

Woods Hole Oceanographic Institution

SEA GRANT PROGRAM



1994-1996 Project Guide

RESEARCH

During the 1994-1996 funding cycle, the Woods Hole Oceanographic Institution (WHOI) 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. Many of the projects address local and regional needs while others have national or even global implications. A major by-product of this research is outreach, in the form of publications, workshops and lectures. Since 1973, WHOI Sea Grant support has resulted in over 500

scientific publications including journal articles, theses, books and maps.

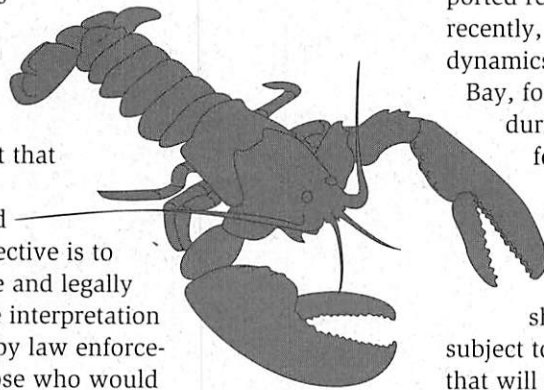
Research and outreach efforts involve the following research and academic institutions, as well as private industry: Woods Hole Oceanographic Institution, Marine Biological Laboratory, University of Pennsylvania's Laboratory for Marine Animal Health, University of Massachusetts at Dartmouth, Medical University of South Carolina, Tufts University, Molecular Probes, Inc., and Hydros, Inc.

FISHERIES AND AQUACULTURE

► Development of Laboratory and Field-Based Techniques for the Detection of Illegally Altered Lobsters

Robert A. Bullis and Roxanna M. Smolowitz, Laboratory for Marine Animal Health, University of Pennsylvania at Marine Biological Laboratory, Woods Hole.

The illegal practice of dipping female, "berried" lobsters in chlorine to remove their eggs has, according to recent reports, become increasingly widespread within the fishery. Up to now, a staining test of the swimmerets that can detect animals whose eggs have been removed by scrubbing has been successful in exposing and limiting the illegal use of berried females. The process of chlorine dipping, however, avoids detection by this method. WHOI Sea Grant is supporting the research and development of a field-based test that would be capable of detecting chlorine-dipped animals. The overall objective is to provide a comprehensive and legally sound framework for the interpretation of guilt or innocence — by law enforcement personnel — of those who would



illegally remove berried females from the fishery. Once a testing mechanism has been established, a technical manual will be prepared outlining techniques, procedures and interpretations for use by the regulating agencies who monitor the lobster fishery.

► Toxic Red Tides in Massachusetts Bay: Nearshore Processes and Transfer of Toxins Through the Pelagic Food Web

Donald M. Anderson, Woods Hole Oceanographic Institution and Jefferson T. Turner, University of Massachusetts at Dartmouth.

For the past several years, WHOI Sea Grant has supported research on toxic dinoflagellate blooms. Most recently, efforts have focused on understanding the dynamics of toxic dinoflagellate blooms in Massachusetts Bay, focusing on management issues that have arisen during the construction of a controversial new outfall for sewage effluent. This area experiences recurrent episodes of Paralytic Shellfish Poisoning (PSP) and is poorly studied with respect to bloom dynamics of toxic *Alexandrium* species. Also, it is "upstream" from important offshore shellfish resources on Georges Bank that are now subject to PSP toxicity, and "downstream" from the outfall that will discharge up to 1.2 billion gallons per day of

The Woods Hole Oceanographic Institution (WHOI) Sea Grant Program supports research, education, and advisory projects to promote the wise use and understanding of ocean and coastal resources for the public benefit. 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 and industry.

Since 1973, WHOI Sea Grant has channeled the expertise of world-renowned ocean scientists toward meeting the research and information needs of users of the marine environment, especially in Massachusetts.

