SUMMARY OF CURRENT RESEARCH PROJECTS

Baruch Marine Field Laboratory, University of South Carolina

Summer 1994

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 more than 1000 scientific articles, reports, and books which contribute new information in subject areas ranging from molecular biology to landscape ecology. The accumulating information provides a fundamental understanding of the structure, function, and condition of coastal ecosystems. Results of research projects are used by educators, coastal resource managers, health and environmental regulators, legislators, and many other individuals and organizations interested in maintaining or improving the health of estuaries in the face of increasing human activities in the coastal zone.

The following is a list of 42 research projects currently being conducted by staff, graduate students, and faculty associated with the Baruch Institute. A wide variety of basic and applied research is represented. Although many other investigators presently use the Field Laboratory to support their studies, the list includes those projects which make most frequent use of the site. Most of the field-oriented studies listed are based in the North Inlet-Winyah Bay National Estuarine Research Reserve. For more information, please contact the individual investigators, Dr. Dennis Allen, or Dr. David Bushek at 803-546-3623.

LONG-TERM MONITORING AND RESEARCH:

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. Daily collections 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. Last summer (1993), automatic samplers were set at two

North Inlet and one Winyah Bay locations to collect water every two hours over 24 hr periods once every 20 days. Now, more than 15 years of daily records will be complimented with finer scale (tidal and diel) measurements of the same parameters. Water chemistry data are incorporated into computer models in an attempt to explain long-term variations in other ecosystem processes such as plant production.

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

Investigators: Dr. Dennis M. Allen, Paul Kenny, and Ginger Ogburn-Matthews
Baruch Marine Laboratory, 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 and other large zooplankton species. Seasonal and interannual changes in the abundance and species composition of the assemblages are documented and correlated 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 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: Drs. Bruce Coull and 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. Small invertebrates, less than 90 microns in size, comprise the meiofauna. The meiofauna study was initiated in 1973 and represents the longest estuarine meiofauna time series in the world. Dozens of macrobenthos species, including a variety of worms and clams, are sieved, identified, and counted in replicated macrobenthos core samples. Simultaneous measurements of physical conditions in the water, sediment, and air help investigators to determine causes of variations over various periods of time. Data from undisturbed North Inlet habitats provide a baseline to which other areas, including contaminated areas, can be compared.

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

Investigators: Dr. James Morris and Robin Krest
Dept. of Biol. Sci. and Marine Science Program, USC

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 Laboratory, USC

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. Since 1983, we have made biweekly collections in the same tidal creek pool 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. Our study in the undisturbed habitats of North Inlet Estuary affords a rare opportunity to understand these ecological processes.

Settlement patterns of the Eastern Oyster in the North Inlet Estuary

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

Patterns of 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.

GEOPHYSICAL AND CHEMICAL PROCESSES:

Groundwater dynamics at the forest-marsh boundary

Investigators: Dr. L. Robert Gardner, Dr. Howard Reeves, Rick Keenan, Pete Thibodeau, and Bob Pickard
Dept. 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. Preliminary results obtained in February 1994 revealed strong upward components of freshwater seepage in the *Juncus*-short *Spartina* zone adjacent to the forest. This suggests that freshwater seepage from the forest inhibits development of hypersaline pore water and thereby prevents *Salicornia* from inhabiting the high marsh adjacent to the forest.

Spatial and temporal variation in porewater salinity

Investigators: Dr. Robert Gardner and John Seigle
Dept. of Biol. Sci., USC

As an REU student, John Seigle is studying the spatial and temporal variation in porewater salinity along a forest-marsh transect across the Crab Haul Creek Basin. The purpose of this study is to understand how elevation, tidal inundation, rainfall, and evapotranspiration lead to the development of hypersaline porewater in the *Salicornia* zone of the marsh. Salinity samples are being obtained by means of equilibration probes and analyzed with a refractometer.

