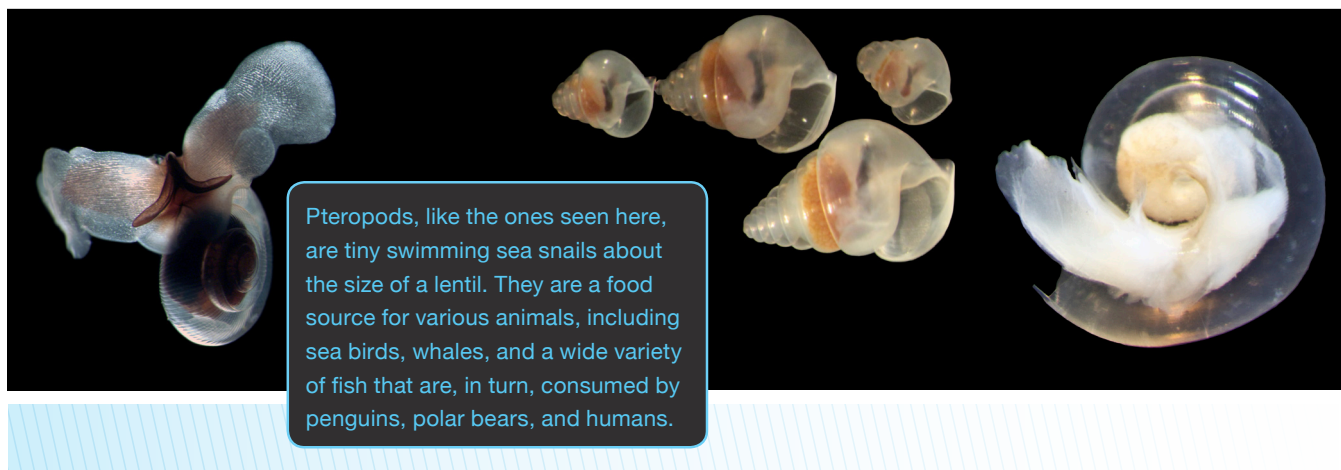




## The Ocean Acidification Initiative

**Goal: \$2.5 million**

Researchers, resource managers and policymakers recognize the urgent need to propel research, technology and education as a basis for sound decision-making and action.



Woods Hole Oceanographic's four Ocean Institutes—Ocean and Climate Change, Coastal Ocean, Deep Ocean Exploration and Ocean Life—allow Institution scientists the ability to seize opportunities in science in ways that traditional modes of funding cannot. They provide a foundation for the advancement of new interdisciplinary research. They foster innovation by bring-ing together the best minds in oceanography, engineering and related fields to explore new ideas and make discoveries. Through a competitive call for proposals, the Institutes play a critical role in our research community by awarding seed funding to new high-risk, high-reward projects each year; many of those projects go on to leverage that seed-funding into millions of dollars in federal support.

