

2013 WHOI Highlights

- » WHOI Principal Investigators Amy Bower, Fiamma Straneo and Robert Pickart were awarded \$11.6 million dollars from the National Science Foundation as part of a five-year, international collaboration to deploy a new observing system that will continuously measure the strength and pathways of ocean currents over the entire subpolar region of the North Atlantic.
- » Senior Scientist Scott Doney was awarded the 2013 A.G. Huntsman Award for Excellence in Marine Science. According to the foundation, Doney's selection was based on his contributions to our understanding of the role of ocean biology in global biochemical cycles, his leadership in bringing the community's intellectual assets to bear on some of the most pressing scientific problems of our time and his tireless education efforts.
- » Explorer and filmmaker James Cameron partnered with WHOI to stimulate advances in ocean science and technology and build on the historic breakthroughs of the 2012 Cameron-led *DEEP-SEA CHALLENGE* expedition exploring deep-ocean trenches. Cameron transferred the submarine *DEEPSEA CHALLENGER* to WHOI, where scientists and engineers will continue to work with him to incorporate the submarine's numerous engineering advancements into future research platforms.
- » A WHOI co-authored study in *Environmental Science and Technology* indicates the source of oil sheens found floating at the ocean surface near the site of the Deepwater Horizon disaster is pockets of oil trapped within the wreckage of the sunken rig.
- » President and Director Susan K. Avery was appointed to a United Nations Scientific Advisory Board. The 26-member board will advise the UN on science, technology and innovation for sustainable development on links between science and public policy.
- » WHOI Marine Chemist Mak Saito teamed up with scientists at Johns Hopkins University and the University of Texas to confirm that the pathogen that causes Lyme disease can exist without iron, a metal that all other life needs to make proteins and enzymes. Instead of iron, the bacteria substitute manganese to make an essential enzyme, thus eluding immune system defenses that protect the body by starving pathogens of iron.
- » The Institution established a new Center for Marine Robotics. The Center brings together academic, national security and industrial partners with the goal of applying the full potential of computation and intelligence to bear on the ocean. The collaboration forms perhaps the largest web of capability and expertise applied to the field of marine robotics.
- » WHOI Chemical Oceanographer Zhaohui 'Aleck' Wang led a multi-institution survey in the waters of the eastern U.S. and the Gulf of Mexico to measure the varying levels of carbon dioxide (CO₂) and other forms of carbon as part of an effort to understand the impacts of ocean acidification. This survey will help researchers determine how distinct bodies of water resist changes in acidity.
- » A new investigation into the role iron played in a post-Ice Age Pacific phytoplankton bloom could have implications for modern day climate change research. A study published in the journal *Nature Geoscience* suggests that a "perfect storm" of nutrients and light is responsible for the bloom in the North Pacific 14,000 years ago—not iron as once thought. This finding has potential implications for geo-engineering efforts to curb climate change by seeding the ocean with iron.
- » WHOI Biologist Heidi Sosik joined a group of oceanographic experts in calling for the establishment of a national network to monitor the diversity of marine life, a key bellwether of ocean and human health, saying it should become a national priority in the next five years.
- » Woods Hole-based scientists, including Tracy Mincer from WHOI, Erik Zettler from Sea Education Association and Linda Amaral-Zettler from the Marine Biological Laboratory, discovered a diverse multitude of microbes colonizing and thriving on flecks of plastic that have polluted the ocean. They dubbed this vast new human-made flotilla of microbial communities the "plastisphere."
- » WHOI scientists collaborated with the non-profit shark research organization OCEARCH on a month-long expedition to tag white sharks off Cape Cod. The OCEARCH vessel is uniquely equipped to catch, tag and bio-sample sharks before they are released, which allowed WHOI researchers to collect valuable blood and tissue samples.
- » A first-ever open source catalog of marine biota was established, boasting about a half a million measurements of plankton biomass so far. WHOI scientists joined researchers from institutions worldwide to contribute to this public catalog, known as the MARE-DAT (Marine Ecosystem Biomass Data) global plankton atlas. This public resource will help researchers better understand marine biodiversity for conservation and monitoring.
- » WHOI Senior Scientist Ken O. Buesseler was appointed a foreign member of the Royal Netherlands Academy of Arts and Sciences. Buesseler is one of two foreign members in the 2013 cohort of 17. The selection committee made special notice of his pioneering role in the detection and interpretation of radioactive plutonium in the oceans resulting from nuclear bomb tests.
- » Schmidt Ocean Institute (SOI) began work with WHOI's Deep Submergence Laboratory to design and build the world's most advanced robotic undersea research vehicle for use on SOI's ship *Falkor*. The new vehicle will be capable of operating in the deepest known trenches on the planet.

