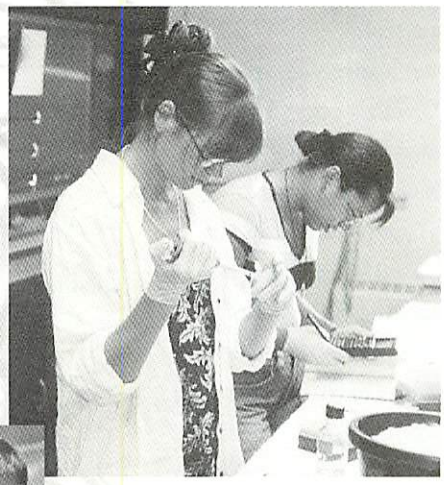
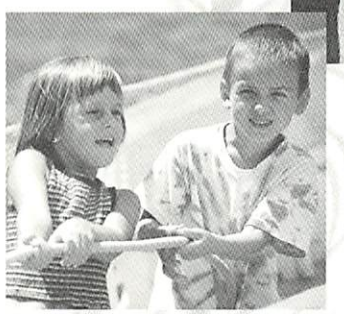
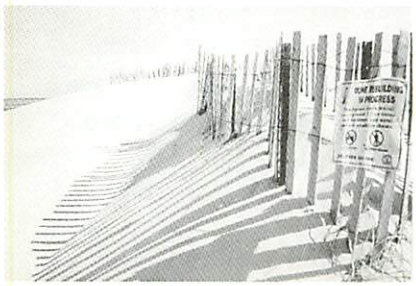
Sea Grant
Woods Hole

Program Guide

2000 - 2002







Woods Hole Oceanographic Institution

The Woods Hole Oceanographic Institution (WHOI) Sea Grant Program supports research, education, and extension projects that encourage environmental stewardship, long-term economic development, and responsible use of the nation's coastal and ocean resources. It is part of the National Sea Grant College Program of the National Oceanic and Atmospheric Administration (NOAA), a network of 29 individual programs located in each of the coastal and Great Lakes states, to foster cooperation among government, academia, industry, scientists, and the private sector.

Sea Grant's affiliation with WHOI began in 1971 with support for a number of individual research projects. In 1973, WHOI was designated a Coherent Sea Grant Program and, in 1985, was elevated to its current status as an Institutional Sea Grant Program. The WHOI Sea Grant Program has made great strides to channel the expertise of world-renowned ocean scientists toward meeting the research and information needs of users of the marine environment. Public and private institutions throughout the Commonwealth of Massachusetts, and the northeast region, participate in the WHOI Sea Grant Program.

Research

During the 2000–2002 funding cycle, the WHOI Sea Grant Program will support 17 concurrent research projects and several smaller "new initiative" efforts aimed at taking the first steps into promising new areas. Together, these projects fit into the following theme areas: Environmental Technology, Estuarine and Coastal Processes, and Fisheries and Aquaculture. Many of these projects address local and regional needs, while others have national or even global implications.

In addition to research, WHOI Sea Grant supports a marine extension program and a communications, public outreach, and education program. During the 2000–2002 biennium, the program will support additional research efforts funded under peer-reviewed regional and national competitions. Major by-products of the WHOI Sea Grant projects include publications, workshops, and lectures. Since 1971, programmatic support has resulted in nearly 700 publications, including journal articles, theses, books, maps, fact sheets, pamphlets, newsletters, and web-based products.

Current research and outreach efforts involve the following academic institutions, as well as private industry: Woods Hole Oceanographic Institution, Marine Biological Laboratory, Boston University Marine Program, University of Massachusetts at Dartmouth, University of New Hampshire, Salem State College, Virginia Institute of Marine Sciences, University of Hokkaido (Japan), Röskilde University (Denmark), Canadian Wildlife Service, Seimac, Ltd. (Canada), Northeast Massachusetts Aquaculture Center, Southeast Massachusetts Aquaculture Center, and Martha's Vineyard Shellfish Group, as well as numerous federal, state, and local agencies and partners, and private individuals.

Sea Grant
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Environmental Technology

▸ Detection and Quantification of Live *Acanthamoeba* in Natural Marine Ecosystems Using Molecular Genetic Methods

Rebecca J. Gast, Woods Hole Oceanographic Institution

Acanthamoeba is a genus of free-living amoebae present in soil, saltwater, and freshwater, including tap water. Although *Acanthamoeba* does not appear to be a human health threat in the ocean, very little is known about the distribution of the potential pathogens in the environment. Their presence at sewage dump sites suggests that *acanthamoebae* may be useful as indicators of sewage contamination because it appears that the presence of detectable numbers of *Acanthamoeba* in marine sediments is due to human activity, and because the presence of the amoebae potentially corresponds with that of coliform bacteria. Until now, the analysis of the natural distribution and abundance of amoebae in general has been problematic, due in part to their small size and an inability to reliably identify them in natural samples. This project has implemented novel molecular tools and techniques—a reverse dot-blot method—to better assess populations of organisms once thought to be 'ambiguous eukaryotic microorganisms,' due to a lack of knowledge about the species abundance and diversity. Having just completed the first year of a two-year project, the investigator has successfully used the dot-blot technique to detect and identify *acanthamoebae* in the marine environment. Efforts are now underway to characterize the natural distribution and abundance of *Acanthamoeba* ribotypes. The determination of what ribotypes are abundant in the environment and how they change over time, or due to human action, may provide information as to why *Acanthamoebae* infections are so rarely seen from marine environments as opposed to freshwater. Refinement of the ribotype work is now underway. (R/B-147)

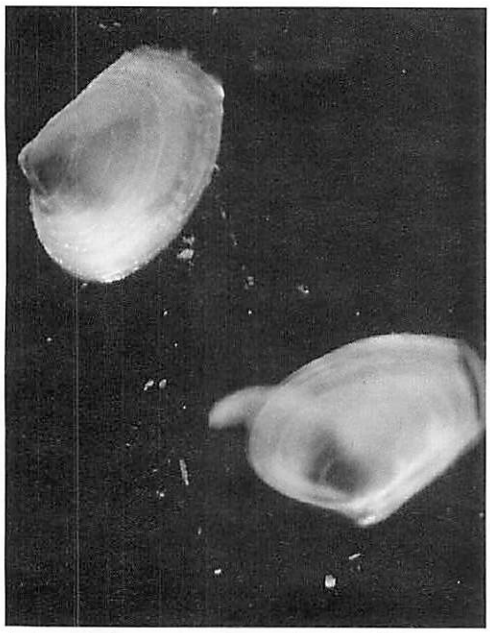
Tom Kleindinst, WHOI

▲ Scientist Becky Gast sampling in Eel Pond.

