

HIGHLIGHTS

of Programs of the Network of COSEE Centers



CREDIT: LAURA MURRAY

The seagrass and restoration team in the Scientist-Educator Partnership Program at COSEE Coastal Trends.



THE OCEAN LITERACY INDEX—
MEASURING OCEAN LITERACY OUTCOMES

COSEE California, a regional center first funded in 2002, is a partnership between University of California, Berkeley's Lawrence Hall of Science (LHS), Scripps Institution of Oceanography, San Diego Unified School District, College of Exploration, and the University of Hawaii.

Over the past decade, much effort has gone into educating the public about ocean sciences, and the relationships among the land, ocean, and atmosphere. Many organizations have worked to measure the resulting public awareness (The OCEAN Project, 1999, 2009; AAAS, 2003; the Woods Institute for the Environment at Stanford University, 2007). Although much was learned from these measurement efforts, none have been aligned with the Ocean Literacy Framework (comprised of "Ocean Literacy: The Essential Principles of Ocean Sciences K-12" and "Ocean Literacy Scope & Sequence for Grades K-12), developed under the leadership of COSEE-CA. In response to this need, the COSEE-CA evaluation team developed a survey instrument to help us understand if these efforts are actually changing Ocean Literacy in the settings where they are being used and if there is differential impact of these efforts on sub-populations. More specifically, learning scientists, evaluation researchers, scientists, and educators are collaborating to develop a survey instrument designed to measure four dimensions: (1) knowledge of the Essential Principles and Fundamental Concepts, (2) attitudes and beliefs about the ocean and about marine life, (3) behaviors related to the ocean and to marine life, (4) exposure to ocean and marine experiences.

The instrument is designed to be easy to administer and analyze so that it will have maximum utility and flexibility. Once complete, this measurement tool will support formative efforts (e.g., guiding the kinds of interventions used for targeted audiences) and summative evaluation (e.g., for measuring the impact of educational outreach efforts). Instrument development work to date has included several iterative stages. First, researchers worked with the COSEE-CA scientists and educators to develop the specifications for the instrument. Next, many items were developed and piloted. Statistical and psychometric analyses were then conducted on these data to determine item fit and both item and scale reliability. Based on these analyses, adjustments (deletions and additions of items) were made. We anticipate having the results of this pilot, a validated instrument, and an algorithm for summarizing results into an Ocean Literacy Index by December 2010.

Dissemination efforts are already underway. In February 2010 we presented at the AGU/ASLO/TOS Ocean Sciences meeting. Since that time, we have communicated with numerous researchers and evaluators across the US who have interest in utilizing the instrument. As soon the instrument is ready, we will use it as part of our COSEE-CA evaluation efforts and disseminate it widely to the field.



TEACHING OCEAN SCIENCES IN THE 21ST CENTURY CLASSROOM: XBOX SERIOUS GAMING FOR SCIENCE

The Teaching Ocean Science in the 21st Century Classroom (TOST) initiative is a collection of COSEE-CA activities aimed at developing and disseminating technology-based instructional strategies and tools and ocean science resources for both formal and informal science education. San Diego Unified School District (SDUSD) and the Birch Aquarium at Scripps (BAS) are partners in this initiative and have established SDUSD and BAS as proving grounds for activities developed a part of TOST. As with all COSEE-CA activities, the ultimate goal is a sustainable model in which researchers engage in these activities as part of the broader impact components of their research proposals.

COSEE-CA recognizes the need to support education and outreach associated with large NSF science initiatives such as the Ocean Observatories Initiative. Working toward providing innovative ways to interest and engage the public in observatories and observatory science, COSEE-CA is collaborating with the OOI Cyberinfrastructure Education team to create a prototype game for use in a science center setting. Serious gaming is a burgeoning field of education, but to date the focus has been on 2-D games that are designed for long-term play. Little work has been done on determining the efficacy of using popular gaming platforms like the XBOX in unconventional settings such as science centers. The game is built on an XBOX platform using open source software. Advantages of using this popular gaming technology include the ability to support the games on any XBOX 360 console or Windows-based desktop machine, as well as the use of standard XBOX gaming controls already familiar to a large number of middle and high school students and many adults. These games can potentially serve as integral components of problem-based learning activities, and can be structured to promote higher-order thinking skills in an entertaining context.

