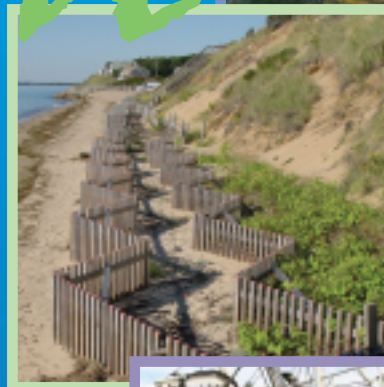


Program Guide

2004-2006



The Woods Hole Sea Grant program, based at the Woods Hole Oceanographic Institution (WHOI), 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, a network of 30 individual programs located in each of the coastal and Great Lakes states. Together, these programs form a national network of over 300 participating institutions involving more than 3,000 scientists, engineers, educators, students, and outreach experts.

Sea Grant's legislative charge is to "increase the understanding, assessment, development, utilization, and conservation of the nation's ocean and coastal resources by providing assistance to promote a strong educational base, responsive research and training activities, and broad and prompt dissemination of knowledge and techniques."

Locally, 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 Woods Hole 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 Massachusetts, and the northeast region, participate in the Woods Hole Sea Grant Program.



RESEARCH

Woods Hole Oceanographic Institution Sea Grant Program



During the 2004–2006 funding cycle, the Woods Hole Sea Grant Program will support 12 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, Woods Hole Sea Grant supports a marine extension program and an outreach and education program. During the 2004–2006 biennium, the program will support additional research efforts funded under peer-reviewed regional and national competitions. Major by-products of these projects include publications, workshops, and lectures. Since 1971, programmatic support has resulted in nearly 800 publications, including journal articles, theses, books, maps, fact sheets, pamphlets, posters, newsletters, and web-based products.

Research and outreach efforts involve the following academic institutions, as well as private industry: WHOI, Marine Biological Laboratory, Boston University Marine Program, Bowdoin College, Harvard University, Cornell University, University of Massachusetts at Amherst, Roger Williams University, Virginia Institute of Marine Sciences, Woods Hole Research Center, U.S. Geological Survey, 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.



Sheri DeRosa, Woods Hole Sea Grant

environmental technology

Environmental Contaminants and Fish Reproduction

Not if, but how? That is the question WHOI postdoctoral investigator Joanna Wilson is asking about how certain environmental contaminants effect marine and freshwater fish reproduction. By applying new research tools—advanced mass spectrometry and proteomics—Wilson and her former graduate advisor, John Stegeman, a WHOI senior scientist, will measure proteins associated with exposure to a group of contaminants known as estrogenic compounds. Estrogen is a key steroid in the control of reproduction in vertebrates: successful reproduction requires control over estrogen levels in both adults and the developing embryo. “The possibility that chemicals may act to disrupt development and/or reproduction is perhaps the most significant concern in environmental toxicology,” says Wilson. “Understanding the mechanisms—both direct and indirect—of chemical exposure on fish reproduction is critical for judging whether chemicals in the environment are endocrine disrupters.” Recent studies have demonstrated that polychlorinated biphenyls (PCBs) and their metabolites appear to interfere with several points along the estrogen pathway. Together, Wilson and Stegeman hope to monitor changes in all proteins along this pathway, in order to identify the key sites of action for environmental estrogens—particularly for those compounds that have indirect mechanisms of action. If successful, their results will advance what is currently known about the reproductive function in fish and will present a new understanding of the mechanisms of toxicity for these compounds.



Courtesy of Stacey Lance, Colby College



How Contaminants “Turn On” Fish Genes

Biomarkers and bioassays are, simply defined, tools developed by researchers to predict or measure a specific biological process. This study, using the Atlantic killifish as a model, will investigate how certain kinds of contaminants alter the set of genes that are expressed, or turned on, in fish. Sibel Karchner, a WHOI research specialist, and Mark Hahn, a WHOI associate scientist, will focus on a group of contaminants known as ortho-substituted polychlorinated biphenyls (ortho-PCBs); the PCBs most abundant in environmental samples. Neither the toxic potential nor the mechanisms by which these ortho-PCBs cause toxicity in fish are well understood. “Though much effort has gone into measuring the concentrations of ortho-PCBs in fish over the years, we still know little about how these chemicals might be interfering with normal cellular processes in fish,” says Hahn. This study will make use of molecular biological techniques to characterize the genes and proteins involved in ortho-PCB toxicity. Ultimately, this study will lead to the development of bioassays and biomarkers that can be used to study the presence and mechanisms of ortho-PCBs in marine and aquatic systems, which, in turn, will aid in assessing the impact of anthropogenic chemicals in the marine environment.