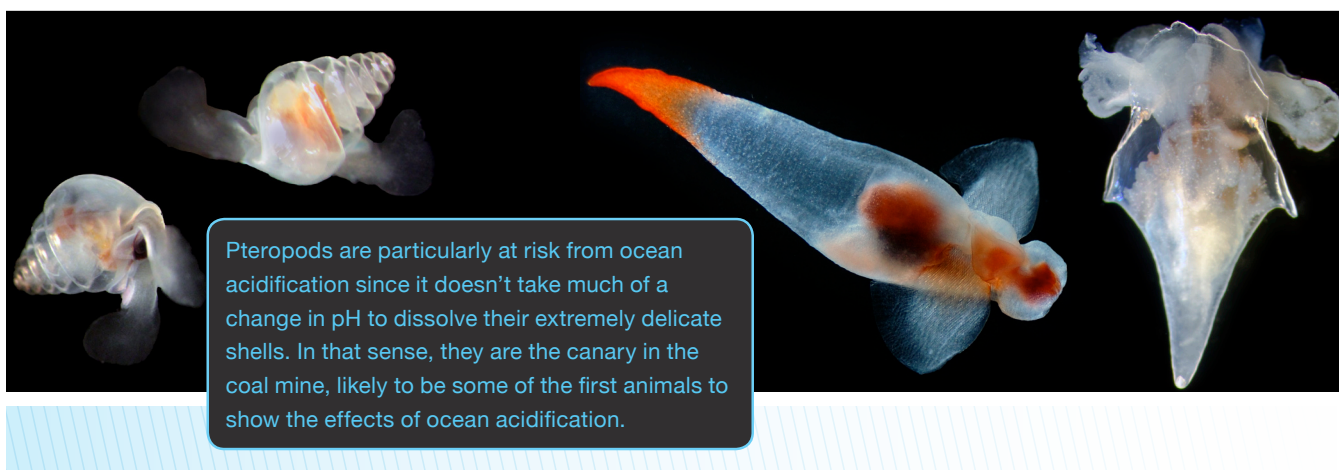
The Ocean Institutes also launch new initiatives that are created to study society's greatest ocean science issues and convey unbiased scientific information to the people who make decisions about stewardship of the planet and its resources. In 2013 they launched the Ocean Acidification Initiative, a research program designed to answer urgent questions about the potentially devastating impacts of an increasingly acidic ocean on the marine food web and fisheries and the societal repercussions of these environmental changes.

Our ocean is becoming increasingly acidic. Rising atmospheric carbon dioxide, primarily from human fossil fuel combustion, reduces ocean pH and causes

wholesale shifts in seawater carbonate chemistry. Nutrient pollution can also drive acidification of estuaries and near shore waters. Many types of shellfish and other invertebrates, critical elements of marine food webs, are now experiencing difficulty in forming their calcium carbonate shells because of the increasing acidic conditions in coastal waters. Other creatures whose blood chemistry is altered by lower pH become disoriented and lose their ability to locate food and evade predators. Today, it is impossible to predict how the impacts of ocean acidification will cascade through marine food webs and how they will affect the economies of coastal communities that rely on aquaculture, commercial fisheries, and tourism based on recreational fishing.

### **Ocean Acidification Initiative**

The Ocean Acidification Initiative is a multi-year effort designed to accelerate the development of new techniques and technologies required to quantify the processes and impacts of ocean acidification. Initially the research will focus on the natural laboratory outside our doors—the U.S. eastern seaboard from Cape Hatteras, North Carolina, to the Gulf of Maine. The methods and concepts that will be developed, and the new insight gleaned as a result of this work can be applied to coastal areas worldwide. Ocean acidification is an enormous scientific, economic and societal problem. While acidification is a global concern, a recent survey of U.S coastal waters led by



Woods Hole Oceanographic Institution researcher, Zhaohui “Aleck” Wang indicates that the Gulf of Maine may be particularly sensitive to acidification. Already, subsurface acidity is relatively high and the saturation state of calcium carbonate – the mineral that many organisms need to make shells – is particularly low. There is an urgent need to better understand this changing ocean chemistry and the impacts on Gulf of Maine organisms and the ecosystem.

Woods Hole Oceanographic investigators in a broad array of disciplines have been working on climate, CO<sub>2</sub> and ocean acidification research for decades. Our scientists have designed and implemented some of the key ocean acidification experiments, and compiled data that are used internationally to assess societal impacts. Their work in the global ocean already has been recognized by the National Science Foundation (NSF). In the first round of targeted ocean acidification grants awarded by the NSF in 2012, the Institution’s researchers garnered approximately 30 percent of the funding—a measure of the excellence of the proposed science and coordination that the Oceanographic is applying to this important research area.

Federal funding, however, does not support all of the ocean acidification work at the Institution. While important, it will not provide the new technological and laboratory-based capabilities that are needed to study the many complex impacts to the marine

environment and food web. Private funding is required to bolster our platform of technology development, seed new high-risk, high-reward lines of inquiry, and continue meaningful outreach to stakeholders. It will propel research forward by speeding the pace of science and funding the foundational research necessary to leverage greater federal support in the future.