FISHERIES AND AQUACULTURE

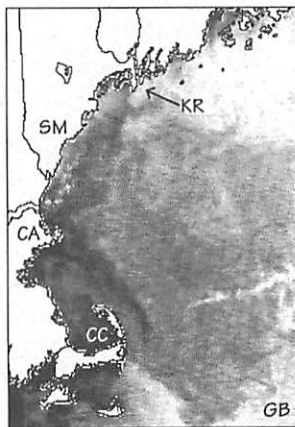
effluent beginning in 1995 or 1996. Current research will provide data both before and after sewage effluent is diverted from Boston Harbor and is instead released from the controversial outfall nine miles offshore in Massachusetts Bay. Also, the manner in which PSP toxins accumulate in different zooplankton size fractions and fish known to be preferred food for humpback and right whales that feed in the Bay will be investigated. Knowledge gained from this study will help assess possible effects of the change in effluent discharge within the Bay with respect to *Alexandrium tamarense* bloom dynamics and the transfer of PSP toxins through the food chain.

► Biomarkers of Reproductive Damage in Coastal Shellfish Populations from Contaminated Habitats

Dale F. Leavitt and Judith E. McDowell,
Woods Hole Oceanographic Institution.

The ecological effects of "in place" toxins is a problem for many coastal ecosystems as sediment reservoirs of contaminants such as PCBs and PAHs may be a long-term source even after significant reduction in point-source inputs has been achieved. This Sea Grant-supported study will provide quantitative assessments on the effects of petroleum hydrocarbons on population processes of a valuable commercial resource, the soft shell clam *Mya*

arenaria. Through field collections and laboratory analyses, this study will allow predictions of changes in population parameters of this species with improvements in water and sediment quality. Also, this study will apply data to a demographic model assessing the interactive effects of contaminant exposure and other environmental variables on population dynamics of soft shell clam populations.



NOAA Coastwatch satellite image of sea surface temperature, on May 23, 1992, at 3 a.m. A warmer (darker) coastal current or plume formed principally from spring runoff from the Kennebec River (KR) in southern Maine (SM) and the Merrimack River near Cape Ann (CA) in Massachusetts was detectable in the imagery. The toxic dinoflagellate *Alexandrium* sp. has been shown to be associated with the less-saline, warmer (darker) surface waters of the plume. The plume extends several hundred kilometers

along the coast from the Kennebec River (KR) in Maine to the east of Cape Cod (CC) affecting nearshore shellfish and may also potentially impact shellfish resources on Georges Bank (GB) as it travels south and further offshore.

MARINE POLICY

► Public Risk Perception and Coastal Flood Insurance

Yoshiaki Kaoru, Graham S. Giese, and Di Jin,
Woods Hole Oceanographic Institution.

Coastal storms, sea level rise, and erosion represent continuous threats of flood damages to coastal residents. To date, most attention of storm and flood impacts has been devoted to monetary damages to residential and commercial properties. Flood risk as perceived by the public has not been systematically investigated, despite the fact that the public's perception of risk significantly influences policy decisions. If the risk of coastal flood as perceived by the public significantly deviates from flood risk estimated by scientists, policy makers need to decide how to weigh public risk perceptions and those of scientists in making coastal management policies. This Sea Grant-supported economic analysis will estimate the flood risk perception of coastal residents, compare these perceptions with those of expert scientists, and measure how individual socio-economic characteristics and flood risk information influence the public's willingness to pay to insure against future flood damages. The results of this project will determine the importance of public risk aversion and lead to better risk communication between the public and scientists and, as no systematic information about public perception of coastal flood risk cur-

rently exists, the results will be of use to local, state and federal coastal resource managers.

► An Optimal Risk Sharing Strategy for Marine Oil Transport

Di Jin, Hauke L. Kite-Powell, and John W. Farrington,
Woods Hole Oceanographic Institution.