▸ Estradiol Dynamics: A Molecular Basis for Potential Endocrine Disruption in Marine Mammals

John J. Stegeman, Woods Hole Oceanographic Institution

Marine mammals are known to have large lipid stores and long lifespans. And, residing at the top of the marine food web, they may be the ultimate sink for persistent chemicals, whether those chemicals are released on land or at sea. Understanding the effects of chemicals on marine mammals can provide a critical point of reference for judging whether such effects are of concern on a global basis. This project seeks to establish a molecular foundation by which to evaluate whether exposure of marine mammals to so-called endocrine disruptors (such as polychlorinated biphenyls (PCBs) and the chlorinated dioxins) poses threats to the reproduction or development of these organisms. Among the key hormonal systems thought to be involved in chemical effects on reproduction is one that controls the levels and action of estradiol. Successful reproduction requires close control over this system in adults. Also, the effects of chemicals on estradiol control during development may play a role in reproductive dysfunction and/or disease later in life. Investigators will examine genes and gene products that control estradiol synthesis, action, and degradation, in a comprehensive approach that, heretofore, has not been accomplished in any marine species. (R/B-162)



Lara Gulmann, WHOI

▲ Juvenile (approximately 2 mm) soft-shell clams, *Mya arenaria.*

▶ Bivalve Dispersal as Indicated by Shell Trace Element Composition

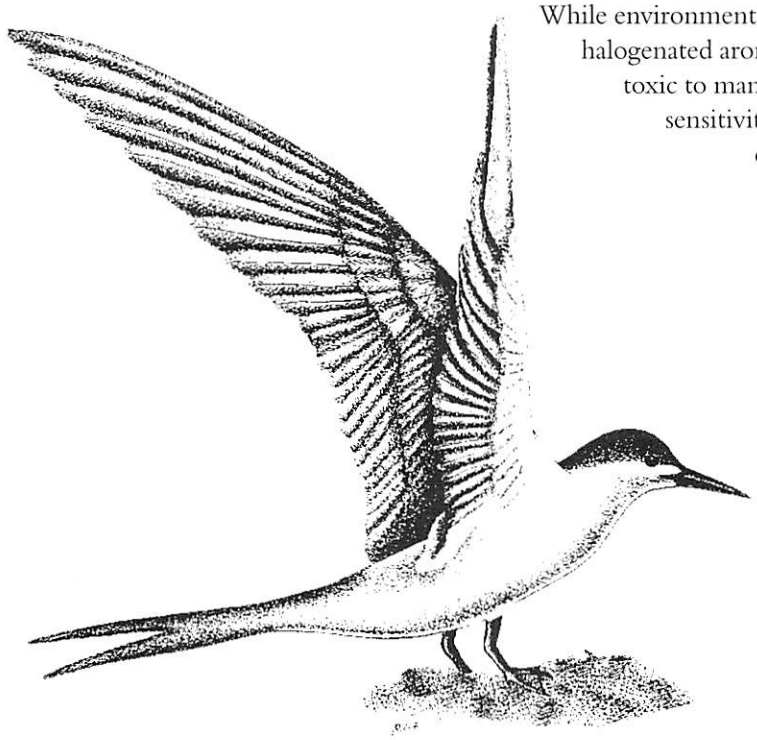
Lauren S. Mullineaux and Stanley R. Hart, Woods Hole Oceanographic Institution

For decades, researchers have been searching for a marker that will help identify the source habitat of larvae settling into a benthic population. Bivalve larvae spend up to 60 days in the planktonic state. During that time, the larvae can be transported substantial distances in coastal currents, making it difficult to determine the geographic origin of the larvae. Ultimately, these dispersal processes have an important impact on the magnitude and variation of recruitment. Using *Mya arenaria*, the soft-shell clam, this project will seek to develop a marker for bivalves by focusing on trace element incorporation by the larval shell. Bivalve larvae incorporate distinctly elevated amounts of trace elements into their shells when they are spawned in water with elevated concentrations of those elements. Because the larval shell is retained as part of the juvenile shell, each bivalve carries a record of the trace element composition of its larval environment: a unique, location-specific fingerprint, of sorts. The trace element composition of water, and overlying sediments of coastal habitats, varies geographically along the coast. To determine whether this variation translates into a useful marker in the bivalve shell, investigators will compare field-collected individuals with those spawned in the laboratory under controlled trace element conditions. The resultant marker will give researchers a powerful and direct tool for tracking larval dispersal in coastal waters, and for understanding the interaction of hydrodynamics and behavior in the dispersal process.(R/O-32)

▶ Impact of Environmental Contaminants on Aquatic Birds: The Molecular Basis of Differential Dioxin Sensitivity

Mark E. Hahn, Woods Hole Oceanographic Institution, and Sean Kennedy, Environment Canada, Canadian Wildlife Service