Tom Kleindinst, WHOI

“Though much effort that has gone into measuring the concentrations of ortho-PCBs in fish over the years, we still know little about how these chemicals might be interfering with normal cellular processes in fish.”

—Mark Hahn

Cover photos

Large photo: Sheri DeRosa, Woods Hole Sea Grant

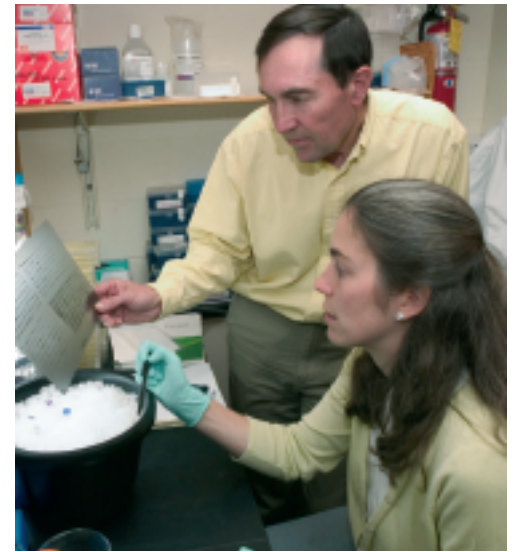
Top small: Dann Blackwood, USGS

Middle small: Jim O’Connell, Woods Hole Sea Grant

Bottom small: Web resource

Two Technologies, One HABs Detection Procedure

As the frequency, severity, and negative impacts associated with harmful algal blooms (HABs) increase worldwide, monitoring for the presence of harmful algal species and toxins becomes even more critical. This project combines the skills and expertise of two research laboratories in a collaborative effort to develop a cell detection and enumeration tool that can be used in the laboratory, on a ship, or built into an automated collection device. Don Anderson, a WHOI senior scientist and director of the U.S. National Office of Marine Biotoxins and Harmful Algal Blooms, specializes in the development of molecular probes to detect and count harmful algal cells. David Walt, a chemistry professor at Tufts University, has pioneered the use of fiber optic technology as a detection tool. Together, they have adapted fluorescence-based fiber optic microsphere technology to detect nucleic acids specific to one harmful algal species, *Alexandrium fundyense*. The first task of this project aims to lower the limit of detection from the current 200 cells per liter (cells/L) to 50 cells/L. Some HAB species can be dangerous at concentrations as low as 200 cells/L; in order to provide an early warning, monitoring programs must be able to detect such species at the lowest possible concentrations. The second task involves application of the fiber optic detection method developed for one species to several individual HAB species for which molecular probes are readily available. Lastly, collaborators will develop ways to analyze multiple HAB species simultaneously, using a single fiber bundle—a critical feature for locations in which multiple HAB species can occur, often at the same time. “The simplicity of this procedure and the ability to re-use the beads and fibers hundreds of times without the loss of sensitivity makes this technology a promising candidate for further development,” explains Anderson.



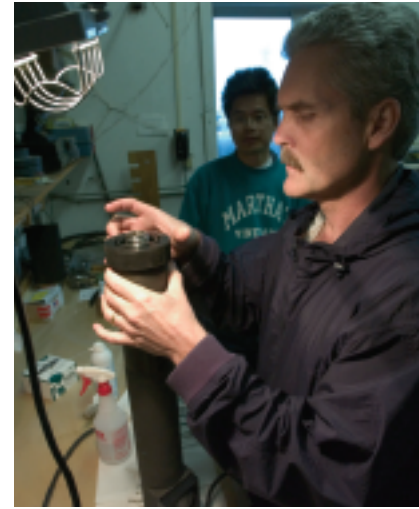
Vehicle Emissions and Atmospheric Deposition

