

# *Woods Hole Sea Grant in the 21st Century*



**A Strategic Assessment  
of Issues and  
Opportunities**





**W**oods Hole Sea Grant in the 21st Century: A Strategic Assessment of Issues and Opportunities is the Woods Hole Sea Grant Program's plan to address local, regional, and national issues and opportunities over the next several years. The plan identifies marine-related issues of importance, institutional resources, and potential partnerships in the Commonwealth of Massachusetts and the Northeast region of the U.S.

Massachusetts is one of only two states that has a Sea Grant College Program and a Sea Grant Institutional Program. The Sea Grant College Program in Massachusetts is located at the Massachusetts Institute of Technology, while the Sea Grant Institution Program is located at the Woods Hole Oceanographic Institution (WHOI). The two programs coordinate solicitation of research proposals throughout Massachusetts, serve in an advisory capacity to each other's research review panels and outreach guidance committees, and collaborate wherever possible in extension and outreach activities.

In order to continue a successful history of developing collaborative, interdisciplinary research programs, Woods Hole Sea Grant solicited ideas from its advisory board, the Marine Outreach Guidance Group, as well as coastal scientists, managers, regulators, and business and environmental group representatives throughout the Commonwealth. In developing this plan, consideration was given to scientific merit, degree of community concern, relevance to the National Sea Grant College Program goals, opportunity for inter-agency collaboration, and degree of public benefit. Issues and opportunities were also assessed on the basis of their relevance to other agency goals and strategic plans.

*Woods Hole Sea Grant in the 21st Century: A Strategic Assessment of Issues and Opportunities* represents the collective concerns of the Massachusetts marine community at all levels. It highlights important marine issues and research needs, suggests investigative approaches, and proposes research-based outreach programs. Perhaps most importantly, this plan serves as a catalyst for creative thinking and identifying new opportunities.

*Judith E. McDowell*

Judith E. McDowell  
Director, Woods Hole Sea Grant

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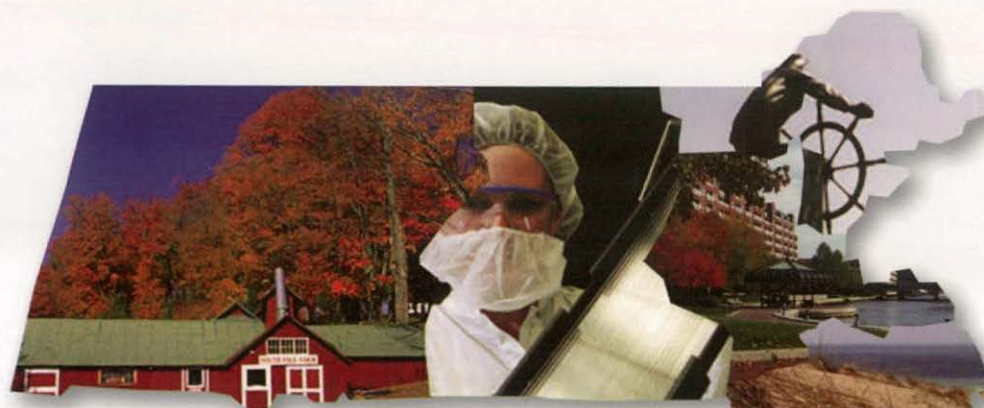
## Sea Grant in the Commonwealth of Massachusetts

The Commonwealth of Massachusetts is one of the smallest states in the U.S. with only 8,257 square miles of total area, yet it is also the third most densely populated state, with a population of over 6.3 million people (*U.S. Census Bureau, 2000*; [quickfacts.census.gov/qfd/states/25000.html](http://quickfacts.census.gov/qfd/states/25000.html)). In particular, the coastal communities of Cape Cod, the islands of Martha's Vineyard and Nantucket, and the South Coast have seen dramatic growth when compared to the rest of the state: populations in these coastal communities represent one-third of the total population.

The Commonwealth's 1,980 miles of coastline include extensive wetlands, tidal flats, and salt marshes, totaling 12 percent of the landmass. The Massachusetts coast is one of the most valuable natural and economic resources of the Commonwealth, providing jobs, transportation, and recreation to residents and visitors. There are 27 distinct watersheds within Massachusetts and critical issues related to the protection of these watersheds include wise planning of both land and aquatic resources.

