Ctenium aromaticum	toothache grass	
Eustachys petraea	pinewoods finger grass	*Chloris petraea*
Setaria magna	giant bristle grass	*Chaetochloa magna*
Setaria parviflora	knot root or marsh bristlegrass	*Setaria geniculata*
Spartina alterniflora	saltmarsh, Atlantic, or smooth cordgrass	
Spartina cynosuroides	big or giant cordgrass	

Species	Common Name	Synonym Name
Poaceae		
Spartina patens	saltmeadow or marsh hay cordgrass	
Phalaris canariensis	common or annual canary grass	
Leersia lenticularis	catchfly grass	*Homalocenchrus lenticularis*
Zizaniopsis miliacea	giant cutgrass	*Zizania miliacea*
Cenchrus tribuloides	sanddune sandbur, sandspur	
Oplismenus hirtellus	shortleaf or bristle basketgrass	*Oplismenus setarius*
Paspalum notatum	Bahia grass	
Paspalum urvillei	Vasey or Vasey's grass	
Paspalum boscianum	bull crown grass	
Paspalum bifidum	pitchfork crown grass	
Paspalum setaceum	fringeleaf, sand, or thin paspalum	
Digitaria sanguinalis	hairy, large, purple, or redhair crab grass	
Digitaria filiformis	slender crab grass	
Digitaria cognata var. cognata	fall witch grass or Carolina crabgrass	*Leptoloma cognatum*
Sacciolepis striata	American cupscale	
Panicum anceps	beaked panic grass or panic grass	
Panicum virgatum	switch grass, old switch panic grass	
Panicum dichotomiflorum	fall panicum or panic grass, western witch grass	
Panicum verrucosum	warty panic grass	
Panicum tenerum	bluejoint panic grass or panicum	
Dichanthelium strigosum var. leucoblepharis	roughhair rosette grass	*Panicum ciliatum*
Dichanthelium aciculare	needleleaf rosette grass	*Panicum angustifolium*
Dichanthelium dichotomum var. dichotomum	cypress panic grass	*P. dichotomum, P. lucidum, P. microcarpon*
Dichanthelium wrightianum	Wright's rosette grass	*Panicum wrightianum*
Dichanthelium acuminatum var. fasciculatum	tapered or western rosette grass, Huachuca panic	*Panicum curtifolium*
Panicum rigidulum var. pubescens	redtop panic grass	*Panicum longifolium*
Dichanthelium sphaerocarpon var. sphaerocarpon	roundseed panic grass or panicum	*Panicum sphaerocarpon*
Dichanthelium scoparium	velvet panicum	*Panicum scoparium*
Saccharum brevibarbe var. contortum	bentawn or sortbeard plume grass	*Erianthus contortus*
Andropogon ternarius	split beard bluestem	
Andropogon virginicus	broom sedge, broomsedge or yellow bluestem	
Andropogon glomeratus	bushy bluestem or broom sedge	
Sorghum halepense	Johnson grass	
Cyperaceae		
Cyperus filicinus	fern flatsedge	*Cypress nuttallii*
Cyperus flavicomus	white-edge flatsedge	*Cyperus albomarginatus*
Cyperus distans	Piedmont flatsedge	
Cyperus esculentus	chufa, chufa flatsedge, yellow nutgrass, yellow nutsedge	
Cyperus compressus	poorland flatsedge	
Cyperus dentatus	toothed flatsedge	
Cyperus pseudovegetus	marsh flatsedge	
Eleocharis quadrangulata	squarestem spikerush or spikesedge	
Eleocharis tuberculosa	cone-cup spikerush	

Species	Common Name	Synonym Name
Cyperaceae		
Eleocharis microcarpa	smallfruit spikerush	
Rhynchospora colorata	starrush whitetop	*Dichromena colorata*
Rhynchospora nitens	shortbeak beaksedge	*Psilocarya nitens*
Bulbostylis capillaris	densetuft hairsedge, threadleaf beakseed	
Schoenoplectus americanus	American, chairmaker's, or Olney bulrush	*Scirpus americanus*
Scirpus robustus	saltmarsh robustus	
Scirpus polyphyllus	leafy bulrush	
Scirpus cyperinus	bulrush, woolgrass	
Scirpus divaricatus	spreading bulrush	
Scirpus pendulus, S. lineatus	drooping, hanging, pendulous, rufous bulrush	*S. fontinalis*
Fuirena pumila	dwarf umbrella sedge	
Rhynchospora tracyi	Tracy's beaksedge	
Rhynchospora corniculata	shortbristle horned beaksedge	
Rhynchospora fascicularis	fascicled beaksedge	
Rhynchospora rariflora	fewflower beaksedge	
Rhynchospora miliacea	millet beaksedge	
Araceae		
Orontium aquaticum	goldenclub	
Peltandra virginica	green arrow arum, Virginia peltandra	
Arisaema triphyllum	Jack-in-the-pulpit, Indian jack in the pulpit	
Lemnaceae		
Lemna perpusilla	minute duckweed	
Wolffiella gladiata	Florida mudmidget	*W. floridana*
Xyridaceae		
Xyris torta	common or slender yelloweyed grass	*X. flexuosa*
Xyris smalliana	Small's yelloweyed grass	
Xyris ambigua	coastal plain yelloweyed grass	
Xyris difformis	bog or southern yelloweyed grass	
Xyris jupicai	Richard's yelloweyed grass	
Xyris caroliniana	Carolina yelloweyed grass	
Eriocaulaceae		
Eriocaulon decangulare	tenangle pipewort	
Eriocaulon compressum	flattened pipewort	
Lachnocaulon minus	Small's bogbutton	
Lachnocaulon anceps	whitehead bogbutton	
Bromeliaceae		
Tillandsia usneoides	Spanish moss	
Pontederiaceae		
Pontederia cordata	pickerelweed	

Species	Common Name	Synonym Name
Juncaceae		
Juncus effusus	common, soft, or lamp rush	
Juncus gymnocarpus	Pennsylvania rush	
Juncus roemerianus	needle rush	
Juncus repens	lesser creeping rush	
Juncus biflorus	bog rush	
Juncus abortivus	annual rush	
Juncus polycephalus	flatleaf or manyhead rush	
Juncus elliottii	Elliott's rush	
Juncus articulatus	jointed rush, jointleaf rush	
Liliaceae		
Asparagus officinalis	asparagus, garden asparagus	
Aletris farinosa	white colicroot	
Hymenocallis floridana	Florida spiderlily	*H. crassifolia*
Smilacaceae		
Smilax pseudochina	bamboo vine	*S. tamnifolia*
Smilax rotundifolia	bullbriar, greenbrier, common catbriar	
Smilax bona-nox	saw greenbrier	
Smilax glauca	cat greenbrier, sawbrier	
Smilax walteri	coral greenbrier	
Agavaceae		
Yucca aloifolia	aloe yucca, Spanish bayonet	
Yucca gloriosa	mound-lily yucca	
Iridaceae		
Iris virginica	Virginia iris, southern blue flag	
Orchidaceae		
Habenaria repens	Water-spider bog orchid	
Platanthera flava var. flava	pale-green orchid	*Habenaria flava*
Platanthera clavellata	small green-wood orchid	*Habenaria clavellata*
Platanthera cristata	crested yellow orchid	*Habenaria cristata*
Salicaceae		
Salix nigra	black willow	
Salix caroliniana	coastal plain or swamp willow	
Myricaceae		
Morella cerifera	wax myrtle	*Myrica cerifera*
Betulaceae		
Alnus serrulata	alder, brook-side or hazel alder	

Species	Common Name	Synonym Name
Fagaceae		
Quercus virginiana	live oak	
Quercus nigra	water oak	
Quercus michauxii	swamp chestnut oak	
Quercus margaretta	sand post oak	
Quercus pagoda	cherrybark or swamp Spanish oak	*Quercus falcata var.pagodifolia*
Quercus laevis	turkey oak	
Quercus laurifolia	laurel oak	
Ulmaceae		
Ulmus americana	American elm	
Urticaceae		
Boehmeria cylindrica	small spike false nettle	
Polygonaceae		
Rumex acetosella	sheep, field, or red sorrel	
Rumex hastatulus	heartwing dock or sorrel	
Polygonum hydropiperoides	swamp smartweed or water pepper	
Polygonum setaceum	bog smartweed	
Polygonum sagittatum	arrowleaf tearthumb or knotweed, arrowvine	
Chenopodiaceae		
Chenopodium album	lambsquarters, white goosefoot	
Atriplex cristata	crested saltbush	*Atriplex arenaria*
Atriplex patula	spear saltbush or saltweed	
Salicornia maritima	slender glasswort	*Salicornia europaea*
Salicornia virginica	Virginia glasswort	
Suaeda linearis	annual seepweed, sea blite	
Amaranthaceae		
Alternanthera philoxeroides	Alligator or pig weed	
Amaranthus cannabinus	tidalmarsh amaranth	
Caryophyllaceae		
Stellaria media	chickweed	
Cerastium glomeratum	sticky chickweed	*Cerastium viscosum*
Nymphaeaceae		
Nymphaea odorata	American or white waterlilly	
Ranunculaceae		
Ranunculus pusillus	low spearwort, weak buttercup	
Magnoliaceae		
Liriodendron tulipifera	tulip tree or popular, yellow popular	
Magnolia virginiana	sweetbay	
Magnolia grandiflora	southern magnolia	

Species	Common Name	Synonym Name
Lauraceae		
Persea borbonia	redbay	
Sassafras albidum	sassafras	
Brassicaceae		
Cardamine pensylvanica	Pennsylvania or Quaker bittercress	
Grossulariaceae		
Itea virginica	Virginia sweetspire	
Hydrangeaceae		
Decumaria barbara	woodvamp or climbing hydrangea	
Hamamelidaceae		
Liquidambar styraciflua	sweet gum	
Rosaceae		
Duchesnea indica	Indian strawberry	
Rubus argutus	sawtooth or prickly Florida blackberry	*Rubus betulifolius*
Rubus hispidus	bristly dewberry	
Rubus trivialis	southern dewberry	
Rosa palustris	swamp rose	
Photinia pyrifolia	red chokeberry	*Sorbus arbutifolia*
Prunus serotina	black cherry, black chokecherry	
Prunus caroliniana	Carolina laurel cherry	
Fabaceae		
Chamaecrista fasciculate var. fasciculata	sleeping plant	*Cassia fasciculata*
Chamaecrista nictitans var. nictitans	partridge pea	*Cassia nictitans*
Crotalaria purshii	Pursh's rattlebox	
Crotalaria rotundifolia	rabbitbells	*Crotalaria angulata*
Crotalaria spectabilis	showy crotalaria or rattlebox	
Desmodium nudiflorum	barestem tickclover, nakedflower ticktrefoil	
Desmodium canescens	hoary tickclover or ticktrefoil	
Glottidium vesicarium	bagpod	
Wisteria frutescens	American wisteria	
Strophostyles helvola	wild bean, fuzzy bean	
Linaceae		
Linum striatum	ridged yellow flax, rigid flax	
Linum virginianum	woodland flax	
Polygalaceae		
Polygala mariana	Maryland milkwort	
Euphorbiaceae		
Triadica sebiferum	chinese tallow-tree	*Sapium sebifera*
Chamaesyce polygonifolia	seaside sandmat or spurge	*Euphorbia polygonifolia*
Chamaesyce maculata	large spurge, spotted sandmat	*Euphorbia maculata*

Species	Common Name	Synonym Name
Anacardiaceae		
Toxicodendron radicans	poison ivy, eastern poison ivy	*Rhus radicans*
Toxicodendron pubescens	poison oak, Atlantic poison oak	*T. toxicodendron*
Rhus copallina	dwarf or winged sumac	
Aquifoliaceae		
Ilex vomitoria	yaupon	
Ilex glabra	inkberry	
Ilex opaca	American holly	
Aceraceae		
Acer rubrum	red maple	
Hippocastanaceae		
Aesculus pavia	red buckeye	
Vitaceae		
Parthenocissus quinquefolia	Virginia creeper, woodbine, fiveleaved ivy	
Vitis rotundifolia	muscadine, muscadine grape	
Vitis aestivalis	summer grape	
Ampelopsis arborea	peppervine	
Tiliaceae		
Tilia americana var. caroliniana	Carolina basswood	*Tilia caroliniana*
Malvaceae		
Hibiscus moscheutos	crimsoneyed rosemallow, swamp rosemallow	
Hibiscus laevis	halberdleaf or scarlet rosemallow	*Hibiscus militaris*
Clusiaceae		
Hypericum galioides	bedstraw St. Johnswort	
Hypericum cistifolium	roundpod St. Johnswort	
Hypericum setosum	hairy St. Johnswort	
Hypericum gymnanthum	claspingleaf St. Johnswort	
Hypericum mutilum	dwarf St. Johnswort	
Hypericum denticulatum	coppery St. Johnswort	
Cistaceae		
Helianthemum corymbosum	pinebarren frostweed	
Lechea maritima	beach pinweed	
Violaceae		
Viola X primulifolia	primrose violet	
Viola lanceolata	lanceleaf violet, bog white violet	
Cactaceae		
Opuntia ficus-indica	prickly pear, Indian fig, tuna cactus	*Opuntia compressa*
Opuntia pusilla	cockspur pricklypear	*Opuntia drummondii*