Under the Oil Pollution Act (OPA) of 1990, oil carriers effectively face unlimited liability in U.S. waters. Attempts by the U.S. federal government to implement regulations in keeping with OPA 90 have led to an impasse as the established marine insurance industry refuses to back certificates of financial responsibility under OPA 90. All tankers coming into U.S. ports must have such a certificate. Under this project, researchers will develop an analytical model, based on economic theory and a review of relevant factors in environmental law, damage assessment, and marine insurance, to determine the optimal level of risk sharing (liability limits) in marine transportation of oil. Also, researchers will apply the model, using empirical data on oil transport markets and spill damage assessment, to develop preliminary guidance regarding an optimal liability limit. This study will provide analytically defensible suggestions for an economically optimal level of liability to help resolve this impasse.

MARINE BIOTECHNOLOGY

► Molecular Probes for Cytochrome P4501A: Provision and Use in Chemical Effects in Research and Monitoring

John J. Stegeman, Woods Hole Oceanographic Institution.

Detecting and interpreting the significance of chemical effects on marine biota continues to be an important environmental and scientific issue. These studies involve the use of highly specific molecular probes for establishing the degree, sites of action, and significance of effects of critical environmental contaminants. Continuing Sea Grant support for studies of a family of enzymes, cytochrome P4501A, yield important clues about contaminant detection. This project will produce, evaluate and provide highly specific molecular probes for establishing details about marine environmental contaminants and their effects. The assessment and interpretation of chemical effects in resident biota in estuarine and marine resource species will be greatly enhanced by methods for examining cytochrome P4501A regulation in specific cells. The approaches and probes may be applied in biomarker analysis of commercial, endangered and rare species, to conclusively address questions of chemical effects in the marine environment.

► Detection and Quantification of Harmful Species Using Molecular Probes: Phase II

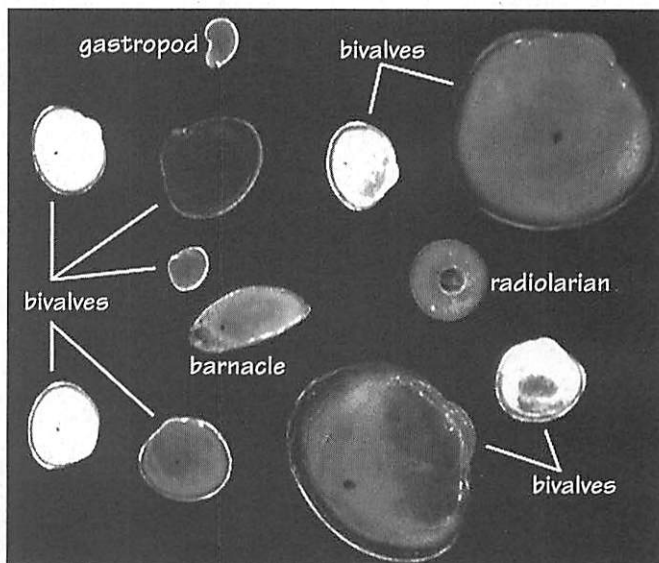
Donald M. Anderson, Woods Hole Oceanographic Institution; Victoria L. Singer, Molecular Probes, Inc.; and Gregory J. Doucette, Medical University of South Carolina.

Over the last two decades, the economic and public health impacts from harmful algal blooms ("red tides") have increased dramatically in the United States and throughout the world. One result of this expansion is that regulatory officials and the fishing industry now face a broad array of affected species spanning all levels of the food chain, many of which can be contaminated by several different toxins. These changes have forced a major reevaluation of strategies to monitor seafood products for marine biotoxins, now a time-intensive and costly process. This project — a collaboration between academia, commercial interests, and a federal marine biotoxins and seafood safety program — will investigate two promising approaches to the rapid and accurate detection and enumeration of harmful algal species, with the goal of developing molecular probe-based assays that can be used in the laboratory and the field by personnel with varied levels of technical expertise.