*The Sea Grant Program at the Woods Hole Oceanographic Institution provides critical information to help understand and protect our marine environment. Through research, outreach and educational activities, the Sea Grant Program continues to develop innovative approaches to better manage our ocean resources.*

—John Kerry, U.S. Senator, Massachusetts



The communities in **central and western Massachusetts** have replaced many traditional manufacturing operations with new industries, such as biotechnology and fiber optics development.

The **northeastern region** of the state has seen a transition: textile mills along the banks of the Merrimack River have been replaced by high-technology electronics companies.

**Metro Boston** is a center of educational institutions, financial service companies, medical centers, and advanced technology centers.

**Southeastern Massachusetts**, including Cape Cod, the islands of Martha's Vineyard and Nantucket, and the South Coast, is the center of marine science related industries, including marine instrumentation, fishing, aquaculture, and tourism

Despite its small geographic size, the Commonwealth of Massachusetts has many diverse communities—cities, colonial villages, historic mill towns, and rustic farmlands. The economic base of these communities is equally diverse.

Massachusetts continues to show strong economic growth in the 21st century. The Corporation for Enterprise Development's *State Asset Development Report Cards* for 2001–2003 ([sadrc.cfed.org](http://sadrc.cfed.org)) show Massachusetts as a leader in economic performance, business vitality, development capacity, and education, building on the area's strengths: knowledge-based economy, highly educated work force, high quality of life in communities, increased global trade, and industry clusters that share resources.

The Massachusetts marine economy—providing nearly 82,000 jobs, or 2.5 percent of the state's workforce—is responsible for \$1.9 billion in earnings. Jobs in this sector are distributed in commercial seafood industries, marine transportation, tourism, recreation, marine technology and education, and coastal construction and real estate. Current estimates of various marine related industries are listed below.

#### Annual Value of Some Marine-related and Other Industries in Massachusetts<sup>a</sup>

Recreational Fishing <sup>b</sup> :	\$500 Million to \$1.1 Billion (1998-2004)
Tourism <sup>c</sup> :	\$11.1 Billion (2003)
Agriculture <sup>d</sup> :	\$384 Million (cranberries account for 20% of this total; 2002)
Forest Products <sup>e</sup> :	\$580 to \$845 Million (2003)
Commercial Fishing Landings <sup>f</sup> :	\$585 Million (2003)
Commercial Fishing Support <sup>g</sup> :	\$132 Million (1997)
Commercial Fishing Salaries <sup>g</sup> :	\$659 Million (1997)
Mining (sand & gravel) <sup>g</sup> :	\$71 Million (2003)
Aquaculture <sup>d</sup> :	\$9.5 Million (2002)
Coastal Construction & Real Estate <sup>k</sup> :	\$177 Million (1997)
Marine Instrumentation <sup>k</sup> :	\$239 Million (1997)
Marine Transportation <sup>h</sup> :	\$235 Million (1997)
Biotechnology <sup>k</sup> :	\$6.7 Billion (2001)

a Figures represent most current data available; they do not reflect associated economic multipliers.

b National Marine Fisheries Service (Steinback, et al, 1998), Massachusetts Division of Marine Fisheries (2004)

c Massachusetts Office of Travel and Tourism (2003)

d US Department of Agriculture, National Agriculture Statistics Service (2002)

e Massachusetts Forest Products Association

f National Marine Fisheries Service, Annual Commercial Landings Statistics (2003)

g The Mineral Industry of Massachusetts (2003)

h EconData.net (1997)

i University of Massachusetts Donahue Institute (2000)

j Massachusetts Biotechnology Council (2004)

k Massachusetts Ocean Management Task Force Report, [www.mass.gov/czm/momi/finalrpts.htm](http://www.mass.gov/czm/momi/finalrpts.htm) (2004)



*Woods Hole Sea Grant is a valuable partner in efforts to educate our local citizenry about the coastal and marine environment. My constituents have benefited greatly from the training sessions and other outreach events that focus on important issues facing the region.*  
—Therese Murray, State Senator, Massachusetts





*I am continually impressed with the program's commitment to supporting marine research, technology development, and outreach efforts that will best serve the needs and interests of the Commonwealth of Massachusetts.*  
**—Matthew Patrick, State Representative, Massachusetts**