Species	Common Name	Synonym Name
Lythraceae		
Decodon verticillatus	swamp loosestrife	
Cuphea carthagenensis	Colombian waxweed	
Melastomataceae		
Rhexia petiolata	fringed meadowbeauty	
Rhexia alifanus	savannah meadowbeauty	
Rhexia aristosa	awnpetal meadowbeauty	
Rhexia mariana	Maryland meadowbeauty	
Onagraceae		
Ludwigia leptocarpa	anglestem primrose-willow	
Ludwigia virgata	savannah primrose-willow	
Ludwigia maritima	seaside primrose-willow	
Ludwigia microcarpa	smallfruit primrose-willow	
Ludwigia palustris	marsh primrose-willow	
Oenothera laciniata	cut-leaf evening-primrose	
Oenothera fruticosa	narrowleaf evening-primrose	
Haloragaceae		
Proserpinaca palustris	marsh mermaid-weed	
Proserpinaca pectinata	mermaid-weed	
Myriophyllum aquaticum	parrot feather watermilfoil	*M. brasiliense*
Araliaceae		
Aralia spinosa	devil's walkingstick	
Apiaceae		
Hydrocotyle umbellata	manyflower marsh pennywort, umbrella pennyroyal	
Hydrocotyle verticillata	whorled marsh pennywort, whorled pennyroyal	
Centella asiatica	spadeleaf	
Eryngium integrifolium	blueflower or simple leaf eryngo	
Sium suave	common or hemlock water-parsnip	
Lilaeopsis chinensis	eastern grasswort	
Ptilimnium capillaceum	herbwilliam, threadleaf mockbishopweed	
Ptilimnium macrospermum		
Oxypolis filiformis	water cowbane	
Nyssaceae		
Nyssa sylvatica	black gum or tupelo	
Nyssa biflora	swamp tupelo	
Nyssa aquatica	water tupelo	
Cornaceae		
Cornus foemina	stiff dogwood	*Cornus stricta*
Cornus florida	flowering dogwood	
Clethraceae		
Clethra alnifolia	coastal sweet pepperbush	

Species	Common Name	Synonym Name
Ericaceae		
Zenobia pulverulenta	honeycup	
Lyonia ligustrina	maleberry, he-huckleberry	
Lyonia lucida	fetterbush lyonia	
Lyonia mariana	staggerbush	
Gaylussacia dumosa	dwarf huckleberry	
Vaccinium arboreum	tree sparkleberry, tree-huckleberry	
Vaccinium tenellum	small black blueberry	
Vaccinium corymbosum	blueberry, highbush blueberry	
Vaccinium crassifolium	creeping blueberry	
Primulaceae		
Samolus valerandi ssp. parviflorus	water pimpernel	*Samolus parviflorus*
Plumbaginaceae		
Limonium carolinianum	Carolina sealavender	*Limonium nashii*
Symplocaceae		
Symplocos tinctoria	sweetleaf	
Oleaceae		
Fraxinus americana	American ash; white ash	
Osmanthus americana	devilwood, wild olive	
Loganiaceae		
Gelsemium sempervirens	Carolina or yellow jessamine	
Mitreola petiolata	lax hornpod, miterwort	*Cynoctonum mitreola*
Buddlejaceae		
Polypremum procumbens	juniper leaf	
Gentianaceae		
Sabatia difformis	lanceleaf rose gentian	
Sabatia stellaris	rose of Plymouth, common marsh-pink	
Sabatia calycina	coastal rose gentian	
Sabatia dodecandra	marsh rose gentian	
Menyanthaceae		
Nymphoides aquatica	big floatingheart	
Asclepiadaceae		
Asclepias perennis	aquatic milkweed	
Asclepias lanceolata	fewflower milkweed	
Cynanchum angustifolium	Gulf coast swallowwart	*Cynanchum palustre*
Convolvulaceae		
Ipomoea quamoclit	cypressvine, cypressvine morning glory	
Ipomoea purpurea	common morning glory	
Ipomoea sagittata	saltmarsh morning glory	

Species	Common Name	Synonym Name
Cuscutaceae		
Cuscuta compacta	compact dodder	
Verbenaceae		
Verbena urticifolia	white verbena or vervain	
Phyla nodiflora	sawtooth fogfruit, turkey tangle fogfruit	*Lippia nodiflora*
Phyla lanceolata	frog fruit, lanceleaf fogfruit	*Lippia lanceolata*
Callicarpa americana	American beautyberry	
Lamiaceae		
Teucrium canadense	wood sage; germander	
Hyptis alata	clushered bushmint, bitter mint	
Scutellaria integrifolia	helmet flower, skullcap	
Pycnanthemum muticum	clustered mountainmint	
Solanaceae		
Physalis walteri	Walter's or sand groundcherry	*Physalis viscosa ssp. maritima*
Solanum carolinense	horse nettle; bull nettle, sand briar	
Scrophulariaceae		
Bacopa caroliniana	blue waterhyssop	
Gratiola pilosa	shaggy hedgehyssop, hairy gratiola	
Verbascum thapsus	flannel plant; woolly mullein, velvet plant	
Nuttallanthus canadensis	Canada or oldfield toadflax	*Linaria canadensis*
Veronica arvensis	corn, rock, or wall speedwell	
Seymeria cassioides	yaupon blacksenna	
Agalinis maritima	saltmarsh false foxglove	
Bignoniaceae		
Bignonia capreolata	cross vine	*Anisostichus capreolata*
Campsis radicans	trumpet vine, cow-itch, trumpet creeper	
Lentibulariaceae		
Utricularia subulata	zigzag or wiry bladderwort	
Utricularia purpurea	purple bladderwort	
Utricularia gibba	conespur bladderpod, humped bladderwort	*Utricularia biflora*
Acanthaceae		
Justicia americana	American waterwillow (occurrence questionable)	
Justicia ovata	looseflower waterwillow	
Plantaginaceae		
Plantago lanceolata	English or lanceleaf plantain, ribgrass	
Plantago virginica	Virginia plantain, paleseed Indianwheat	
Rubiaceae		
Cephalanthus occidentalis	common buttonbush	
Diodia virginiana	Virginia buttonweed	
Diodia teres	poorjoe, rough buttonweed	

Species	Common Name	Synonym Name
Rubiaceae		
Mitchella repens	partridgeberry	
Galium pilosum	hairy bedstraw	
Galium obtusum	bluntleaf or bristly bedstraw	
Caprifoliaceae		
Lonicera japonica	Japanese or Chinese honeysuckle	
Campanulaceae		
Lobelia elongata	longleaf lobelia	
Lobelia nuttallii	Nuttall's lobelia	
Asteraceae		
Ambrosia artemisiifolia	ragweed	
Lactuca graminifolia	grassleaf or wild lettuce	
Sonchus oleraceus	common sow thistle	
Hieracium gronovii	Gronovis or leafy hawkweed, queendevil	
Krigia virginica	Virginia dwarf dandelion	
Pyrrhopappus carolinianus	Carolina false dandelion, Carolina desert chicory	
Taraxacum officinale	common dandelion, blowball	
Arnoglossum ovatum	ovateleaf cacalia	*Cacalia lanceolata*
Erechtites hieracifolia	burnweed, fireweed	
Cirsium horridulum var. horridulum	yellow thistle	*Carduus spinosissimus*
Cirsium repandum	sandhill thistle	*Carduus repandus*
Elephantopus tomentosus	hairy elephantfoot, devil's grandmother	
Eupatorium perfoliatum	boneset	
Eupatorium capillifolium	dog fennel	
Eupatorium rotundifolium	roundleaf eupatorium or thoroughwort	
Eupatorium album	white thoroughwort	
Mikania scandens	climbing hempweed or hempvine	
Pluchea rosea	rosy camphorweed	
Pluchea foetida	stinkweed, stinking camphorweed	
Pluchea camphorata	camphorweed	
Pseudognaphalium obtusifolium spp. obtusifolium	rabbit tobacco	*Gnaphalium obtusifolium*
Baccharis angustifolia	saltwater false willow	
Baccharis halimifolia	eastern baccharis	
Erigeron quercifolius	oakleaf fleabane	
Boltonia caroliniana	Carolina doll's daisy	
Sericocarpus linifolius	narrowleaf whitetop aster	*Aster bifoliatus*
Symphyotrichum tenuifolium	perennial saltmarsh aster	*Aster tenuifolius*
Solidago sempervirens	seaside goldenrod	
Euthamia tenuifolia var. tenuifolia	slender goldentop	*Solidago microcephala*
Borrichia frutescens	sea oxeye, bushy sea oxeye, bushy seaside tansy	
Coreopsis gladiata	coastal plain tickseed	
Marshallia graminifolia	grassleaf Barbara's buttons	
Artemisia ludoviciana	gray sagewort, prairie sage, white sagebrush	

Appendix D

Common Invertebrates (>5 mm) in North Inlet, SC

Common Invertebrates (>5 mm) in North Inlet, SC

Keys to the taxonomic abbreviations, habitat designations and relative abundance are provided at the end of the list. Although many other species continue to be encountered (especially with specialized sampling gear and strategies), this list includes species that would most likely be found by observers in the intertidal and shallow tidal areas of this high-salinity estuary. Documentation of the occurrences of most come from Fox and Ruppert (1985) and Ruppert and Fox (1988). Recent additions to their comprehensive lists are documented in unpublished data or digital files. Voucher specimens for many species are located in the preserved sample archives at the Baruch Marine Field Laboratory.

			Season			
Scientific Name	**Common Name**	**Habitat**	**W**	**Sp**	**Su**	**F**
Ph. Porifera - sponges						
Cliona celata		CS, OR	A	A	A	A
Cliona vastifica	yellow boring sponge	CS, OR		C		
Haliclona permollis		CS, OR	A	A	A	A
Haliclona loosanoffi		OR	C	C	C	C
Hymeniacidon heliophila		CS, OR	C	C	C	C
Lissodendoryx isodictyalis		OR	C	C	C	C
Microciona prolifera		OR	C	C	C	C
Ph. Cnidaria						
Cl. Anthozoa - anemones, corals, sea whips						
Aiptasia pallida	pale anemone	OR	A	A	A	A
Astrangia poculata (A. danae)	northern star coral	CS	C	C	C	C
Calliactis tricolor	hermit anemone	PB		C		C
Ceriantheopsis americanus	tube anemone	PB	C	C	C	
Haloclava producta	white burrowing anemone	PB	C	C	C	
Leptogorgia virgulata	sea whip	CS	A	A	A	A
Paranthus rapiformis	white burrowing anemone	PB	C	C	C	C
Renilla reniformis	sea pansy	CS, PB	A	A	A	A
Cl. Hydrozoa - Hydroids						
Hydractinia echinata	snail fur	PS			C	
Obelia dichotoma	sea thread hydroid	CS	C	C		
Plumularia floridana		CS			C	
Schizotricha tenella		OR		C	C	C
Tubularia crocea		PS	A			A
Bougainvillia carolinensis		TC		A	A	
Nemopsis bachei		TC		C	C	
Turritopsis nutricula		TC		C	C	
Cl. Scyphozoa						
Stomolophus melagris	cannonball jellyfish	TC		C	A	C
Chrysaora quinquecirrha	sea nettle	TC			C	
Aurelia aurita	moon jelly	TC			C	C
Cl. Cubozoa						
Chiropsalmus quadrumanus	box jelly	TC			C	C

Scientific Name	Common Name	Habitat	Season W	Sp	Su	F
Ph. Ctenophora - comb jellies						
Mnemiopsis leidyi	warty comb jelly	CS	C	C	C	C
Beroe ovata		TC			C	C
Ph. Hemichordata - acorn worms						
Balanoglossus aurantiacus	golden acorn worm	PB	C	C	C	C
Saccoglossus kowalevskii	helical acorn worm	PB	A	A	A	A
Ph. Chordata						
sPh. Tunicata- tunicates, sea squirts						
Molgula manhattensis	sea grapes	CS, PS	A	A	A	A
Ph. Echinodermata						
Cl. Ophiuroidea - brittle stars, basket stars						
Hemipholis elongata	blood brittle star	PB	C	C	C	
Micropholis atra	burrowing brittle stars	PB	C	C	C	C
Micropholis gracillima		PB	C	C	C	C
Ophiophragmus wurdemanii		PB	C	C	C	
Ophiothrix angulata	spiny or angular brittle star	CS, OR	A	A	A	A
Cl. Echinoidea - sea urchins, sea biscuits & sand dollars						
Mellita quinquiesperforata	sand dollar	CS, PB	A	A	A	A
Cl. Holothuroidea - sea cucumbers						
Leptosynapta tenuis	white synapta	PB	C	C	C	C
Pentamera pulcherrima		CS		A		
Thyonella gemmata	green sea cucumber	CS, PB				
Ph. Chaetognatha - arrow worms						
Parasagitta tenuis		CS	A	A	A	A
Flaccisagitta enflata		CS	A	A	A	A
Ferosagitta hispida		CS	A	A	A	A
Sagitta bipunctata		TC		C	C	C
Ph. Phoronida - phoronids						
Phoronis architecta		PB	C	C		C
Ph. Ectoprocta - bryozoans, moss animals						
Aeverrillia setigera		CS	C	C	C	C
Amathia distans	bushy bryozoans	CS	C	C	C	C
Bowerbankia gracilis		OR, CS	C	C	C	C
Bugula neritina	bushy bryozoans	CS	C	C	C	C
Electra monostachys		CS		C		
Membranipora tenuis	white crust	CS	C	C	C	C
Parasmittina nitida		CS	C	C	C	C
Schizoporella unicornis	orange crust	CS		C	C	
Zoobotryon verticillatum	bushy bryozoans	CS				C

