A blue-ribbon panel review of the STC Program (AAAS 2010) concluded that the program effectively integrated research, education, and diversity, generating new knowledge relevant to U.S. and global concerns and producing graduates and post-doctoral scholars that differ in outlook and approach as compared to alumni of more traditional educational programs. The report commended the program for increased racial, ethnic, and gender diversity relative to the populations at the centers’ home institutions.

Each of the three centers briefly described below are concerned with engaging the next generation of scientists and targeting multiple stages of education, from precollege through graduate studies. Through the six articles in this issue, you will discover how each center is extending its findings to educational audiences.

**CENTER FOR DARK ENERGY BIOSPHERE INVESTIGATIONS (C-DEBI)**

Katrina Edwards, Professor of Biological Science and Earth Science at the University of Southern California and former Director of C-DEBI, collaborates with fellow scientists to change our images of the deep sea from a barren plain dotted with hydrothermal vents to one humming with microbial life or “dark energy.”

Edwards describes the purpose of C-DEBI: “In our STC we are trying to resolve the extent, diversity, and biogeochemical consequences on a global basis for the existence of “intraterrestrial” life—organisms that live deep in the sub-seafloor. This habitat is nearly a completely unexplored realm of science on Earth and presents really exciting opportunities for novel discovery and exploration. Innovation comes into play in the science, engineering and technological requirements to do our work at and below the seafloor. It is not easy to accomplish, and we have to invent the means to conduct our experiments!”

C-DEBI’s scientific objective is to facilitate exploration of the Earth’s “deep ocean biosphere.” Although nearly half of the total biomass on Earth resides in sub-surface habitats such as mines, aquifers, soils on the continents and sediments and rocks below the ocean floor, little is known about the sub-surface communities. Researchers do not know if these communities are unique from other benthic systems. They don’t know the source of the microbial life. New research has shown that three or four times more bacteria live on exposed deep-sea rock than in the waters above. C-DEBI’s research connects with astrobiology in considering life in extreme environments.

C-DEBI provides research findings to academic communities via traditional methods such as journal articles and conference presentations. The general public learns about the discoveries through the C-DEBI website (http://www.darkenergybiosphere.org/), its newsletter, and news releases. However, a strong component of C-DEBI consists of the educational programs that share discoveries with undergraduates, precollege teachers, and the public.

C-DEBI researchers apply new technologies to gain information in extreme environments, such as the deep ocean, and their educational programs are designed to engage precollege students in the same technologies to solve problems. One project outlined in this issue involves students designing underwater robots. The Adopt-a-Microbe project collaborates with the International Ocean Drilling Project that collects samples from ocean sub-surfaces.

C-DEBI, funded since 2010, supports a variety of programs at the college level including an intensive summer course on...
microbiology with both lab and field components. C-DEBI works with two-year colleges whose students benefit from an exposure to deep biosphere research, discovery and innovation in time to make career choices.

**CENTER FOR COASTAL MARGIN OBSERVATION AND PREDICTION (CMOP)**

“We are facing an era of increasing development on coastal margins worldwide, for which we need an effective management plan informed by sound science. Ten of the world’s most populated river basins will account for 25% of the global gross domestic product by 2050,” observes António Baptista, Director and Principal Investigator of CMOP. “For society to achieve sustainable development in these 10 basins, and others around the world, it is critical to develop not only the science and supporting tools but also translation skills. We need to understand how coastal margins function and learn how to export what we learn (tools and science) broadly.”

Baptista, an oceanographic scientist at the Oregon Health & Science University, notes that while scientists do a great job of understanding important processes in nature, they are less able to characterize complex ecosystem function and predict its change. Historically, scientists have often not been effective at translating what they know into guidelines that are transportable to decision makers. Baptista champions CMOP in its interactions with stakeholders to accelerate the process of translation into application.

CMOP, funded in 2006, focuses on the Columbia River watershed that drives the economic engine of a huge region extending from the northwest U.S. into Canada. Both national and international issues of hydroelectric generation, flood protection, and sustainability of aquatic animals under the U.S. Endangered Species Act will reach a flash point in 2014. Baptista predicts that all decisions regarding future management strategies will require concessions across diverse goals and interests.

Baptista admits that CMOP may never become a household name. The target of CMOP is not the general public, but rather today’s resource managers and students. Postdoctoral trainees, graduate students, and middle and high school students are engaged with the diverse and complex components of CMOP. The CMOP faculty and researchers are increasing their interactions with students, increasing the intensity of the communication and sharing ownership of the process.

One of the CMOP products is the Science and Technology University Research Network (SATURN)—a river-to-shelf network of sensors, platforms, models, data, analyses and social processes. Information from SATURN provides real data to Columbia River stakeholders, all levels of students and Native American Tribes of the Columbia River. A shared scientific understanding of the Columbia River environment is integral to the negotiations between the governments of the United States, Canada and tribes.