In spite of recent economic growth and prosperity in these industrial sectors within Massachusetts, there are concerns that need to be addressed to endure future growth and prosperity, especially in Southeastern Massachusetts, Cape Cod, and the Islands. These issues include education and job training, expanded infrastructure for emerging and expanding industries (e.g., aquaculture, biotechnology, and communications), and balanced and sustained growth. In 2003, Massachusetts undertook an extensive review of ocean industries and use conflicts within its coastal waters; a task force made its recommendations in the 2004 report, *Waves of Change, the Massachusetts Ocean Management Task Force* ([www.mass.gov/czm/momi/finalrpts.htm](http://www.mass.gov/czm/momi/finalrpts.htm)).

Many of the challenges identified in the Commonwealth mirror those facing coastal regions throughout the U.S.—discussed extensively in the Pew Oceans Commission report *America's Living Oceans: Charting a Course for Sea Change*, and the U.S. Commission on Ocean Policy report *An Ocean Blueprint for the 21st Century*. These documents have been used extensively in discussions shaping the strategic planning process for Woods Hole Sea Grant.

Likewise, Sea Grant's parent agency, NOAA, in its 2005–2010 strategic plan, identified four mission goals:

- (1) Protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach to management
- (2) Understand climate variability and change to enhance society's ability to plan and respond
- (3) Serve society's needs for weather and water information
- (4) Support the nation's commerce with information for safe, efficient, and environmentally sound transportation



Additionally, NOAA has selected five priorities:

- developing, valuing, and sustaining a world-class workforce
- integrating global environmental observation and data management
- ensuring sound, state-of-the-art research
- promoting environmental literacy
- exercising international leadership

These cross-cutting issues are further integrated within the theme approach outlined in Sea Grant's *Strategic Plan for FY2003-2008 and Beyond*. Collectively, these documents guided the development of Woods Hole Sea Grant theme areas and delineate the most important tasks to meet local, regional, and national needs.

## Sea Grant at the Woods Hole Oceanographic Institution

Woods Hole Sea Grant is based at the Woods Hole Oceanographic Institution (WHOI). WHOI is the largest independent oceanographic research laboratory in the world, established in 1930 with a grant from the Rockefeller Foundation following the recommendations of a National Academy of Science committee. Nearly 50 percent of the Institution's current operating budget of \$127 million is supported by federal research grants, awarded through a competitive process.

Most of the Institution's investigators are based in five science departments: Applied Ocean Physics and Engineering, Biology, Geology and Geophysics, Marine Chemistry and Geochemistry, and Physical Oceanography. Economists and other social scientists at WHOI's Marine Policy Center assess current national and international oceanic issues, serving as a link between public policy and scientific research.

WHOI maintains close collaborations with the National Marine Fisheries Service's Northeast Fisheries Science Center, and, through its own Cooperative Institute for Climate and Ocean Research (CICOR), other NOAA Cooperative Institutes throughout the U.S., including the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), located at the University of New Hampshire. Further interactions with NOAA can be seen in the Coastal Training Program, a partnership between Woods Hole Sea Grant, Massachusetts Office of Coastal Zone Management, and the Waquoit Bay National Estuarine Research Reserve.

*WHOI's Sea Grant Program should be very proud of its significant impact on the ability of our scientists and students to initiate and sustain critically important projects that other federal agencies do not sponsor. It has been a remarkable success with respect to the quality of the science produced and the communications of the results through public outreach.*

—Dr. Robert B. Gagosian, President and Director, Woods Hole Oceanographic Institution





# Program Vision

The Woods Hole Sea Grant Program began as a Coherent Program in 1973 with a budget of approximately \$200,000. Initially a research-based program, it achieved Institutional Program status in 1985, with a balance of research and outreach activities at a level of 60 percent/40 percent, respectively. The program assumed the traditional Sea Grant approach in 1990 when the Marine Advisory, or Extension, component was restructured. An Outreach and Education Program was introduced that same year.

At WHOI, Woods Hole Sea Grant is uniquely positioned to draw upon the Institution's resources—including world-class research and engineering innovation, and access to privately and publicly funded programs from which to leverage support for Sea Grant's priority issues. This adds value to the national Sea Grant network, just as Woods Hole Sea Grant adds value to WHOI, through its unique integration of science and outreach activities, the large number of Sea Grant supported-publications (nearly 800 publications since the program's inception), and the wide range of marine extension services, outreach, and education programs provided locally and regionally.