Two prototype games are currently in various stages of development, one focused on exploration of hydrothermal vents and another focused on manipulating equipment that is part of a seafloor cabled observatory. The games have been piloted with audiences at the Birch Aquarium at Scripps and modifications made based on user feedback. A formal formative evaluation of the most recent and most sophisticated version of the game is scheduled for August 2010 and will focus on students enrolled in the Birch Aquarium at Scripps summer camps.

A trailer for the most recent versions of the games is available on YouTube:

<http://www.youtube.com/watch?v=EAtt067MbJE>

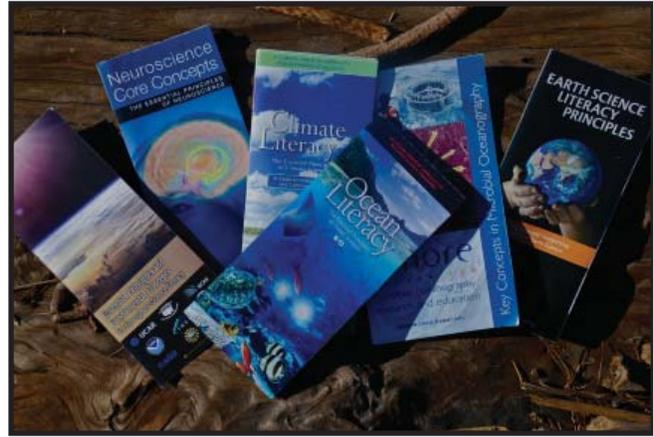


Boys (9 and 13 years old) testing out the Xbox 360 Deep-Sea Extreme Environment Pilot (DEEP) game at the Birch Aquarium at Scripps.



OCEAN LITERACY FRAMEWORK

COSEE California, a regional center funded since 2002, has been a leader in the Ocean Literacy Campaign (OLC), a wide-ranging, collaborative, and de-centralized effort by scientists and educators to create a more ocean-literate society. This highlight features the two community-created, consensus documents that make up the Ocean Literacy Framework, *Ocean Literacy: The Essential Principles of Ocean Sciences K-12* (2004; known as the *Ocean Literacy Principles*) and the *Ocean Literacy Scope and Sequence for Grades K-12* (2010; known as the *Scope and Sequence*).



The Ocean Literacy Framework is integral to the OLC, which is a primary initiative of COSEE-CA. The Framework provides formal and informal educators and curriculum and program developers with a “road map” that helps them build coherent and conceptually sound learning experiences for students from Kindergarten through 12th grade. Making the Framework has been a massive collaborative and iterative undertaking that has involved hundreds of dedicated scientists and educators working together and generously giving their time, energy, and expertise. This Framework is the first to identify, articulate, and organize the core concepts of ocean sciences for educational purposes. It has become a powerful rallying point for elevating the prominence of ocean sciences in the mainstream K-12 and informal science education systems. While it is not new for educators and scientists to work together on a project, the process of continued collaboration and partnership between educators and scientists in different agencies and organizations is significant, and has added to the potency of the OLC.

The Ocean Literacy Framework has been a ground breaking set of documents, both as a product and because of its development process. The *Ocean Literacy Principles*, in particular, is creating a ripple effect across the entire ocean literacy community. These ripples so far include, but are not limited to: 1) A textbook and curriculum (*Life on an Ocean Planet* by Current Publishing and NMEA; *Ocean Sciences Curriculum Sequence for Grades 3-5* by the Lawrence Hall of Science, funded by NOAA); 2) Foundation for programs and exhibits at informal science education institutions (Smithsonian Sant Ocean Hall; Aquarium of the Pacific); 3) A requirement in grant programs in two large federal agencies (NOAA; NSF); 4) Exclusive focus of national and international conferences; 5) Inspiration for children’s music (the Banana Slug String Band).



Kazuya Hirai leading a teacher workshop on fisheries for high school teachers following the Japan Ocean Literacy Symposium at the Tokyo University of Marine Science and Technology.