This initiative will require \$2.5 million in its first two years in order to enable researchers to:

- Quantify the processes that control seawater acidity in estuaries and the coastal ocean;
- Develop technologies for ocean acidification research, including next-generation sensors that can be deployed remotely to measure ocean acidity and its effects on the ocean and ocean life;
- Determine the impacts of ocean acidification at both organism and ecosystem levels; assess and model the ecological and societal consequences of these impacts, and communicate this information with local and national stakeholders.

The U.S. fishery alone contributed some \$42 billion to America’s economy in 2011. Scientists, resource managers and policymakers recognize the urgent need to strengthen the science as a basis for sound decision-making and action. They believe that the new methods and concepts developed within this initiative will be exportable and relevant to many coastal areas worldwide.



“In science, I’m much more intrigued by what I don’t know than what I do know. For example, I know that ocean acidification—a change in ocean chemistry attributed to increased carbon dioxide in our atmosphere and sea—has the potential to change marine life. In the lab, we expose corals and other shell-making organisms to future ocean conditions and learn how they react. As I expect, most wither. What I don’t expect is that others thrive. I need to know why.”

—Dan McCorkle, Senior Scientist  
and Chair of the Geology and  
Geophysics Department

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*The Institution has identified priority areas that require immediate funding in the next two years to propel ocean acidification science:*

### **Laboratory for Experimental Marine Ocean Acidification Research .....\$1,000,000**

A key objective of the initiative is the development of a laboratory at the Institution with specialized facilities in which the many, complex biological impacts of ocean acidification can be studied under controlled conditions. WHOI has been at the forefront of a genomics revolution in oceanography, yet we are still in the early stages of studying interactions between the environment and an organism’s physiology. New approaches to molecular biology are necessary to allow scientists to see directly how ocean acidification impacts marine microbes, plants, and animals. With a dedicated laboratory and lab personnel, we seek to conduct innovative fisheries/shellfish research. This work provides the data to develop ecosystem models that can be used to predict where ocean acidification will be manifested in the coastal ocean and its implications for marine organisms, as well as allow for the development of mitigation and remediation strategies for stakeholders as ocean acidification intensifies in the next decade, as it is projected to do.

### **Sensor Development and Integration \$1,000,000**

Ship-based measurements alone are inadequate for monitoring coastal and off-shore waters, so developing sensors capable of measuring the ocean’s chemistry 24/7 is essential to understanding the impacts of ocean acidification. Scientists need to measure four parameters of water chemistry: pH, carbon dioxide partial pressure, total dissolved inorganic carbon, and alkalinity. Today, however, no one system allows them to collect more than one of those parameters. The “Holy Grail” is the creation of a single sensor package that can measure multiple parameters and can be deployed from a variety of platforms, such as moored buoys, vessels, AUVs, floats and gliders with high data-rate recording capability of weeks to months. Some key technological obstacles stand in the way of long-term measurements: limited power supplies; insufficient speed and miniaturization; and limited payloads of reagents, the compounds necessary for chemical analysis. Several WHOI investigators are already pursuing the development of these much-needed sensors. The top priorities in years one and two are: to apply tested and emerging technologies from other fields, such as medicine, that will address current obstacles; and to field test multiparameter sensor systems in local waters on a variety of platforms.

### **Collaboration with Stakeholders .....\$500,000**

To facilitate communication and put research in to action, WHOI scientists will strengthen existing collaborations and develop new ones with regional elected officials, resources managers, business and industry leaders, and the general public. We will build on our connections and partnerships at the state and regional level by establishing an Atlantic Ocean Acidification Network. The network will translate current scientific understanding into forms more useful for the public and decision makers while also highlighting the challenges facing fisherman, industry and communities. The next step will involve developing collaborations to monitor acidification at key sites such as hatcheries and shellfish beds, test and evaluate adaptation strategies for the shellfish industry, and explore in more detail the potential social and economic costs of acidification.