Nitrogen pollution in coastal ecosystems can lead to eutrophication—a condition associated with degraded coastal habitat, changes to community structure, and increased occurrences and duration of harmful algal blooms. As inputs of nitrogen to coastal waters are on the rise—due in part to population growth in the coastal zone—coastal managers will require accurate and location-specific information about the contribution of nitrogen sources in order to make effective management decisions. This project investigates atmospheric deposition, perhaps the least understood and quantified source of nitrogen. (Estimates for some northeastern U.S. estuaries list atmospheric deposition as the source for up to 90 percent of all nitrogen inputs.) While most studies to date have focused on regional-scale deposition patterns, researchers will look at atmospheric deposition locally by measuring vehicle emissions around two Cape Cod embayments. Led by Cornell University professor Bob Howarth, author of several reports on nitrogen inputs to coastal estuaries, Cornell senior research associate Roxanne Marino, and Woods Hole Research Center scientist Eric Davidson, researchers will design a series of collection techniques to characterize the runoff of nitrogen from impermeable surfaces, where they expect atmospheric deposition to be high and retention to be very low. They will also look at the relative importance of wet and dry deposition along transects from the roadways. “If we find that the emissions of vehicles from local traffic prove to be an important source of nitrogen pollution to coastal waters,” says Howarth, “it may encourage a variety of policy approaches for reducing this source, including alternative transportation strategies, tightening of vehicle emission standards on SUVs and trucks, and treating road runoff.”



Compact Digital Imaging System Aids in Species ID

“The sparseness of species-level data is the single biggest impediment to development of accurate population models of marine organisms,” says Cabell Davis, a plankton biologist at WHOI. Currently available sampling methods—from traditional manual net, pump, and bottle collections to newer automated acoustical and video sampling systems—do not provide the kind of high-resolution abundance data at the level of species that is necessary for modeling and predicting populations. Davis is working with engineers at WHOI, MIT, and the Navy toward development of an autonomous multi-scale digital imaging system to identify and map distributional patterns of aquatic species of plankton, micronekton (shrimp, for example), and nekton (squid and fish, for example). “The new method will use holographic imaging technologies to capture high quality three-dimensional images for accurate species identification,” says Davis. The new imaging system will be compact so that it can be incorporated into robotic sampling platforms—such as autonomous underwater vehicles (AUVs)—for remote acquisition of species-level data. Such information is of critical importance to fisheries and water quality research and management.

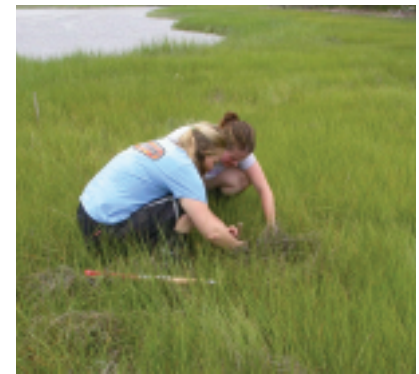


Tom Kleindinst, WHOI

estuarine & coastal processes

Oil Undercover: Ecological Effects of a 30-year-old Oil Spill

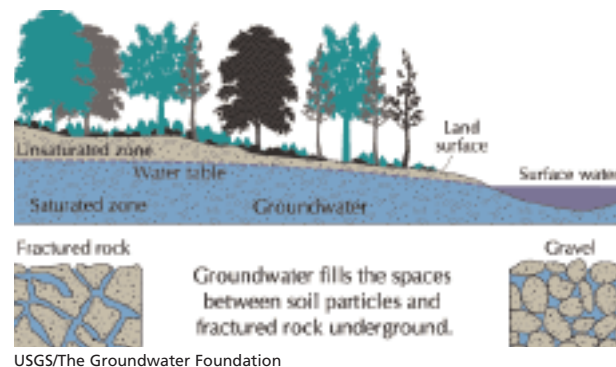
Since 1969, when the barge *Florida*, headed for the Cape Cod Canal, ran aground and spilled over 650,000 liters of No. 2 fuel oil on a pristine section of Cape Cod coastline, Woods Hole scientists have studied the salt marsh sediments for ecological effects and recovery. Immediate effects were devastating: large kills of fish, crustaceans, worms, mollusks, and other invertebrates extending from the shoreline out to depths of 7–10 meters and large areas of dead *Spartina* marsh grasses. In the first years after the spill, considerable oil content was measured in marsh and estuarine organisms, and consequent changes in species composition and benthic fauna density was recorded. Twenty years later, scientists found that aromatic hydrocarbons in surface sediments had largely disappeared, oil concentrations in organisms were much lower, and marsh grass recovery was well underway. Thirty years later, marsh vegetation surrounding Wild Harbor appeared healthy and no different from nearby, unaffected marshes. Yet cores collected in 2000 show substantial residue of No. 2 fuel oil below 10 cm in the salt marsh sediments. Could this subsurface reservoir of petroleum still be a source of ecological change? To find out, Boston University Marine Program professor Ivan Valiela and graduate students Ylva Olsen and Jennifer Culbertson are examining salt marsh biota for oil spill-related effects, as well as species most likely to be exposed to remaining oil, such as salt marsh grasses, fiddler crabs, and ribbed mussels. Using mass spectrometry, researchers will test whether resident organisms exhibit long-term bioaccumulation of oil and make comparisons across the trophic levels of the food web. Additionally, transplantation experiments will determine whether oil-free biota (cordgrass and mussels) respond to exposure at the oiled habitat to the same degree as the chronically-exposed biota. “We expect that our results will be useful to coastal resource managers and others involved in developing oil spill management plans, since we will be able to document the long-term effects not readily detected in short-term studies,” says Culbertson.