Salt-marsh geomorphology and ecological development: Influence upon habitat linkages within and across ecosystem boundaries

Investigators: Drs. Eric Keopfler and Richard Dame, Daniel Childers, and Bjorn Kjerfve
Coastal Carolina University, Florida Int. University, and Dept. of Biol. Sci., USC

Using aerial imagery, GIS, and image analysis, we will investigate relationships of salt marsh ecosystem morphology to important resource management characteristics including habitat extent, habitat quality, and habitat linkages (material flux). Marsh geomorphology, creek network features, and marsh vegetation patterns will be quantified by image analysis to generate a series of dimensional (area, length) and non-dimensional (ratio, fractal, diversity) spatial indices. These indices will be compared to fishery landing data and material flux information to determine how marsh estuarine ecosystem morphology influences the support of living marine resources. Multivariate statistical techniques will be utilized to explore the relationship between the marsh estuarine spatial indices and important habitat linkages (material fluxes). Using spatial indices and ancillary data, multivariate models (discriminant analysis and multiple regression) will be constructed to predict material flux dynamics. The major hypothesis of this study is that spatial characteristics reflective of salt marsh maturity control habitat structure [quality] and whole system material flux.

Spatial dynamics of nutrient and sediment removal by riverine wetlands

Investigators: Drs. Joseph P. Schubauer-Berigan, Carol A. Johnston, and Scott D. Bridgham
Baruch Marine Laboratory, USC, University of Minnesota, and Notre Dame University

Estuarine wetlands have important, though unquantified, water quality functions. Large areas of these wetlands have been developed with a resulting loss in water quality benefits. We are studying the spatial attributes of sediment and nutrient removal in two estuarine wetlands with very different sedimentation regimes. Our overall goal is to evaluate the characteristics of riverine wetland soils that maximize sediment and nutrient removal and to determine the relative importance of these sediment and nutrient removal processes within and between wetlands of different soil types. Specifically, our objectives are: (1) to statistically quantify the spatial distribution of soil properties and processes in riverine wetlands with different soil types, (2) to determine the relative importance of nitrogen and phosphorus removal via sedimentation, organic matter accretion, sorption and gaseous losses, and (3) to develop relationships between these processes and the spatially-distributed soil characteristics.

The effects of brittle stars on sediment solute transport

Investigators: Tim Shepherd, Dr. Steve Stancyk, and Dr. Tim Shaw
Marine Science Program and Dept. of Chem., USC

This study examines how brittle stars affect solute concentrations in the sediment. *Microphiopholis gracillima* will be placed in cores that have dialysis tubes running through the sediments. Cesium will be used as an inert tracer to follow solute movement through the sediment. A cesium gradient will be created using the bottom dialysis tube after the brittle stars have established a burrow. The transport of cesium through the sediment will be followed by sampling the other dialysis tubes, leaving the cores undisturbed. The results will allow modeling of solute transport, which will give clues to how brittle stars influence the sediment environment where they are found.

The effect of bioturbation by fiddler crabs on salt marsh sediments and sediment chemistry

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

Previous studies have suggested that bioturbation by fiddler crabs (*Uca* spp.) may cause seasonal variation in the permeability of salt marsh sediments and, thus, the transport of nutrient-rich porewaters. Bioturbation also suspends marsh sediments that have high levels of adsorbed nutrients which then desorb into the water column. As a result, bioturbation may play a significant role in controlling the nutrient chemistry of creek waters and indirectly the productivity of the salt marsh system. The influence of bioturbation of fiddler crabs on the composition and chemistry of salt marsh sediments will be studied by determining burrow densities, turnover rates, volumes of displaced sediments, and analyzing sediment samples for nutrients. The spatial and temporal effect of bioturbation on radioisotope profiles and inventories will also be measured.

POPULATION DYNAMICS AND COMMUNITY ECOLOGY:

Use of flooded marshes by migratory fishes and crustaceans

Investigator: Dr. Dennis Allen
Baruch Marine Laboratory, USC

The movement of a diverse assemblage of fishes, shrimps, and crabs into intertidal habitats with flooding tides is widely recognized, but quantitative information regarding the structure and dynamics of these migrations is scarce. In this study, the timing and magnitude of movement of swimming and crawling fauna onto the vegetated marsh surface is measured with lift nets. Replicate nets buried at different elevations along transects extending from tidal creek banks to the high marsh are lifted at predetermined stages of the tide to capture tidal migrants. Preliminary work indicates that the timing and distribution of animals varies among species and life stages and that weather conditions and time of day influence the way the migratory fauna uses the marsh. Additional studies on diets and food availability will provide insights into growth and production patterns for species which forage on the flooded intertidal zone.

