

Woods Hole Sea Grant: Environmental Technologies

Snapshot

WHOI Sea Grant's investment in environmental technologies has resulted in the development of new tools for analyzing and interpreting the effects of toxic chemicals on the reproduction, development, and disease defenses in marine animals and for detecting the presence of harmful algal species before bloom conditions occur.

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Background

Coastal ecosystems in southeastern Massachusetts are subjected to many of the same perturbations as other coastal ecosystems: increasing pressure on coastal resources as coastal populations and development increase, conflicts between private ownership of the coast and public access, tourism, pollution, declining natural fisheries and exploration of alternative fisheries, development of aquaculture, natural shoreline change through storms, erosion, and coastal processes, and human-induced coastal change.

Public awareness and concern for environmental problems in coastal ecosystems are very high within local communities of southeastern Massachusetts. Local concerns -- groundwater contamination and sediment contamination in an urban harbor -- and the remediation required to minimize ecological and human health threats, provide a central focus for research and outreach in environmental technologies. In response to these and a wide range of other environmental problems, an Enviro-Tech Center has been located at the Massachusetts Military Reservation. The Center fosters the development of innovative technologies by the private sector and encourages partnerships with educators and students to explore educational and economic opportunities associated with environmental technologies. In addition, academic programs are beginning to focus on training students for career opportunities in environmental technologies at the secondary, undergraduate and postgraduate levels.

Objectives

WHOI Sea Grant's theme in Environmental Technologies is consistent with the needs for better information and application of new technologies and was developed as a way to respond to local and regional concerns such as those highlighted above. Within the framework of the NOAA Sea Grant Strategic Plan, 1995-2005, WHOI Sea Grant efforts are focused on three major portfolios: Economic Leadership, Coastal Ecosystem Health and Public Safety, and Education and Human Resources. Within these portfolios there are major strategic initiatives in advanced technology for commercial products, seafood production, coastal economic development, coastal ecosystem processes, public safety, technology transfer, and public outreach. To fulfill our objectives and mandate within the strategic plan, WHOI Sea Grant's theme in Environmental Technologies has focused on:

- Incorporation of the tools of molecular biology to better understand and characterize the effects of toxic chemicals on reproduction, development, and disease defense in marine animals;
- Development of new analytical tools and instrumentation for monitoring water quality and sediment quality in coastal habitats;
- Identification of unique molecular or immunological properties of individual plankton species that allow the development of species-specific probes that can be used to characterize the distribution of these organisms in natural habitats.

Sea Grant Involvement

Since 1990 the WHOI Sea Grant program has made an investment in attracting and supporting activities in the field of marine biotechnology. These efforts have focused on:

(1) the initiation of research projects that will develop and deploy innovative technologies to address specific problems in coastal ecosystems; and

(2) the development of advisory and outreach activities to foster information transfer, education and development of new monitoring and treatment technologies.

Program components include the application of molecular biology to better understand contaminant effects in the environment and ecological processes. In addition, predictive models have been developed that integrate analytical approaches for identifying contaminant distribution and effects in coastal environments with management approaches for reducing the input and impact of contaminants in the environment. These components compliment two portfolios within the national strategic plan, economic leadership and coastal ecosystem health and public safety, by integrating product development leading to a better understanding and prediction of contaminant fate and effects in coastal and estuarine environments.

Producing Significant Results

Research Support

Novel Biomarkers of Dioxin Effects, Mark E. Hahn, WHOI Biology Department (R/P-64)

Detection and Quantification of Live Acanthamoebae in Natural Marine Ecosystems using Molecular Genetic Methods, Rebecca J. Gast, WHOI Biology Department (R/B-147)

Estradiol Dynamics: A Molecular Basis for Potential Endocrine Disruption in Marine Mammals, John J. Stegeman, WHOI Biology Department (R/B-162)

Bivalve Dispersal as Indicated by Shell Trace Element Composition, Lauren S. Mullineaux, WHOI Biology Department, and Stanley R. Hart, WHOI Geology and Geophysics Department (R/O-32)

Impact of Environmental Contaminants on Aquatic Birds: The Molecular Basis of Differential Dioxin Sensitivity, Mark E. Hahn, WHOI Biology Department (R/P-64)

Molecular Biomarkers of Chemical Sensitivity in Protected Species: II. Cell Culture Bioassays, Mark E. Hahn, WHOI Biology Department (R/B-151)

Biochemical Toxicology in Cetaceans, John J. Stegeman and Michael J. Moore, WHOI Biology Department (R/B-152)