While environmental contaminants, such as dioxins and related planar halogenated aromatic hydrocarbons (PHAH) are known to be highly toxic to many vertebrate animals, there are dramatic differences in sensitivity, both within and among vertebrate classes. These differences are a major limitation in ecological risk assessment, which often requires extrapolation among species. This project seeks to assess the mechanistic basis for such differences among three species of birds, including common and roseate terns, two coastal Massachusetts species that are at risk from contaminants. Herring gulls will also be included in the study. The investigator will test the hypothesis that differential sensitivity to dioxin-like compounds in birds is due, at least in part, to differences in the characteristics or expression of the aryl hydrocarbon receptor (AhR), an intracellular protein that mediates most dioxin effects. This protein has been well studied in mammals, but has not been extensively characterized in non-mammalian vertebrates. The approaches to be used in this



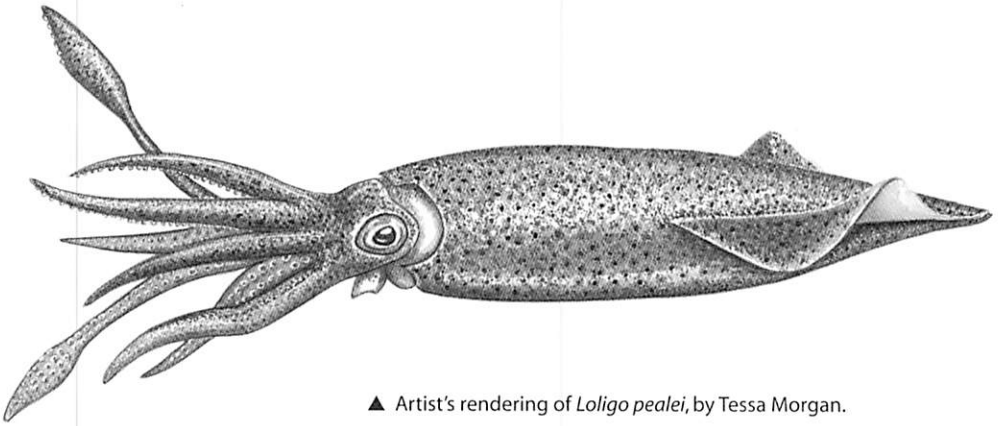
▲ Roseate Tern. Illustrated by Roberta Furgalack.

project—cloning, *in vitro* expression, and analysis of protein function—represent a new way to study the impact of environmental contaminants on protected species. (R/P-64)

▶ Determining Reproductive Success of Commercially Valuable Squid in New England with DNA Fingerprinting

Roger Hanlon, Marine Resources Center, Marine Biological Laboratory

Worth $30 million per year in the Northeast U.S., the short-fin squid, *Loligo pealei*, is now being heavily exploited by fishers who traditionally harvested groundfish. Squid live for only six to fifteen months and heavy fishing pressure on squids during their inshore migration to spawn could have adverse affects on recruitment. This project seeks to provide solid biological data on reproductive success in *Loligo pealei*. These data would allow investigators to address the following question—one that is vital to fisheries management: is there multiple paternity in many, or most, individual egg capsules laid by female *Loligo pealei*? Female squid lay egg capsules, each containing approximately 150 eggs. Behavioral evidence suggests that multiple paternity may be extensive, but genetic proof of paternity is required because mating success often does not equate to fertilization success due to sperm competition, which occurs in many species including squids. The investigator will apply DNA fingerprinting techniques to egg capsules to measure the degree of multiple paternity within individual egg capsules. These egg capsules are the result of complex mating trials conducted in the laboratory by the investigator. Additional laboratory trials will be conducted on sexual selection and mating to answer related questions on multiple paternity as the results from the DNA fingerprinting tests become available. Field samples of egg capsules will also be collected and analyzed and results will be verified and compared to laboratory findings. (R/B-163).



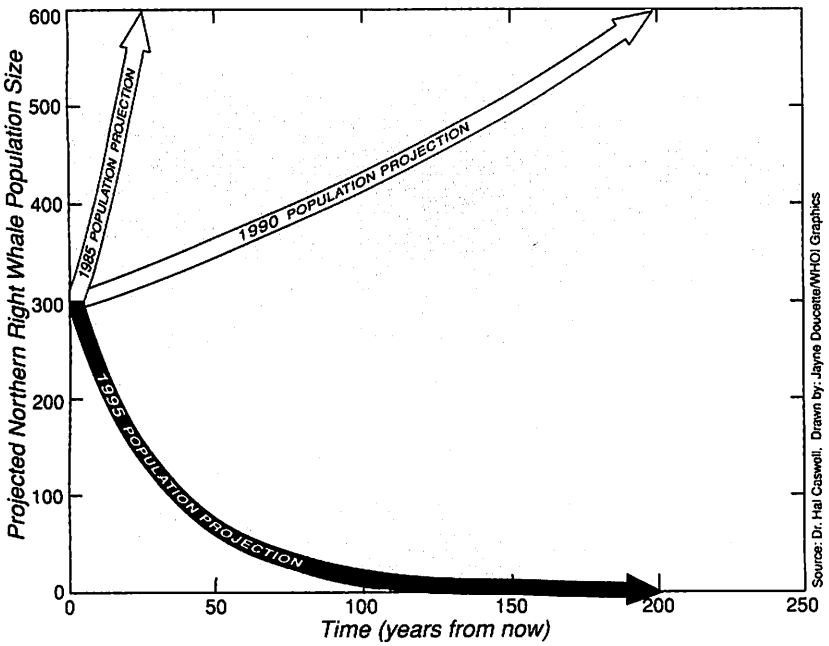
▲ Artist's rendering of *Loligo pealei*, by Tessa Morgan.

