



COASTAL OCEAN INSTITUTE

AND RINEHART COASTAL RESEARCH CENTER

2007 Annual Report



Message from COI Director Don Anderson



A major goal of the Coastal Ocean Institute (COI) is to facilitate research in coastal marine science. We do this by providing funds for research projects, supporting critical coastal infrastructure such as the Martha's Vineyard Coastal Observatory, funding graduate students and postdoctoral investigators, and sponsoring workshops and symposia on coastal issues. Here, we highlight another means of funding – COI Fellows. Each Fellow receives three months of salary support for three years. This is a significant contribution to an investigator's budget. More importantly, it allows that scientist to pursue activities that might be risky or otherwise difficult to fund.

COI Fellows are selected in a competitive process that is open to all WHOI scientists whose research embraces the themes of the Institute. Given the high caliber of all WHOI scientists, the selection of a Fellow is a rigorous and difficult process. We convene a panel of WHOI scientists, who meet and discuss the

applicants in great detail. To level the playing field between established scientists and younger investigators, the panel looks for more than just exceptional scientific stature and accomplishments. Fellows are ranked on the extent to which the fellowship will make a difference in their research programs – and in particular, why this type of unrestricted funding is needed, as opposed to the more conventional funding avenues for research programs.

It is gratifying to see the creative and productive ways that our scientists choose to use their fellowship support. For example, Biologist Becky Gast is using her fellowship to expand her professional skills and expertise in a new field of study. One of her funded projects is to examine microscopic pathogens in coastal waters. Becky realized that she knew very little about whether humans were becoming sick from exposure to these pathogens, so she requested fellowship funds to allow her to delve into the fields of epidemiology and public health assessment.

Geologist Rob Evans has assumed a leadership role in a group effort to create a national funding program on shoreline change. Considerable time is needed to convince federal agencies and Congress to support a given line of research; yet, WHOI scientists are largely funded by specific grants and contracts that do not allow them the freedom to conduct activities beyond the reach of their proposals. Program

development efforts, such as creating science plans, setting up workshops, and taking multiple trips to Washington, DC, require internal unrestricted support, like that provided by Institute fellowships.

Acoustics expert Andone Lavery has chosen to use her fellowship to conduct original research that takes advantage of facilities and ship time made available for a limited period. Her COI fellowship enables her to capitalize on unique opportunities and accomplish work that would not be possible through the traditional funding process, with its long lead times.

It is indeed an honor for a WHOI scientist to be appointed an Institute Fellow. I hope you enjoy learning about the nature of these positions, their value to our scientists, and their importance to the activities of the Institutes and WHOI.

– Don Anderson □

Table of Contents

Message from the COI Director

Don Anderson 1

Coastal Oceans and Human Health

Rebecca Gast 2

Toward a National Program on

Shoreline Change Rob Evans 3

Coastal Ocean Acoustics

Andone Lavery 4

Friends of Coastal Science

Ken Woodcock 5

COI Financial Information 6

Coastal Ocean Institute

www.whoi.edu/institutes/coi

COI email . . coastalresearch@whoi.edu

Don Anderson . . danderson@whoi.edu

Judy Kleindinst . . jkleindinst@whoi.edu

Jane Neumann . . jneumann@whoi.edu

Editor: Alison Kline: akline@whoi.edu



Coastal Oceans and Human Health

Over the past several years, my research program has grown to include work assessing the presence and distribution in the coastal marine environment of human and zoonotic pathogens. Zoonotic pathogens are agents – usually micro-organisms such as bacteria, viruses or parasites – that cause infections in animals and can be transmitted to humans. Scientists are learning a great deal about the environmental presence of these organisms, but what is lacking is a reasonable understanding of the potential human health risks due to pathogens found in the marine environment that are not marine in origin.

Traditionally, assessment of human health risks in the ocean have focused on marine organisms known to cause diseases or health issues, such as harmful algal blooms and *Vibrio* species. Harmful algae are microscopic plants, while *Vibrio* are bacteria (associated with cholera, among other diseases). Both of these pathogens can produce toxins that cause gastro-intestinal or respiratory problems, infections of the skin, and can be fatal to humans and marine animals.

