SUMMARY OF CURRENT RESEARCH PROJECTS

Baruch Marine Field Laboratory, University of South Carolina

Summer 1993

Since 1969, more than 400 scientific research projects and 250 student theses and dissertations have been completed by Baruch Institute research associates. This work has resulted in the publication of almost 1000 scientific articles and books. The Baruch Institute is particularly well recognized for its interdisciplinary approach to understanding how the North Inlet Estuary is structured and how it functions in the near absence of human disturbance.

Summer 1993 marks the rebirth of the Marine Field Laboratory and a new era of scientific research. The new 19,000 sq ft Marine Laboratory and Seawater System replace similar facilities lost to Hurricane Hugo in 1989. For the first time in four summers, quality space and equipment are available and many newly funded research projects are making use of the Laboratory. The following is a list of research projects being conducted at the Marine Field Laboratory by resident staff scientists, faculty members, and graduate students. This randomly ordered list indicates a wide diversity of basic and applied scientific research. All of the field-oriented studies involve measurements within the North Inlet-Winyah Bay National Estuarine Research Reserve. For more information about the studies, contact Dr. Dennis Allen at 546-3623.

Groundwater dynamics at the forest-marsh boundary

Investigators: Dr. L. Robert Gardner, Dr. Howard Reeves, and Rick Keenan
Depart. of Geol. Sci., USC

Underground freshwater inflow to tidally dominated estuaries such as North Inlet may be substantial. Transects of special pipe wells have been located from within the Hobcaw forest to the edges of tidal creeks. Measurements of salinity, water depth, direction of flow, and head pressure below the marsh and forest will allow researchers to describe the dynamics of groundwater flow. Computer based models will be developed to determine the effects of tidal forcing, evapotranspiration, rainfall, and sea level rise. With a better understanding of the long-term effects of these factors on the coastal water table aquifer, we may be able to predict and alter flow paths and discharge points of contaminants into estuaries.

Effects of coastal development on watershed ecology

Investigators: Matt Wahl, Dr. Hank McKellar, Dr. H. Aelion, and Dr. Tom Williams
Dept. of Env. Health Sci., USC and Baruch Forest Science Institute, CU

Surface water runoff from small coastal watersheds is being measured and analyzed to quantify differences in systems with different management scenarios. Amounts of organic carbon and nutrients added to high salinity estuaries differ between natural forested (like Hobcaw Barony around North Inlet) and urbanized (like Murrells Inlet) watersheds. Rain gauges and flow control structures on each stream record information on runoff. Water samples are collected during and following storm events. A computer-based model which takes into account the geomorphology, percent impervious surface, vegetation, and other physical characteristics of the watershed, will be developed to help predict timing and magnitude of runoff and nutrient loading.

Chemoreception in turbulent flow: how blue crabs find their prey

Investigators: Dr. David Wethey, Dr. Richard Zimmerfaust, Dr. N. Dean Pentcheff, and Chris Finelli
Dept. of Biol. Sci., USC

Chemical scents associated with animals are moved by tidal currents. Scents can serve as cues for predators seeing food. In this study, the dynamics of odorant transport in water flowing through tidal creeks and Spartina marshes will be measured with continuously recording instruments. Dyes will be mixed with odorant chemicals so that measurements of mixing rates and plume formations can be made with videotape recorders. Field and laboratory studies will help develop an understanding of how crabs use sight, touch, and smell to locate food. The information will be useful in developing and testing foraging and biophysical theory.

Effects of microclimate on the behavior and microhabitat selection by the salt marsh periwinkle

Investigators: Eduardo Gomez-Cornejo and Dr. David Wethey
Dept. of Biol. Sci., USC

The goal of this project is to define and measure the environmental factors (relative humidity, temperature, wind, light, salinity) that promote periods of inactivity and microhabitat selection by the common snail, Littoraria irrorata. Behavioral responses to changes in microclimatic conditions are observed as the snails relocate within the salt marsh cordgrass canopy. Efforts are being made to learn how the snails detect preferred salinity and how the retention of water within the semi-terrestrial animals is related to changes in atmospheric and marsh canopy conditions. The use of new and powerful tools in environmental physics will allow the investigators to develop predictive models which can be used to evaluate how changing marsh habitat conditions affect local animal populations.