Scientific Name	Common Name	Habitat	Season W	Sp	Su	F
Ph. Entoprocta - kamptozoans						
Barentsia laxa		CS, OR		C	C	
Pedicellina cernua		CS		C		
Ph. Mollusca - chitons, snails, squids, octopods						
Cl. Gastropoda - snails, sea slugs, gastropods						
sCl. Prosobranchia - snails						
Astyris lunata	lunar dove snail	CS	A		A	A
Busycon carica	knobbed whelk	PB	C	C	C	C
Cerithiopsis emersoni	awl miniature cerith	CS, OR	C	C	C	C
Cerithiopsis greeni	Greens miniature cerith	CS	C			C
Crepidula plana	eastern white slipper snail	CS, PB		C	C	
Fasciolaria (lilium) hunteria	banded tulip	PB		C	C	
Hydrobiidae sp A, B & C	hydrobiids	SM	C		C	C
Littorina irrorata	marsh periwinkle	SM	C	C	C	C
Melampus bidentatus	common marsh snail; eastern melampus	SM	C	C	C	C
Nassarius obsoletus (Ilyanassa)	eastern mud snail	PB, SM	A	A	A	A
Polinices duplicatus	Atlantic moon snail	PB	C	C	C	C
Simnialena uniplicata	single-toothed simnia	CS	C	C	C	C
Terebra dislocata	eastern or Atlantic auger	PB	C	C	C	C
Urosalpinx cinerea	Atlantic oyster drill	CS, OR	A	A	C	A
Buscycon spiratum	fig whelk	TC			C	
O. Heterostropha						
Boonea impressa	oyster mosquito	OR	A	A		A
Turbonilla sp. cf *T. holmesi*	name status unclarified	CS	C			
sCl. Opisthobranchia - sea slugs, sea hares, bubble shells						
O. Nudibranchia - nudibranchs						
Aplysia brasilian	sooty sea hare	TC		C		
Armina tigrina	striped sea slug; tiger armina	PB	A	A	A	A
Ancula evelinae		CS			C	C
Berghia coerulescens (verrucicornis)	anemone sea slug	OR	C			C
Cratena pilata		PS	C			C
Doridella obscura	obscure corambe	CS			C	C
Doriopsilla pharpa	lemon drop sea slug	CS, OR	A	A	A	A
Polycera hummi		CS		C		
Tritonia bayeri		CS	C		C	
Cl. Cephalopoda - squids octopods						
Lolliguncula brevis	Atlantic brief squid	CS		C	C	C
Octopus vulgaris	common octopus	TC	C	C	C	C
Cl. Bivalvia - clams, mussels, oysters						
Aligena elevata	eastern aligena	PB	C	C	C	
Brachidontes exustus	scorched mussle	PS, OR	A	A	A	A
Chione cancellata	cross-barred venus	CS	A	A	A	A
Crassostrea virginica	eastern oyster	OR,PS,SM,CS	A	A	A	A
Diplothyra smithii	Smiths or oyster piddock	CS		C		

Scientific Name	Common Name	Habitat	Season W	Sp	Su	F
Cl. Bivalvia - clams, mussels, oysters (continued)						
Donax variabilis	coquina; variable coquina	OB	C	C	C	C
Gemma gemma	gem clam; amethyst gem clam	SM				C
Geukensia demissa	Atlantic ribbed mussle	SM	C	C	C	C
Ensis directus	razor clam	PB	C	C	C	
Lepton sp		PB	C			
Macoma tenta	elongate macoma	PB	C	C	C	
Mercenaria mercenaria	northern quahog	PB, CS, OR	A	A	A	A
Mulinia lateralis	dwarf surf clam	PB	C	C	C	C
Musculus lateralis	lateral mussel	PS		C		
Ostrea equestris	horse or crested oyster	CS		C		
Petricola pholadiformis	false angel wing	PS		A		
Solen viridis	slender razor clam; green jackknife clam	PB		C	C	
Tagelus divisus	divided sand clam; purplish tagelus	PB	C	C	C	C
Tagelus plebeius	common sand clam; stout tagelus	PB	A	A	A	A
Tellina texana	Texas or say tellin	PB	C	C	C	C
Ph. Nemertea- proboscis or ribbon worms						
Amphiporus ochraceus		CS	C	C	C	C
Carcinonemertes carcinophila		PB		C		
Carinoma tremaphoros		PB	C	C	C	C
Carinomella lactea		PB	C	C	C	C
Lineus bicolor		PS		C	C	
Lineus socialis		PS		C		
Nemertopsis bivittata	species name non-existent in itis	PS		C		C
Zygonemertes virescens		CS	C	C	C	C
Zygeupolia rubens		OB		C		C
Ph. Platyhelminthes - flatworms						
Bdelloura candida		PB		C		
Plagiostomum sp.		PS			A	
Stylochus ellipticus		PS, CS	C	C	C	C
Ph. Annelida - segmented worms						
Cl. Polychaeta - paddle-footed annelids						
F. Capitellidae						
Capitella capitata		SM	C		C	C
Heteromastus filiformis		PB, SM	A	A	A	A
Notomastus hemipodus		PB		C	C	C
Notomastus latericeus		PB		C	C	C
Notomastus lobatus		PB	C	C	C	C
F. Chaetopteridae						
Chaetopterus variopedatus	parchment tube worm	PB	C	C	C	C
Spiochaetopterus oculatus	cellophane tube worm	PB	C	C	C	C
F. Cirratulidae						
Caulleriella killariensis		PB	C			C

Scientific Name	Common Name	Habitat	Season W	Sp	Su	F
F. Cirratulidae						
Caulleriella killariensis		PB	C			C
Tharyx setigera		PB		C		
F. Dorvilleidae						
Dorvillea sociabilis	millipede worm	OR	C	C		C
F. Eunicidae						
Lysidice ninetta		OR	C	C		
Marphysa sanguinea	rockworm	OR, CS	C	C	C	C
F. Glyceridae - blood worms						
Glycera americana		PB, SM	C	C	C	C
Glycera dibranchiata	bloodworm	PB	A	A	A	A
F. Hesionidae						
Podarke obscura	swift-footed worm	CS, OR	C	C	C	C
F. Lumbrineridae						
Lumbrineris impatiens		OB	C	C	C	C
F. Magelonidae						
Magelona papillicornis		PB	C	C		C
Magelona phyllisae	shovel headed worm	PB		C		
F. Maldanidae - bamboo worms						
Axiothella mucosa		PB		C	C	
Branchioasychis americana		SM		C		C
Clymenella torquata		PB	C	C	C	C
F. Nephtyidae - shimmy worms						
Nephtys bucera		PB	C			C
Nephtys picta		PB	C	C	C	C
F. Nereididae						
Laeonereis culveri		SM	C	C	C	C
Nereis falsa		CS, PS, OR	C	C	C	C
Neanthes succinea (Nereis)		OR, PS, SM	C	C	C	C
F. Oenonidae	Arabellidae					
Arabella iricolor	opalworm	PB	C	C	C	C
Drilonereis magna	threadworm	PB	A	A	A	A
F. Opheliidae						
Armandia maculata		CS	C			C
F. Onuphidae						
Diopatra cuprea	plumed worm	PB	A	A	A	A
Kinbergonuphis jenneri	genus name not recognized by itis; soda straw worm	PB	A	A	A	A

Scientific Name	Common Name	Habitat	Season W	Sp	Su	F
F. Orbiniidae						
Haploscoloplos fragilis		PB, SM	C	C	C	C
Haploscoloplos robustus		PB	C	C	C	C
Scoloplos rubra		PB		C	C	C
F. Oweniidae						
Owenia fusiformis	shingle tube worm	PB	C	C	C	C
F. Pectinariidae (Amphictenidae) - ice cream cone worms						
Pectinaria gouldi (Cistenides)	ice cream cone worm	PB	C	C	C	C
F. Phyllodocidae						
Nereiphylla fragilis (Phyllodoce)	green oyster worm	OR	A	A	A	A
F. Paraonidae						
Aricidea fragilis	unicorn worm	PB	C	C	C	C
F. Polynoidae - scaleworms						
Lepidasthenia commensalis (Lepidametria)		OR, PS	C	C	C	C
Lepidasthenia varius		PB	C	C	C	C
Lepidonotus sublevis		CS	C	C	C	C
F. Sabellidae - feather duster worms						
Demonax microphthalmus		CS	C	C	C	C
Fabricia sabella		CS	C	C		C
Manayunkia aestuarina		SM			C	
Notaulax nudicollis	name not found in itis	OR, CS	C	C	C	C
F. Serpulidae - feather duster worms						
Hydroides dianthus		OR, CS	A	A	A	A
F. Spionidae - palp worms						
Dispio uncinata		OB		C	C	C
Polydora colonia		CS, OB	C			C
Polydora ligni		OR		C		
Polydora websteri		OR	C	C	C	
Marenzellaeria viridis (Scolecolepides)		PB	C			C
Minuspio cirrifera (Prionospio)		CS, OB	C			
Scolelepis squamata		OB	A	A	A	A
Spio multioculata		PB	C	C	C	C
Spio setosa		PB	C	C		C
Spiophanes bombyx		PB		C	C	C
Streblospio benedicti		SM	C		C	C
F. Syllidae						
Autolytus fasciata (Proceraea)		CS	C		C	C
Brania clavata		CS, OR	C	C	C	C
Eusyllis lamelligera		CS, OR	C	C	C	C
Exogone dispar		CS	C	C	C	C

Scientific Name	Common Name	Habitat	Season W	Sp	Su	F
F. Syllidae (continued)						
Odontosyllis fulgurans		CS	C	C	C	C
Syllis gracilis		CS		C		
F. Terebellidae - spaghetti worms						
Amphitrite ornata		CS		C		
Loimia medusa		CS		C	C	
Pista palmata		CS	C	C	C	C
Polycirrus eximius		CS, OR	C	C	C	C
Terebella rubra		OR	C	C	C	C
Thelepus setosus		CS, OR	C	C	C	C
Cl. Oligochaeta						
Oligochaeta sp.		SM	C			C
Ph. Arthropoda - crustaceans, insects and chelicerates						
sPh. Chelicerata - horseshoe crabs, sea spiders, mites						
Cl. Merostomata - horseshoe crabs						
Limulus polyphemus	horseshoe crab	PB		C		
Cl. Pycnogonida - sea spiders						
Anoplodactylus lentus	black sea spider	CS		A		A
Callipallene brevirostris		OR				C
Tanystylum orbiculare		CS	C	C	C	C
sPh. Crustacea - crustaceans						
Cl. Cirripedia - barnacles						
Balanus eburneus	ivory barnacle	OR	C	C	C	C
Balanus improvisus		OR, CS	C	C	C	C
Balanus venustus		CS	C	C		C
Chthamalus fragilis	fragile barnacle	PS, SM	A	A	A	A
Conopea galeata	seawhip barnacle	CS	C	C	C	C
Cl. Malacostraca						
O. Stomatopoda - mantis shrimps						
Squilla empusa	mantis shrimp	PB	C	C		C
O. Tanaidacea						
Hargeria rapax		SM	C			C
O. Decapoda - lobsters, shrimp, crabs						
Arenaeus cribrarius	speckled swimming crab	OB			C	C
Armases cinereum (Sesarma)	wharf crab	SM	C	C	C	C
Austinixa cristata (Pinnixa)	cristate pea crab	OB		C	C	
Callinectes sapidus	blue crab	CS, PB	A	A	A	A
Callinectes similis	lesser blue crab	PB			C	
Callinectes ornatus	shelligs crab	PB			C	
Clibanarius vittatus	thinstripe hermit crab	CS, PB		C	C	
Dissodactylus mellitae	sand dollar pea crab	PB	C		C	
Dyspanopeus sayi (Neopanope)	Say mud crab	PS	C	C		C
Emerita talpoida	Atlantic sand crab	OB	C	C	C	C