Nothing is known about the risks in coastal waters due to freshwater or terrestrial organisms like the parasites *Giardia* and *Cryptosporidium*, and infectious bacteria such as *Legionella*, *Brucella* and *Leptospira*. These organisms can be introduced by humans into the marine environment through sewage or terrestrial runoff, and can be carried by marine vertebrates (both birds and mammals).

One general assumption has been that these land-based organisms could not survive long enough in a saline environment to cause infections. Recent studies of these parasites, however, show that they are not only present in the marine environment, but they are also there in potentially viable forms. Whales and seals carry strains of *Giardia*, *Cryptosporidium*, *Brucella* and *Leptospira*. Oysters and clams in the Chesapeake Bay have been shown to accumulate the infective forms of *Giardia* and *Cryptosporidium* in their guts. All of these organisms have fairly low infectious doses (between 10 and 100 cells can cause disease in humans) and likely represent health risks.

As a COI Fellow, I have been pursuing studies in basic epidemiology and public health, while strengthening my research program through contacts

at local and state public health departments. These interactions among scientists and health agencies have helped to raise awareness of pathogens that cause particular diseases and of the potential need to monitor those pathogens.

With the support from my COI fellowship, I worked on a study in Mt. Hope Bay, located between Massachusetts and Rhode Island, that has been heavily impacted by pollution from sewage outfall and industrial activity. I worked with a public health intern to examine the incidence of *Legionella* pneumonia and tularemia in Rhode Island and Massachusetts, with a particular focus on the counties near the Mt. Hope Bay area. We found that Rhode Island had significantly more cases of legionnaires' disease, although it was not possible to correlate them to particular types of exposure.

I am also participating in a beach epidemiology study taking place over the next two years in southern California. In addition to analyzing water samples for the presence of particular pathogens such as *Legionella*, we will be analyzing beach sand samples to explore the potential links between pathogens in beach sand and human disease.

The study of oceans and human health is relatively new; and, while there have not been any documented large-scale disease outbreaks that have been linked to marine exposure, it is possible that coastal communities have levels of endemic disease that have gone undiagnosed or unreported.

– Becky Gast □



Photo by Rebecca N. Bustin, USGS in Ohio.

Becky Gast in a lab at the Orange County Sanitation District facility, where she was executing an evaluation study for the Doheny Beach Epidemiology Project. Becky is using COI fellowship funds to expand her skills in epidemiology and public health assessment.

Toward a National Program on Shoreline Change

Most people are aware that our shorelines are at risk from over-development, rising sea level, and intense storms that erode coastlines. Although scientists have made progress in many areas of coastal geology over the last decade, our fundamental understanding of shoreline change has been limited by a lack of a broad yet integrated scientific focus, a lack of resources, and an apparent lack of understanding on the part of policy-makers who establish regulations about human activity along the coast.

Surprisingly, a simple question such as, “at what rates of sea-level rise will barrier beaches become submerged?” cannot yet be answered. Addressing such a question will involve a wide range of researchers (climatologists, geologists, physical oceanographers, etc.) who make observations at the shoreline and offshore, as well as modelers who can take these observations and produce process-based models that predict shoreline evolution.

So why isn't more being done about this problem? The large budgets of the federal agencies nominally tasked with protecting the shoreline suggest that such work is being accomplished. But little of this money actually goes to competitive, peer-reviewed proposals that would answer fundamental questions about shoreline change.

Working with intern Patricia Bowie from Duke University, who is supported by COI New Initiative funds, we have examined the distribution of funds to coastal research. In fiscal year 2006, only \$16.5 million in federal funds were allocated to peer-reviewed



Photo by Jim O'Connell, WHOI.

Houses perched perilously close to the edge of a severely eroding coastal bank along Nantucket's eastern shore. These houses are but a few of the 87,000 homes in the US predicted to be lost over the next 60 years due to coastal erosion. With COI fellowship funds, Rob Evans and colleagues are trying to initiate a national program for focused research on shoreline change.

grants for coastal research out of a combined budget of \$15.9 billion (one tenth of one percent) from the National Oceanic and Atmospheric Administration (NOAA), the US Army Corps of Engineers (USACE), the US Geological Survey (USGS), the National Science Foundation (NSF), and the Office of Naval Research (ONR).