Anna Carter, Boston University Marine Program

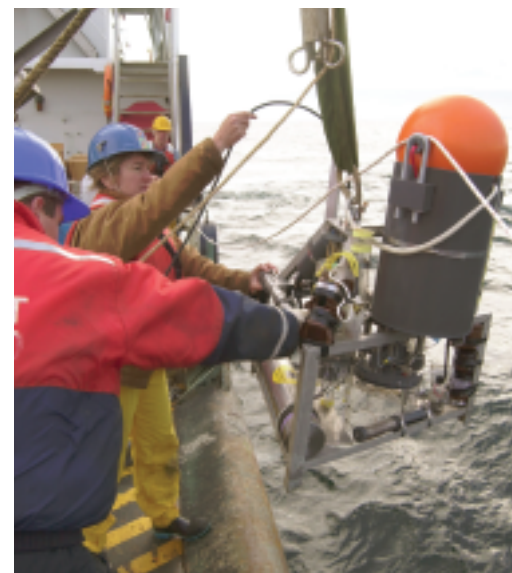
Undergrads Track Groundwater Pathways to Casco Bay

Groundwater refers to the water that usually lies beneath the surface of the land—in cracks and spaces in soil, sand, and rock—and moves through an aquifer on its way to a discharge point, typically a lake, river, estuary, or the coastal ocean. Tracking and quantifying groundwater discharge involves the use of natural geochemical tracers. WHOI geochemist Dan McCorkle has developed a radiocarbon-based approach to studying groundwater discharge into estuaries and the coastal ocean. Bowdoin College professor Ed Laine, working with undergraduate students, recently identified thin, near-bottom layers of low-salinity water in several parts of Casco Bay, Maine. Through this project, the researchers will team up to introduce Laine's students to a range of approaches designed to help them recognize and quantify submarine groundwater discharge (SGWD), while learning state-of-the-art techniques in environmental isotope geochemistry. Natural geochemical tracers—such as radium, radon, and C^{14} —provide researchers with tools needed to identify and quantify groundwater inputs to coastal and estuarine systems. This enables researchers to make connections between SGWD inputs and the transport of nutrients—and pollutants—from land-based sources. Developed for carbonate-dominated geological environments, common to the southeastern coastal U.S., this relatively new approach has never been used to estimate SGWD estimates in a hard rock setting. Casco Bay's bedrock environment presents such an opportunity. “Problems common to many coastal areas point to the need to better understand groundwater–surface water–seawater interactions,” explains McCorkle. Such problems include saltwater intrusion due to increasing demands on aquifers and nutrient loading of groundwater and surface water—and the subsequent discharge into estuaries and the coastal ocean. “Geochemical tracers can provide a valuable perspective on these interactions.”



Here Today, Where Tomorrow? Heavy Metals in Coastal Environments

Long before 1988, when presidential candidate George Bush declared it “the filthiest harbor in America,” the sediments and water quality of Boston Harbor have been scrutinized. In 2004, nearly four years after the region's sewage discharge was diverted from the harbor to a site nine miles offshore in Massachusetts Bay, scientists study the harbor with new questions: what do the sediments near the original discharge site look like today? have things improved? and what about sediments near the new outfall discharge? Bill Martin is part of a team of investigators sampling harbor and bay sediments to answer those questions. Martin, along with his WHOI colleagues Roger Francois and graduate student Linda Kalnejais, joined forces with a USGS Woods Hole Marine Field Center investigation led by Mike Bothner, whose data from the site goes back to the late 1970s. “Mike's data show that heavy metal concentrations in the harbor sediments have been decreasing,” explains Martin. “We want to know whether the decrease is due simply to dilution of polluted sediments by clean inputs, or rather, to transfer of the metals to other locations.” In an earlier phase of the study, also funded by Woods Hole Sea Grant, investigators collected and analyzed sediment cores from a harbor site (Hull Bay) and a Massachusetts Bay site (just west of the outfall) to get a better understanding of sediment cycling and factors controlling heavy metal cycling. The current phase focuses on metal cycling within the sediments, which appears to result in a concentrated layer of metals in the solid phase, near the sediment surface. “If that is the case,” says Martin, “metals could be re-suspended by bottom currents and transported