► Development of Species-Specific Immunofluorescent Markers for Larvae of Benthic Invertebrates

Cheryl Ann Butman and Elizabeth D. Garland, Woods Hole Oceanographic Institution.

The need for easy, rapid, reliable identification of benthic invertebrates and other small, morphologically indistinguishable marine organisms at the larval stage is undisputed. The recent addition of molecular methods to the arsenal of techniques for use in species identification is revolutionizing systematics, ecology and applied science; such methods are sure to improve the state of larval taxonomy. This project will develop species-specific immunofluorescent markers for broad-scale applications in processing large numbers of field samples for planktonic larval distributions. Proving the concept and application of immunofluorescent, species-specific markers for the identification of planktonic larvae would be invaluable for monitoring environmental quality (as "biosensors" for early detection of environmental deterioration or other biological hazards); for in situ aquaculture (identification of potential food items, predators and competitors or the targeted culture species); for ecosystems research (providing information on the biggest black box in the system, larval supply); for fisheries management (providing critical information for analyses of food-web relationships); and for early detection of invasions of exotic species that may displace local dominant endemics.



During the planktonic larval phase, different species of bivalves—several of which are shown here—are extremely difficult to identify, due to subtle differences in shell shape and hinge structure. With Sea Grant support, researchers are working to develop species-specific fluorescent probes, that would enable biologists to quickly identify organisms beyond the level of major taxonomic group, to a level that has greater ecological significance and impact.

PUBLIC OUTREACH & 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-



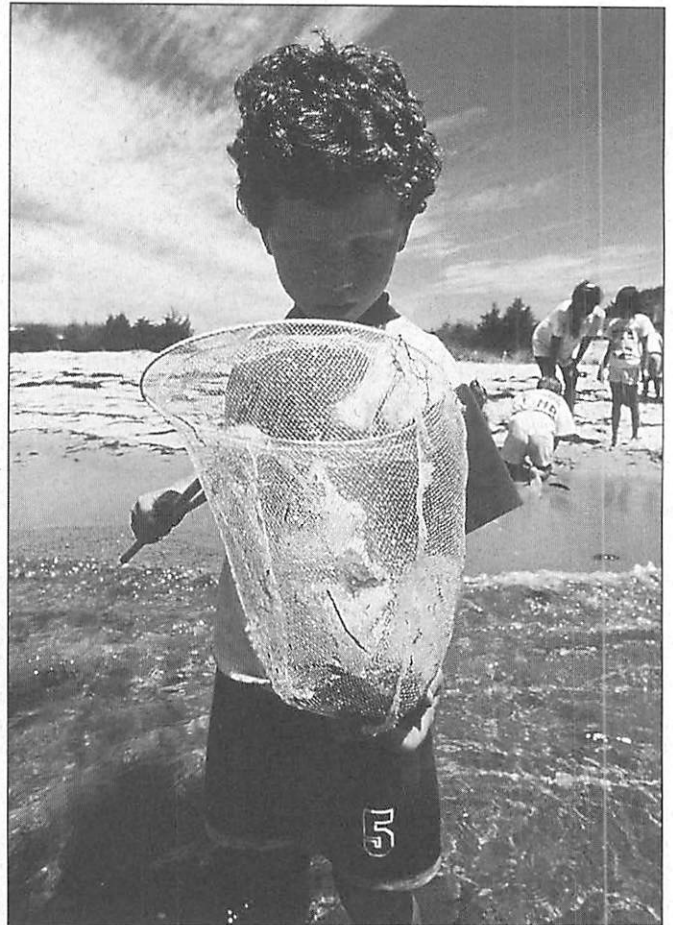
WHOI Sea Grant sponsors an annual, community-wide storm drain painting project. Hundreds of storm drains have been stenciled with the message "Don't Dump. Drains to Ocean."