Yet the scale of coastal development is vast and expanding. More than 155 million people (53 percent) of the US population now reside in coastal counties – a number that is projected to grow to 168 million over the next decade. Another 180 million people visit the US coast every year. According to a Heinz Center study released in 2000, roughly 350,000 buildings are located within 500 feet of the ocean, 87,000 homes are located within FEMA-defined 60-year erosion hazard areas, and as many as 1,500 homes and surrounding land are lost to erosion each year. However,

these estimates are extrapolated to the national level from a select number of local estimates, which focus only on non-urban environments.

The need to extrapolate from a small sample to the entire coastline makes it difficult to estimate the economic impact of shoreline loss. As a consequence, estimates vary widely. Working with Patricia Bowie and Porter Hoagland in the WHOI Marine Policy Center on a project started with COI funding, we have used information provided by towns along with modern internet tools, such as Zillow.com, to come up with what we believe are accurate estimates of the property exposed to risk on barrier islands in the US.

Eventually, these numbers can be coupled to improved models of coastal evolution that will incorporate results associated with mitigation actions, such as the construction of seawalls. Historically, given the choice between either understanding the underlying causes of a shore-



related problem or taking immediate restorative action, stakeholders choose the latter, however ill-advised. Our goal is to be able to provide the data that facilitates informed decision-making with long-term benefits, rather than quick, temporary fixes to coastal threats.

In order to tackle the problem of a lack of focused funding, a group of COI-affiliated scientists is working to initiate a national program in coastal change, pulling together key federal agencies. It has been a slow process, as the politics are complex; but, working with Rocky Geyer, former

Director of the Rinehart Coastal Research Center at WHOI, we are hopeful that we will soon be able to approach NOAA and begin to form an interagency partnership. Private support will play a crucial role in the success of this program, especially in its early stages, but the bulk of the funding will need to come from federal agencies, since this will be a national effort.

We have obtained funding from the COI and are using that support to cover our time and travel, as we seek to build a scientific consensus on the nature of such a

program and identify agency partners in Washington, DC. Once those steps are accomplished, we can then work with congressional delegations around the country to try to get research funds appropriated into these programs. This “program development” work is critical to the education of policy makers on coastal issues and the creation of new funding opportunities in the area of coastal change research. We are fortunate to have the support of the COI for these activities.

– Rob Evans □

Coastal Ocean Acoustics

An over-arching goal of my research is to understand the fundamental physics of acoustic scattering and propagation in the ocean. Acoustics can be used to infer, for example, the abundance of marine organisms or properties of oceanic turbulence. Understanding the distribution and abundance of marine organisms has implications for fisheries management, stock assessment, and ecosystem dynamics, while measurements of turbulence may lead to an improved understanding of ocean mixing, which contributes to ocean circulation, climate, and biological functions in the ocean.

Acoustic scattering techniques, also known as sonar (for sound navigation and ranging), have been commonly used for decades to image the ocean interior. For example, sonar is used by fishermen for locating schools of fish; by the navy for locating mines; and by scientists for imaging the ocean bottom and studying zooplankton distribution, internal waves, hydrothermal vents, and many other applications.

Despite its wide use, a thorough understanding of sonar echoes is by no means common. Interpreting the scattered signals is complicated by the presence of numerous sources of scattering as well as by the dependency of the scattering on the characteristics of the scatterers (such as shape or sound-speed contrast) and on the acoustic frequency. Traditional acoustic techniques are based on a single, or

a small number of single, acoustic frequencies, thus restricting the amount of information contained in the returned signal and limiting the inferences that can be made regarding the type of scatterer, its size, shape, and other characteristics.