## Strategic Issues

Many of the issues that impact Massachusetts' coastal waters mirror key issues for coastal areas throughout the United States:



- ▶ Increasing pressure on coastal resources due to rising coastal population
- ▶ Increasing coastal development
- ▶ Conflicts between private ownership of the coast and public access
- ▶ Tourism
- ▶ Pollution
- ▶ Declining natural fisheries and exploration of alternative fisheries
- ▶ Growth in aquaculture
- ▶ Natural shoreline change (through storms, erosion, coastal processes, and sea level rise)
- ▶ Human-induced coastal change (alteration of the shoreline for recreational or developmental purposes)
- ▶ Accelerated sea level rise as a result of climate change

Because Woods Hole Sea Grant cannot effectively take on every issue, the program staff monitors the efforts of the region's



regulatory agencies, organizations, and private programs to assess how and to what degree issues are being addressed. Frequently, Woods Hole Sea Grant joins forces with other groups to address specific research, technology, and outreach issues or problems. The ability to form such collaborations is one of the program's greatest strengths and helps leverage funding and increase the scope and impact of core programmatic efforts.

The NOAA Sea Grant *Strategic Plan for FY 2003-2008 and Beyond* focuses on ten theme areas that are connected to NOAA's mission goals and strategies. The theme areas include: aquaculture, biotechnology, coastal communities and economies, coastal hazards, digital ocean, ecosystems and habitats, fisheries, marine and aquatic science literacy, seafood science and urban coasts. Within these themes are national priority areas in aquatic invasive species, fisheries extension, harmful algae blooms, oyster disease research.

Consistent with the goals of the national strategic plan, Woods Hole Sea Grant is implementing its strategic plan within four major theme areas:

#### **FISHERIES AND AQUACULTURE**

#### **ENVIRONMENTAL TECHNOLOGIES**

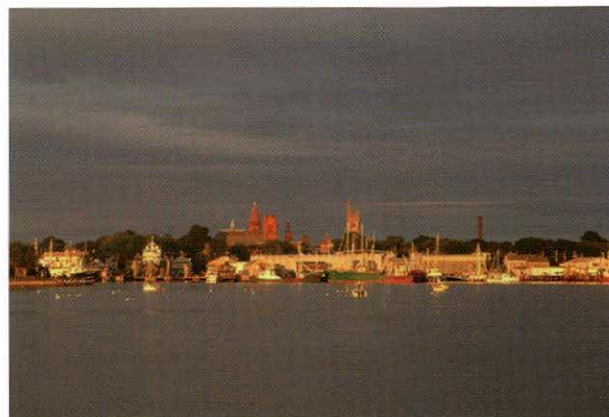
#### **ESTUARINE AND COASTAL PROCESSES**

#### **OUTREACH AND EDUCATION**

These areas have been identified by three distinct mechanisms:

- Solicitation of research ideas from the academic community; selection of those ideas that best represent scientific excellence and that meet the goals of the National Sea Grant Strategic Plan;
- Through our interactions with our advisory groups; identification of potential products and outreach mechanisms for transfer of information, especially within the context of the management and information needs of the Commonwealth of Massachusetts, particularly southeastern Massachusetts;
- Interaction with state and federal agencies to transfer technical information into the development of new policies and practices.

In each theme area, research progress and application of results determine the identification of milestones.







Diane Murphy, Cape Cod Cooperative Extension

## FISHERIES AND AQUACULTURE

In Fisheries and Aquaculture, Woods Hole Sea Grant has identified two priority areas that best fit within the region's academic and research environment: revitalizing our nation's fisheries and development of sustainable aquaculture. In New England, these areas are very closely linked technologically and culturally. Thematic elements include:

- Development of technology and programs to promote stock enhancement of natural fish and shellfish resources, including mechanisms to evaluate the efficacy of enhancement programs and the overall effectiveness of such programs;
- Investigation of larval recruitment processes for fish and shellfish and development of means to understand the relationship between recruitment and physical and chemical characteristics of the environment;
- Investigation of disease processes in marine organisms with an emphasis on prophylactics and management of diseased stocks to minimize economic losses to the natural fisheries and aquaculture industries; and
- Promotion of business and industrial development through expanding efforts in coastal management and through understanding of the economics of marine related businesses.