The *Ocean Literacy Principles* has become a model for scientists and educators in other disciplines of science to identify, articulate, and organize the critical ideas of their respective fields into a consensus document (atmospheric science, climate science, Earth science, neuroscience, and microbial oceanography).

www.oceanliteracy.net



COMMUNICATING OCEAN SCIENCES INFORMAL EDUCATION NETWORK (COSIEN)

This highlight is about spin-off programs derived from the Communicating Ocean Sciences (COS) college course first developed by COSEE-CA in 2003. One derivative program, COSIEN, funded in 2009 by NSF ISE, takes advantage of the substantive, long-term partnerships between the informal science education institutions (ISEI) and universities established by the original COSEE-CA grant and the 2006 ISE-funded Communicating Ocean Sciences to Informal Audiences (COSIA) project.

COSIEN strengthens and expands the 3-way partnerships between universities, ISEI, and COSEE-CA developed through COSIA, and formalizes their role in a network that shares common objectives in communicating science to the public, introducing current and future scientists to the role ISEI play in broader impact efforts, and promoting ocean literacy. COSIEN leverages our successful COSIA partnerships, activities, and materials as assets that support a new distributed leadership—each of the original partners takes the helm to lead new efforts, including expanding the network with additional partnerships. Institutions and individuals bring expert knowledge and experiences to share while engaging in opportunities to learn and develop their abilities to engage with the public.

COSIEN was created for informal educators and university scientists to collaborate towards shared goals; Regional Centers within this network build communities that leverage local organizations and expertise. Nationally, COSIEN is providing: (1) support for teaching the COS/COSIA college courses, (2) professional development for university and agency scientists interested in learning how to communicate their science and research more effectively and about the role ISEI can play in promoting the broader impact of their research, (3) professional development for practicing informal science educators that is grounded in research on learning and centered on reflective practice and effective inclusion of diverse audiences, (4) diverse role models and inquiry-based ocean sciences activities for underrepresented children and families visiting ISEI nationwide, and (5) providing the next generation of educators and scientists—university students—with knowledge and experiences in science teaching, focused on science pedagogy in informal settings, and the role ISEI play in supporting broader impact efforts.

National COSEE Network Centers that participate in leadership roles within COSIEN include: COSEE-CA (LHS/UC Berkeley; Scripps/Birch Aquarium); COSEE-Pacific Partnerships (Oregon State University/Hatfield Marine Science Center), COSEE-West (University of Southern California/Aquarium of the Pacific), COSEE-Coastal Trends (Hampton University/Virginia Aquarium), and COSEE-NOW (Liberty Science Center/Rutgers University). These Centers are teaching the COSIA course, leading professional development programs for informal educators, and offering workshops for university and agency scientists and Knauss Fellows.



UC Berkeley undergraduate science students presenting activities to visitors to Lawrence Hall of Science.



University of Southern California graduate student preparing to present her research to visitors at the Aquarium of the Pacific.



TEACHING OCEAN SCIENCES IN THE 21ST CENTURY CLASSROOM: LAB TO CLASSROOM VIDEOCONFERENCING

The Teaching Ocean Science in the 21st Century Classroom (TOST) initiative is a collection of COSEE-CA activities aimed at developing and disseminating technology-based instructional strategies and tools and ocean science resources for both formal and informal science education. San Diego Unified School District (SDUSD) and the Birch Aquarium at Scripps (BAS) are partners in this initiative and have established SDUSD and BAS as proving grounds for activities developed a part of TOST. As with all COSEE-CA activities, the ultimate goal is a sustainable model in which researchers engage in these activities as part of the broader impact components of their research proposals.

Lab to Classroom Videoconferencing: Advances in information and communications technology (ICT) is making it easier to connect students to researchers using simple videoconferencing tools (e.g., Skype, Acrobat Connect) that allow students and researchers to interact in novel ways. COSEE-CA is experimenting with these tools and approaches to identify effective practice in using ICT to provide students with insight into the research process and close connections to researchers and their laboratory activities. At the same time, researchers—in particular graduate students—are learning effective communication skills and how to align their presentations to specific classroom needs, all from the comfort of their own lab! This next generation of ocean scientists is being empowered to carry what they learn into their future outreach activities.