Estuarine and Coastal Processes

▶ Controls on Nitrogen Fluxes from Estuarine Sediments: The Importance of Salinity

Anne E. Giblin and Charles S. Hopkinson, Jr., The Ecosystems Center, Marine Biological Laboratory

Nitrogen is the key element limiting primary production in estuaries. While a great deal of research has been done to examine the relationship between nitrogen loading from a watershed and primary productivity, very little work has been done to consider the quantity and timing of freshwater runoff to an estuary. The overall goal of this project is to study how nitrogen release from estuarine sediments changes in response to changes in overlying water salinity. To achieve that goal, investigators will determine the effect of salinity on nitrogen storage and release from sediments, determine the effect of porewater salinity on rates of sediment nitrification and denitrification, and model the implications of salinity control of benthic nutrient dynamics on temporal and spatial patterns of estuarine metabolism. With the project's second year now underway, investigators are monitoring salinity, temperature, and benthic nitrogen fluxes and denitrification rates in the upper portion of the Parker River, located on the north shore of Massachusetts. Inventories of dissolved and exchangeable ammonium in the sediments are also being measured over the course of the season. Investigators found that denitrification rates decreased, following an increase in salinity. This study complements the investigators' work on the nitrogen cycle and denitrification in estuaries. The release of adsorbed ammonium during low river discharge in summer can be quite important ecologically: it occurs when watershed inputs of nitrogen are at their lowest. This ammonium pulse, coupled with the longer residence time that accompanies the decrease in water flow, may be important in beginning and maintaining summer phytoplankton blooms in the upper estuary. Also, year to year differences in salinity, and potentially nitrogen loss due to denitrification, may be one factor determining the year to year variation in primary productivity in estuaries. (R/M-141)



▶ Demographic Analysis of the North Atlantic Right Whale

Hal Caswell, Woods Hole Oceanographic Institution

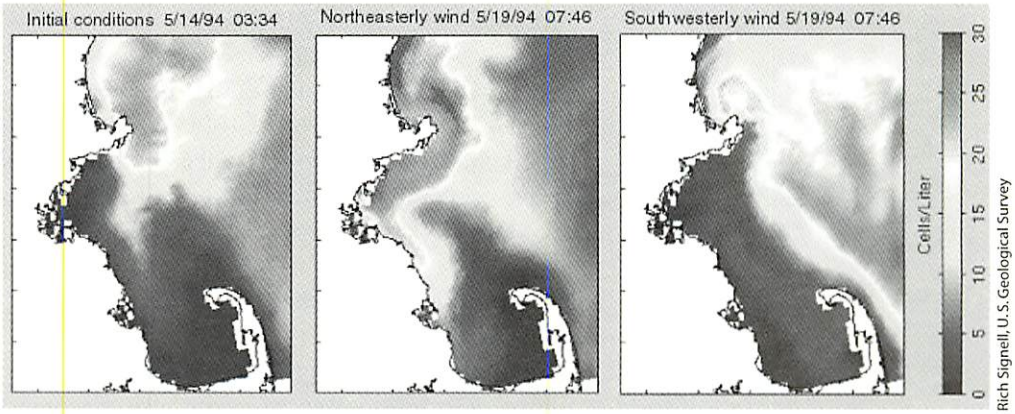
The North Atlantic right whale (*Eubalaena glacialis*) is one of the world's most endangered whales. Its management raises more political, economic, and policy issues than perhaps any other marine mammal. Within the last few years, the right whale's status has led to the closing of fishing areas, lawsuits against the Commonwealth of Massachusetts, and changes in shipping regulations by the World Trade Organization. This project will provide a detailed population analysis to provide an accurate picture of the recent trends, current status, and projected fate of the right whale population, which is essential for determining whether current efforts are appropriate, evaluating the effects of such efforts, and considering new or different management tactics. A previous finding by the investigator—that crude survival probability has declined to the point

that the population is incapable of persisting—underscores the urgency of the situation facing this species. A more detailed analysis of the population, applying rigorous statistical methods to a more detailed model of the life cycle, is critical to determining which parts of the life cycle are responsible for the trends in survival, projecting the consequences of those trends, and exploring strategies to improve population performance. (R/M-45)

▶ Post-Outfall Studies of Toxic *Alexandrium* Populations in Massachusetts Bay

Donald M. Anderson, Woods Hole Oceanographic Institution

Past Sea Grant investigations have confirmed the importance of a coastal current as a southward transport mechanism for toxic cells. At the downstream end of this transport pathway, efforts are needed to understand the dynamics of *Alexandrium* blooms in Massachusetts Bay and to assist in management decisions relating to a controversial sewage outfall. Opponents of the outfall have argued that one result of the new discharge patterns will be an enhancement of toxic or harmful blooms, leading to more paralytic shellfish poisoning (PSP) and, potentially, to mortality of endangered species such as the North Atlantic right whale. By collecting data on *Alexandrium* population dynamics, nutrient concentrations, and distributions in the area surrounding the sewage outfall, the investigator hopes to develop a sufficient understanding of the bloom dynamics of *Alexandrium* so that an informed evaluation of the actual impact of the outfall, once operational, will be possible. Specifically, this project will characterize the meteorological and hydrographic factors which regulate the introduction of *Alexandrium* into Massachusetts Bay, examine the vertical migration behavior of *Alexandrium* cells within the bay, and assess the extent to which *Alexandrium* populations in the bay might be affected by outfall nutrients. (R/B-158)



▲ Modeled distribution of *Alexandrium* during idealized conditions. a) initial distribution of *Alexandrium* cells entering Massachusetts Bay near Cape Ann; b) distribution after 5 days of a constant northeast wind (7m/sec); c) distribution after 5 days of a constant southwest wind (7m/sec).