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 we interact with 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 annual public lecture series, "Oceans Alive;"
- On-line accessibility to WHOI Sea Grant information and resources, as well as pointers to other useful information, via Mosaic and Gopher applications, for Internet users;
- 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 availability of the new WHOI Sea Grant publications catalog;
- Co-sponsorship, along with Massachu-

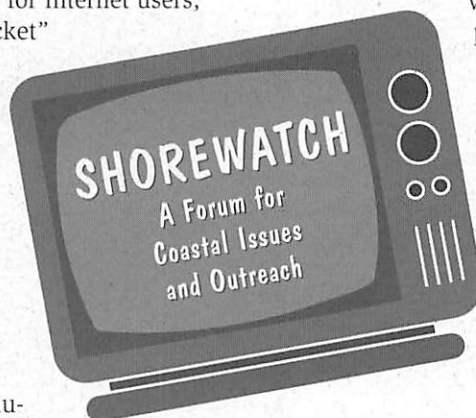


A "Sea Urchin" examines his catch while exploring the seashore at Nobska Beach, Woods Hole. The program encourages a "hands-on, get-wet-and-muddy" philosophy to introduce children to the environment.

sets Coastal Zone Management (MCZM), of the cable access television series "SHOREWATCH: A Forum for Coastal Issues and Outreach," now reaching a potential audience of over one million viewers throughout Massachusetts and California;

- Organizing and participating in events throughout the year such as annual beach cleanups and guided coastal walks during "Coastweeks;" storm drain painting projects to inform citizens of the dangers associated with dumping waste down storm drains; feature articles in *Nor'easter* magazine, a regional Sea Grant publication, as well as contributions in numerous marine educational newsletters and magazines;

- WHOI Sea Grant's involvement in several annual educational events, including local science and technology fairs, conferences, and symposia.



COASTAL PROCESSES

► Ecologically-Based Environmental Management

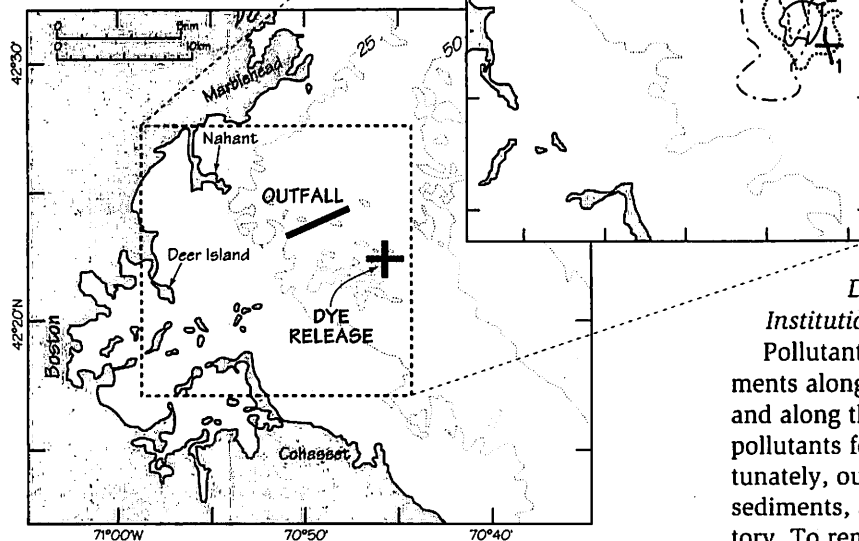
*Brian L. Howes and Dale D. Goehringer,
Woods Hole Oceanographic Institution.*

This Sea Grant-supported study is designed to encompass all of the major ecological processes dominating the water quality and productivity of a coastal system, Nantucket Harbor: nutrient conditions, high frequency oxygen monitoring, groundwater inputs, sediment nutrient regeneration, circulation, submerged macrophyte production, and fish, shellfish and infaunal populations. By choosing Nantucket Harbor as the study site — a healthy system which has only recently begun to show signs of nutrient-related stress in some of its associated, smaller water bodies — researchers will have a basis for comparison to the many studies that look at already eutrophied waters. Also, this study represents a new approach to coastal water quality management in that it seeks to manage coastal waters at the ecosystem level, and is designed to represent a model upon which management plans for other coastal communities can be based.