Dann Blackwood, USGS

elsewhere.” An expanded sampling program will include a third fine-grained sediment site, this one in Cape Cod Bay. Based on storm wind and sediment transport patterns, Cape Cod Bay may accumulate metals that have been remobilized from the Boston Harbor site. Researchers will investigate whether the sedimentary behavior of metals at the Cape Cod Bay site are similar to those at the outfall site in Massachusetts Bay. “What we find out will help us project the effects of anthropogenic metal release in the region and interpret future monitoring data,” says Martin. “And that information should be applicable to other urban coastal areas—a key goal of this project.”



fisheries & aquaculture

Fish Otoliths Contain Clues to Larval Distribution Mystery

How do you track a moving target? It depends on the size of the target. WHOI fish ecologist Simon Thorrold and research associate Jennifer FitzGerald are taking aim at a very small target: larval Atlantic cod (*Gadus morhua*). Like most marine fish, cod have a pelagic larval phase, meaning that their dispersal range is, potentially, quite wide. Understanding larval dispersal is critical to fisheries management for a number of reasons, including population connectivity and its direct correlation to colonization patterns of new habitats, the resiliency of populations to harvest, and the design of marine protected areas (MPAs). Developed for land-based species, traditional methods of tracking populations do not translate well to the marine environment. Mark-recapture approaches, for example, can be ruled out for a number of reasons: cod spawn millions of eggs, yet mortality is extremely high (some estimates are 99.9 percent egg mortality), making recovery of a tagged individual highly unlikely. Another approach, genetic tags, is also problematic in species with little genetic variation among populations. Recent work with fish otoliths, however, shows great promise as natural tag. Otoliths are formed through concentric additions—on a daily basis—of mineralized tissue around a central nucleus. Not only do these additions provide an accurate means of determining age and growth, their chemical composition reflects the chemical composition of the water that passed across the gills and intestinal membranes of a fish on that same day. Presently, elemental signatures can be measured in otoliths at spatial scales approaching that of daily increments. However, physiological effects, such as differences in growth rates, may decouple otolith composition from the chemistry of ambient waters in which the fish is living at any given point in time, compromising these signatures. Using mass spectrometry, investigators will develop methods to quantify new isotope systems that can serve as geochemical proxies for temperature in cod otoliths, and calibrate these systems with laboratory-reared cod larvae maintained at constant temperatures. Ideally, these tracers will be used to accurately reconstruct temperature histories of individual larvae, shedding light on a number of key unanswered questions for Atlantic cod populations and their management.

“Otoliths may provide a permanent record of water mass exposure throughout the life of an individual—from spawning until death.”

—Simon Thorrold



Simon Thorrold, WHOI

Otoliths are formed through daily additions of mineralized tissue around a central nucleus. These additions, as shown here on a bluefish otolith, resemble tree rings. Each “ring” represents a daily record of seawater chemistry.

Searching for Disease in All the Right Places

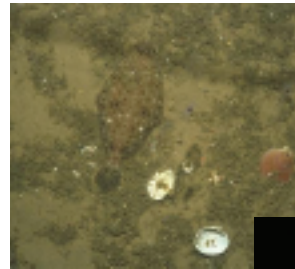
In 1995, significant mortality in cultured hard clams, or quahogs (*Mercenaria mercenaria*) from multiple sites in Provincetown and Duxbury, Massachusetts, devastated the local industry. Growers turned to Woods Hole researchers who, with emergency funding from Sea Grant, identified a parasite as the cause. Since that time, the parasite (named QPX for quahog parasite unknown) has been detected in cultured and wild clams in other northeast U.S. locations. While QPX research has led to many important discoveries about the parasite, important questions remain unanswered, including the environmental source of the QPX organism. One theory proposes that QPX is found naturally along all Atlantic coast sediments and infects hard clams during stressful environmental events. Recent studies suggest that, while climate stress and adaptation may play a part in the occurrence of the disease in some stocks, this may be only part of the story. Another theory suggests that QPX is present only in the fauna and/or sediment of specific bays or estuaries, or that QPX is associated with a specific alternate or carrier host. Using traditional histological and molecular tools, WHOI biologist Rebecca Gast and Marine Biological Laboratory pathologist Roxanna Smolowitz, along with colleagues from Virginia Institute of Marine Sciences and Roger Williams University, will screen for the presence of the QPX organism in samples of sediment, water, algae, and invertebrates from sites where QPX infections have occurred and where they have not. “This project will identify potential alternate hosts or environmental refuges that may harbor the QPX organism outside of the clam,” explains Gast. “Performing surveys at two distant sites—both impacted by the disease—helps to identify commonalities, and will assist [the industry and regulators] in developing aquaculture management plans.”