In 2010, three Scripps graduate students and the lab PI, Bill Gerwick, connected to nine 7th grade life science classes via SKYPE in a series of nine 45-minute videoconferences on the topic of marine natural products research. This project is an ongoing partnership between the Gerwick lab and a group of three life science teachers at Pershing Middle School. The science teachers collaborate on an intensive, semester-long unit focused on drug discovery. Capitalizing on the teacher team's well-developed unit of study and the obvious overlap with leading-edge research at Scripps, COSEE-CA has been experimenting with optimal approaches to structuring this activity to most effectively reach the students. The lab PI and graduate students conducted a mini-lab tour, gave a power point presentation of their research activities, and fielded student questions.

Teachers are currently writing up the “how to” document that will be distributed to other teachers in the district, and are exploring ways they can further capitalize on the connection to the research lab. In the interest of sustainability, the collaboration is being turned over to the graduate students and teachers with little facilitation by COSEE-CA staff. We are also applying the approach to other ocean science topics by offering “Virtual Lab Tours” as a broader impact option for researchers.



Students and the lab staff were able to interact with each other in a videoconference. Almost 300 students participated over the course of 9 videoconferences in three days.



Graduate student Emily Trentacoste explains research on the uses of tropical marine algae in drug discovery in a live two-way broadcast between Bill Gerwick's Lab and classrooms at Pershing Middle School.



COMMUNICATING OCEAN SCIENCES COLLEGE COURSES

Communicating Ocean Sciences in K-12 Classrooms (COS K-12) was developed by COSEE-CA in 2002. Based on the success of this course, a derivative course, Communicating Ocean Sciences to Informal Audiences (COSIA), was developed with funding from an NSF ISE grant awarded in 2006. These courses bring together ocean and climate scientists in universities with formal and informal educators to teach college courses to undergraduate and graduate students. In COS K-12 students conduct their “field” practicum in a K-12 classroom; in COSIA they are in an informal science education institution, such as a science center, or aquarium (<http://www.coseeca.net/programs/communicatingoceansciences>).



A University of California, Berkeley undergraduate student engages in a sink and float activity with young visitors on a field trip to the Lawrence Hall of Science.

COS promotes strategic collaborations between scientists and educators that improve ocean sciences education and increase public understanding of the vital role the ocean plays in our lives. COS courses seek to: 1) improve the ability of science faculty to communicate science concepts and research; 2) provide science faculty and students experience using instructional materials that exemplify best practices in science teaching and learning theory; 3) introduce future scientists (undergraduate and graduate students) to the importance of education, outreach, and the “broader impact” of ocean sciences research; 4) promote mutually beneficial collaborations between scientists and educators co-teaching the course; and 5) provide K-12 students from underrepresented populations and visitors to science centers with ocean sciences learning opportunities and role models.

Courses have been shared throughout the COSEE Network and beyond—most COSEEs are offering one or both courses, with many offering it at more than one university. The number (over 25) and range of institutions (e.g., Scripps, Hampton, Rutgers, University of Washington, and Maui College) finding success with the courses demonstrate the flexibility of the model and universality of the needs it addresses. Approximately 1,200 students have taken the courses and have taught ocean sciences to over 30,000 children and families. An evaluation report of COSIA with case studies, is available at:

http://www.inverness-research.org/abstracts/ab2010-06_Rpt-COSIA-final-eval-rpt.html

COS will result in a generation of scientists committed to education from the outset of their careers, thoughtful about their teaching, and sensitized to the need for outreach. They will develop high quality educational outreach and broader impact activities integral to their research. The courses also bring a much needed and unique resource to K-12 schools and informal science education institutions and provide a powerful method of reaching historically underrepresented students with diverse college-aged role models. The course curriculum has now been successfully adapted for additional audiences: 1) a professional development program for informal science educators; and 2) COS Workshops for university and agency scientists and for Knauss Fellows. The development of these efforts has resulted in the formation of a robust network of partnerships (see COSIEN Highlight). COS has brought nearly \$5 million into the National COSEE Network.