▶ The Recycling of Anthropogenic Metals in Massachusetts Bay Sediments: Assessing the Impact of the New Outfall

Roger Francois, Raja S. Ganeshram, and William R. Martin, Woods Hole Oceanographic Institution

Boston's new sewage outfall in Massachusetts Bay will become operational in the near future. It is expected that, once on-line, the outfall will lead to an increased supply of organic detritus and anthropogenic metals to the sediments in the area. The resulting changes in the sedimentary environment will affect the rates at which metals are recycled by sedimentary processes, which in turn may alter the balance between burial and return to the water column of anthropogenic metals. The goal of this project is to document the changes in metal cycling resulting from the operation of the new sewage outfall. Initially, these investigators will make measurements before the outfall is on-line to record any changes that may occur once it is operational. The measurements that are central to this project are based on two new methods, both using instruments which are designed for *in situ* deployment in order to avoid sample recovery artifacts. The researchers will use benthic flux chambers, in which the dissolved oxygen level is maintained near that of bottom water for several days, to make direct determinations of metal fluxes across the sediment–water

interface. They will obtain profiles of metal concentrations vs. depth in sediment pore waters using gel probes, which have the potential of avoiding artifacts resulting from the more widely used core recovery/core sectioning/centrifugation/filtering methods. These measurements, coupled with flux and profile measurements of other chemical components of pore waters, will provide the investigators with direct information on metal cycling rates and the mechanisms of metal recycling. (R/B-160)

▶ Development of a Carbon Isotopic Method for Quantifying Groundwater Inputs to Estuaries

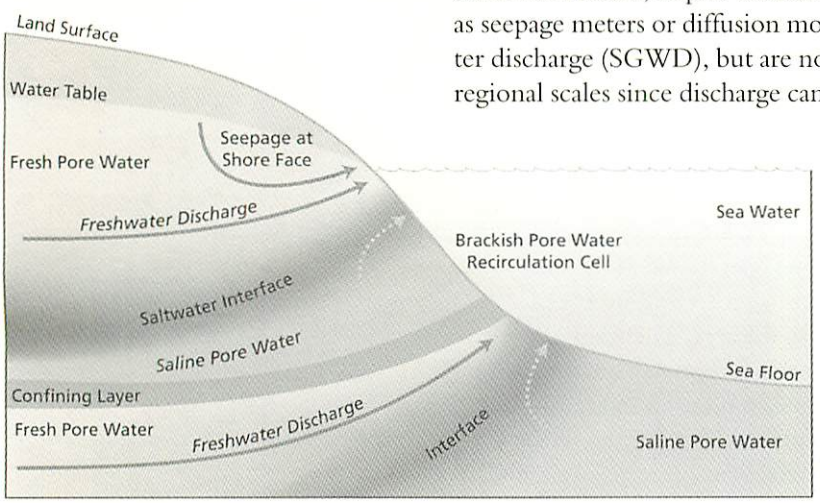
Daniel C. McCorkle, Woods Hole Oceanographic Institution

Many important interactions between groundwater, surface water, and seawater take place in coastal regions. Examples include salt intrusion, which occurs in many coastal areas as a result of increasing demands on aquifers, and nutrient and pollutant release to the coastal ocean by both groundwater and surface water flow. This project, set to begin in 2001, seeks to develop a new geochemical tool for estimating groundwater discharge into estuaries and the coastal ocean. The approach will use the chemical and carbon isotopic signature of groundwater to distinguish groundwater discharge from surface (river) flow. As part of this project, a field study will be conducted at North Inlet, South Carolina. This carbon isotope-based approach will complement another Sea Grant project, *(see* "Groundwater Discharge of Nutrients into Coastal Ponds as Traced by Radium Isotopes," *below)*. If successful, these two projects will provide tools with which to estimate groundwater fluxes—and the associated fluxes of nutrients and contaminants—in a variety of settings. (R/M-47)

▶ Groundwater Discharge of Nutrients into Coastal Ponds as Traced by Radium Isotopes

Matthew A. Charette and Kenneth O. Buesseler, Woods Hole Oceanographic Institution

This project will look at the importance of sub-surface (groundwater) pathways in delivering dissolved nutrients, such as nitrate and phosphate, to coastal waters. Such pathways are often overlooked, in part because they are difficult to measure. Traditional methods, such as seepage meters or diffusion models, merely prove the existence of submarine groundwater discharge (SGWD), but are not a good means for estimating groundwater flow on regional scales since discharge can be patchy. In this project, set to begin in 2001, investigators will use radium isotopes as tracers of SGWD. Key questions to be considered include: Is submarine groundwater a significant source of nitrogen to coastal ponds on Cape Cod? What role does SGWD play in nutrient budgets for these coastal ponds? What are the sources of nutrients transported by submarine groundwater? By investigating these questions, this project provides a unique opportunity to better understand the importance of groundwater processes in the supply and cycling of nutrients in nearshore regions. In addition, the project provides an excellent opportunity to develop a SGWD budget for the Cape Cod region. The radium budgets will provide estimates of SGWD, which, in turn, will provide information on fluxes of nutrients, contaminants, or elements associated with the groundwater. In the end, these results could help environmental managers identify problem areas and any resulting impact on local ecosystems. (R/M-46)



▲ Cross-section and principle transport features of a coastal groundwater system.

Fisheries and Aquaculture

▲ Artist's rendering of the American lobster, *Homarus americanus,* by Tessa Morgan.

▶ Augmenting the Lobster Catch: Oyser Aquaculture in Modified Lobster Traps

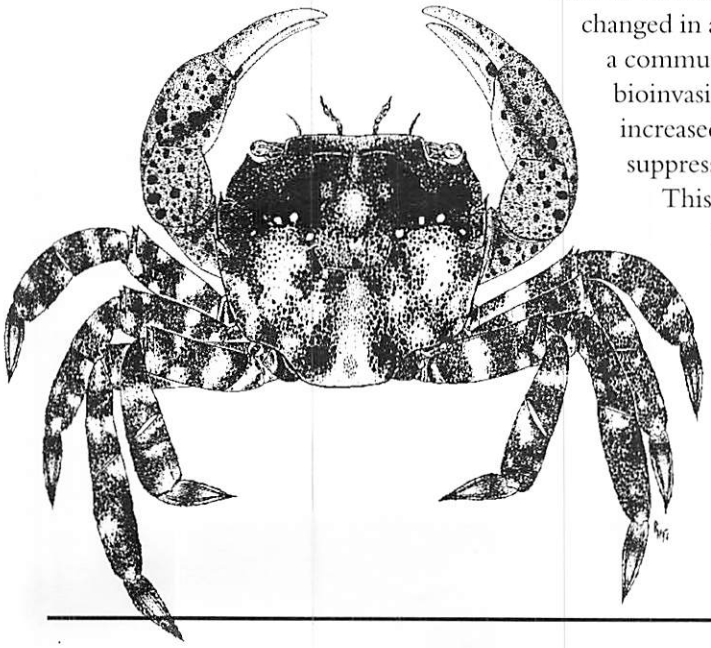
Dale F. Leavitt, Southeastern Massachusetts Aquaculture Center (SEMAC)/WHOI Sea Grant and Cape Cod Cooperative Extension, and Joseph K. Buttner, Salem State College