### **Vision:**

*There will be a diverse and healthy fisheries resource, particularly shellfish, in the southeastern Massachusetts region.*

**GOAL 1: To maintain and improve marine and estuarine habitat important to commercially important wild resources.**

**Objective:** Implement an eelgrass planting/restoration program to improve habitat conditions for commercially important shellfish species in the region.

**GOAL 2: To enhance, restore and/or maintain wild populations of commercially important resources.**

**Objective 1:** Test and compare various methods of restoration of bay scallops, and implement the most promising methods to measurably improve local bay scallop harvests.

**Objective 2:** Implement remote set technology on a regional scale to restore and enhance native oyster populations to improve oyster harvest and create a diverse habitat for associated marine organisms.



Courtesy, SEMAC office



**Vision:**

*The aquaculture industry in southeastern Massachusetts will become more diversified and more competitive in a global economy.*

**GOAL:** To develop new candidate farmed species and to apply new farming technologies appropriate for southeastern Massachusetts within the bounds of minimal environmental impacts.

**Objective 1:** Explore the culture potential of underutilized shellfish species, such as razor clams and soft shell clams, in southeastern Massachusetts.

**Objective 2:** Quantitatively compare various types of culture methods and equipment in terms of survival, growth, cost effectiveness and environmental impact.

**Vision:**

*Science-based decisions will promote healthy natural ecosystems while allowing economic development that is culturally significant within the region's coastal environment.*

**GOAL:** Stakeholders in the southern New England region will use knowledge gained from Woods Hole Sea Grant programs to promote science-based decision-making.

**Objective 1:** Provide a means to translate science and technology into applications relevant to southeastern Massachusetts and relay that information to appropriate user groups.

**Objective 2:** Educate stakeholders in southern New England who will promote sustainable, environmentally sound policies.

**What people are saying about William Walton, Woods Hole Sea Grant Fisheries and Aquaculture Specialist—**

*Thanks so much for coming out to be in our EstuaryLive production. You were great—excellent descriptions, lots of props and hands-on opportunities for close-ups.*

—Joan Muller, Education Coordinator, Waquoit Bay NERR

*Thanks for getting in the pond with us, helping to save some oysters for harvesting. And those fresh oysters were delectable...*

—From the members of AmeriCorps Cape Cod, Class VI

*The Bourne Shellfish Working Group (BSWG) would like to thank you for being a panel member [for] our discussion about shellfish transfers and relays at our May meeting. We had a lot of expertise on the panel, good questions and comments from the attendees, and excellent information from the panel members. We had nothing but good comments about the meeting and hopefully we can do it again sometime during the fall or winter...*

—Win McLane, Chair, BSWG



Diane Murphy, Cape Cod Cooperative Extension





**What people are saying about Jim O'Connell, Woods Hole Sea Grant Coastal Processes Specialist—**

*Thank you again for your contribution to the "On the Waterfront Institute." You are a true find—a passionate and inspiring scientist who also understands the needs of teachers and the minds of middle school students, and how to communicate to all of the above effectively! We look forward to more opportunities for collaboration.*

**—Sukey Padawer,**  
Senior Program Developer/Educator  
New England Aquarium

*Thank you so much for sharing your knowledge about coastal processes with the Barnstable Middle School students and bringing it to a level that they were able to understand. AmeriCorps members also enjoyed your presentation. We learn something new from you every time we see you!*

**—AmeriCorps Cape Cod**

**Vision:**  
*Science-based decisions will lead to more naturally appearing and naturally functioning coastal landforms and littoral systems, while balancing impacts of living along the shore.*