OCEAN SCIENCES CURRICULUM SEQUENCES

COSEE California, a regional center first funded in 2002, is a partnership between University of California, Berkeley's Lawrence Hall of Science (LHS), Scripps Institution of Oceanography, San Diego Unified School District, College of Exploration, and the University of Hawaii. This highlight focuses on the development of the Ocean Sciences Curriculum Sequences (OSS) for Grades 3-5 and 6-8, funded by NOAA Environmental Literacy Grants in 2007 and 2009. These projects involve a partnership between COSEE-CA and COSEE-NOW at Rutgers University. OSS is designed to be appropriate for adoption by entire states and/or school systems in order to reach the widest possible audience. OSS Grades 3-5 will be published in late 2010 with OSS Grades 6-8 following in 2012. The development process also serves as a model for how scientists and science educators can effectively work together in a collaborative and iterative process that results in a readily accessible and high impact product.

The development process for OSS emphasized strategic and long-standing collaborations between scientists and educators to improve ocean sciences education and increase public understanding of the vital role the ocean plays in our lives. OSS brought scientists and educators together to develop a balanced approach for inserting ocean sciences content into the mainstream K-12 science curriculum. Ocean Literacy: The Essential Principles of Ocean Sciences K-12 and the Ocean Literacy Scope and Sequence for Grades K-12 provided the conceptual foundation for the curriculum. Scientists and educators began the development process by drawing on current research in ocean sciences and science learning to form the conceptual framework, the progression of concepts, and the unit topics.

Scientists serve as advisors and reviewers of the instructional materials and scientist feedback is iteratively incorporated into the pilot, the national trial, and the final versions of the curriculum. These interactions around the curriculum development have led to lasting partnerships and collaborations on several subsequent projects. Two recent COSEE proposals (COSEE-SE and COSEE-OCEAN) included plans to implement OSS Grades 3-5 in several large urban school districts.

The OSS materials have potential to become the most widely used K-8 ocean sciences curriculum nationwide. We anticipate that thousands of teachers will, for the first time, use ocean sciences to address their science standards in ways that enhance learning, reaching unprecedented numbers of students. OSS materials will provide teachers with essential tools for advancing Earth systems science and ocean literacy. They will also provide a proof-of-concept that content about the ocean can be incorporated into middle schools in ways that enhance learning, address standards, and build on existing instructional programs. OSS also serves as a model for development of future ocean and Earth systems science materials and programs for secondary audiences.

"Working on the Ocean Sciences Curriculum Sequence has enriched me both as an educator and as a scientist—it is a rare opportunity to sit with top-notch scientists and brilliant educators to think deeply about what is important in ocean science, and what we feel a young student really needs to know to interpret and appreciate the world around them. It not only helps the students, but it helps us to see the world and our science through fresh eyes."

—Dr. Drew Talley, University of San Diego and Ocean Discovery Institute



PACIFIC OCEAN LITERACY FOR YOUTH, PUBLICS, PROFESSIONALS AND SCIENTISTS (POLYPPS)

POLYPPS is new a collaboration to extend the COSEE-CA courses Communicating Ocean Sciences (COS) and Communicating Ocean Sciences for Informal Audiences (COSIA) to the Central Pacific region. This highlight focuses on the professional development workshops offered on the islands of Oahu, Maui, and Hawaii as well as on the courses taught at the University of Hawaii at Manoa (UHM) at the graduate level and at the University of Hawaii – Maui College at the undergraduate level.

In March 2009, twenty-two formal and informal educators gathered at the campuses of the Hawaii Institute of Marine Biology and UHM on Oahu to learn about the COS/IA courses and share ideas with colleagues about developing courses for university and informal education audiences. Half of the participants were from Oahu and the other half were from the islands of Hawaii, Kauai, and Maui. COSEE-CA Lawrence Hall of Science partners led the workshop with the assistance of POLYPPS staff.

Because of the importance of place-based education in Hawaii, POLYPPS is working to contextualize COS/IA course elements through local and traditional exemplars and knowledge systems. POLYPPS has engaged a dynamic and respected group of traditional practitioners to advise efforts for respectfully and responsibly integrating aspects of traditional ecological knowledge with the course material. These components will be introduced gradually into the COS/IA curriculum over the next 2 years, with the hope of providing a process model for other institutions interested in similar efforts.