Rebecca Gast, WHOI

Taking the Guesswork out of Species Recognition

Defining essential fish habitat is a critical component of the Magnuson–Stevens Fishery Conservation and Management Act. Multi-species fisheries management requires an understanding of the critical habitat of all species in communities where commercially important finfish and shellfish stocks thrive. To date, habitats have been classified and characterized using acoustic techniques, sidescan sonar, remotely operated vehicles, video imaging, and submersibles. While all have important capabilities, they share an inability to characterize images to describe substrate and habitat automatically and rapidly. What is needed, says WHOI biologist Sanjay Tiwari, “is a set of automated image processing tools that can be trained to classify an infinite variety of habitats based on a scheme that we as humans consider important to benthic organisms.” The scheme of choice: texture. Working with fellow WHOI biologist Scott Gallager, they will first define the signatures of texture and color for each target species—accounting for variations in illumination, scale, and orientation—and then segment images into different textures, a process called texture segmentation. Next, they will develop a pattern recognition system, or classifier. The anticipated result—a robust algorithm for the segmentation of complex underwater images—will address a variety of needs in the oceanographic community, including habitat characterization and identification of pelagic and benthic flora and fauna.



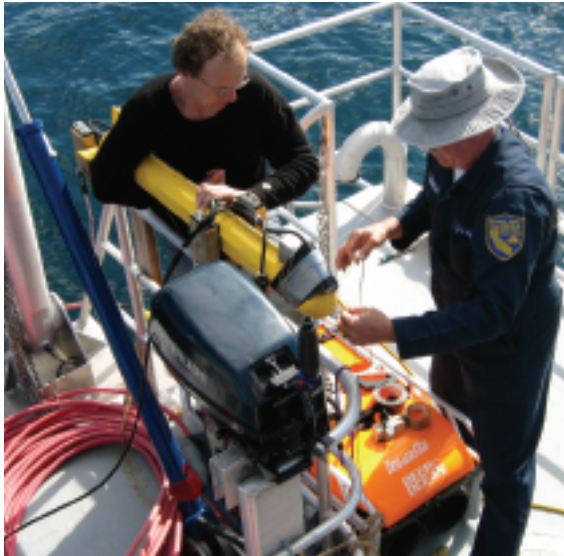
Page Valentine, USGS



Using texture as an indicator of species recognition, this image of a flounder, camouflaged against a sandy bottom, can be segmented and then classified by the pattern recognition system.

Acoustics Used to Find Squid Spawning Grounds

The west coast U.S. fishery for squid (*Loligo opalescens*) is valued at \$24–30 million annually and is estimated to be at or near maximum sustainable yield. Yet fishing pressure continues—in many cases, directly on sites of egg deposition. This disruptive practice, says squid biologist Roger Hanlon of the Marine Biological Laboratory, may significantly affect mate selection, egg laying, and even the viability of the egg capsules. Squids live only 6–12 months, thus successful annual recruitment to the fishery is mandatory. “Unlike other marine animals,” explains Hanlon, “squids offer a great advantage because they deposit egg capsules in large communal beds directly on the substrate. That allows us a direct measure of reproductive success, and provides a unique biological assay to begin to assess annual recruitment potential.” Hanlon, along with WHOI senior scientist Ken Foote, a leader in the ocean acoustics field, will configure, test, and utilize the latest acoustical technology to survey primary egg beds along the southern and central California coast and locate the primary inshore spawning grounds and egg beds over two



Ken Foote, WHOI

Co-principal investigator Roger Hanlon holds the sidescan sonar while California Department of Fish and Game Captain Raymond Michalski, attaches a video camera to the vehicle. The camera allows for visual ground-truthing while the sonar registers echoes from the seafloor and benthic organisms such as squid egg beds. The surface vessel platform is *R/V Shearwater*, owned and operated by the NOAA Channel Islands National Marine Sanctuary in Santa Barbara, CA.