Collaboration between extension, academia, and industry is widely recognized as an effective means to identify and resolve problems. This study will draw upon that successful model to determine if small-scale oyster culture can be integrated successfully and economically with inshore lobster fishing. The objectives of the study are: to determine if lobster traps can be suitably modified to permit the addition of an oyster growout cage; to determine if the integration of oyster culture with lobster traps impacts lobster catch; to determine oyster survival and growth in modified lobster traps; to quantify the economic return associated with this experiment; and, to involve and educate fishers and regulatory groups as to the benefits of an integration of fishing and aquaculture. The project will be divided into three phases: setup, field testing, and data analyses and reporting. Ten Massachusetts lobster fishers will be involved in conducting a portion of the experiment and collecting data, and investigators will set up a control experiment. The data generated by the lobster fishers and the investigators will be compared and analyzed; these results will be compared with production data from conventional oyster grow-out technology. With the current status of the lobster as "overfished," management efforts to reduce lobster catches are imminent. Aquaculture, though not a global solution to regulated fisheries, offers a way for fishers to supplement their incomes and remain in a vocation tied to the sea. (R/A-43)

▶ Effects of the Asian Shore Crab, *Hemigrapsus sanguineus,* in New England: Changes in Resident Crab Populations?

Nancy J. O'Connor, University of Massachusetts, Dartmouth

Quantification of the ecological effects of non-indigenous marine species is a relatively new area of research. Non-indigenous species can have several effects on native species, causing them to decrease, increase, or remain unchanged in abundance. Changes, if any, to a community during and after a bioinvasion must be clearly shown for increased public support for prevention, suppression, or eradication measures. This project will seek to determine if the recent establishment of a Massachusetts marine bioinvader, the Asian shore crab *Hemigrapsus sanguineus*, has affected populations of



▲ Artist's rendering of Asian shore crab, *Hemigrapsus sanguineus,* by Bart Harrison.

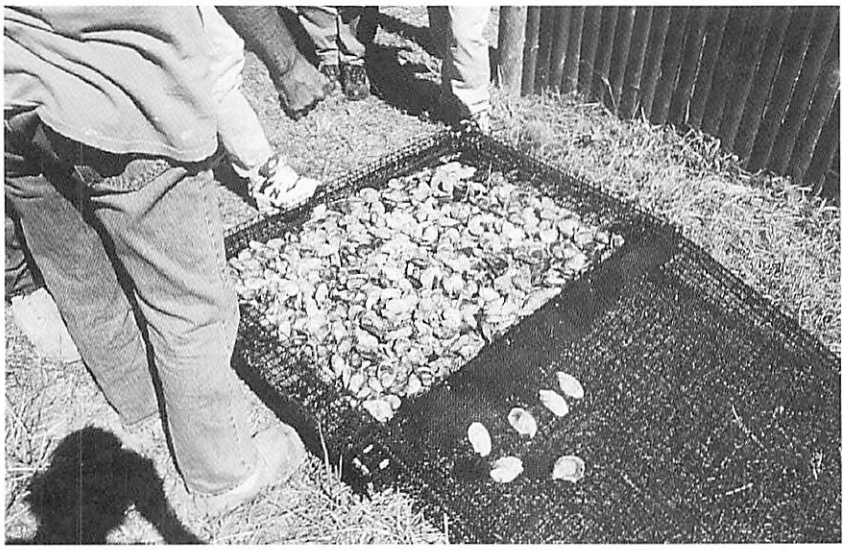
resident crabs, namely the green crab (*Carcinus maenas*), rock crabs (primarily *Cancer irroratus*), and mud crabs in the family Xanthidae. The investigator will follow temporal changes in crab populations as *Hemigrapsus* invades and increases in abundance and compare spatially separated populations to determine whether any changes observed are consistent in direction and magnitude among sampling sites. (R/B-161)

The following project is part of a National Strategic Investments (NSI) competition in Oyster Disease Research, made possible by a special National Sea Grant College Program award.

▶ Investigations into the Prevalence and Mortality Associated with SSO and SSO-like Infections of *Crassostrea virginica* on the East Coast of the U.S.

Roxanna M. Smolowitz, Marine Biological Laboratory

Haplosporidium costale (a.k.a., Seaside Organism, or SSO) was first identified as a cause of significant disease in the Eastern Oyster (*Crassostrea virginica*) on the Atlantic coast of Virginia in 1962. SSO parasites and the disease caused by the organism are now endemic in Eastern oysters in Virginia and Maryland. Though SSO infected oysters have been identified, sporadically, in Eastern oysters from Virginia to Maine, significant mortalities have been thought to occur only from Virginia to Maryland. During the 1980s, SSO infected oysters were identified in various areas of Massachusetts, though mortality was not observed and shipment of positive-test animals was not restricted. During the spring of 1998, oyster culturists on Martha's Vineyard experienced mortality in 20–70 percent of their oysters. Histological examinations showed SSO infections with sporulating forms, marking the first time that mortality resulting from SSO infections were noted in this area. Unfortunately, standard histological techniques cannot distinguish between the plasmodial stages of SSO, fall sporulating SSO-like, or MSX organisms (MSX, short for multinucleated sphere unknown, is another oyster disease). This severely hampers the ability to attribute mortality to one or another of these *Haplosporidium* parasites. Recent DNA-based molecular diagnostic techniques, however, do allow for differentiation of morphologically similar organisms. This project, involving investigators from multiple states, employs such techniques to determine if SSO is a significant cause of mortality in Eastern oysters in Massachusetts, Virginia, and Connecticut. Their research, now in its second year, will determine if SSO-like organisms are indeed *Haplosporidium costale*, or another, similar organism, and whether or not mortality results from infections with this SSO-like organism. Investigators will also attempt to define the SSO life cycle and tissue location in various phases of the annual infection cycle by elucidating the seasonal patterns of the disease. Oysters have been deployed and will be monitored and analyzed at one site each in Massachusetts, Connnecticut, and Virginia. (R/B-156)