Hydrodynamic transport of larvae and chemical cues

Investigators: Christopher Finelli and Dr. David Wethey
Dept. of Biol. Sci., USC

The influence of tidal current flow on (1) the deposition and erosion of invertebrate larvae and (2) transport processes controlling distribution of chemical odorants will be studied in the field and laboratory. Field experiments will relate settlement of planktonic larvae on surfaces to physical and chemical characteristics at the boundary layer. Laboratory flume experiments will allow for precise measurements and observations on how microscopic invertebrate larvae respond to different physical conditions and chemical cues. The information will be useful to the understanding and control of biological fouling problems and applicable to aquaculture.

Characterization of the use of a constructed marsh by fishes and motile macroinvertebrates

Investigator: Dr. Dennis Allen, Andrew Reilly, and George Matsui
Baruch Marine Laboratory, USC

The goal of this study is to determine patterns and the extent of tidal migrations by fishes, shrimps, and crabs into vegetated intertidal habitats. A new technique is being used to quantify the use of these areas during different stages of the tide. Nets buried around sections of flooded marsh are lifted from a remote location and animals trapped within the area remain until they can

be removed at low tide. Replicated nets set at different elevations within the same marsh are being used to find how and when different species/life stages move from open water into the dense stands of grass. These will be among the first quantitative estimates of how marshes are used by estuarine fishes, shrimps, and crabs. Coastal zone managers can use this information to estimate the value of marshes to fisheries.

Trophic transfer of an organophosphate pesticide from benthos to fish

Investigators: Lisa DiPinto, Teresa Donelan, and Dr. Bruce Coull
Marine Science Program, USC

Spot are dominant fishes in local estuaries, and they obtain their food by sieving small benthic invertebrates from mouthfuls of sediment. Meiobenthic copepods exposed to contaminants may facilitate the transfer of pollutants from sediments to fishes. In this study, radio labeled Azinphosmethyl (a pesticide) is added to sediments and the contaminant is taken up by copepods. The copepods are then fed to juvenile spot. The concentration and internal location of the chemical in the fish are measured with liquid scintillation chromatography. One goal is to develop a model system to trace the path of contaminants through estuarine food webs. Another is to develop an assay technique which will be more sensitive and less expensive than existing ones. The results will provide insights into physiological processes at the cellular and tissue levels.

Effect of PAH contaminated sediments on juvenile spot feeding

Investigators: Kimberly Marshall and Dr. Bruce Coull
Marine Science Program, USC

Whether spot will feed in sediments contaminated with PAH is the focus of these laboratory experiments. PAH is a by-product of gasoline combustion, and it can be concentrated in areas where boat use is high. Contaminated and not contaminated sediments spiked with known quantities of meiofauna are used to compare the feeding responses of spot. Preliminary test show an avoidance of the polluted sediments by the fishes.

Brittlestar population studies: use of skeletal growth rings as markers

Investigators: Dr. William Dobson and Dr. Stephen Stancyk
Appalachian State University and Marine Science Program, USC

Large populations of brittlestars which live in sediments in the North Inlet Estuary have been the subject of many physiological studies over the past decade. In this study, animals from natural populations are sized, marked with dyes, and returned to the same area. Replaced animals are confined in large plastic cores so that the same individuals can be relocated every three months and brought into the lab for inspection. The goal is to determine the efficacy of using growth rings in vertebral ossicles as markers for aging individuals and for correlating age bands to temporal events which may result in changes in brittlestar growth. This information will help quantify the importance of brittlestars in estuarine ecosystems.

Settlement patterns of the Eastern Oyster in the North Inlet Estuary

Investigators: Paul Kenny and Dr. Dennis Allen
Baruch Marine Lab, USC

Patterns of planktonic oyster larvae settlement and their relationships to biotic and abiotic characteristics of the estuary have been studied since 1982. This long-term investigation involves collecting and counting recently metamorphosed oysters on settlement plates. The plates are suspended in vertical arrays next to intertidal oyster reefs. Biweekly processing has provided information about seasonal and interannual variations in settlement success. Although the timing and duration of the settlement season are stable among years, large fluctuations in abundance are typical. Such information allows us to monitor the condition of the oyster resource and determine natural factors which influence the population.