fishing seasons. During the first phase of the project, investigators found a very suggestive association of backscattering pattern from side-scan sonar and occurrence of squid egg beds during the initial cruise in Monterey Bay. Similarly suggestive backscattering patterns were observed during a second cruise in southern California; this association was demonstrated during a third cruise in Monterey Bay. During Cruise 3, small numbers of lone males were seen scattered widely on the bottom, mainly in the general vicinity of eggs, while paired, spawning squids were sighted only occasionally. This unusual observation, says Hanlon, suggests that the operational sex ratio was far higher than observed over the previous three years in the same area—now heavily skewed towards males. Additional cruises will refine and extend the sampling methodology, and provide a broader-scale survey of the distribution of squid egg beds in Monterey Bay.

Outreach & Education

Woods Hole Sea Grant gears its outreach and education programs to citizens, educators and students, coastal decision-makers, and ocean science researchers—providing these groups with the tools and skills they need to make connections between ocean science information and ocean issues, in order to apply that knowledge to science-based decision-making.

Two if by Sea

Two if by Sea, the joint newsletter of the two Massachusetts Sea Grant programs, is one vehicle for sharing research results and news of education and outreach programs. Three issues each year help readers and the media stay informed of Sea Grant success stories.

Low Power Radio as an Outreach Tool

“Welcome to the village of Woods Hole. We know you're here because you're listening to this. We figured you might have a few minutes to kill, so we prepared a little something for you, to tell you about our town.”

So begins Sea Grant's low power radio (LPR) program that can be heard from the ferry parking lot on 1620 AM. Each year, 375,000 cars and 65,000 trucks travel by ferry from Woods Hole to Martha's Vineyard, passing through a staging area before boarding the ferry. Thus, the vehicle drivers and passengers are, essentially, a captive audience. Three 10-minute segments, produced by the local National Public Radio station, WCAI-FM, educate and inform locals and tourists about the town and its history.



Oceans Alive public lectures

Woods Hole is a world-class science town and Sea Grant's annual public lecture series, “Oceans Alive,” makes marine research accessible and interesting. Since 1989, the lectures have been bringing science to the community, giving scientists an opportunity to share their work with neighbors, colleagues, and students.

Workshops for educators

Ask educators what they like most about WHOI's “Topics in Oceanography” workshops and an answer you'll hear frequently is the opportunity to learn about exciting new marine research first-hand, as a way to advance their own personal knowledge of and interest in the field. Geared for middle and high school teachers, workshops offer access to marine scientists who share their work and enthusiasm in a small group setting, encouraging the participants and presenters to share questions, ideas, and experiences about research, science teaching, and exciting students about science by using the ocean as a hook.

Massachusetts Coastal Training Program

Sea Grant is a partner, along with Waquoit Bay National Estuarine Research Reserve and Massachusetts Office of Coastal Zone Management, in the Massachusetts Coastal Training Program (CTP)—part of a national effort to provide coastal decision-makers with the support, skills, and information they need to best manage coastal resources. By conducting a market analysis of training providers and a series of audience needs assessments, the Massachusetts CTP is identifying the training needs, interests, and preferences of coastal decision-makers so that training opportunities can be strategically coordinated statewide. For more information, see www.coastaltraining.org.



Courtesy, NE-COSEE



Q: *What do long-clawed hermit crabs look for when selecting a new shell?*

A: Shells coated with the stinging hydroid called **Snail Fur**, for protection from would-be predators.

Woods Hole Sea Grant's newest product, **Beachcomber's Companion**, is geared for beachcombers of all ages. The set of 50 field cards features marine invertebrates common to the Atlantic coast and provides identification information (features, size), where to find them (dead or alive), and cool facts. A website, www.beachcomberscompanion.net will offer additional web-only cards and links to other great beachcombing information.

Coastal Processes Extension

Woods Hole Sea Grant's Coastal Processes Extension program helps to identify the risks and impacts associated with the region's coastal natural hazards. Partners include U.S. Geological Survey (USGS), Cape Cod Cooperative Extension (CCCE), Massachusetts Coastal Zone Management (MCZM), the Cape Cod Commission, the Federal Emergency Management Agency (FEMA), and coastal communities throughout Massachusetts.