To address some of these difficulties, my work as a COI Fellow focuses on developing high-frequency broadband acoustic scattering techniques to investigate

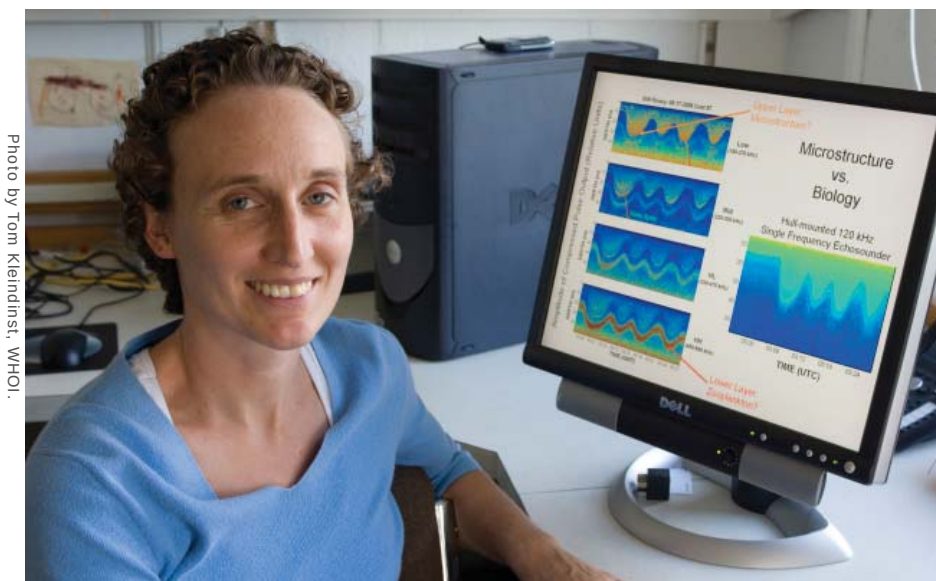


Photo by Tom Kleindinst, WHOI.

Andone Lavery in her office with results from one of her acoustic scattering experiments. Andone is using COI fellowship funds to collaborate in multi-institution, multi-investigator acoustic experiments in coastal environments.



coastal environments. In contrast to traditional single-frequency techniques, broadband techniques allow the frequency spectrum to be determined, representing an under-utilized, yet powerful, discrimination and quantification tool. In addition to developing broadband techniques to investigate scattering in coastal regions, I develop physics-based scattering models that I validate in controlled laboratory experiments, which are critical to accurately interpret the scattered signals.

Last summer, as part of a large Navy-funded multi-investigator experiment, I deployed a newly developed high-frequency broadband acoustic scattering instrument in the North Atlantic off the coast of

New Jersey. During the month-long cruise on the R/V *Oceanus*, internal waves generated at the continental shelf break were followed as they propagated shoreward. Acoustic images of the internal waves were used to track the development and propagation of the waves. Breaking internal waves can generate high levels of turbulence, which, in turn, can scatter sound. The broadband acoustic measurements allowed us to determine in which regions the scattering is produced by turbulence as opposed to microorganisms.

Most recently, my research is focused on developing acoustic propagation techniques to investigate turbulence in shallower coastal regions. As sound waves travel

through the ocean, they are affected by many physical processes, such as turbulence, fluctuations in temperature and salinity, or passage through intervening bubble clouds caused by breaking surface waves. By looking at the changes in the acoustic signals, inferences about the physical processes giving rise to the changes can be made.

Also, in collaboration with Jim Preisig (WHOI) and David Farmer (URI), as a part of a Navy-funded experiment taking place at the Martha's Vineyard Coastal Observatory in October 2007, I am investigating the effects of turbulence and bubbles on the transmission of high-frequency sound in shallow coastal environments.

- Andone Lavery □

Friends of Coastal Science

Ken Woodcock has been involved with WHOI since 2004, when his friend, Carl Peterson, WHOI Trustee and President of the WHOI Associates, introduced him to the organization. Ken and Carl have shared many mornings chasing stripers with their fly rods on Potter Pond, a coastal pond in Matunuck, Rhode Island, where they first became friends.

Ken's professional career began with government service in Washington, DC, where, in the early 1970's, he wrestled with energy and environmental regulatory, legislative and economic issues. In 1981, he was involved in the founding of The AES Corporation (a global power company), where he remains a consultant. Efforts to launch new electric generating businesses entailed extensive foreign travel to places such as Namibia, Vietnam and China. He thrived

on finding the new, environmentally acceptable, low-cost power supply option that could best serve a country.



Photo courtesy of the Woodcocks.