Scientific Name	Common Name	Habitat	Season W	Sp	Su	F
O. Decapoda - lobsters, shrimp, crabs (continued)						
Euytium limosum	broadbacked mud crab	TC SM	C	C	C	C
Eurypanopeus depressus	flatback mud crab	OR	A	A	A	A
Hepates epheliticus	calico box crab	TC		C		
Libinia dubia	longnose spider crab	CS, PB		C	C	
Libinia emarginata	portly spider crab	CS		C	C	
Metaporhaphis calcarata	hairy arrow crab	CS		C	C	
Menippe mercenaria	Florida stone crab	CS, PB	C			
Ocypode quadrata	Atlantic ghost crab	OB		C	C	C
Ovalipes ocellatus	lady crab; ocellate lady crab	OB, CS		C		
Pagurus longicarpus	long-armed hermit crab	PB, CS	A	A	A	A
Pagurus pollicaris	flatclaw hermit crab	PB, CS		C	C	C
Panopeus herbstii	oyster or Atlantic mud crab	CS, OR	C	C	C	C
Petrolisthes armatus	invasive porcellanid	TC	A	A	A	A
Pinnixa chaetopterana	tube pea crab	PB	C	C	C	C
Polyonyx gibbesi	eastern tube crab	PB		C		
Portunus gibbesii	iridescent swimming crab	CS		C	C	C
Portunus sayi	Sargassum crab	CS			C	
Portunus spinimanus	blotched swimming crab	CS		C	C	
Sesarma reticulatum	marsh crab	TC SM	C	C	C	C
Uca pugilator	Atlantic sand fiddler	SM, PB	A	A	A	A
Uca pugnax	Atlantic marsh fiddler	SM	A	A		A
Zaops ostreum (Pinnotheres)	oyster pea crab	OR	C	C	C	
sO. Natantia - shrimps						
Acetes americanus carolinae		TC		C	C	C
Alpheus heterochaelis	bigclaw snapping shrimp	SM, CS	C			C
Alpheus normanni	green snapping shrimp	CS	A	A		A
Biffarius biformis (Callianassa)	biform ghost shrimp	PB	C	C	C	C
Callichirus major (Callianassa)	Carolinian ghost shrimp	OB	C	C	C	C
Latreutes parvulus		CS			C	
Lucifer faxoni		TC		C	C	
Lysmata wurdemanni	peppermint shrimp	CS			C	
Neopontonides beaufortensis		SC		A	A	
Palaemonetes pugio	daggerblade grass shrimp	SM, CS	A	C		A
Palaemonetes vulgaris	marsh grass shrimp	CS, OR	A	A	A	A
Farfantepenaeus aztecus	brown shrimp	CS		C	C	C
Farfantenaeus duorarum	pink shrimp	CS	C	C		C
Litopenaeus setiferus	white shrimp	CS		C	C	C
Cuapetes americanus	was Periclimenes longicaudatus	CS		C	C	C
Sicyonia dorsalis	rock shrimp	CS, PB			C	
Rimapenaeus constrictus	roughneck shrimp	CS		C	C	C
Upogebia affinis	coastal mud shrimp	PB	C	C	C	C
O. Mysida - opposum shrimp						
Chlamydopleon dissimile	was Bowmaniella floridana	OB		C	C	C
Metamysidopsis swifti		OB			A	
Neomysis americana		CS	C	A	C	C
Americamysis bigelowi		TC		C	C	
Americamysis bahia		TC		C	C	

Scientific Name	Common Name	Habitat	Season W	Sp	Su	F
O. Mysida - opposum shrimp (continued)						
Promysis atlantica		TC		C	C	
Heteromysis formosa		TC		C	C	
Brasilomysis castroi		TC		C	C	
O. Cumacea - cumaceans						
Cyclaspis pustulata		OB			C	
Oxyurostylis smithi		CS	C	C		C
Spilocuma watlingi		OB			C	
O. Isopoda - isopods, pillbugs						
Livoneca redmanii	was Aegathoa oculata	CS	C	C	C	
Ancinus depressus		OB	C		C	C
Sphaeroma quadridentatum		TC			C	
Edotia triloba/montosa		TC		C	C	C
O. Amphipoda - amphipods						
sO.Gammaridea - gammarid amphipods						
F. Ampeliscidae						
Ampelisca verrilli		PB	A	A	A	A
F. Ampithoidae						
Cymadusa compta		CS		C		
F. Aoridae						
Lembos smithi		CS	C	C	C	C
Lembos sp.		CS	C	C	C	C
F. Bateidae						
Batea catharinensis		CS	C	C	C	C
F. Corophiidae						
Corophium acherusicum		CS	C	C	C	C
F. Colomastigidae						
Colomastix halichondriae		CS	C		C	C
F. Liljeborgiidae						
Listriella clymenellae		PB		C	C	
F. Gammaridae						
Gammarus palustris		SM	C	C		C
Gammarus mucronatus		PS		C		
F. Haustoriidae						
Haustorius canadensis		OB	C	C	C	C
Neohaustorius biarticulatus		OB	C		C	C
Neohaustorius schmitzi		OB		C	C	
Parahaustorius longimerus		OB		C	C	C
Protohaustorius deichmannae		OB			C	
Pseudohaustorius caroliniensis		PB	C	C	C	C

Scientific Name	Common Name	Habitat	Season W	Sp	Su	F
F. Ischyroceridae						
Cerapus tubularis		CS			C	C
Ericthonius brasiliensis		CS	C	C	C	C
F. Melitidae						
Dulichiella appendiculata		CS	C		C	C
Melita nitida		CS, OR	C	C	C	C
F. Photidae						
Microprotopus shoemakeri		CS				C
F. Phoxocephalidae						
Eobrolgus spinosus		CS	C	C	C	C
F. Pontoporeiidae						
Bathyporeia parkeri		OB			C	
F. Stenothoidae						
Stenothoe georgiana		PS, CS	C	C	C	C
Stenothoe minuta		PS			C	
F. Talitridae - beach hoppers						
Orchestia grillus		SM	C	C	C	C
Orchestia sp A		SM	C		C	C
sO. Caprellidea - skeleton shrimp						
Caprella equilibra		CS	C	C	C	C
Caprella penantis		PS		C		
Paracaprella tenuis		CS	C	C	C	C

Table Key

Taxanomic code abbreviations

Ph. = phylum
sPh.= subphylum
Cl. = class
sCl. = subclass
O. = order
sO. = suborder
F. = family

Seasonal abundance abbreviations

W = winter
Sp = spring
Su = summer
F = fall

A = Abundantly observed
C = Commonly observed
blank space = present in NI, but not abundantly or commonly observed

Habitat types and interpretation

OB = Outer Beaches - intertidal sand and high energy surf zone
PB = Protected Beaches - low energy intertidal sand and mud flats
SM = Salt Marsh - vegetated region of estuary with Spartina and Juncus
CS = Creeks and Sounds - subtidal areas which are always inundated with water
OR = Oyster Reefs - intertidal and subtidal oyster shell and growths of oysters
PS = Pilings and Seawalls - vertical structure in the subtidal and intertidal zones
TC = Post R&S additions from DM Allen, most occurring in/near Town Creek, North Inlet

If the listing of the habitat types are not in alphabetical order: this indicates that the first habitat in the list had the greater abundance of the animal or the animal occurred over more seasons than the following habitat.

Appendix E

Cartilaginous and Bony Fishes Collected in North Inlet and Winyah Bay Estuaries, Georgetown, SC 1978-2014

Cartilaginous and Bony Fishes Collected in North Inlet and Winyah Bay Estuaries, Georgetown, SC 1978-2014

Life stages observed in North Inlet are: L = larvae, J = juveniles, A = adults.
Sources for North Inlet records are: Ogburn et al., 1988; Allen and Barker, 1990; and subsequent catches.
Sources for Winyah Bay are: CCU = Abel et al., 2007; MRRI = Wenner et al., 1981; CEIP = Allen et al., 1982; and p= personal observations by DM Allen.
Common names are those designated by the American Fisheries Society.
Check **www.baruch.sc.edu** for species updates.

		North Inlet			Winyah
Scientific Name	**Common Name**	**L**	**J**	**A**	**Bay**
Carcharhinidae - requiem sharks					
Carcharhinus isodon	finetooth shark			A	CCU
Carcharhinus acronotus	blacknose shark		J	A	CCU
Carcharhinus brevipinna	spinner shark				CCU
Carcharhinus leucas	bull shark		J	A	CCU
Carcharhinus limbatus	blacktip shark		J	A	CCU
Carcharhinus plumbeus	sandbar shark		J	A	CCU
Carcharhinus obscurus	dusky shark		J		
Ginglymostomacirratum	nurse shark				CCU
Negaprion brevirostris	lemon shark		J	A	CCU
Rhizoprionodon terraenovae	Atlantic sharpnose shark		J	A	CCU
Squalidae - dogfish sharks					
Mustelus canis	smooth dogfish			A	CCU
Squalus acanthias	spiny dogfish			A	
Sphyrnidae - hammerhead sharks					
Sphyrna lewini or S. gilberti	scalloped hammerhead		J	A	CCU
Sphyrna tiburo	bonnethead		J	A	CCU
Rajidae - rays or skates					
Raja eglanteria	clearnose skate			A	MRRI
Dasyatidae - stingrays					
Dasyatis americana	southern stingray			A	CEIP
Dasyatis centroura	roughtail stingray			A	CEIP
Dasyatis sabina	Atlantic stingray		J	A	CEIP, MRRI
Dasyatis say	bluntnose stingray			A	p
Gymnuridae - butterfly rays					
Gymnura micrura	smooth butterfly ray		J	A	p
Myliobatidae - eagle rays					
Aetobatus narinari	spotted eagle ray		J		CCU
Rhinoptera bonasus	cownose ray		J	A	CEIP

Scientific Name	Common Name	North Inlet L	North Inlet J	North Inlet A	Winyah Bay
Acipenseridae - sturgeons					
Acipenser oxyrinchus	Atlantic sturgeon		J		MRRI
Acipenser brevirostrum	shortnose sturgeon				MRRI
Lepisosteidae - gars					
Lepisosteus osseus	longnose gar		J	A	CEIP, MRRI
Elopidae - ladyfishes and tarpons					
Elops saurus	ladyfish	L	J	A	CEIP
Megalops atlanticus	tarpon	L	J	A	CEIP
Albulidae - bonefishes					
Albula vulpes	bonefish		J		
Anguillidae - freshwater eels					
Anguilla rostrata	American eel		J	A	CEIP, MRRI
Muraenidae - moray eels					
Gymnothorax nigromarginatus	blackedge moray		J		
Ophichthidae - worm and snake eels					
Bascanichthys sp.	eel		J		CEIP
Myrophis punctatus	speckled worm eel	L	J	A	CEIP, MRRI
Ophichthus gomesii	shrimp eel		J	A	CEIP
Congridae - conger eels					
Conger oceanicus	conger eel		J		
Ariosoma balearicum	bandtooth conger				MRRI
Clupeidae - herrings, shads, menhadens, and sardines					
Alosa aestivalis	blueback herring		J		CEIP, MRRI
Alosa mediocris	hickory shad		J		
Alosa sapidissima	American shad		J	A	MRRI
Brevoortia tyrannus	Atlantic menhaden	L	J	A	CEIP, MRRI
Dorosoma cepedianum	gizzard shad		J		CEIP, MRRI
Dorosoma petenense	threadfin shad		J		CEIP, MRRI
Opisthonema oglinum	Atlantic thread herring		J		
Sardinella aurita	Spanish sardine		J		
Engraulidae (syn. Engraulididae) - anchovies					
Anchoa hepsetus	striped anchovy	L	J	A	CEIP, MRRI
Anchoa mitchilli	bay anchovy	L	J	A	CEIP, MRRI
Cyprinidae - carps and minnows					
Cyprinus carpio	common carp				MRRI
Synodontidae - lizardfishes					
Synodus foetens	inshore lizardfish		J	A	CEIP
Ariidae - sea catfishes					
Ariopsis (Arius) felis	hardhead catfish		J	A	CEIP, MRRI
Bagre marinus	gafftopsail catfish			A	CEIP, MRRI