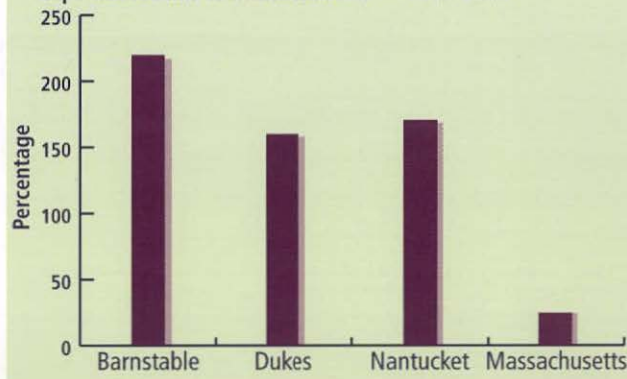
## COASTAL PROCESSES

Coastal ponds, estuaries, embayments, open coasts, and coastal resources are highly impacted by society's commercial, recreational, and residential activities. In southeastern Massachusetts, development in coastal communities was among the highest rate of increase within the Commonwealth of Massachusetts.

The population of Barnstable County (Cape Cod), Dukes County (Martha's Vineyard), and Nantucket County has been dramatic when compared to overall population growth in the Commonwealth.

Other threats to coastal communities include sea-level rise, erosion, conflicts between the protection of waterfront property and the preservation of the beneficial functions of coastal landforms and resources, conflicts between private ownership of the coast and public access, and recreational demands of the increasing coastal population (boating, fishing, shellfishing, beaches). Research supported within this theme is often multidisciplinary and interfaces directly with the management community charged with making regulatory decisions.

**Comparison of population growth: Cape and Islands to Massachusetts — 1960-2000**



U.S. Census of Population figures, courtesy Cape Cod Commission

**GOAL 1: Stakeholders will use science-based information to make more informed decisions about coastal land use issues.**

**Objective:** Increase the availability of science-based information for coastal residents, managers, stewards, and decision-makers regarding protection, prediction, risk reduction, and economic impacts associated with living along the shore.

**GOAL 2: Stakeholders will maximize use and enjoyment of coastal resources while minimizing human impacts on the beneficial functions of coastal landforms and coastal processes.**

**Objective:** Stakeholders will have scientific-based information to make more informed decisions about land-use issues, particularly regarding coastal landform function and coastal processes.



# ENVIRONMENTAL TECHNOLOGY

Woods Hole Sea Grant's Environmental Technology theme focuses on the initiation of research projects that will develop and deploy innovative technologies to address specific problems in coastal ecosystems; and the development of extension and outreach activities to foster information transfer, education, and development of new monitoring and treatment technologies. Thematic components include:

- Marine biotechnology, including the development of molecular markers for understanding contaminant effects in the environment and probes for application to ecological processes;
- Remediation technologies, including the development of new approaches to understanding the degradation of contaminants in the environment; and
- Remote technologies for monitoring the marine environment.



Tom Kleindinst, WHOI Sea Grant

**GOAL:** New tools and technologies will be deployed that can be applied to predicting and monitoring changes in environmental variables and protecting resources in coastal ecosystems.

**Objective 1:** Principal investigators will conduct research projects that will develop and deploy innovative technologies to address specific problems in coastal ecosystems.

**Objective 2:** Extension and outreach staff will develop programs to facilitate information transfer about the development of new treatment and monitoring technologies.

## Vision:

*New technologies and tools will allow improved capabilities for prediction of environmental changes, leading to protection of resources in coastal ecosystems.*



Tom Kleindinst, WHOI Sea Grant

## Technology Aids Fishery Management

Assessing supply and balancing it with demand is no doubt one of the biggest challenges for fisheries managers. In California, the squid fishery is at or near maximum exploitation, and increasing values have resulted in added fishing pressure over the past decade. Complicating matters, squid have a 6–12-month life cycle, making successful annual recruitment to the fishery critical.

"Squid are being exploited at an unprecedented rate, especially in Monterey Bay," says Roger Hanlon, a scientist at the Marine Biological Laboratory who has studied squid behavior and reproduction for over 20 years. "Does it make sense to allow direct fishing of spawning squids before enough eggs are laid for next year's recruitment class?" he asks.

To answer that question, California fisheries biologists and NOAA Sanctuary managers first needed information about the location of primary egg beds and inshore spawning grounds. With Sea Grant support, Hanlon, along with WHOI engineer Ken Foote, teamed up to marry technology and biology by designing an innovative project using sonar to locate squid eggs. Squids lay their eggs—up to 200 of them—in finger-shaped, gelatinous tubes. Female squids deposit the egg fingers into huge, communal egg masses, called mops. It turns out that side scan sonar can detect the presence of the egg mops, displaying them as dark spots on multi-beam bathymetry images taken from remotely operated vehicles. Investigators will refine the methodology and continue the survey of egg mass distribution in Monterey Bay on upcoming cruises in an effort to provide fishery and sanctuary managers with monitoring and stock assessment tools.