Production, degradation, and biotic effects of noxious chemicals generated by some benthic invertebrates

Investigators: Dr. Sarah Woodin, Dr. Rick Lovell, and Dr. Pernell Lewis
Dept. of Biol. Sci. and Marine Science Program, USC

Measurements of the production and degradation of bromophenols, noxious organic compounds which effect other animals, are being made in Debidue Creek. The chemicals are produced by polychaete worms and acorn worms. Field and laboratory experiments are being conducted to determine the effects of these biogenic compounds on the recruitment of invertebrates (settlement of planktonic larvae to the contaminated sediments) and predation by fishes. Additional studies are characterizing the responses of populations of bacteria to the presence of the chemicals around the worm burrows. These compounds are similar to another group of compounds (chlorophenols) released by pulp mills and other industries. The studies will reveal how estuarine organisms react to long-term exposures to contaminants of these types.

Negative recruitment cues for infauna

Investigators: Sara Lindsay and Dr. Sarah Woodin
Dept. of Biol. Sci. and Marine Science Program, USC

The goal of this research is to verify the existence, identity, and generality of impacts of negative cues on the settling stages of invertebrate larvae. Experiments in the laboratory involve the exposure of polychaete worm and other larvae to sediments that have been chemically and/or physically altered from the natural state. One manipulative study examines invertebrate larvae responses to changes in porewater constituents such as ammonium. Initial results indicate that larvae of some species can distinguish between recently disturbed and undisturbed habitats.

Relationships between levels of pollutants and macrofauna diversity

Investigators: Dionne Hoskins and Dr. Sarah Woodin
Marine Science Program and Dept. of Biol. Sci., USC

The number and diversity of clams, worms, and other benthic invertebrates will be compared between polluted sites in Murrells Inlet and uncontaminated sites in North Inlet. An attempt will be made to establish relationships between concentrations of PAH and heavy metals and benthic fauna assemblages.

Chemically mediated interactions in a sedimentary assemblage

Investigators: Dr. Charles Lovell, Dr. Sarah Woodin, Dr. David Lincoln, and Charles Steward
Dept. of Biol. Sci., USC

In this study, investigators are evaluating impacts of toxic chemicals (bromophenols) produced by burrowing polychaetes on marine sediment microflora. Respiration and assimilations rates of bacteria populations are being conducted using biochemical and radiotracer techniques. Phospholipid fatty acid analyses and DNA restriction fragment length polymorphism studies are providing insights into microbial community ecology. Field and laboratory measurements indicate that long-term exposure to biologically produced bromophenols has selected for microbial populations which can mineralize these compounds. Such bacteria populations may provide a means of identifying chemically impacted sites and may be useful in clean up efforts (bioremediation).

Microbial brophodynamics

Investigators: Yvette Piceno and Dr. Charles Lovell
Dept. of Biol. Sci., USC

Clams, polychaetes, and other infauna consume sediment bacteria, but not all are digested. This study is aimed at determining what characteristics of bacteria are correlated with digestibility in deposit and filter feeding macroinvertebrates. DNA restriction fragment length polymorphism analysis is being used to determine bacterial community structure and polymerase chain reaction/DNA sequencing is being used to identify digestible bacteria species. Bacteria probably provide an important source of nitrogen for benthic consumers. If we know what types of bacteria can be digested and how many are available, we can estimate the amount of biologically available nitrogen these bacteria represent and how much of the infaunal requirements they supply.

Symbiosis of the pea crab with two polychaete worms

Investigators: Michael Grove and Dr. Sarah Woodin

Symbiotic relationships between the pea crab, Pinnixa chaetopterana and its host polychaetes Chaetopterus variopedatus and Amphitrite ornata are being investigated on tidal flats in Debidue Creek. Growth rates of the animals are being measured in the field and under known feeding regimes in the laboratory. The initial stages of the relationship are being examined by observing larval crab settlement in the field as well as in the laboratory where chemical and physical conditions can be manipulated. Video, doppler flow probe, and oxygen measurement techniques are used to quantify the effects of crabs on water flow, food capture, and oxygen consumption of the worms. The work will be useful in understanding evolutionary trends in marine symbiosis.