The effect of salinity on the growth and development of larval estuarine dependent fishes

Investigators: Dr. V. Pernell Lewis
Dept. of Biol. Sci. and Marine Science Program, USC

Salinity may be a major environmental factor influencing the utilization of estuaries by larval fishes. The goal of this study is to examine the role of salinity in determining the distribution of larval fishes within the estuary. The energetics of growth in three different salinities (2, 12 and 35 ppt) for three common species (Atlantic menhaden, spot, and southern flounder) will be determined. Metabolic rates, proximate composition, and growth rates will be among the primary variables measured to assess the effect of salinity on these larval fish. Their distribution in Winyah Bay and North Inlet will also be determined relative to salinity zones. Salinity preference will be determined in the laboratory using a salinity gradient test.

Storm induced salinity pulses in the estuary and effects on larvae

Investigators: Courtney Richmond and Dr. Sarah Woodin
Dept. of Biol. Sci., USC

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 affect 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.

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

Investigators: Drs. Sarah Woodin, Charles Lovell, David Lincoln, and Pernell Lewis
Dept. of Biol. Sci. and Marine Science Program, USC

Measurements of the production and degradation of bromophenols, noxious organic compounds which affect other animals, are being made in Debidue Creek. The chemicals are produced by polychaete 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.

Molecular ecology of biohalogenation and dehalogenation

Investigators: Kevin Fielman, Dr. David Lincoln, and Dr. Sarah Woodin
Dept. of Biol. Sci., USC

Halogenated aromatic compounds are important pollutants in a variety of industrial processes. Similar compounds are also produced naturally by a wide variety of marine organisms. We are examining the extent to which the capacity of organisms to produce and degrade naturally-occurring halogenated organic compounds determines the biological impact of

pollutants in marine benthic communities. DNA probes developed from common worm species which contain high concentrations of halogenase and/or dehalogenase will be used to compare the potential for halophenol metabolism of organisms at three sites: one with native worm species which produce large quantities of bromophenols, a nearby site which has substantial chlorophenol contamination from sulfate-process paper pulp mill effluent, and a control site lacking halophenols. These studies will allow us to assess the activities and potentials for halogenases and dehalogenases to influence benthic community species composition and enable us to determine if these characters are important determinants of organism survival and persistence in polluted habitats.

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.

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).

Use of vegetated vs. unvegetated intertidal marsh by the grass shrimp, *Palaemonetes pugio*

Investigators: William Ellis and Dr. Robert Feller
Dept. of Biol. Sci., USC

The goal of this study is to determine distribution and abundance of grass shrimp on the marsh surface. Lift nets, set in vegetated and unvegetated areas, are deployed at various stages of the tide. Shrimp and other fauna trapped within the study area are identified and counted. Replication of lift net arrays permits a quantitative estimate of grass shrimp distribution and abundance. Results will indicate the importance of natural marsh habitat to populations of this important estuarine species.

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 is being studied in the field and laboratory. Field experiments relate settlement of planktonic larvae on surfaces to physical and chemical characteristics at the boundary layer. Laboratory flume experiments 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.

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.

Chemoreception in turbulent flow: how blue crabs find their prey

Investigators: Dr. David Wethey, Dr. Richard Zimmer-Faust, 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 seeking food. In this study, the dynamics of odorant transport in water flowing through tidal creeks and *Spartina* marshes is continuously recorded. Dyes are 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.

Chemical ecology of a marine predator-prey interaction

Investigators: Peggy O'Neill and Dr. Richard Zimmer-Faust
Marine Science Program, USC

Chemical cues attract predatory blue crabs to infaunal clams, an important prey item. Behavioral assays are essential to the understanding of an animal's perception of chemical stimuli. In this study, a field bioassay will be used to identify the prey attractants involved in searching and feeding by blue crabs. Clam metabolites will be used as the source of attractant material. Freshly caught crabs will be fitted with small back packs consisting of two thin polyethylene tubes threaded in plastic guides glued onto the dorsal shell, each delivering stimuli to one side of the head. Molecular weight filtration and selective enzyme degradation will be

used to initially characterize prey attractants. Results from this field project will help establish the chemical basis for predatory response.