Dale Leavitt, WHOI Sea Grant

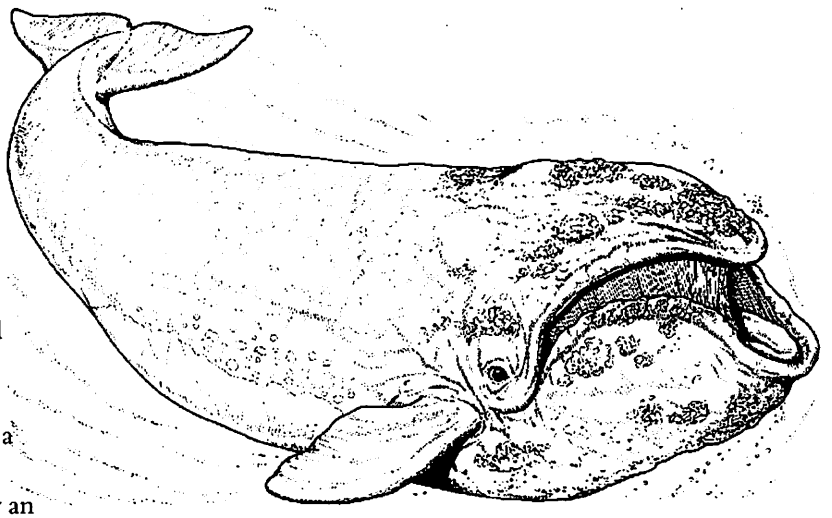
▲ Tray of Eastern oysters, *Crassostrea virginica.*

The following project is part of a National Strategic Investments (NSI) competition in Sea Grant Technology, made possible by a special National Sea Grant College Program award.

▶ Reducing the Risk of Open Ocean Aquaculture Facilities to Protected Species

Walter Paul, Woods Hole Oceanographic Institution

The possible entanglement of endangered and protected marine mammals, in particular the North Atlantic Right Whale, in open ocean aquaculture installations is impeding the permitting process for future offshore operations. This project seeks to develop a wireless communication link, using a low Earth-orbiting satellite system, that would reliably sense an entanglement event and communicate the occurrence to shore in order to initiate rescue efforts. The investigator, an ocean engineer, will work with colleagues to first conduct a survey of responses of entangled right whales to determine which response can most reliably identify an entanglement event. This will involve identifying a suitable longline sensor, possibly a section of breakaway material that fails when tension on the longline exceeds normal operational limits. This so-called "weak link" mechanism would be designed to fail at the time an entanglement event, triggering emergency communication to shore. This project involves a partnership with an industry partner to assemble a satellite transmitter buoy that broadcasts a signal when its release is triggered by the weak link mechanism. The weak link and transmitter buoy will be tested at a submerged aquaculture longline structure located in open waters southwest of Martha's Vineyard to study the function and survivability of the setup. (R/M-43).



▲ Northern right whale, *Eubalaena glacialis.*

The following project is part of a National Strategic Investments (NSI) competition in Environmental Marine Biotechnology, made possible by a special National Sea Grant College Program award.

▶ Novel Biomarkers of Dioxin Effects

Mark E. Hahn, Woods Hole Oceanographic Institution

Environmental contaminants, including planar halogenated aromatic hydrocarbons, or PHAH, are widely distributed in the world's oceans. The highest concentrations of these chemicals are often found in urban harbors and other coastal areas; however, PHAH have been documented in remote locations as well, including open ocean, polar regions, and in the deep sea. These chemicals pose a well-documented risk to marine organisms and ecosystems. In order to more accurately measure the impact of PHAH in marine environments, there is a need to identify responses that can serve as sensitive indicators, or biomarkers, of adverse effects in marine animals. Existing biomarkers, such as cytochrome P4501A (CYP1A) have not been closely linked to toxic endpoints, despite extensive research. Though useful as markers of exposure to contaminants, CYP1A may be less useful as an indicator of toxic effects. This project seeks to identify genes whose expression is induced or repressed by TCDD in killifish and that are directly related to changes in cell growth and proliferation—the hallmarks of PHAH toxicity. In addition, the investigator will clone and sequence selected candidate genes potentially linked to toxicity, and test the value of these genes as biomarkers by measuring their expression in animals exposed to PHAH in the laboratory and in the marine environment. (R/P-64)

Sea Grant Public Outreach, Education, and Extension Projects

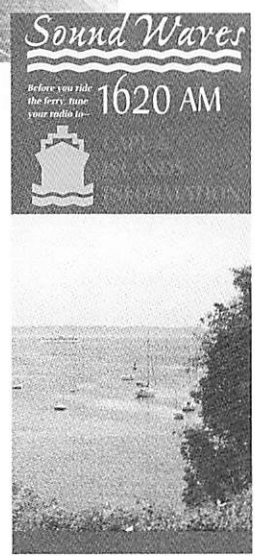
▶ WHOI Sea Grant Communications, Public Outreach, and Education

Tracey I. Crago and Sheri D. DeRosa, Woods Hole Oceanographic Institution

The primary goal of the WHOI Sea Grant Program's communications, public outreach, and education effort is effective and active dissemination of Sea Grant information and research. Achieving this goal involves effectively translating and transferring the results of Sea Grant-supported research to individuals, agencies, and other user groups in need of information about the coastal and marine environment. The WHOI Sea Grant communications program reaches out to its audiences in an attempt to answer questions, increase environmental awareness, improve science literacy, and bridge the gap between scientific research—especially marine and coastal research—and an informed and knowledgeable public.