Scientific Name	Common Name	North Inlet L	North Inlet J	North Inlet A	Winyah Bay
Ictaluridae - freshwater and bullhead catfishes					
Ameiurus natalis	yellow bullhead		J	A	
Ameiurus (Ictalurus) catus	white or bullhead catfish				MRRI
Ameiurus (Ictalurus) platycephalus	flat bullhead				MRRI
Ameiurus (Ictalurus) nebulosus	brown bullhead				MRRI
Ictalurus punctatus	channel catfish				MRRI
Ictalurus furcatus	blue catfish				DNR
Gobiesocidae - clingfishes					
Gobiesox strumosus	skilletfish	L	J	A	CEIP, MRRI
Batrachoididae - toadfishes					
Porichthys plectrodon	Atlantic midshipman			A	
Opsanus tau	oyster toadfish		J	A	CEIP, MRRI
Antennariidae - frogfishes					
Antennarius ocellatus	ocellated frogfish			A	
Histrio histrio	sargassumfish		J		
Gadidae - codfishes					
Urophycis floridana	southern hake		J	A	CEIP, MRRI
Urophycis regia	spotted hake		J	A	CEIP, MRRI
Ophidiidae - cusk-eels					
Ophidion marginatum	striped cusk-eel		J	A	CEIP, MRRI
Hemiramphidae - halfbeaks					
Hyporhamphus unifasciatus	silverstripe halfbeak		J		
Belonidae - needlefishes					
Strongylura marina	Atlantic needlefish		J	A	p
Tylosurus crocodilus	houndfish		J		
Cyprinodontidae - killifishes and pupfishes					
Cyprinodon variegatus	sheepshead minnow		J	A	CEIP
Fundulidae - killifishes and topminnows					
Fundulus confluentus	marsh killifish		J	A	
Fundulus heteroclitus	mummichog	L	J	A	CEIP
Fundulus luciae	spotfin killifish		J	A	
Fundulus majalis	striped killifish	L	J	A	
Lucania parva	rainwater killifish		J	A	
Poeciliidae - livebearers					
Gambusia affinis	western mosquitofish		J	A	p
Poecilia latipinna	sailfin molly		J	A	p
Atherinopsidae - new world silversides					
Membras martinica	rough silverside		J	A	CEIP
Menidia beryllina	inland or tidewater silverside		J	A	
Menidia menidia	Atlantic silverside	L	J	A	CEIP

Scientific Name	Common Name	North Inlet L	North Inlet J	North Inlet A	Winyah Bay
Fistulariidae - cornetfishes					
Fistularia tabacaria	bluespotted cornetfish		J		
Syngnathidae - pipefishes and seahorses					
Hippocampus erectus	lined seahorse		J	A	
Syngnathus floridae	dusky pipefish		J	A	CEIP
Syngnathus fuscus	northern pipefish		J	A	CEIP, MRRI
Syngnathus louisianae	chain pipefish		J	A	CEIP
Dactylopteridae - flying gurnards					
Dactylopterus volitans	flying gurnard		J		
Scorpaenidae - scorpionfishes					
Scorpaena brasiliensis	barbfish		J	A	
Scorpaena calcarata	smoothhead scorpionfish				MRRI
Centropomidae - snooks					
Centropomus undecimalis	common snook		J		
Moronidae - temperate basses					
Morone americana	white perch		J	A	MRRI
Morone chrysops	white bass				MRRI
Morone saxatilis	striped bass		J	A	MRRI
Serranidae - sea basses and groupers					
Centropristis philadelphica	rock sea bass		J	A	CEIP, MRRI
Centropristis striata	black sea bass		J	A	MRRI
Diplectrum formosum	sand perch		J		
Epinephelus morio	red grouper		J		
Mycteroperca bonaci	black grouper		J		
Mycteroperca phenax	scamp		J		
Mycteroperca microlepis	gag	L	J		CEIP
Rypticus maculatus	whitespotted soapfish		J		
Centrarchidae - sunfishes					
Centrarchus maculatus	flier		J		
Chaenobryttus (Lepomis) gulosus	warmouth				MRRI
Lepomis auritus	redbreast sunfish				MRRI
Lepomis microlophus	redear sunfish				MRRI
Lepomis punctatus	spotted sunfish				MRRI
Micropterus salmoides	largemouth bass				MRRI
Priacanthidae - bigeyes					
Pristigenys alta	short bigeye		J		
Pomatomidae - bluefishes					
Pomatomus saltatrix	bluefish		J	A	CEIP, MRRI
Rachycentridae - cobias					
Rachycentron canadum	cobia		J		CEIP

Scientific Name	Common Name	North Inlet L	North Inlet J	North Inlet A	Winyah Bay
Echeneidae (Echeneididae) - remoras					
Remora remora	remora		J		
Echeneis naucrates	sharksucker		J		
Carangidae - jacks and pompanos					
Caranx hippos	crevalle jack		J	A	CEIP
Caranx latus	horse-eye jack		J	A	
Chloroscombrus chrysurus	Atlantic bumper	L	J	A	CEIP, MRRI
Selene vomer	lookdown		J	A	CEIP, MRRI
Trachinotus carolinus	Florida pompano		J		
Trachinotus falcatus	permit		J		
Oligoplites saurus	leatherjacket		J		
Lutjanidae - snappers					
Lutjanus analis	mutton snapper		J		
Lutjanus apodus	schoolmaster		J		
Lutjanus griseus	gray snapper		J		CEIP, MRRI
Lutjanus synagris	lane snapper		J		
Lobotidae - tripletails					
Lobotes surinamensis	tripletail		J		p
Gerreidae - mojarras					
Diapterus auratus	Irish pompano		J		CEIP
Eucinostomus argenteus	spotfin mojarra	L	J		CEIP
Eucinostomus gula	silver jenny	L	J		CEIP
Haemulidae - grunts					
Haemulon plumieri	white grunt		J		
Orthopristis chrysoptera	pigfish	L	J	A	CEIP
Sparidae - porgies					
Archosargus probatocephalus	sheepshead	L	J	A	CEIP, MRRI
Diplodus holbrookii	spottail pinfish		J		
Lagodon rhomboides	pinfish	L	J	A	CEIP, MRRI
Pagrus pagrus	red porgy		J		
Kyphodsidae - sea chubs,rudderfishes					
Kyphosus sp.	Bermuda or yellow chub		J		
Sciaenidae - drums and croakers					
Bairdiella chrysoura	silver perch	L	J	A	CEIP, MRRI
Cynoscion nebulosus	spotted seatrout	L	J	A	CEIP, MRRI
Cynoscion arenarius	sand seatrout		J		
Cynoscion regalis	weakfish	L	J	A	CEIP, MRRI
Larimus fasciatus	banded drum	L	J	A	MRRI
Leiostomus xanthurus	spot	L	J	A	CEIP, MRRI
Menticirrhus americanus	southern kingfish	L	J	A	CEIP, MRRI

Scientific Name	Common Name	North Inlet L	North Inlet J	North Inlet A	Winyah Bay
Sciaenidae - drums and croakers (continued)					
Menticirrhus littoralis	Gulf kingfish				CEIP
Menticirrhus saxatilis	northern kingfish	L	J		CEIP
Micropogonias undulatus	Atlantic croaker	L	J	A	CEIP, MRRI
Pogonias cromis	black drum	L	J		CEIP, MRRI
Sciaenops ocellatus	red drum	L	J	A	CEIP, MRRI
Stellifer lanceolatus	star drum	L	J		CEIP, MRRI
Ephippidae (Ephippididae) - spadefishes					
Chaetodipterus faber	Atlantic spadefish	L	J		CEIP, MRRI
Chaetodontidae - butterflyfishes					
Chaetodon ocellatus	spotfin butterflyfish		J		
Pomacanthidae - Angelfishes					
Pomacanthus paru	French angelfish		J		
Pomacentridae - damselfishes					
Abudefduf saxatilis	sergeant major		J		
Mugilidae - mullets					
Mugil cephalus	striped mullet		J	A	CEIP, MRRI
Mugil curema	white mullet		J	A	CEIP
Sphyraenidae - barracudas					
Sphyraena barracuda	great barracuda		J		
Sphyraena borealis	northen sennet		J		
Labridae - wrasses					
Tautoga onitis	tautog		J		
Uranoscopidae - stargazers					
Astroscopus guttatus	northern stargazer		J	A	
Astroscopus y-graecum	southern stargazer		J	A	MRRI
Blenniidae - combtooth blennies					
Chasmodes bosquianus	striped blenny	L	J	A	CEIP
Hypleurochilus geminatus	crested blenny	L	J	A	
Hypsoblennius hentz	feather blenny	L	J	A	CEIP, MRRI
Hypsoblennius ionthas	freckled blenny		J	A	MRRI
Eleotridae (Eleotrididae) - sleepers					
Dormitator maculatus	fat sleeper		J	A	
Elotris pisonis	spinycheek sleeper		J	A	
Gobiidae - gobies					
Ctenogobius boleosoma	darter goby	L	J	A	CEIP
Ctenogobius shufeldti	freshwater goby	L	J	A	CEIP, MRRI
Evorthodus lyricus	lyre goby	L	J	A	
Gobionellus oceanicus	highfin or sharptail goby	L	J	A	CEIP
Gobiosoma bosc	naked goby	L	J	A	CEIP
Gobiosoma ginsburgi	seaboard goby	L	J	A	CEIP

Scientific Name	Common Name	North Inlet L	North Inlet J	North Inlet A	Winyah Bay
Gobiidae - gobies (continued)					
Microgobius gulosus	clown goby	L	J	A	CEIP
Microgobius thalassinus	green goby	L	J	A	CEIP
Microdesmidae - wormfishes					
Microdesmus longipinnis	pink wormfish			A	
Trichiuridae - ribbonfishes and cutlassfishes					
Trichiurus lepturus	Atlantic cutlassfish		J	A	p
Scombridae - mackerels, tunas, albacores, and bonitos					
Scomberomorus cavalla	king mackerel			A	
Scomberomorus maculatus	Spanish mackerel		J	A	CEIP
Stromateidae - butterfishes, harvestfishes, and rudderfishes					
Peprilus paru	harvestfish	L	J		CEIP, MRRI
Peprilus triacanthus	butterfish		J		CEIP, MRRI
Triglidae - searobins					
Prionotus carolinus	northern searobin	L	J		MRRI
Prionotus evolans	striped searobin	L	J		MRRI
Prionotus scitulus	leopard searobin		J	A	MRRI
Prionotus tribulus	bighead searobin	L	J	A	CEIP, MRRI
Paralichthyidae - lefteye flounders and sand flounders					
Ancylopsetta ommata	ocellated flounder	L	J	A	CEIP, MRRI
Citharichthys macrops	spotted whiff	L	J	A	
Citharichthys spilopterus	bay whiff	L	J	A	CEIP, MRRI
Etropus crossotus	fringed flounder	L	J	A	CEIP, MRRI
Etropus cyclosquamus	shelf flounder		J		
Etropus rimosus	gray flounder				
Hippoglossina oblonga	four spot flounder		J	A	
Paralichthys albigutta	Gulf flounder	L	J	A	
Paralichthys dentatus	summer flounder	L	J	A	CEIP, MRRI
Paralichthys lethostigma	southern flounder	L	J	A	CEIP, MRRI
Scophthalmidae - turbots					
Scophthalmus aquosus	windowpane	L	J	A	MRRI
Cynoglossidae - tonguefishes					
Symphurus civitatium	offshore tonguefish		J	A	
Symphurus plagiusa	blackcheek tonguefish	L	J	A	CEIP, MRRI
Achiridae - American and scrawled soles					
Trinectes maculatus	hogchoker	L	J	A	CEIP, MRRI
Monacanthidae - filefishes					
Aluterus schoepfii	orange filefish		J		
Stephanolepis hispidus	planehead filefish	L	J	A	CEIP, MRRI

Scientific Name	Common Name	North Inlet L	North Inlet J	North Inlet A	Winyah Bay
Diodontidae - burrfishes and porcupinefishes					
Chilomycterus schoepfii	striped burrfish		J	A	MRRI
Tetraodontidae - blowfishes, rabbitfishes, and puffers					
Lagocephalus laevigatus	smooth puffer		J	A	
Sphoeroides maculatus	northern puffer		J	A	CEIP
Sphoeroides spengleri	bandtail puffer		J		

Appendix F

Amphibian and Reptile List for Hobcaw Barony and Adjacent Estuarine Habitats

Amphibian and Reptile List for Hobcaw Barony and Adjacent Estuarine Habitats

Scientific Name	Common Name
CLASS: AMPHIBIA - Amphibians	
Sirenidae - Sirens	
Siren lacertina	Greater Siren
Salamandridae - Newts & Salamanders	
Notophthalmus viridescens	Eastern Newt
Amphiumidae - Amphiuma	
Amphiuma means	Two-Toed Amphiuma
Ambystomatidae - Mole Salamanders	
Ambystoma cingulatum	Flatwoods Salamander
Ambystoma mabeei	Mabee's salamander
Ambystoma opacum	Marbled Salamander
Plethodontidae - Lungless Salamanders	
[1]*Desmognathus auriculatus*	Southern Dusky Salamander
[1]*Eurycea cirrigera*	Southern Two-lined Salamander
Eurycea quadridigitata	Dwarf Salamander
Pseudotriton montanus	Mud Salamander
Scaphiopodidae - Spadefoots	
Scaphiopus holbrookii	Eastern Spadefoot
Bufonidae - Toads	
Bufo quercicus	Oak Toad
Bufo terrestris	Southern Toad
Hylidae - Tree Frogs	
Acris gryllus	Southern Cricket Frog
Hyla chrysoscelis	Cope's Gray Treefrog
Hyla cinerea	Green Treefrog
Hyla femoralis	Pine Woods Treefrog
Hyla gratiosa	Barking Treefrog
Hyla squirella	Squirrel Treefrog
Pseudacris crucifer	Spring Peeper
Pseudacris ocularis	Little Grass Frog
Ranidae - True Frogs	
Rana catesbeiana	American Bullfrog
Rana clamitans	Green Frog
Rana grylio	Pig Frog
Rana palustris	Pickerel Frog
Rana sphenocephala	Southern Leopard Frog