COI Friend and WHOI Corporation member, Ken Woodcock, was introduced to WHOI by long-time friend, Carl Peterson, WHOI Trustee and President of the Associates.

Ken's involvement in COI stems from his passion to protect the coastal ponds of Rhode Island and his interest in climate change, science and engineering. His "retirement" keeps him balancing many interests, including WHOI. He serves environmental organizations such as The Nature Conservancy and the Land Trust Alliance. In Matunuck, he runs an historical association and has founded an historic house museum. He has an expanding involvement with the National Trust for Historic Preservation. Ken also sits on the Board of Visitors of the business school at the University of Pittsburgh.

Ken and his wife, Dottie, live in Washington, DC, and Matunuck, Rhode Island. They are both involved in the rich cultural life that Washington offers.



Financial Information

Campaign Progress

In August 2007, the Commonwealth of Massachusetts awarded a \$10 million matching grant to WHOI through the Massachusetts Technology Collaborative's John Adams Innovation Institute. These state funds helped leverage a \$97.7 million federal contract that names WHOI as the implementing organization for the coastal and global components of the National Science Foundation's \$331 million Ocean Observatories Initiative. WHOI will lead a team that includes: Scripps Institution of Oceanography at the University of California, Oregon State University's College of Oceanic and Atmospheric Sciences and Raytheon. As part of the coastal initiative, WHOI will develop, install, and operate the Pioneer Array off the continental shelf south of Martha's Vineyard. The state funds will be used to provide additional gliders, buoys, AUVs, and improvements to underwater communications for the Pioneer Array. Data from the Pioneer Array will help to improve understanding of how ocean circulation effects the transfer of nutrients from deep water to shallow coastal waters, impacting the ocean carbon budget and the food web, thus effecting climate and marine productivity.

COI Leveraging

The majority of funds that support the COI and its research have come from generous individual donors. These donations leverage significant federal and state funds and additional private support. Since 2001, COI-funded research has conservatively leveraged over \$30 million from federal and state agencies to further support coastal research.

A prominent and recent example is the investment COI made by funding a New Initiative project for co-PI's Al Plueddemann, John Trowbridge and Heidi Sosik. This project, "A Coastal Ecosystem Research Initiative for the Northwest Atlantic" played a key role in three major developments this year, two of which are highlighted above: (1) a WHOI-led Integrated Ocean Observing system (IOOS) project funded by NOAA at \$8.2 million; (2) the \$97.7 million federal contract (mentioned above) for which WHOI will serve as the implementing organization; and (3) the \$10 million award from the John Adams Innovation Institute of the Commonwealth of Massachusetts. Many others at WHOI and elsewhere were involved in obtaining these major sources of funds for coastal observing systems, but the involvement of Plueddemann, Trowbridge, and Sosik was critical in the development and ultimate success of these proposals.

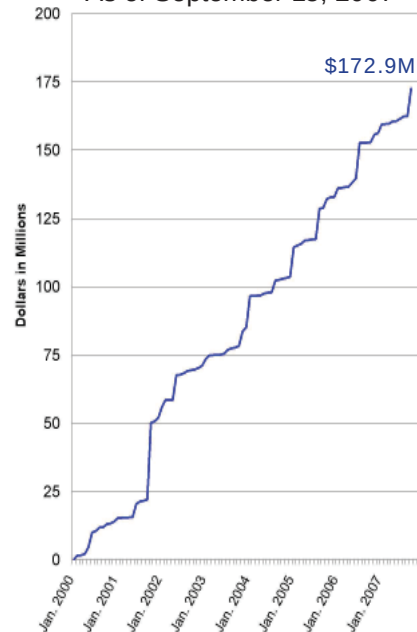
We cannot over-emphasize how grateful we are to those who contribute to our cause and hope all of you can see how important this type of "seed money" can be to our research programs. Thank you!

Woods Hole Oceanographic Institution

Campaign Funds Raised to Date

\$172,875,640

As of September 15, 2007



**COI Support
2001-2007
\$4,482,103**

Research Grants	\$2,592,124
Research Fellows	\$650,776
Postdocs	\$442,134
Graduate Students	\$357,240
MVCO Support	\$226,136
Small boat/Instrumentation	\$133,289
Symposia/Workshops	\$80,404