Identifying Wastewater-Derived Nitrogen in Aquatic Ecosystems: Tests of a Stable Isotope Tracer Approach, Ivan Valiela, Boston University Marine Program (R/M-40)

Detection of Harmful Algal Species using Molecular Probes: Field Trials, Donald M. Anderson, WHOI Biology Department (R/B-146)

Identification of Bioactive Marine Natural Products Using a Fish Cell Culture Bioassay, Mark E. Hahn, WHOI Biology Department (R/B-124)

Impact of Environmental Contaminants on an Aquatic Bird Population, Mark E. Hahn and Michael J. Moore, WHOI Biology Department (R/P-58)

Fish Cytochrome P450 Genes Involved in Chemical Effects, John J. Stegeman, WHOI Biology Department (R/P-60)

Molecular Biological Approaches for Non-Destructive Assessment of Chemical Effects on Marine Mammals, John J. Stegeman and Michael J. Moore, WHOI Biology Department (R/P-61)

Molecular Biomarkers of Chemical Sensitivity in Protected Species: A New Approach to Environmental Risk Assessment, Mark E. Hahn, WHOI Biology Department (R/B-137)

Development of Species-Specific Immunofluorescent Markers for Bivalve Larvae with an Application to Fisheries Management, Cheryl Ann Butman and Elizabeth D. Garland, WHOI Applied Ocean Physics and Engineering Department (R/B-139)

Molecular Probes for Cytochrome P4501A: Provision and Use in Chemical Effects Research and Monitoring, John J. Stegeman, WHOI Biology Department (R/P-53)

Detection and Quantification of Harmful Species Using Molecular Probes: Phase II, Donald M. Anderson, WHOI Biology Department, Victoria L. Singer, Molecular Probes, Inc., and Gregory J. Doucette, Medical University of South Carolina (R/B-130)

Development of Species-Specific Immunofluorescent Markers for Larvae of Benthic Invertebrates, Cheryl Ann Butman and Elizabeth D. Garland, WHOI Applied Ocean Physics and Engineering Department (R/B-132)

A Novel Cell Culture Assay to Detect Contamination of Marine Resources, John J. Stegeman and Mark E. Hahn, WHOI Biology Department (R/P-49)

Autonomous Instrumental Technique for the Self-Calibrating, Time Series Measurement of Oxygen in Coastal Aquatic Ecosystems, Craig D. Taylor and Brian Howes, WHOI Biology Department (R/O-19)

Quick Enzymatic Test for Contamination of Marine Resources by Toxic Organics, John J. Stegeman and Mark E. Hahn, WHOI Biology Department (R/P-37)

Extension Support

WHOI Sea Grant [Focal Points](#), fact sheets for legislators and coastal decision-makers:

- Research Update: Contaminants in the Marine Environment and Their Effects on Marine Mammals
- The Massachusetts Bay Outfall
- Endocrine Disruption in Wildlife Populations
- Harmful Algal Blooms (HABs) in the United States
- New Tools for Assessing Water Quality: Stable Isotope Analysis of Nutrients

Contributions to the Scientific Community

Research projects supported between 1990-2000 have yielded numerous advances and discoveries within the scientific community. A few highlights include:

- Investigators used cell culture instead of chemical analysis to detect the presence of contaminants, based on a biomarker response. These studies, conducted in the early 1990s, represented a novel approach to contaminant assessment in coastal habitats.
- A study employing molecular biological techniques resulted in the development of probes to identify organisms known to cause harmful algal blooms (HABs).
- A gene library was the result of a Sea Grant project to look at biochemical processes in marine organisms specifically directed at identifying genes responsible for detoxification processes.
- A tissue library of cetacean samples for the study of chemical sensitivity in marine protected species was developed by investigators studying molecular biomarkers.
- Looking at aquatic bird populations, investigators showed that exposure to contaminated feeding areas has no clear impact on endocrine dysfunction, proving the complexities of cause-and-effect relationships in nature in several degraded habitats. This project also served as the basis of a Ph.D. thesis.
- If investigators are successful, a new tracer for identifying bivalve larvae -- by looking at the trace metal composition of larval shells -- will greatly enhance the ability of researchers and resource managers to understand distribution of various populations of bivalves.

Investment in Education

Graduate Student Support: 28 students; 183.5 months

Undergraduate Student Support: 4 students; 12 months

What it Cost

Research Support (1990-2000):

Sea Grant Funds: \$2,810,446

Matching Funds: \$1,462,479

Total: \$4,272,925

Last updated: January 14, 2015

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