THE POWER OF UNRESTRICTED GIVING



The freedom to explore new ideas and novel methods of understanding them is at the core of what our researchers do at the Woods Hole Oceanographic Institution. Unrestricted gifts are critical in allowing this intellectual freedom to take place, resulting in discoveries and technologies that have helped make WHOI a world leader in ocean science and engineering. Our scientists and engineers receive unrestricted support in the form of innovation and early career awards, travel grants and fellowships; you'll read about some of the projects made possible by these funds in the following pages.



On behalf of WHOI's Board of Trustees, Corporation, scientists, engineers, students and staff, I thank our donors for their unrestricted support of our endeavors. Please enjoy a brief glimpse into some of the work these gifts made possible in 2013. Of course, for each project included here, there are many more that benefited from our donors' investment in the people and technology behind these innovative ideas. We are all indeed grateful.

Sincerely,

Susan K. Avery, President and Director

266 Woods Hole Rd.
Fenno House, MS #40
Woods Hole, MA 02543 USA
508.289.4895
www.whoi.edu/support



Out of the Lab and Into the Field

Two MIT/WHOI Joint Program Students Test Their Skills

Field experience is critical in every MIT/WHOI Joint Program student's education, but getting out of the lab can be expensive and difficult without federal grants to pay the way. Unrestricted funds made it possible for students Deepak Cherian and Anna Wargula to see first-hand what it takes to successfully gather the types of data they've been working with for years in the lab.

Wargula, an ocean engineering student, spent the fall of 2013 in Duck, North Carolina, deploying pressure gauges and current meters in a wave study directed by WHOI Physical Oceanographer Britt Raubenheimer. While Wargula was involved in planning arrays and data quality control in the lab, she had never seen the instruments at work in the crashing waves along the coast.

"Anna's expertise for future work will include working with field observations," Raubenheimer said. "Obtaining field experience has been valuable for her research and will increase her career options."

For Wargula, time in the surf gave her insight into the pressures of coping with unpredictable weather, equipment breakdowns and even tiredness and fatigue. The experience will help her as she pursues her research focus of understanding wave and current patterns in rivers, she said.

"A lot can change very quickly, so just knowing what could change physically in those systems helps you know what to expect in the data," Wargula said. "I never got to experience the start-to-finish frustration and late night 'I hope this works!' feeling before [this]."

Securing a berth on a research ship can be even more difficult for a student without a grant to pay for days at sea. Unrestricted funds helped Physical Oceanography student Deepak Cherian travel to Sri Lanka in 2013, where he volunteered on a research cruise to study sharp frontal systems in the Bay of Bengal. While he was a world away from his research focus of eddy interactions with the continental shelf waters of New England, he learned how seasoned researchers deploy some of the same tools he will use for his own research as his career progresses.

Teachable Moments

Chemist Ken Buesseler Empowers Citizen Scientists After Fukushima

Nearly three years after an earthquake and tsunami in Japan caused the largest-ever accidental release of radiation into the ocean, scientists are predicting some of the irradiated water from the Fukushima Dai-ichi plant will reach the West Coast of the United States within the next few months. And while scientists, like WHOI Marine Chemist Ken Buesseler, say radiation levels will not be harmful to humans or animals, they're hearing from concerned residents from Alaska to Southern California.