Taking a long-term view, the key to scientific input and scientifically based decisions in coastal margins will depend upon the workforce in training now. The articles on CMOP’s collaborative design and use of applied science in an Alaska Native village provide two examples of coastal margin education. While CMOP scientists take their scientific message to new audiences, CMOP educators create, test and refine new educational delivery systems.

**CENTER FOR MICROBIAL OCEANOGRAPHY: RESEARCH AND EDUCATION (C-MORE)**

When the worldwide HMS Challenger expedition (1872-1876) initiated the beginning of the discipline of oceanography, imaging technology was limited to light microscopes and the scientists could only see large planktonic organisms. A century later in 1978, John Waterbury discovered a new group of tiny, marine cyanobacteria, between 0.2 and 2 micrometers, that were abundant, cosmopolitan, important in the carbon cycle, but previously unknown to science. Recently more discoveries about marine microbes provided genetic evidence to support a third domain of life, archaea, in addition to the existing bacteria and eukaryota domains. Novel, unexpected pathways of energy and matter flow demanded a reassessment of the state of knowledge of marine ecosystems.

In 2006, C-MORE was established to achieve a more comprehensive understanding of the diverse and complex microbial assemblages in the sea and their potential for change under future Earth climates. “We didn’t just want to rewrite the same book,” says David Karl, Professor of Oceanography at the University of Hawaii and Director of C-MORE. “Rather, we wanted to create an entirely new medium for the creation and dissemination of new knowledge, one that would be built around enduring partnerships, novel education and outreach activities with research that matters. Marine microbes are vital to planetary habitability, but at the same time they are invisible to the naked eye. A challenge for education is to bring these tiny creatures to life for both children and adults.” One of the articles in this issue describes how young scientists communicate their research and career experiences to non-scientific audiences.

Also, you will learn about a C-MORE education project that brings microscopes and marine plankton to Hawaii’s middle schools. Students and their teachers are introduced to the abundance and diversity of microscopic life in their local waters. When teachers participate in four-day research cruises through the Science Teachers Aboard Research Ships (STARS) project, they work alongside scientists and assist with sample collection and analysis. Sophisticated technology becomes part of their daily experience.
C-MORE research takes advantage of the marine molecular revolution where DNA sequence analysis, high-speed computation, and other new tools combine with more traditional ecological and biogeochemical investigations to provide new views of an old ocean. Karl assembled a team of investigators including senior researchers as well as younger scientists who showed potential for future leadership.

“Our goal was to create a scientific family, where excellence in research would be based on trust, cooperation and built-in mentoring for future generations,” Karl describes.

C-MORE co-Director Ed Delong, who has discovered new information about marine archaea, says, “C-MORE research spans the spectrum from genomic analyses, to understanding population and community diversity, to in-depth characterization of model systems, building new in situ instrumentation, and developing computational models of microbial oceanographic and ecosystem processes.”

REFERENCES


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C-DEBI URL http://www.darkenergybiosphere.org/
C-MORE URL http://cmore.soest.hawaii.edu/
CMOP URL http://www.stccmop.org/

**LUNDIE SPENCE, PH.D.** is a marine educator who recently retired as Director of the Center of Ocean Sciences Education Excellence SouthEast (COSEE SE), administered by South Carolina Sea Grant Consortium. Previously, she worked at NC State University with North Carolina Sea Grant. She has focused efforts in broadening participation in the ocean sciences, on STEM projects using the basic observation buoy (BOB) with the South East Atlantic Coastal Ocean Observing Regional Association (SECOORA) and the prevention and reduction of marine debris.

**CARRIE THOMAS, PH.D.** is Director of COSEE SE and a research associate professor in the Department of Marine, Earth, and Atmospheric Sciences at NC State University where she also serves as the departmental director of undergraduate programs. Her research interests include: benthic community responses to climate change along the Antarctic Peninsula; exploring the ecology of harmful algal blooms in the Gulf of Mexico; improving science communication in the ocean sciences; and increasing diversity in the ocean sciences workforce.

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**JOIN NMEA**

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<th>CATEGORY</th>
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<tr>
<td>STUDENT</td>
<td>Any full-time student. 1 year–$20</td>
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<td>ACTIVE</td>
<td>Any person who supports the goals of NMEA. 1 year–$50; 2 years–$78; 3 years–$118</td>
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<tr>
<td>CHAPTER AFFILIATE</td>
<td>Any person who belongs to a regional chapter. 1 year–$45; 2 years–$68; 3 years–$103</td>
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<td>FAMILY</td>
<td>Active members receiving only one set of mailings per household. 1 year–$75</td>
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<td>ASSOCIATE</td>
<td>Any person providing additional support to NMEA. 1 year–$65</td>
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<td>ASSOCIATE</td>
<td>Any personal providing substantial additional support to NMEA. 1 year–$100+</td>
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<td>LIFE</td>
<td>Any person who wishes to join as an active member for life. $600 or more</td>
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<tr>
<td>INSTITUTIONAL</td>
<td>Any active nonprofit organization with goals similar to NMEA. 1 year–$50</td>
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<tr>
<td>CORPORATE</td>
<td>Any company or organization involved with the marine education market. $500 or more.</td>
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