Audiences with whom we interact on a frequent basis include educators, students, scientists, members of coastal outreach organizations and local regulatory agencies, visitors to the Woods Hole Oceanographic Institution, members of the general public interested in marine and coastal issues, commercial and recreational fishermen and boaters, and local business owners, among others. Some of the ways WHOI Sea Grant reaches its audiences include:

- WHOI Sea Grant's sponsorship of the annual public lecture series, "Oceans Alive"
- On-line accessibility to WHOI Sea Grant information and resources—via the Internet—and pointers to other useful information; check out our homepage at www.whoi.edu/seagrant/
- Publication and distribution of *Marine Science Careers: A Sea Grant Guide to Ocean Opportunities*, updated in 2000, and a companion web site, www.marinecareers.net



▲ WHOI Sea Grant reaches out to audiences interest in coastal and marine issues by sponsoring guided walks, ecotours, lectures, and a summer program for children called "Sea Urchins." Sea Grant also produces publications to keep its audiences current on breaking research discoveries and techniques.
Photos by Tom Kleindinst, WHOI.

- Distribution of a WHOI "teacher packet" including materials and resources available to educators
- Sponsorship of "Sea Urchins," an annual, hands-on, educational summer program for children ages 5-7, emphasizing exploration of the marine and coastal environment
- Dissemination of Sea Grant and other marine-related publications and videos, and the availability of the WHOI Sea Grant publications catalog
- Organization of and participation in events throughout the year, including annual beach cleanups and guided coastal walks during "Coastweeks," and storm drain painting projects to inform citizens of the dangers associated with dumping waste down storm drains
- Contributions to the northeast regional Sea Grant web site, web.mit.edu/seagrant/northeast/index.html; co-sponsorship of the joint WHOI/MIT Sea Grant newsletter, *Two if by Sea*; publication of numerous fact sheets, *Focal Points* and *Marine Extension Bulletins*, brochures, and contributions to various marine educational newsletters and magazines
- WHOI Sea Grant's involvement in several annual educational events, including local science and technology fairs, conferences, and symposia.

James O'Connell, WHOI Sea Grant

▸ WHOI Sea Grant Marine Extension Program

Dale F. Leavitt and James F. O'Connell, Woods Hole Oceanographic Institution and Cape Cod Cooperative Extension

Transferring the results of research and providing general marine-related information are important components of the WHOI Sea Grant Program. The following examples demonstrate how WHOI Sea Grant's Marine Extension Program facilitates communication among users and managers of marine resources, including members of the fishing community, local officials, environmental regulatory agencies, and the public:

- Establishment of two series of fact sheets, one designed for coastal decision-makers and the general public *(Focal Points);* the other designed for technical users *(Marine Extension Bulletins).*

Dale Leavitt, WHOI Sea Grant

- *Directory of Cape and Islands Coastal Outreach Organizations* is a compilation of local private and public organizations that regularly deal with issues pertaining to coastal and marine management. The *Directory* is a handy reference tool that serves to encourage collaboration among these groups; it is updated annually.
- Members of the coastal outreach community in southeastern Massachusetts participate in an electronic mail group (semco@whoi.edu) maintained by Sea Grant to enhance the networking and information sharing.
- Workshops, courses, tours, and site visits provide an opportunity for local users and producers of marine resource information to share their knowledge and concerns, thereby producing a more efficient and effective resource management system. During the past year, Sea Grant has co-sponsored or participated in the following: shellfish disease (workshop); shellfish culture techniques (course), fish farming and pond culture (course), restocking programs (pilot projects), new aquaculture technology (demonstration project), QPX research, dune and beach profiling techniques (field trips), among others.
- WHOI Sea Grant Marine Extension Program provides assistance by conducting literature searches, offering training programs, assisting in management and regulatory decisions, and helping to transfer the newest technology being developed within the scientific research program.

Two areas of particular interest in the region have served as the main focus areas of the WHOI Sea Grant Marine Extension Program:

Fishing and Aquaculture—Our fisheries and aquaculture outreach focuses on building partnerships and resource networks within the region to cover topics that the industry deems important. Working with the aquaculture industry in Massachusetts, the program has co-hosted workshops, courses, and tours of facilities to showcase the latest research and technology. Recent pilot projects aimed at assisting towns with shellfish restocking programs are aimed at augmenting wild fisheries and boosting the economic and aesthetic value of improved commercial and recreational harvests.

WHOI News Office

Coastal Processes—Our coastal processes outreach focuses on the management of the region's coastal landforms: bluffs, beaches, dunes, barrier beaches, salt marshes, and tidal flats. Together, these landforms serve as the region's coastal hazards defense system—a system that is self-sustaining under natural conditions, but one that has been and is presently being modified to accommodate coastal development. Our objective, therefore, is to assist the region in sustaining its coastal landforms given the reality of present and future coastal development.

James O'Connell, WHOI Sea Grant

Taking a systems approach, we work with individuals, communities, and resource managers at town, county, state and federal levels to (1) develop methods for quantification changes in coastal landform sustainability, and (2) use this information for improved coastal landform management. Our methods include one-on-one discussions, field visits and demonstrations, classroom presentations, and public meetings and workshops.

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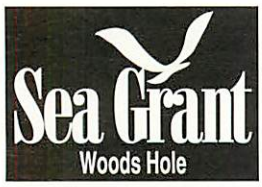

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