Scientific Name	Common Name
Microhylidae - Narrow-mouthed Toads	
Gastrophryne carolinensis	Eastern Narrow-mouthed Toad
CLASS: REPTILIA - Reptiles	
Alligatoridae - Alligators & Caimans	
Alligator mississippiensis	American Alligator
Chelydridae - Snapping Turtles	
Chelydra serpentina	Snapping Turtle
Kinosternidae - Mud & Musk Turtles	
Kinosternon baurii	Striped Mud Turtle
Kinosternon subrubrum	Eastern Mud Turtle
Sternotherus odoratus	Common Musk Turtle
Emydidae - Pond Turtles & Terrapins	
Trachemys scripta	Common Slider
Clemmys guttata	Spotted Turtle
Deirochelys reticularia	Chicken Turtle
Terrapene carolina	Eastern Box Turtle
Malaclemys terrapin	Diamondback Terrapin
Trionychidae - Softshell Turtles	
Apalone spinifera	Spiny Softshell
Cheloniidae - Marine Turtles	
Caretta caretta	Loggerhead
Chelonia mydas	Green Sea Turtle
Polychrotidae - Anoloid Lizards	
Anolis carolinensis	Green Anole
Phrynosomatidae - North American Spiny Lizards	
Sceloporus undulatus	Eastern Fence Lizard
Scincidae - Skinks	
Eumeces fasciatus	Five-lined Skink
Eumeces inexpectatus	Southeastern Five-lined Skink
Eumeces laticeps	Broad-head Skink
Scincella lateralis	Ground Skink
Teiidae - Ground Lizards, Racerunners & Whiptails	
[2]*Aspidoceles sexlineatus*	Six-Lined Racerunner
Anguidae - Alligator & Glass Lizards	
Ophisaurus ventralis	Eastern Glass Lizard
Colubridae - Typical Snakes	
Carphophis amoenus	Eastern Worm Snake
Cemophora coccinea	Scarlet Snake
Coluber constrictor	Racer

Scientific Name	Common Name
Colubridae - Typical Snakes (continued)	
Coluber constrictor priapus	Southern Black Racer
Diadophis punctatus	Ringneck Snake
Elaphe guttata	Corn Snake
Elaphe obsoleta	Rat Snake
Farancia abacura	Mud Snake
Farancia erytrogramma	Rainbow Snake
Heterodon platirhinos	Eastern Hog-nose Snake
Heterodon simus	Southern Hog-nose Snake
Lampropeltis getula getula	Eastern Kingsnake
Lampropeltis triangulum elapsoides	Scarlet Kingsnake
Masticophis flagellum flagellum	Eastern Coachwhip
Nerodia erythrogaster erythrogaster	Redbelly Water Snake
Nerodia fasciata confluens	Broad-banded Water Snake
Nerodia taxispilota	Brown Water Snake
Opheodrys aestivus	Rough Green Snake
Rhadinaea flavilata	Pine Woods Snake
Storeria dekayi	Brown Snake
Storeria occipitomaculata	Redbelly Snake
Tantilla coronata	Southeastern Crowned Snake
Thamnophis sauritus	Eastern Ribbon Snake
Thamnophis sirtalis	Common Garter Snake
Virginia valeriae	Smooth Earth Snake
Elapidae - Cobras & Coral Snakes	
Micrurus fulvius	Northern Coral Snake
Viperidae - (Pit) Vipers	
Agkistrodon contortrix contortrix	Southern Copperhead
Agkistrodon piscivorus piscivorus	Eastern Cottonmouth
[3]*Crotalus horridus (atricaudatus)*	Timber Rattlesnake (Canebrake)
[4]*Crotalus adamanteus*	Eastern Diamondback Rattlesnake
Sistrurus miliarius miliarius	Carolina Pigmy Rattlesnake

[1] These individuals were observed & collected in 1965

[2] Original genus *Cnemidophorus* changed to *Aspidoceles*.

[3] Subspecies is not recognized by the Integrated Taxonomic Information System

Appendix G

Mammal List for Hobcaw Barony and Adjacent Estuarine Habitats

Mammal List for Hobcaw Barony and Adjacent Estuarine Habitats

Scientific Name	Common Name
Didelphidae	
Didelphis virginiana	Virginia Opossum
Soricidae	
Sorex longirostris	Southeastern Shrew
Blarina carolinensis	Southern Short-Tailed Shrew
Cryptotis parva	Least Shrew, Little Short-Tailed Shrew
Talpidae	
Scalopus aquaticus	Eastern Mole
Condylura cristata	Star-nosed Mole
Vespertilionidae	
Eptesicus fuscus	Big Brown Bat
Lasionycteris noctivagans	Silver-Haired Bat
Pipistrellus subflavus	Eastern Pipistrelle
Lasiurus borealis	Red Bat
Lasiurus seminolus	Seminole Bat
Lasiurus cinereus	Hoary Bat
Nycticeius humeralis	Evening Bat
Plecotus rafinesquii	Rafinesque's Big-Eared Bat
Molossidae	
Tadarida brasiliensis	Brazilian Free-Tailed Bat
Leporidae	
Sylvilagus palustris	Marsh Rabbit
Sylvilagus floridanus	Eastern Cottontail
Sciuridae	
Sciurus carolinensis	Gray Squirrel
Sciurus niger	Eastern Fox Squirrel
Glaucomys volans	Southern Flying Squirrel
Castoridae	
Castor canadensis	American Beaver
Cricetidae	
Oryzomys palustris	Marsh Rice Rat
Peromyscus gossypinus	Cotton Mouse
Sigmodon hispidus	Cotton Rat
Neotoma floridana	Eastern Woodrat
Reithrodontomys humulis	Eastern Harvest Mouse
Ochrotomys nuttalli	Golden Mouse
Microtus pennsylvanicus	Meadow Vole

Scientific Name	Common Name
Muridae	
Rattus rattus	Black Rat
Rattus norvegicus	Norway Rat
Mus musculus	House Mouse
Canidae	
Canis latrans	Coyote
Urocyon cinereoargenteus	Gray Fox
Vulpes vulpes	Red Fox
Ursidae	
Ursus americanus	Black Bear
Procyonidae	
Procyon lotor	Raccoon
Mustelidae	
Mustela frenata	Long-tailed weasel
Mustela vison	Mink
Mephitis mephitis	Striped skunk
Lontra (Lutra) canadensis	River Otter
Felidae	
Lynx (Felis) rufus	Bobcat
Delphinidae	
Tursiops truncatus	Bottle-Nosed Dolphin
Trichechidae	
Trichechus manatus	West Indian Manatee
Suidae	
Sus scrofa	Wild boar, Feral Pig
Cervidae	
Odocoileus virginianus	White-Tailed Deer

Appendix H

Bird Species Observed in North Inlet-Winyah Bay Area

Bird Species Observed in North Inlet-Winyah Bay Area

Common name	Scientific name
Snow Goose	*Chen caerulescens*
Brant	*Branta bernicla*
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
Gadwall	*Anas strepera*
Eurasian Wigeon	*Anas penelope*
American Wigeon	*Anas americana*
American Black Duck	*Anas rubripes*
Mallard	*Anas platyrhynchos*
Mottled Duck	*Anas fulvigula*
Blue-winged Teal	*Anas discors*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Northern Pintail	*Anas acuta*
Green-winged Teal	*Anas crecca*
Canvasback	*Aythya valisineria*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Common Eider	*Somateria mollissima*
Surf Scoter	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Black Scoter	*Melanitta americana*
Long-tailed Duck	*Clangula hyemalis*
Bufflehead	*Bucephala albeola*
Common Goldeneye	*Bucephala clangula*
Hooded Merganser	*Lophodytes cucullatus*
Red-breasted Merganser	*Mergus serrator*
Ruddy Duck	*Oxyura jamaicensis*
Northern Bobwhite	*Colinus virginianus*
Wild Turkey	*Meleagris gallopavo*
Red-throated Loon	*Gavia stellata*
Common Loon	*Gavia immer*
Pied-billed Grebe	*Podilymbus podiceps*
Horned Grebe	*Podiceps auritus*
Eared Grebe	*Podiceps nigricollis*
Great Shearwater	*Puffinus gravis*
Wilson's Storm-Petrel	*Oceanites oceanicus*
Wood Stork	*Mycteria americana*
Magnificent Frigatebird	*Fregata magnificens*
Northern Gannet	*Morus bassanus*
Double-crested Cormorant	*Phalacrocorax auritus*
Great Cormorant	*Phalacrocorax carbo*

Common name	Scientific name
Anhinga	*Anhinga anhinga*
American White Pelican	*Pelecanus erythrorhynchos*
Brown Pelican	*Pelecanus occidentalis*
American Bittern	*Botaurus lentiginosus*
Least Bittern	*Ixobrychus exilis*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Snowy Egret	*Egretta thula*
Little Blue Heron	*Egretta caerulea*
Tricolored Heron	*Egretta tricolor*
Reddish Egret	*Egretta rufescens*
Cattle Egret	*Bubulcus ibis*
Green Heron	*Butorides virescens*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Yellow-crowned Night-Heron	*Nyctanassa violacea*
White Ibis	*Eudocimus albus*
Glossy Ibis	*Plegadis falcinellus*
Roseate Spoonbill	*Platalea ajaja*
Black Vulture	*Coragyps atratus*
Turkey Vulture	*Cathartes aura*
Osprey	*Pandion haliaetus*
Swallow-tailed Kite	*Elanoides forficatus*
Mississippi Kite	*Ictinia mississippiensis*
Bald Eagle	*Haliaeetus leucocephalus*
Northern Harrier	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Red-shouldered Hawk	*Buteo lineatus*
Broad-winged Hawk	*Buteo platypterus*
Red-tailed Hawk	*Buteo jamaicensis*
Golden Eagle	*Aquila chrysaetos*
Yellow Rail	*Coturnicops noveboracensis*
Black Rail	*Laterallus jamaicensis*
Clapper Rail	*Rallus longirostris*
King Rail	*Rallus elegans*
Virginia Rail	*Rallus limicola*
Sora	*Porzana carolina*
Common Gallinule	*Gallinula galeata*
American Coot	*Fulica americana*
Black-bellied Plover	*Pluvialis squatarola*
American Golden-Plover	*Pluvialis dominica*
Snowy Plover	*Charadrius nivosus*
Wilson's Plover	*Charadrius wilsonia*
Semipalmated Plover	*Charadrius semipalmatus*
Piping Plover	*Charadrius melodus*
Killdeer	*Charadrius vociferus*
American Oystercatcher	*Haematopus palliatus*
Black-necked Stilt	*Himantopus mexicanus*

Common name	Scientific name
American Avocet	*Recurvirostra americana*
Spotted Sandpiper	*Actitis macularius*
Solitary Sandpiper	*Tringa solitaria*
Greater Yellowlegs	*Tringa melanoleuca*
Willet	*Tringa semipalmata*
Lesser Yellowlegs	*Tringa flavipes*
Upland Sandpiper	*Bartramia longicauda*
Whimbrel	*Numenius phaeopus*
Long-billed Curlew	*Numenius americanus*
Marbled Godwit	*Limosa fedoa*
Ruddy Turnstone	*Arenaria interpres*
Red Knot	*Calidris canutus*
Sanderling	*Calidris alba*
Semipalmated Sandpiper	*Calidris pusilla*
Western Sandpiper	*Calidris mauri*
Least Sandpiper	*Calidris minutilla*
White-rumped Sandpiper	*Calidris fuscicollis*
Baird's Sandpiper	*Calidris bairdii*
Pectoral Sandpiper	*Calidris melanotos*
Purple Sandpiper	*Calidris maritima*
Dunlin	*Calidris alpina*
Stilt Sandpiper	*Calidris himantopus*
Buff-breasted Sandpiper	*Tryngites subruficollis*
Ruff	*Philomachus pugnax*
Short-billed Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Wilson's Snipe	*Gallinago delicata*
American Woodcock	*Scolopax minor*
Wilson's Phalarope	*Phalaropus tricolor*
Red-necked Phalarope	*Phalaropus lobatus*
Red Phalarope	*Phalaropus fulicarius*
Sabine's Gull	*Xema sabini*
Bonaparte's Gull	*Chroicocephalus philadelphia*
Laughing Gull	*Leucophaeus atricilla*
Ring-billed Gull	*Larus delawarensis*
Herring Gull	*Larus argentatus*
Great Black-backed Gull	*Larus marinus*
Least Tern	*Sternula antillarum*
Gull-billed Tern	*Gelochelidon nilotica*
Caspian Tern	*Hydroprogne caspia*
Black Tern	*Chlidonias niger*
Common Tern	*Sterna hirundo*
Forster's Tern	*Sterna forsteri*
Royal Tern	*Thalasseus maximus*
Sandwich Tern	*Thalasseus sandvicensis*
Black Skimmer	*Rynchops niger*
Razorbill	*Alca torda*
Rock Pigeon	*Columba livia*