"I get phone calls, probably once a day on average, because people are afraid about radiation levels," Buesseler said. "So far we've been able to tell them 'yes, the isotopes are coming across the ocean, yes they'll show up on the beaches, but at levels we think are safe.'"

Buesseler has been monitoring radiation levels and pathways in the Pacific Ocean since the early days of the disaster. Early on he realized that gathering the data wasn't enough—the public needed to understand what it all meant for their coastline, and their health.

Unrestricted funds allowed Buesseler to coordinate two well-attended public forums, one in Japan in 2012 and one in Woods Hole in 2013, bringing together experts in

radioactivity, food safety, ocean policy, fisheries and others to present cutting-edge research and analysis on the impact of the Fukushima disaster. This international effort culminated in a first-ever English/Japanese language edition of *Oceanus Magazine*.

He also founded the Center for Marine and Environmental Radioactivity (CMER) in 2013, with the mission of training the next generation of radiochemists and informing the public about the risks and benefits of radioactive material in the environment.

Buesseler has met with politicians and policymakers, too, stressing the need to monitor radiation levels as a way to assuage constituents' fears and misconceptions about radioactivity. "There's this interest and concern by the public, but no one is measuring it," he said.

And he's not stopping there. He set up a crowdsourcing website that lets citizen scientists help him monitor radiation levels where they live by sending him water samples. The site can be found at ourradioactiveocean.org.

"Even one more sample would be better than none. The citizen scientist learns about radiation and learns about ocean currents," he said. "This is a teachable moment, and may help alleviate a lot of the fear."

Early Career Award: Mark Baumgartner

Understanding a Critical Link in the Oceanic Food Chain

They may be one of the smaller animals in the ocean, but the copepod *Calanus finmarchicus* is a big player when it comes to the food chain. The tiny, krill-like zooplankton are one of the most abundant animals in the ocean and are a key link between phytoplankton at the base of the food chain and bigger animals like fish, seabirds and even whales.

Juvenile *Calanus finmarchicus* often go through a summer hibernation period called diapause, where they delay developing into adults by going dormant. Before hibernating, they fatten up on lipids from phytoplankton and descend in the water column, evading predators at the surface. Scientists know little about how the process works, and so far, no one has been able to get copepods to enter diapause in the lab. Further study of this phenomenon could have big implications for those concerned about what happens higher up the food chain.

"If you can figure out what initiates diapause—what keeps them there and how many copepods do it—you could plug that information into models to better predict population growth and ultimately the health of the ecosystem," WHOI Biologist Mark Baumgartner said.

It's for this type of high-risk, high-reward inquiry that Baumgartner was a recipient

of the Early Career Scientist award in 2013. The award allows an untenured assistant or associate scientist to devote three months a year solely to research. For Baumgartner, that means he is able to analyze and publish the results of his work with WHOI Biologist Ann Tarrant on copepod diapause.

"Access to the Early Career award is letting us publish the results of this exciting work," Baumgartner said. "That's important because if we want to get support for follow-up studies, funding agencies will want published results."

Instead of trying to coax copepods into diapause in the lab, they are trying to better understand the process by observing copepods in the ocean, and by looking at their genetic makeup in the lab. Baumgartner traveled to Trondheim, Norway in 2012 where he and Tarrant collected copepods to analyze and identify the genes that trigger diapause.

Baumgartner believes that this study could help fisheries managers better predict changes in threatened stocks like cod that feed on *Calanus finmarchicus* during their early development.

"Copepods are a critical part of the ecosystem," he said. "If you order fish at a restaurant, you should probably care about this species."