Storm induced salinity pulses in the estuary and effects on larvae

Investigators: Courtney Richmond and Dr. Sarah Woodin

Precipitation events and subsequent runoff from coastal watersheds result in changes in tidal creek water salinities. The timing, frequency, and magnitude of freshwater inflows may have implications for the survival and development of planktonic larvae in the tidal creeks. In

laboratory experiments, larvae at various stages of development have been exposed to different salinity regimes to determine how different kinds of salinity events effect the animals' well being. An understanding of the impacts of rapid changes in water quality on invertebrate recruitment processes is of interest to the management of both developed and natural watersheds.

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

Investigators: Dr. James Morris and Betsy Haskin

Salt marsh grass, Spartina alterniflora, dominates the intertidal marsh in North Inlet Estuary. Regular measurements of grass density, height, stem width, and other characteristics allows for estimates of growth and primary production rates. Manipulative field experiments and long-term measurements of abiotic conditions including pore water salinity are providing insights into factors which affect production. Large monthly and interannual variations in the amount of organic material produced by the cordgrass are related to such factors as sea level and precipitation patterns.

Oyster Landing Basin seine collection program: long-term monitoring of fish, shrimp, and crab populations

Investigators: Ginger Ogburn-Matthews, Paul Kenny, and Dr. Dennis Allen
Baruch Marine Lab, USC

Biweekly collections have been made in the same tidal creek pool since 1983 to determine seasonal and interannual variations in the abundance, biomass, and length distributions of animals using this nursery habitat. Seine samples have been processed for information which will provide insights into relationships between more than 60 species of fishes and decapod crustaceans and physical characteristics of the system. Relatively little is known about what and how natural factors affect the extent to which young-of-the-year animals use shallow marsh habitats. An understanding of natural variability in abundance, growth, and production rates is essential to evaluate and adjust man's impacts on habitats and populations. Our study in the undisturbed habitats of North Inlet Estuary affords a rare opportunity to understand these ecological processes.

Town Creek zooplankton program: long-term monitoring of holo- and meroplankton assemblages

Investigators: Dr. Dennis M. Allen, Ginger Ogburn-Matthews, and Paul Kenny
Baruch Marine Lab, USC

Collections have been made at the same location, stage of tide, and time of day using the same sampling technique every two weeks for more than 12 years. Oblique 153 micron mesh collections sample copepod and small invertebrate larvae whereas 365 micron epibenthic sled collections take larval fishes, shrimps, and crabs as well as a number of the larger zooplankton species. Seasonal and interannual changes in the abundance and species composition of the assemblages are documented. These changes are examined with respect to fluctuations in the physical characteristics of the estuary. These data sets are among the most complete and longest running in the world. They reveal rates and directions of change in an undisturbed estuarine ecosystem. Relationships between population parameters and weather events have been demonstrated. Since so many of the zooplankton species are developmental stages of larger

animals, the study provides indications of the reproductive and potential recruitment success of species of commercial and/or recreational importance.

North Inlet benthos program: long-term monitoring of meiofauna and macrobenthos

Investigators: Dr. Bruce Coull and Dr. Robert Feller
Marine Science Program, USC

Regular (biweekly or monthly) collections of two size fractions of animals which live in the sand or mud have been made at the same time and locations in the North Inlet Estuary since 1981. The meiofauna (<90 microns) study was initiated in 1973 and represents the longest estuarine meiofauna time series in the world. Dozens of less familiar species along with a variety of worms and clams are sieved, identified, and counted in replicated core samples. Simultaneous measurements of physical conditions in the water, sediment, and air help investigators to determine causes of variations over short and long periods of time. Studies in undisturbed North Inlet habitats provide a baseline to which other areas, including contaminated areas, can be compared.