Common name	Scientific name
Eurasian Collared-Dove	*Streptopelia decaocto*
Mourning Dove	*Zenaida macroura*
Common Ground-Dove	*Columbina passerina*
Yellow-billed Cuckoo	*Coccyzus americanus*
Barn Owl	*Tyto alba*
Eastern Screech-Owl	*Megascops asio*
Great Horned Owl	*Bubo virginianus*
Barred Owl	*Strix varia*
Short-eared Owl	*Asio flammeus*
Northern Saw-whet Owl	*Aegolius acadicus*
Common Nighthawk	*Chordeiles minor*
Chuck-will's-widow	*Antrostomus carolinensis*
Eastern Whip-poor-will	*Antrostomus vociferus*
Chimney Swift	*Chaetura pelagica*
Ruby-throated Hummingbird	*Archilochus colubris*
Rufous Hummingbird	*Selasphorus rufus*
Belted Kingfisher	*Megaceryle alcyon*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-bellied Woodpecker	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Red-cockaded Woodpecker	*Picoides borealis*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
American Kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
Eastern Wood-Pewee	*Contopus virens*
Acadian Flycatcher	*Empidonax virescens*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Gray Kingbird	*Tyrannus dominicensis*
Scissor-tailed Flycatcher	*Tyrannus forficatus*
Loggerhead Shrike	*Lanius ludovicianus*
White-eyed Vireo	*Vireo griseus*
Yellow-throated Vireo	*Vireo flavifrons*
Blue-headed Vireo	*Vireo solitarius*
Red-eyed Vireo	*Vireo olivaceus*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Fish Crow	*Corvus ossifragus*
Purple Martin	*Progne subis*
Tree Swallow	*Tachycineta bicolor*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Bank Swallow	*Riparia riparia*

Common name	Scientific name
Cave Swallow	*Petrochelidon fulva*
Barn Swallow	*Hirundo rustica*
Carolina Chickadee	*Poecile carolinensis*
Tufted Titmouse	*Baeolophus bicolor*
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
Brown-headed Nuthatch	*Sitta pusilla*
Brown Creeper	*Certhia americana*
House Wren	*Troglodytes aedon*
Winter Wren	*Troglodytes hiemalis*
Sedge Wren	*Cistothorus platensis*
Marsh Wren	*Cistothorus palustris*
Carolina Wren	*Thryothorus ludovicianus*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Eastern Bluebird	*Sialia sialis*
Swainson's Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttatus*
Wood Thrush	*Hylocichla mustelina*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Northern Mockingbird	*Mimus polyglottos*
Brown Thrasher	*Toxostoma rufum*
European Starling	*Sturnus vulgaris*
American Pipit	*Anthus rubescens*
Cedar Waxwing	*Bombycilla cedrorum*
Ovenbird	*Seiurus aurocapilla*
Worm-eating Warbler	*Helmitheros vermivorum*
Louisiana Waterthrush	*Parkesia motacilla*
Northern Waterthrush	*Parkesia noveboracensis*
Black-and-white Warbler	*Mniotilta varia*
Prothonotary Warbler	*Protonotaria citrea*
Swainson's Warbler	*Limnothlypis swainsonii*
Orange-crowned Warbler	*Oreothlypis celata*
Kentucky Warbler	*Geothlypis formosa*
Common Yellowthroat	*Geothlypis trichas*
Hooded Warbler	*Setophaga citrina*
American Redstart	*Setophaga ruticilla*
Cape May Warbler	*Setophaga tigrina*
Northern Parula	*Setophaga americana*
Bay-breasted Warbler	*Setophaga castanea*
Yellow Warbler	*Setophaga petechia*
Blackpoll Warbler	*Setophaga striata*
Black-throated Blue Warbler	*Setophaga caerulescens*
Palm Warbler	*Setophaga palmarum*
Pine Warbler	*Setophaga pinus*
Yellow-rumped Warbler	*Setophaga coronata*

Common name	Scientific name
Yellow-throated Warbler	*Setophaga dominica*
Prairie Warbler	*Setophaga discolor*
Black-throated Green Warbler	*Setophaga virens*
Yellow-breasted Chat	*Icteria virens*
Eastern Towhee	*Pipilo erythrophthalmus*
Bachman's Sparrow	*Peucaea aestivalis*
Chipping Sparrow	*Spizella passerina*
Clay-colored Sparrow	*Spizella pallida*
Savannah Sparrow	*Passerculus sandwichensis*
Nelson's Sparrow	*Ammodramus nelsoni*
Saltmarsh Sparrow	*Ammodramus caudacutus*
Seaside Sparrow	*Ammodramus maritimus*
Fox Sparrow	*Passerella iliaca*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
White-crowned Sparrow	*Zonotrichia leucophrys*
Dark-eyed Junco	*Junco hyemalis*
Summer Tanager	*Piranga rubra*
Scarlet Tanager	*Piranga olivacea*
Northern Cardinal	*Cardinalis cardinalis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Blue Grosbeak	*Passerina caerulea*
Indigo Bunting	*Passerina cyanea*
Painted Bunting	*Passerina ciris*
Bobolink	*Dolichonyx oryzivorus*
Red-winged Blackbird	*Agelaius phoeniceus*
Eastern Meadowlark	*Sturnella magna*
Rusty Blackbird	*Euphagus carolinus*
Common Grackle	*Quiscalus quiscula*
Boat-tailed Grackle	*Quiscalus major*
Brown-headed Cowbird	*Molothrus ater*
Orchard Oriole	*Icterus spurius*
Baltimore Oriole	*Icterus galbula*
Purple Finch	*Haemorhous purpureus*
House Finch	*Haemorhous mexicanus*
Pine Siskin	*Spinus pinus*
American Goldfinch	*Spinus tristis*
Evening Grosbeak	*Coccothraustes vespertinus*
House Sparrow	*Passer domesticus*

Total species: 276

Appendix I

Species List and State Records of Insects Collected from Hobcaw Barony, South Carolina

Species List and State Records of Insects Collected from Hobcaw Barony, South Carolina*

University of Guelph Field Entomology Class, Spring of 2004.
Gard Otis, Instructor; Steve Paiero, Assistant Instructor

ORDER	FAMILY	Genus/Species
Coleoptera	Buprestidae	*Acmaeodera*
Coleoptera	Buprestidae	*Brachys*
Coleoptera	Buprestidae	*Buprestis salisburyensis* Herbst, 1801
Coleoptera	Buprestidae	*Haplanthaxia*
Coleoptera	Buprestidae	*Haplanthaxia quercata* (Fabricius)
Coleoptera	Buprestidae	*Taphrocerus*
Coleoptera	Carabidae	*Calybe sallei* (Chev.)
Coleoptera	Carabidae	*Panagaeus crucigerus* Say
Coleoptera	Elateridae	*Alaus myops* (Fabricius)
Coleoptera	Elateridae	*Cardiophorus*
Coleoptera	Elateridae	*Melanotus*
Coleoptera	Eucnemidae	*Dirrhagofarsus lewisi* Reitter
Coleoptera	Monommidae	*Hyporhagus*
Coleoptera	Oedemeridae	*Xanthochroa erythrocephala* (Germar)
Coleoptera	Scarabaeidae	*Canthon laevis* (Drury)
Coleoptera	Scarabaeidae	*Melanocanthon bispinatus* (Robinson)
Coleoptera	Trogossitidae	*Tenebroides bimaculata* Melsheimer
Dermaptera	Labiidae	*Labia*
Dermaptera	Labiidae	*Labia cf. curvicauda* (Motschulsky)
Dermaptera	Labiidae	*Vostox brunneipennis* (Audinet-Serville, 1839)
Diptera	Asilidae	*Laphria saffrana*
Diptera	Chloropidae	*Ectecephala*
Diptera	Lauxaniidae	*Trigonometopus*
Diptera	Micropezidae	*Grallipeza nebulosa* (Loew)
Diptera	Micropezidae	*Taeniaptera*
Diptera	Otitidae	*Chaetopsis*
Diptera	Otitidae	*Delphinia picta* (Fabricius)
Diptera	Otitidae	*Euxesta*
Diptera	Otitidae	*Zacompsia fulva* Coquillett
Diptera	Psilidae	*Loxocera cylindrica* Say, 1823
Diptera	Pyrgotidae	*Boreothrinax*
Diptera	Syrphidae	*Milesia virginiensis* (Drury)

ORDER	FAMILY	Genus/Species
Hemiptera	Achilidae	*Epiptera*
Hemiptera	Aradidae	*Mezira*
Hemiptera	Aradidae	*Proxius gypsatus* Bergroth
Hemiptera	Belostomatidae	*Abedus immaculatus* (Say)
Hemiptera	Belostomatidae	*Lethocerus uhleri* (Montandon)
Hemiptera	Berytidae	*Jalysus*
Hemiptera	Caliscelidae	*Bruchomorpha oculata* Newman
Hemiptera	Cercopidae	*Aphrophora*
Hemiptera	Cercopidae	*Clastoptera*
Hemiptera	Cicadellidae	*Draeculacephala*
Hemiptera	Cicadellidae	*Gyponana*
Hemiptera	Cicadellidae	*Homalodisca*
Hemiptera	Cicadellidae	*Norvellina*
Hemiptera	Cicadellidae	*Oncometopia*
Hemiptera	Cicadellidae	*Osbornellus*
Hemiptera	Cicadellidae	*Penthimia americana* Fitch
Hemiptera	Cicadellidae	*Ponana*
Hemiptera	Cicadellidae	*Scaphytopius*
Hemiptera	Cicadellidae	*Texananus*
Hemiptera	Cicadellidae	*Tylozygus bifidus* (Say)
Hemiptera	Cixiidae	*Oecleus*
Hemiptera	Cixiidae	*Oliarus*
Hemiptera	Cixiidae	*Pintalia delicata* (Fowler)
Hemiptera	Coreidae	*Althos obscurator* (Fabricius)
Hemiptera	Coreidae	*Euthochtha galeator* (Fabricius)
Hemiptera	Coreidae	*Leptoglossus phyllopus* (Linnaeus)
Hemiptera	Cydnidae	*Amnestus spinifrons* (Say)
Hemiptera	Cydnidae	*Pangaeus bilineatus* (Say)
Hemiptera	Cymidae	*Cymus*
Hemiptera	Delphacidae	*Delphacodes*
Hemiptera	Delphacidae	*Pissonotus aphidioides* VanDuzee
Hemiptera	Derbidae	*Cedusa*
Hemiptera	Derbidae	*Otiocerus degeeri* Kirby
Hemiptera	Derbidae	*Otiocerus stolli* Kirby
Hemiptera	Flatidae	*Anormenis septentrionalis* (Spinola)
Hemiptera	Flatidae	*Cyarda melichari* Van Duzee
Hemiptera	Gelastocoridae	*Gelastocoris oculatus* (Fabricius)

ORDER	FAMILY	Genus/Species
Hemiptera	Geocoridae	*Geocoris uliginosus* (Say)
Hemiptera	Hydrometridae	*Hydrometra*
Hemiptera	Largidae	*Largus succinctus* (Linnaeus)
Hemiptera	Lyctocoridae	*Lyctocoris stali* (Reuter)
Hemiptera	Membracidae	*Archasia auriculata* (Fitch)
Hemiptera	Membracidae	*Archasia pallida* (Fairmaire)
Hemiptera	Membracidae	*Ceresa*
Hemiptera	Membracidae	*Cyrtolobus*
Hemiptera	Membracidae	*Glossonotus*
Hemiptera	Membracidae	*Micrutalis calva* (Say)
Hemiptera	Membracidae	*Ophiderma*
Hemiptera	Membracidae	*Platycotis vittata* (Fabricius)
Hemiptera	Membracidae	*Smilia camelus* (Fabricius)
Hemiptera	Membracidae	*Telamona*
Hemiptera	Membracidae	*Tylopelta americana* (Goding)
Hemiptera	Mesoveliidae	*Mesovelia mulsanti* White
Hemiptera	Miridae	*Corticoris*
Hemiptera	Miridae	*Poecilocapsus lineatus* (Fabricius)
Hemiptera	Miridae	*Pseudoxenetus regalis* (Uhler)
Hemiptera	Miridae	*Sixeonotus*
Hemiptera	Miridae	unidentified Miridae
Hemiptera	Pachygronthidae	*Oedancala*
Hemiptera	Pentatomidae	*Banasa dimidiata* (Say)
Hemiptera	Pentatomidae	*Banasa euchlora* Stål
Hemiptera	Pentatomidae	*Banasa packardi* Stål
Hemiptera	Pentatomidae	*Dendrocoris*
Hemiptera	Pentatomidae	*Euschistus*
Hemiptera	Pentatomidae	*Hymenarcys nervosa* (Say)
Hemiptera	Pentatomidae	*Mormidea lugens* (Fabricius)
Hemiptera	Pentatomidae	*Oebalus pugnax* (Fabricius)
Hemiptera	Pentatomidae	*Parabrochymena arborea* (Say)
Hemiptera	Pentatomidae	*Thyanta calceata* (Say)
Hemiptera	Reduviidae	*Apiomerus crassipes* (Fabricius)
Hemiptera	Reduviidae	*Empicoris*
Hemiptera	Reduviidae	*Melanolestes picipes* (Herrich-Schaffer)
Hemiptera	Reduviidae	*Microtomus purcis* (Drury)
Hemiptera	Reduviidae	*Oncerotrachelus acuminatus* (Say)