Population genetic structure of *Perkinsus marinus*

Investigators: Drs. David Bushek and John Graves
Baruch Marine Laboratory, USC and Virginia Institute of Marine Science

Perkinsus marinus is a protozoan pathogen of the eastern oyster *Crassostrea virginica* that causes extensive mortality during summer. Previously restricted to estuaries south of Chesapeake Bay, it has recently spread as far north as Massachusetts and is currently devastating oyster populations along the Atlantic and Gulf coasts. Isolates of the parasite are being collected in a hierarchical sampling design and cultured *in vitro*. Restriction fragment length polymorphism (RFLP) and DNA sequence analysis will be used to determine population structure. Results will help identify source populations of the recent northward spread and mechanisms of *P. marinus* dispersal. Knowledge of the population genetic structure will also provide a means to (1) evaluate the effectiveness of management strategies, (2) enforce management regulations, and (3) improve the application of laboratory-based investigations.

Brittlestar population studies: use of skeletal growth rings as markers

Investigators: Drs. William Dobson and 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 alter brittlestar growth. This information will help quantify the importance of brittlestars in estuarine ecosystems and provide means of quantifying effects on brittlestar growth.

Symbiosis of the pea crab with two polychaete worms

Investigators: Michael Grove and Dr. Sarah Woodin
Dept. of Biol. Sci., USC

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.

Microbial mediation of environmental stresses

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

This project examines nitrogen fixing bacterial (NFB) communities associated with the salt marsh cordgrass, *Spartina alterniflora* and environmental stresses affecting them. Stress factor gradients in salt marshes result in a transition from highly productive tall form *Spartina* at the banks of tidal creeks to less productive short form plants at higher elevations. Differences in rhizosphere NFB, essential symbiotes of *Spartina*, due to the differing environmental stresses may help explain the observed pattern of plant distribution and productivity. Field NFB communities will be experimentally manipulated through a reciprocal transplant experiment. Correlations between environmental stressors, rates of N_2 fixation, plant productivity, and NFB community structure will be determined, allowing definition of the influence of NFB communities on *Spartina* productivity.

Microbial food web structure/function in North Inlet

Investigators: Drs. Alan Lewitus and Eric Koepfler
Baruch Marine Laboratory, USC and Coastal Carolina University

Long-term trends and seasonal distributions of chlorophyll and nutrients derived from the LTER program suggest that the North Inlet food web is dominated by a "microbial loop" structure and top-down control. Although it is apparent that phytoplankton and bacterial dynamics are driven by regenerated nitrogen sources (NH_4, DON), the specific pathways of nitrogen flux are unknown. For example, one of us (EK) found that glycine enrichment of incubated field samples greatly increased chlorophyll levels, indicating that either phytoplankton took up glycine directly, or that phytoplankton used NH_4 remineralized after bacterial uptake of glycine. Follow-up experiments will determine the relative contributions of phytoplankton and bacteria to the uptake of regenerated nitrogen sources, and to what extent bacteria and phytoplankton growth rates are regulated by grazers (top-down control) and nutrient supply (bottom-up control).

Trophic interactions of ambush predator dinoflagellates in estuarine microbial food webs

Investigators: Drs. Alan Lewitus and JoAnn Burkholder
Baruch Marine Laboratory, USC and North Carolina State University

With the recent advent of improved sampling, fixing, and detecting procedures in microbial ecology, heterotrophic dinoflagellates have emerged as an ecologically important and trophically diverse group. Included in this group are the so-called "ambush predators", species that, in the absence of prey (algae, protozoa, or fish), occur as benthic dormant cysts but, after detecting prey, excyst into flagellated cells, swarm up from the benthos, and devour the prey. Information on the abundance of ambush predator dinoflagellates is scant. However, one toxic species (*Pfiesteria piscimorte*) has been discovered throughout southeastern U.S. estuaries (including Charleston Harbor), and was the causative factor in >30% of North Carolina fish kills documented since 1991. Our work will focus on the role of this species (also called the "phantom dinoflagellate") in estuarine food webs, specifically determining its saprotrophic response to fish, the impact of its grazing activity on natural prey populations, and its effect on growth, fecundity, and survival of potential microfaunal predators.