Shoreline Change

Woods Hole Sea Grant, working with USGS, CCCE, and MCZM, generated long-term shoreline change data along 856 miles of the Massachusetts shore. Working with the regional planning agency, the Cape Cod Commission, Woods Hole Sea Grant analyzed the data and produced a Barnstable County-wide map identifying erosion-prone areas as part of the FEMA-funded Pre-disaster Mitigation Initiative. Sea Grant Extension staff continue to actively work with local communities in identifying erosion control mitigation methods to reduce the environmental and economic impacts associated with shoreline change.



Jim O'Connell, Woods Hole Sea Grant/CCCE

Cape Cod Landforms and Coastal Processes Poster

Woods Hole Sea Grant, working with CCCE, produced a large-format poster to illustrate how coastal landforms function in response to coastal natural processes and the impacts that human activities impart on these beneficial functions. The poster expands science-based coastal processes knowledge that will lead to prediction of potential impacts from human activities along the shore and thus further protection of coastal resources.

Beach and Dune Profile Monitoring

Beaches, dunes and near-shore areas are the most dynamic areas on the face of the earth, changing constantly in response to winds, waves, tides, storms, relative sea level rise, and human activities. Yet the complex interactions that produce such changes are not well understood or documented. Recognizing this data gap in monitoring beach and dune changes, Woods Hole Sea Grant and CCCE established a volunteer monitoring program for beach and dune profiling. Volunteers—including citizens, waterfront homeowners, town officials, students, and teachers—monitor monthly, seasonal, and pre- and post-storm beach and dune changes at several Massachusetts beaches. The goal is to document changes and make correlations to long-term shoreline changes. A beach and dune profile monitoring training DVD has been produced to help train and expand participation in the project.



Jim O'Connell, Woods Hole Sea Grant/CCCE

Technical Assistance

Woods Hole Sea Grant's coastal processes outreach focuses on providing the most up-to-date scientific and technical information relating to erosion control, flooding, human impacts on the beneficial functions of coastal landforms, relative sea level rise, and other coastal issues. We routinely work in the field with local officials in identifying and suggesting alternatives to minimize potential impacts from proposed shoreline development. We also provide workshops, field trips, training, lectures and one-on-one discussions.



Sheri DeRosa, Woods Hole Sea Grant

Fisheries & Aquaculture Extension



With a focus on shellfish—important both commercially and recreationally—and nearshore coastal issues (e.g., eelgrass decline and water quality), Woods Hole Sea Grant serves a diverse group, including commercial shellfishermen, aquaculturists, natural resource managers, researchers, and citizens. Partners include Cape Cod Cooperative Extension (CCCE), the Southeastern Massachusetts Aquaculture Center, and the Barnstable County Shellfish Advisory Committee.

Oyster Restoration

In response to dwindling numbers of oysters, Woods Hole Sea Grant has worked in cooperation with CCCE to restore banks of oysters along the shores of Cape Cod. Juvenile oysters, spawned in a hatchery and attached to pieces of shell, have been deployed in nine towns. These oysters provide valuable habitat and may improve water quality—and eventually a nice catch for a fisherman.



Assessment of Shellfish Habitat

Woods Hole Sea Grant has helped to develop a simple, inexpensive means of assessing and comparing habitats in terms of shellfish survival and growth. This tool allows shellfish growers and natural resource managers to identify optimal sites for shellfish. A training DVD describing this assessment tool will soon be available.

Management of Shellfish Diseases

While the region's shellfish diseases do not affect human health, they pose a significant hurdle to shellfish farmers and to sustainable management of the public shellfisheries. Woods Hole Sea Grant is working with growers, resource managers, and scientists to develop reasonable protocols for movement of shellfish as well as improved culture methods to reduce losses.

Eelgrass Restoration

To stem the tide of decline of eelgrass beds across the region, the program is exploring several methods of restoration of this valuable habitat. Most recently, Woods Hole Sea Grant has initiated a field test of planting eelgrass seeds. Seeds, collected from flowering stalks, are harvested and planted in promising areas.



Fisheries and Aquaculture Extension photos by Bill Walton, Woods Hole Sea Grant/CCCE

Assistance to the Massachusetts Shellfish Aquaculture Industry

Woods Hole Sea Grant works closely with shellfish farmers, providing technical advice and information on issues of concern such as predator management, control of diseases and marketing issues. Recently, we assisted with the authoring of Best Management Practices for the industry as well as development of a regional campaign to identify Cape Cod and Islands cultured shellfish.



**Woods Hole Oceanographic
Institution
Sea Grant Program**

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