From Pirates to Climate Change

A Story Told in Leaf Wax

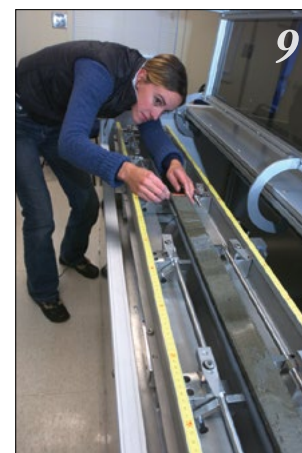
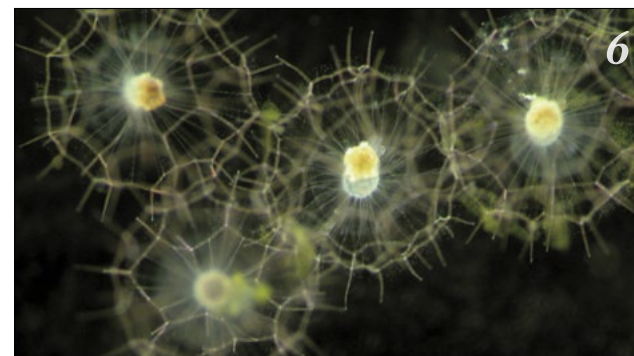
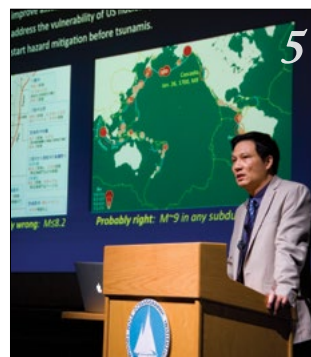
Today the Horn of Africa is the driest region in the world, but new research suggests the easternmost tip of the African continent may have transformed from grasslands to desert sands much faster than previously thought—over the span of several hundred years instead of thousands. This new insight into the past, published in the journal *Science* by WHOI Geologist Jessica Tierney and Columbia University Marine Geologist Peter deMenocal in October 2013, could help climate modelers better predict future changes as the earth's ocean and atmosphere grow warmer in mere decades.

"We'd like to understand why those transitions happen abruptly—what's driving it," Tierney said. "It's possible people in their lifetime could see something start to transition—if these sorts of transitions happen in the future."

Unrestricted funds allowed Tierney, a second-year assistant scientist, to travel to the Lamont-Doherty Earth Observatory to complete analyses on several projects while renovations were finished at her new space in WHOI's MacLean Laboratory. With funding from the National Science Foundation's Paleoclimate Perspectives on Climate Change, she and deMenocal studied leaf wax, analyzing hydrogen and carbon isotopes preserved in the leaves' protective outer coating to understand what the climate was like when those plants were alive. The samples came from sediment cores with a story of their own; they were taken from the pirate-filled Gulf of Aden in 2001, the last time a U.S. research ship was allowed to sample in those waters. Recently featured in *The Atlantic Monthly*, deMenocal said the experience was like being in the Wild West; their ship was in constant danger of pirate attack.

Those sediment cores have proven to be worth the risk. Tierney and deMenocal continue to glean detailed information about climate changes ranging from as far back as several glacial cycles to as recently as the 1700s.

"It's relevant to present and future climate change because we want to understand the tipping points in these climate systems," Tierney said. "There are implications for the people living there, for geopolitics and for security."



1. MIT/WHOI Joint Program student Anna Wargula recovers a pressure gauge and current meters with a team in Duck, North Carolina.

2. Physical Oceanographer Britt Raubenheimer encourages her students to get valuable field experience.

3-4. Scientists predict that water exposed to radiation from Fukushima will reach U.S. shores in early 2014. Marine Chemist Ken Buesseler is enlisting citizen scientists to help him monitor radioactivity in ocean water.

5. Marine Geophysicist Jian Lin speaks at the 2013 Morss Colloquium "Fukushima and the Ocean" at WHOI.

6-8. Copepods are a critical part of the marine ecosystem, and Biologist Mark Baumgartner is studying why they hibernate.

9. Geologist Jessica Tierney analyzes sediment cores for clues about climate changes that happened centuries ago.