► Boundary Mixing in Massachusetts Bay

*Wayne R. (Rocky) Geyer and James R. Ledwell,
Woods Hole Oceanographic Institution.*

As a follow-up to a 1992-1994 Sea Grant-supported study, investigators will: determine the rate of vertical mixing across the thermocline in a



Rhodamine dye was released into Massachusetts Bay in the shape of a '+' in August, 1993. The vertical and horizontal spreading of the dye was monitored for the next 4 days. Horizontal spreading of the dye is depicted in the inset (numbers correspond to days, 1 being the deployment day). The spreading of the dye patch allows the mixing rates of the Bay to be quantified, which will lead to more accurate estimates of the dilution and transport of the sewage effluent.

boundary region of Massachusetts Bay through a controlled dye release; determine mechanisms responsible for the mixing; and determine the contribution of boundary mixing to the overall vertical exchange rate in the bay. Completion of these objectives will provide better understanding of nutrient exchanges and enable investigators to quantify the transport of natural and anthropogenic materials across the nearshore zone. Also, this study will add to the understanding of how the controversial Boston Harbor sewage outfall, now under construction, will impact Massachusetts Bay.

► Benthic Processing of Sewage Additions: Controls of Denitrification in High Energy Environments

*Anne E. Giblin and Charles S. Hopkins, Jr.,
Ecosystems Center, Marine Biological Laboratory.*

Another continuing project taking place in Massachusetts Bay related to the multi-million dollar Boston Harbor sewage outfall project, this study investigates the importance of benthic processing of sewage inputs into coastal waters. By looking at and comparing benthic environments with fine grained and coarse grained sediments — the latter considered a "higher energy environment" due to more intense mixing and flushing — the project will

yield information such as whether different treatment options are more appropriate in some sedimentary environments than others. These results will be of use to coastal communities involved in developing nutrient loading bylaws. In addition, the project will provide information on the basic controls of benthic nutrient regeneration that are essential for further development of a linked hydrodynamic and water quality model for Massachusetts Bay.

► Tidal Flat Deposition: Processes and Rheology

David G. Aubrey, Woods Hole Oceanographic Institution.

Pollutants are known to accumulate with fine sediments along the coastal zone, within estuaries, in lagoons and along the open coast. The fate of some of these pollutants follows the fate of these fine sediments. Unfortunately, our present ability to predict transport of fine sediments, and therefore certain pollutants, is unsatisfactory. To remedy this problem, researchers will develop a consistent theoretical methodology to examine fine sediment deposition in tidal flats, areas that commonly surround heavily polluted harbors. The approach is to combine divergent methodologies of hydrodynamic modeling (tidal propagation and nonlinear interaction) with improved models of rheology and accurate field observations.

MARINE ADVISORY PROGRAM

Graham S. Giese and Dale F. Leavitt,
Woods Hole Oceanographic Institution.

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 Advisory Program facilitates communication among users and managers of marine resources, including members of the fishing community, local officials, environmental regulatory agencies and the public:

- *The Directory of Cape and Islands Coastal Outreach Organizations* is a compilation of local, private, and public organizations that regularly deal with issues pertaining to the coastal and marine environment.

- MOGNET is a computer-based network designed to (1) link together and provide communication between the region's environmental outreach organizations, and (2) provide access by those organizations to new research results and synthesis of existing knowledge available on the global Internet system.