Predation on marine invertebrate larvae by oysters: the cost of cannibalism

Investigators: Mario Tamburri and Dr. Richard Zimmer-Faust
Dept. of Biol. Sci., USC

Behavioral observations and experiments in the laboratory and natural environment will reveal relationships between feeding of adult oysters and settlement of oyster larvae. Benthic suspension feeders, such as oysters, comprise a major source of mortality among planktonic invertebrate larvae. Given the high abundance of oysters and their ability to filter huge volumes of water, their potential impact on the survival of many kinds of larvae, including their own, may be great. One of the goals of the project will be to determine how predation of invertebrate larvae by adult oysters influences the distribution and structure of estuarine populations.

Effect of fiddler crab bioturbation on salt marsh sediments

Investigators: Barbara McCraith and Dr. L. Robert Gardner
Dept. of Geol. Sci., USC

Fiddler crabs have a significant impact on salt marsh soil structure through extensive burrowing activities. Their role in sediment reworking is being quantified by determining burrow densities, turnover rates, and volumes of displaced sediments. Spatial and temporal effects of crab bioturbation on radioisotope and trace metal profiles will be measured. Burrowing activity probably influences important salt marsh processes such as nutrient cycling and production but very little quantitative evidence has been gathered. Results from this study may be useful in our understanding of the movement of pollutants through salt marsh sediments.

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

Investigators: Danny Taylor and Dr. Dennis M. Allen
Baruch Marine Laboratory, USC

An automated weather station with a computerized data acquisition system provides up-to-the-minute measurements of atmospheric and water column parameters. Wind speed, wind direction, air temperature, barometric pressure, solar radiation, and precipitation are measured with sensors mounted on a tower at the pier. Other sensors measure tidal height, conductivity, and water temperature beneath the pier. Records have been gathered for more than 10 years for most parameters and the data have been instrumental in determining how hourly, daily, weekly, seasonal, and annual variations in weather affect other ecosystem characteristics such as nutrient cycling, plant production, and the growth and migrations of animals. The Oyster Landing site is also a National Weather Service installation.

Water chemistry: long-term monitoring of tidal water from North Inlet Estuary

Investigators: William Johnson, Dr. James Morris, and Dr. L. Robert Gardner
Baruch Marine Laboratory, Dept. of Biol. Sci., and Dept. of Geol. Sci., USC

Water samples have been collected at various times and locations in the North Inlet Estuary since about 1976. Information obtained from collections made daily from 1978 to 1993 have provided an understanding of how weather events, changes in sea level, and other physical factors affect concentrations of nitrogen, phosphorus, and organic compounds in the water column. Other analyses yield data on chlorophyll (an indicator of microscopic plant production) and suspended sediment concentrations in the tidal creeks. Starting this summer (1993), a change in sampling strategy was initiated. Now, more than 15 years of daily records will be complimented with finer scale (tidal and diel) measurements of the same parameters. Automatic samplers will be set at several locations to collect water every two hours over 24 hr periods once every 20 days. Water chemistry data are incorporated into calculations and computer models in an attempt to explain long-term variations in other ecosystem processes such as plant production.

Wading bird responses to Hurricane Hugo

Investigators: Dr. Keith Bildstein and Dr. Dennis M. Allen
Hawk Mountain Sanctuary Association and Baruch Marine Laboratory, USC

The responses of five species of wading birds breeding at the Pumpkinseed Island Colony in Mud Bay (Winyah Bay) to Hurricane Hugo are being investigated. The numbers of great egrets, snowy egrets, glossy ibises, and tricolored herons breeding at the site appear to have been minimally affected by the storm. The number of white ibises breeding at the site plummeted from an average 7,000 pairs in the decade preceding the storm to no birds in 1990, 500 pairs in 1991, 2,500 pairs in 1993, and 4,000 pairs in 1993. The total absence of white ibis nesting in the spring following the fall hurricane occurred even though the nesting habitat (marsh grass) was not significantly changed. Species-specific differences in responses to the storm appear to be linked to the hurricane's effects on principal prey used by the birds. An annual census of white ibis and other nesting birds is being conducted on Pumpkinseed Island to determine the length of time needed by the population to return to pre-storm breeding levels.