The role of alternative respiration in phytoplankton

Investigators: Drs. Alan Lewitus and Todd Kana
Baruch Marine Laboratory, USC and Horn Point Environmental Laboratory, UMd

In the variable estuarine environment, phytoplankton frequently experience shifts in resource availability that affect intracellular energy levels. When conditions lead to energy overproduction (e.g. the transition from dark [night] to bright [day] light), phytoplankton use a variety of metabolic processes to get rid of the excess energy. One such energy-dissipating mechanism is alternative respiration. Studies at the Baruch Field Lab will compare the presence and expression of the alternative pathway in phytoplankton from relatively undisturbed (North Inlet) and impacted estuaries (Winyah Bay). Laboratory measurements on the activity and capacity of alternative respiration under varying light, nutrient, and organic substrate conditions will yield insight into the role of the pathway in isolates from these estuaries. The distribution of alternative respiration in field populations also will be determined using a monoclonal antibody to the main enzyme of the pathway.

Wading bird responses to Hurricane Hugo

Investigators: Drs. Keith Bildstein and 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. An annual census of white ibis and other nesting birds is being conducted on Pumpkinseed Island to determine the length of time needed for the populations to return to pre-storm breeding levels. 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. In contrast, 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. Since then, the population has been steadily increasing with 500 pairs observed in 1991, 2,500 pairs in 1992, 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.

HABITAT ALTERATION AND POLLUTION:

Effects of coastal development on watershed ecology

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

Surface water runoff from small coastal watersheds is being measured and analyzed to quantify differences in systems with different management scenarios. Rain gauges and flow control structures on each stream in North Inlet and Murrells Inlet watersheds record information on runoff. Water samples are collected during and following storm events. The quality, quantity, and timing of stormwater runoff is being compared to groundwater quality and the rise and fall of the water table. 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. Preliminary results suggest significantly different runoff patterns between forested and

suburbanized watersheds. The suburbanized site exhibited increases in the frequency and magnitude of runoff events. The suburbanized site also had higher mean concentrations of suspended sediment, nitrate/nitrite, and orthophosphate and lower concentrations of dissolved organic carbon. Groundwater observations indicate strong upwelling at both sites suggesting a significant groundwater contribution to storm runoff. Both sites exhibited a threshold water table level below which rainwater input went into groundwater recharge.

Development of a predictive model for assessing wetland alterations

Investigator: Dwayne E. Porter, Dr. F. John Vernberg, and Dr. Winona Vernberg
Baruch Institute, USC

The goal of this study is to assess and compare changes in wetland acreage in the relatively pristine North Inlet Estuary versus the urbanized Murrells Inlet Estuary. Using the tools of Geographic Information Processing (GIP), a spatial model is being developed to assess not only physiographic alterations, but also alterations allowed under regulatory permitting programs. This study utilizes Geographic Information Systems (GIS), remote sensing and digital image processing, and Global Positioning Systems (GPS) for database development, model development, and validation. By comparing the two estuaries, a better understanding of the potential impact of urbanization on coastal wetlands will be gained.

Implementation and validation of coastal NPS pollution model

Investigators: Dwayne E. Porter and Christopher Corbett
Baruch Institute and Marine Science Program, USC

This investigation develops an integrated NPS/GIS model to characterize and quantify differences in runoff between an urbanized watershed in Murrells Inlet and an undeveloped forested watershed in North Inlet. The NPS model simulates surface water runoff, transport of nitrogen and phosphorous compounds, sediment erosion and deposition, and chemical oxygen demand (COD). High nutrient levels can result in eutrophication of receiving waters, sediments carry large quantities of adsorbed pollutants, and high COD levels threaten organisms in the water. Calibration of the coastal NPS model will enable predictions of individual storm runoff for both watersheds on a seasonal basis. The impact of proposed changes in land use and land cover can also be modeled. Knowledge of how nonpoint source components behave as they are transported through a watershed will provide a foundation for future NPS studies.