Roger Hanlon, MBL



## OUTREACH AND EDUCATION

*I am writing to thank you for all [of the] helpful information I've attained through your booklet on marine science careers. I am a high school junior from St. Louis, and from my location I'm unable to access the ocean... Your website and booklet have helped [lead] me in the right direction. Thank you for taking the time to help people like me reach for their dreams.*

—Katie

*Thanks again for the invitation to participate in "Ocean Alive." I was impressed by the turnout and the inquisitiveness of the audience. It's rare that we get a chance to discuss these issues in a forum without the usual tensions that follow fisheries management. "Oceans Alive" is a unique program that bridges the gap between the science community and the general public. I have greatly enjoyed the series both as an audience member and participant.*

—Steve Murawski,

Northeast Fisheries Science Center, NOAA NMFS

*Although I teach in inner city Worcester, I will be able to adapt the information I learned to areas in and near the school's landscape. I am always looking for interesting lessons that integrate math and science. I like that it is hands-on learning—students have to collect data, document it, and work as a team.*

—High School teacher, Worcester, MA

"Topics in Oceanography" teacher workshop

### Vision:

*Massachusetts citizens will have an understanding of the role the oceans play in their lives, continue to seek information on coastal issues, and apply that knowledge to science-based decision-making.*

At Woods Hole Sea Grant, the goal of the Outreach, and Education theme is effective dissemination of Sea Grant information, research, and technology. By reaching out to audiences in an attempt to answer questions, increase environmental awareness, improve science literacy, and bridge the gap between marine research and an informed and knowledgeable public, the Sea Grant outreach effort is making significant contributions to citizens and organizations within the Commonwealth of Massachusetts as well as the northeast region and the nation.

**GOAL:** Citizens will have the tools to make connections between ocean science information and coastal and ocean decisions.

**Objective 1:** Citizens of southeastern Massachusetts will have multiple opportunities, in a variety of venues, to access Sea Grant research applicable to their interests and needs.

**Objective 2:** Coastal decision-makers will utilize Sea Grant research results and outreach products, and participate in training opportunities, to increase their ability to design environmentally sound policies.

**Objective 3:** Educators in southeastern Massachusetts will use ocean science examples, including Sea Grant funded research, to convey basic scientific concepts to their students.



[www.marinecareers.net](http://www.marinecareers.net)

[www.beachcomberscompanion.net](http://www.beachcomberscompanion.net)



## WOODS HOLE OCEANOGRAPHIC INSTITUTION

### SEA GRANT PROGRAM

**Judith McDowell**, Director

(508) 289-2557; [jmcdowell@whoi.edu](mailto:jmcdowell@whoi.edu)

**William Walton**, Extension Fisheries and Aquaculture Specialist

(508) 375-6849; [wwalton@whoi.edu](mailto:wwalton@whoi.edu)

**James O'Connell**, Extension Coastal Processes Specialist

(508) 289-2993; [joconnell@whoi.edu](mailto:joconnell@whoi.edu)

**Tracey Crago**, Communicator

(508) 289-2665; [tcrago@whoi.edu](mailto:tcrago@whoi.edu)

**Katherine Madin**, Marine Educator

(508) 289-3639; [kmadin@whoi.edu](mailto:kmadin@whoi.edu)

**Sheri DeRosa**, Program Assistant and Web Designer

(508) 289-2398; [sderosa@whoi.edu](mailto:sderosa@whoi.edu)

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Sea Grant Program at WHOI

193 Oyster Pond Rd., MS #2

Woods Hole, MA 02543-1525

Web [www.whoi.edu/seagrant](http://www.whoi.edu/seagrant)

E-mail [seagrant@whoi.edu](mailto:seagrant@whoi.edu)

Fax (508) 457-2172







WOODS HOLE OCEANOGRAPHIC INSTITUTION

SEA GRANT PROGRAM

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193 Oyster Pond Road, CRL 209, MS #2

Woods Hole, MA 02543-1525