ORDER	FAMILY	Genus/Species
Hemiptera	Reduviidae	*Ploiaria carolina* (Herrich-Schaffer)
Hemiptera	Reduviidae	*Pnirontis cf. languida* Stal
Hemiptera	Reduviidae	*Pnirontis modesta* Banks
Hemiptera	Reduviidae	*Pselliopus cinctus* (Fabricius)
Hemiptera	Reduviidae	*Repipta taurus* (Fabricius)
Hemiptera	Reduviidae	*Sirthenea carinata* (Fabricius)
Hemiptera	Reduviidae	*Zelus*
Hemiptera	Rhyparochromidae	*Cnemodus mavortius* (Say)
Hemiptera	Rhyparochromidae	*Neopamera albocincta* (Barber)
Hemiptera	Rhyparochromidae	*Ozophora*
Hemiptera	Rhyparochromidae	*Paromius longulus* (Dallas)
Hemiptera	Saldidae	*Saldula*
Hemiptera	Saldidae	*Saldoida*
Hemiptera	Scutelleridae	*Diolcus chrysorrhoeus* (Fabricius)
Hemiptera	Scutelleridae	*Tetyra bipunctata* (H.S.)
Hemiptera	Thyreocoridae	*Galgupha*
Hymenoptera	Andrenidae	*Andrena*
Hymenoptera	Andrenidae	*Perdita bradleyi* Viereck
Hymenoptera	Andrenidae	*Perdita halictoides* Smith, 1853
Hymenoptera	Andrenidae	*Perdita novae-angliae* Viereck
Hymenoptera	Anthophoridae	*Ceratina*
Hymenoptera	Anthophoridae	*Florilegus condiguus* (Cresson)
Hymenoptera	Apidae	*Xylocopa micans* Lepeletier
Hymenoptera	Chrysididae	*Chrysis conica* Brullé, 1846
Hymenoptera	Chrysididae	*Neochrysis alabamensis* (Mocsáry, 1914)
Hymenoptera	Colletidae	*Hylaeus schwarzii* (Cockerell, 1896)
Hymenoptera	Halictidae	*Dialictus*
Hymenoptera	Halictidae	*Lasioglossum*
Hymenoptera	Megachilidae	*Heriades variolosa variolosa* (Cresson)
Hymenoptera	Megachilidae	*Megachile*
Hymenoptera	Megachilidae	*Osmia*
Hymenoptera	Sphecidae	*Prionyx parkeri* Bohart & Menke, 1963
Hymenoptera	Vespidae	*Ancistrocerus campestris* (Saussure, 1852)
Hymenoptera	Vespidae	*Ancistrocerus unifasciatus seminole* Bequaert, 1943
Hymenoptera	Vespidae	*Eumenes fraternus* Say, 1824
Hymenoptera	Vespidae	*Euodynerus bidens* (Saussure, 1870)
Hymenoptera	Vespidae	*Euodynerus boscii* (Lepeletier, 1841)

ORDER	FAMILY	Genus/Species
Hymenoptera	Vespidae	*Euodynerus megaera* (Lepeletier, 1841)
Hymenoptera	Vespidae	*Euodynerus parvirudis* (Bohart, 1948)
Hymenoptera	Vespidae	*Euodynerus schwarzi* (Krombein, 1962)
Hymenoptera	Vespidae	*Parancistrocerus fulvipes rufovestis* (Bohart, 1948)
Hymenoptera	Vespidae	*Stenodynerus ammonia paraensis* (Saussure, 1855)
Hymenoptera	Vespidae	*Stenodynerus histrionalis histrionalis* (Robertson, 1901)
Hymenoptera	Vespidae	*Stenodynerus krombeini* Bohart, 1953
Hymenoptera	Vespidae	*Symmorphus canadensis* (Saussure, 1855)
Neuroptera	Berothidae	*Lomamyia banksi* Carpenter
Neuroptera	Sisyridae	*Climacia aerolaris* (Hagen)
Neuroptera	Sisyridae	*Sisyra fuscata* (Fabricus)
Neuroptera	Sisyridae	*Sisyra vicaria* (Walker)
Orthoptera	Batrachidae	*Tettigidea armata* Morse
Orthoptera	Batrachidae	*Tettigidea lateralis lateralis* (Say)
Orthoptera	Gryllidae	*Eunemobius*
Orthoptera	Tetrigidae	*Nomotettix cristatus cristatus* (Scudder)
Orthoptera	Tridactylidae	*Ellipes minutus minutus* (Scud.)

*Note: This is not a complete list in that it is only the material that was collected by some of the instructors, been mounted, identified and had the identification databased. Some additional material has yet to be mounted and student material is not included in this list. Also, they did not collect any Lepidoptera, so there are no butterflies or moths listed. As our interest at the University of Guelph Insect Collection is focused largely on acalyptrate Diptera (a subset of flies), with a bit of interest in aculeate Hymenoptera (the stinging wasps), bugs (Hemiptera) and certain beetles (Coleoptera), many of the other groups were not sampled.

Below Steve Paiero, Assistant Instructor, University of Guelph, has discussed several state records in groups that he is familiar with (they may have been recently recorded but his available literature indicates that they are otherwise unrecorded). Additional ones might exist but they do not have enough literature available to them on the SC fauna to fully determine what new records occur in these other groups.

STATE RECORDS

Panagaeus crucigerus (Carabidae) is a beautiful ground beetle that is known from both NC and FL but had yet to be found in SC.

Dirrhagofarsus lewisi (Eucnemidae) was known from nearby GA, NY, WV and MA, so it too was not surprising to find this species in SC. It apparently develops on beech trees.

Abedus immaculatus (Belostomatidae) is an aquatic predator that had previously been known from nearby Georgia (south to Florida). Several specimens were found in the creek/run-off ditch near the visitors centre.

Proxius gypsatus (Aradidae) appears to be rare (or rarely collected) and was previously recorded in North America only from Florida. One specimen was collected from the lights at the cabins. No hosts plants are recorded.

Otiocerus degeeri (Derbidae) is also newly recorded from SC, but it is not surprising to find it here as it is recorded from almost everywhere else in the eastern USA. It was found feeding on oaks along the roadway.

Otiocerus stolli (Derbidae) is known from NY south to FL but had not previously been recorded to SC. It was found feeding on oaks along the roadway.

Cyarda melichari (Flatidae) is known from as far north as DC and south to FL but has not yet been recorded to SC. This species was found in relatively large numbers along the road in the salt marsh (Clambank Road near the observation tower). It is recorded on several shrubs and on *Juncus*.

The reduviids *Apiomerus crassipes, Melanolestes picipes, Pnirontis modesta, Pselliopus cinctus,* and *Repipta taurus* are all new state records. Most of these species were collected in the vicinity of the cabins, with the exception of *P. modesta*, which was taken near the salt marsh

Appendix J

Butterfly Species Observed on Hobcaw Barony and the North Inlet-Winyah Bay NERR

Butterfly Species Observed on Hobcaw Barony and the North Inlet-Winyah Bay NERR

Common Name	Scientific Name
SWALLOWTAILS	
Pipevine Swallowtail	*Battus philenor*
Zebra Swallowtail	*Eurytides marcellus*
Black Swallowtail	*Papilio polyxenes*
Giant Swallowtail	*Papilio cresphontes*
Eastern Tiger Swallowtail	*Papilio glaucus*
Spicebush Swallowtail	*Papilio troilus*
Palamedes Swallowtail	*Papilio palamedes*
WHITES & SULPHURS	
Cabbage White	*Pieris rapae*
Falcate Orangetip	*Anthocharis midea*
Southern Dogface	*Colias cesonia*
Cloudless Sulphur	*Phoebis sennae*
Little Yellow	*Eurema lisa*
Sleepy Orange	*Eurema nicippe*
COPPERS, HAIRSTREAKS, & BLUES	
Banded Hairstreak	*Satyrium calanus*
Striped Hairstreak	*Satyrium liparops*
Henry's Elfin	*Callophrys henrici*
"Olive" Juniper Hairstreak	*Callophrys gryneus gryneus*
White M Hairstreak	*Parrhasius m-album*
Gray Hairstreak	*Strymon melinus*
Red-banded Hairstreak	*Calycopis cecrops*
Eastern Pygmy-Blue	*Brephidium isophthalma*
Ceraunus Blue	*Hemiargus ceraunus*
Eastern Tailed-Blue	*Everes comyntas*
Spring Azure	*Celastrina ladon*
BRUSHFOOTS	
American Snout	*Libytheana carinenta*
Gulf Fritillary	*Agraulis vanillae*
Zebra Heliconian	*Heliconius charithonia*

Common Name	Scientific Name
BRUSHFOOTS (continued)	
Variegated Fritillary	*Euptoieta claudia*
Phaon Crescent	*Phyciodes phaon*
Pearl Crescent	*Phyciodes tharos*
Question Mark	*Polygonia interrogationis*
Mourning Cloak	*Nymphalis antiopa*
American Lady	*Vanessa virginiensis*
Painted Lady	*Vanessa cardui*
Red Admiral	*Vanessa atalanta*
Common Buckeye	*Junonia coenia*
White Peacock	*Anartia jatrophae*
Red-spotted Purple	*Limenitis arthemis astyanax*
Viceroy	*Limenitis archippus*
SATYRS & WOOD NYMPHS	
Southern Pearly-eye	*Enodia portlandia*
Creole Pearly-eye	*Enodia creola*
Appalachian Brown	*Satyrodes appalachia*
Gemmed Satyr	*Cyllopsis gemma*
Carolina Satyr	*Hermeuptychia sosybius*
Little Wood-Satyr	*Megisto cymela*
Common Wood-Nymph	*Cercyonis pegala*
MILKWEED BUTTERFLIES	
Monarch	*Danaus plexippus*
Queen	*Danaus gilippus*
SKIPPERS	
Silver-spotted Skipper	*Epargyreus clarus*
Long-tailed Skipper	*Urbanus proteus*
Hoary Edge	*Achalarus lyciades*
Southern Cloudywing	*Thorybes bathyllus*
Northern Cloudywing	*Thorybes pylades*
Confused Cloudywing	*Thorybes confusis*
Hayhurst's Scallopwing	*Staphylus hayhurstii*
Horace's Duskywing	*Erynnis horatius*
Zarucco Duskywing	*Erynnis zarucco*
Common Checkered-Skipper	*Pyrgus communis*

Common Name	Scientific Name
SKIPPERS (continued)	
Tropical Checkered-Skipper	*Pyrgus oileus*
Common Sootywing	*Pholisora catullus*
Swarthy Skipper	*Nastra lherminier*
Clouded Skipper	*Lerema accius*
Least Skipper	*Ancyloxypha numitor*
Southern Skipperling	*Copaeodes minimus*
Fiery Skipper	*Hylephila phyleus*
Crossline Skipper	*Polites origenes*
Whirlabout	*Polites vibex*
Southern Broken-Dash	*Wallengrenia ortho*
Northern Broken-Dash	*Wallengrenia egeremet*
Little Glassywing	*Pompeius verna*
Sachem	*Atalopedes campestris*
Delaware Skipper	*Anatrytone logan*
Byssus Skipper	*Problema byssus*
Rare Skipper	*Problema bulenta*
Zabulon Skipper	*Poanes zabulon*
Yehl Skipper	*Poanes yehl*
Broad-winged Skipper	*Poanes viator*
Palatka Skipper	*Euphyes pilatka*
Dion Skipper	*Euphyes dion*
Dun Skipper	*Euphyes vestris*
Lace-winged Roadside-Skipper	*Amblyscirtes aesculapius*
Reversed Roadside-Skipper	*Amblyscirtes reversa*
Dusky Roadside-Skipper	*Amblyscirtes alternata*
Eufala Skipper	*Lerodea eufala*
Twin-spot Skipper	*Oligoria maculata*
Salt Marsh Skipper	*Panoquina panoquin*
Ocola Skipper	*Panoquina ocola*