International research project on flatfish ecology. Quantitative growth dynamics of flatfish as a test of the recruitment hypothesis

Investigators: Dr. John Mark Dean, Dr. Robert Feller, and Marcel Reichert
Baruch Institute, USC

Habitat alteration is considered the greatest long-term threat to marine fisheries productivity, but there is a lack of direct information on the interaction of habitat and recruitment of juvenile fish in their nursery grounds that resource managers can use in policy development and implementation. This study, part of an international cooperative project by the University of South Carolina, North Carolina State University, Louisiana State University, University of Puerto Rico, and the Netherlands Institute for Sea Research, tests whether recruitment of juvenile flatfish is limited by differences in habitat quality. Since July 1993, quantitative monthly sampling has been conducted to determine the species distribution, abundance, and age structure of juvenile flatfish populations in two adjacent areas with presumed differences in habitat quality

(North Inlet and Winyah Bay). Growth, determined on the basis of information extracted from the otoliths will be used as a measure of habitat quality because it integrates both biological and physical factors. Increment formation in the otoliths will be validated in laboratory experiments and growth rates determined for at least three flatfish species at various temperatures.

Relationships between levels of pollutants and macrofauna diversity

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

The number and diversity of clams, worms, and other benthic invertebrates is being 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 with benthic fauna assemblages.

Cycling and biological accumulation of organic contaminants in Winyah Bay

Investigator: Dr. Tim Shaw
Dept. of Chemistry, USC

Typically, fine grained sediments are reservoirs for contaminants such as PCBs, reflecting the history of pollutant input to the bay system. These sediments are observed as contaminant hotspots in several areas of Winyah Bay. In contrast, pesticides are quite soluble and vary as a function of seasonal river runoff. Our goal is to determine if these contaminant sources produce measurable and persistent exposure to the local population through elevated concentrations in local waters and/or in local fish. Our first task will be to measure organic pollutants in sediment, water, and fish samples from sites of varying contaminant load in Winyah Bay. Levels of contamination in bay samples will be compared to more pristine samples from North Inlet. Our second task will be to use radioisotopes to measure the rate of transport of contaminated sediments out of the bay and ultimately make estimates of the persistence of the reservoir of contaminants.

Predicting toxicity and degradability of Quadricyclane, fluorocarbon ethers, and their analogs

Investigators: Drs. Suhbash Basak, Keith Lodge, and Joseph P. Schubauer-Berigan
University of Minnesota and Baruch Marine Field Laboratory, USC

In many instances of chemical risk assessment, one has to predict the toxic potential of molecules in the face of limited or unavailable test data. Many industrial chemicals have been subjected to minimal or no testing. Under these circumstances, a three-tier strategy for the risk assessment of chemicals has been proposed: (1) critical evaluation of test data, (2) identification of potential analogs of a chemical, and (3) estimation of properties using quantitative structure-activity relationship (QSAR) models. In this project, we plan to: (a) select analogs of the chemicals of interest to the Air Force (quadricyclane, fluorocarbonethers) from data bases containing high quality experimental data on properties like aquatic toxicity (LC50), mutagenicity, toxicity to microorganisms, biodegradability, redox potential, etc., (b) carry out SAR studies of the set containing the chemical and the group of selected analogs using physical organic, topological, molecular mechanics, and quantum chemical approaches, and (c) determine selected physicochemical and environmental properties of a number of critical chemicals and their metabolites in order to validate predictive SAR models.

Microbial regulation of sediment toxicity: Interaction between sediment contaminants and bacterial processes

Investigator: Dr. Joseph P. Schubauer-Berigan
Baruch Marine Laboratory, USC

Ammonia is an important and widespread toxicant in marine and freshwater polluted sediments, but rarely reaches toxic levels in unpolluted sediments. We are attempting to define the mechanisms responsible for producing toxic ammonia in contaminated sediments. It is likely that ammonia reaches toxic levels because bacterial processes responsible for ammonia generation and degradation have become uncoupled and unbalanced. At least two mechanisms may be responsible: (1) the bacterial groups that degrade ammonia have become inhibited or (2) pollution has enhanced bacterial generation of ammonia.

Core nutrient profiles, nutrient flux, and sediment respiration will be measured as will rates of potential denitrification, ammonification, and nitrification. Bulk sediment characterization at each site includes nutrients (NH_3, NO_3, NO_2), CHN, moisture content, ashable organic matter, AVS, and contaminant scans for organics and metals.

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 that 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 laboratory study, radio labeled Azinphosmethyl (a pesticide) is added to sediments where it is taken up by copepods. The copepods are then fed to juvenile spot. Subsequently, the concentration and localization of the chemical in the fish are determined 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.