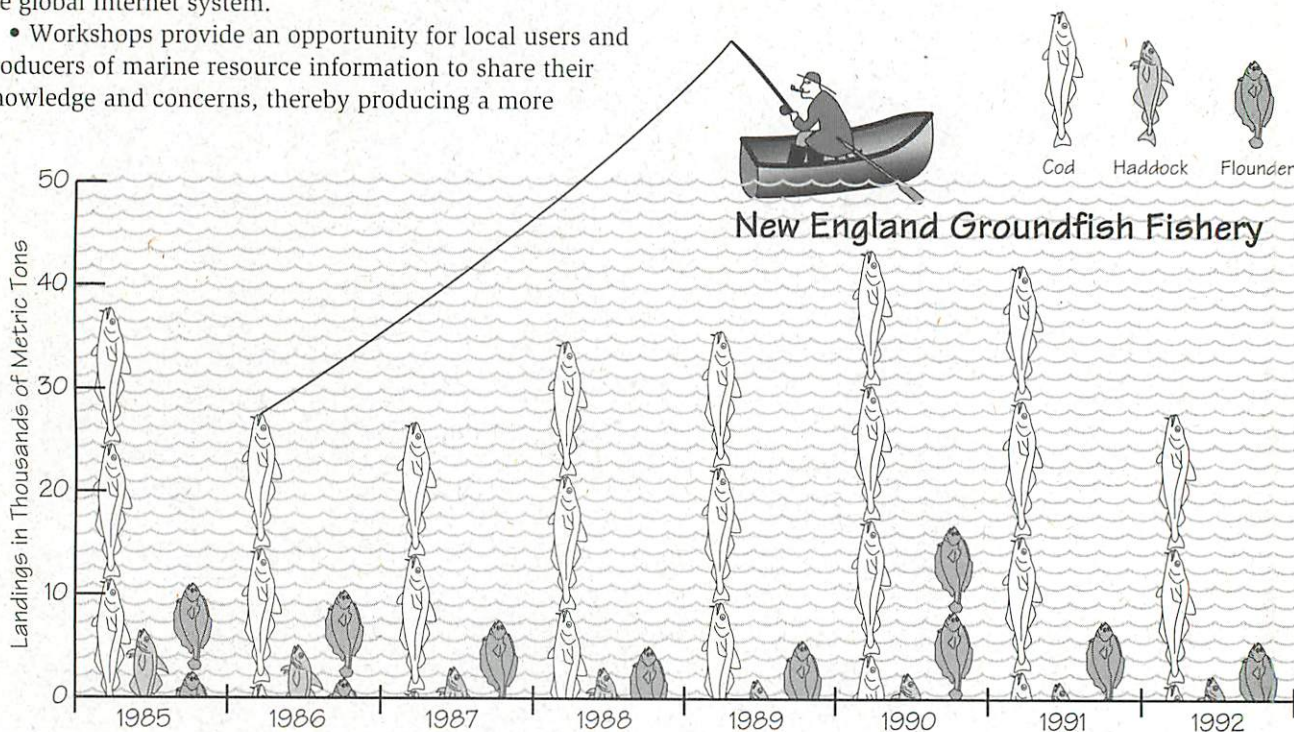
- Workshops provide an opportunity for local users and producers of marine resource information to share their knowledge and concerns, thereby producing a more

efficient and effective resource management system.

Two areas of particular interest in the region, and therefore main focus areas of the WHOI Sea Grant Marine Advisory Program, are:

- **Fishing & Aquaculture**—two interrelated areas where our outreach efforts have been required. With the proposed fishing restrictions soon to be enacted in the Northwest Atlantic Ocean, many New England fishermen are looking to marine aquaculture as a means to provide an income while allowing them to continue to derive their livelihood from the sea. The WHOI Sea Grant Marine Advisory Program has been providing assistance to potential aquaculturists by conducting literature searches and providing grant writing and technological advice and referrals to help them optimize their farming efforts.

- **Coastal Processes**—another major focus of our outreach activities. In particular, we are striving to maintain or restore the sustainability of the region's salt marshes, beaches, dunes, and barrier beaches.



Sea Grant Program, Woods Hole Oceanographic Institution

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