Evaluation responses provided evidence that the workshop was a great success, with three university campuses committed to teaching one or both of the COS/IA courses. Many other participants discussed adapting the COSIA course for informal education docents. Participants from UHM and UH-Maui College adapted the COS/IS courses for their graduate and undergraduate classrooms.

The graduate-level course targeted students interested in improving both their teaching skills and their ability to communicate about complex science concepts, especially culturally relevant ocean sciences education. The course was developed through a curricular framework that links local and indigenous concepts of environmental stewardship with ocean literacy principles. The instructors introduced graduate students to teaching science using inquiry-based pedagogy with grade-level appropriate instructional materials that were developed and tested by the Lawrence Hall of Science. Another important component of the course was communicating science informally to a general audience.

The undergraduate course combined instruction on effective ways of communicating scientific knowledge with direct experiences in K-12 classrooms and informal education sites, such as aquariums and marine-related tourist operations. Instructors emphasized and demonstrated inquiry-based teaching methods and learning pedagogy. Together with formal or informal educator-partners, students were required to develop an activity or presentation that included the essential parts of the learning cycle, accommodated multiple intelligences, and was inclusive of all learning styles.



UH Sea Grant graduate students participate in an undersea mapping activity based on the COSEE-CA COS Course.



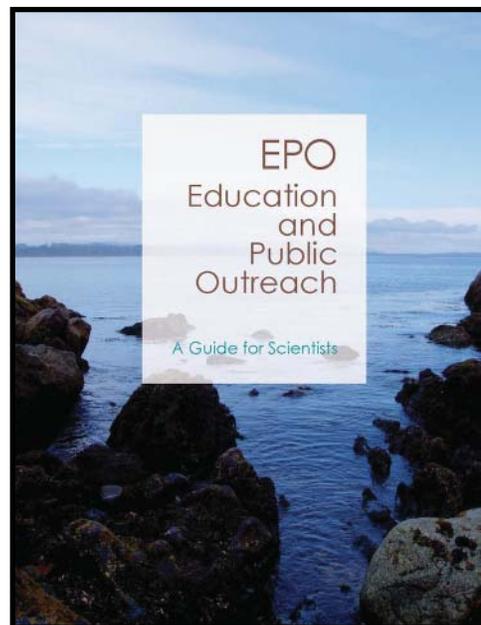
EDUCATION AND PUBLIC OUTREACH: A GUIDE FOR SCIENTISTS

COSEE-CA is a regional center first funded in 2002. COSEE-CA has as one of its key initiatives facilitating mutually beneficial partnerships between scientists and educators and sharing effective practices for connecting these partnerships with the broader community. In 2006, COSEE-CA (C. Peach, S. Franks and E. Simms), COSEE-Mid-Atlantic (J. McDonnell) and COSEE-New England (A. Thorrold) created a guide for scientists interested in participating in education and public outreach (EPO). EPO refers broadly to efforts to increase awareness and understanding of science. Audiences targeted by EPO can include students, teachers, children, adults, and just about any conceivable subset of these (e.g., economically disadvantaged youth, adult education instructors, museum visitors, parents, newspaper readers, high school students).

This publication represents a cross-center effort aimed at catalyzing research scientists' participation in EPO. It provides them with strategies and guidance for developing or engaging in outreach activities and directly addresses how they can work with educators to satisfy funding agencies "broader impacts" requirements. Each committee member brought a somewhat different perspective on researcher/educator partnerships to the group. This led to extremely productive discussion and a document that is sensitive to the needs and priorities of both scientists and educators. The guide is an outline of the major issues, strategies, and tools required to engage scientists in E&O, not a complete or prescriptive treatise.

The guide was published by the Oceanography Society as a separate print publication, as a downloadable pdf document, and as a navigable web-based resource (http://www.tos.org/epo_guide/). The print version and url for the online for the web-based resource and pdf are widely distributed at scientific conferences, oceanographic institutions, and via email distribution lists.

This "capacity building" activity has contributed to the forging of the strong national partnerships that are required to sustain and grow the National COSEE Network. As a result of the products of such partnerships, COSEE has come to be recognized as a national leader in engaging the research community in science education, as evidenced by requests for COSEE participation in workshops related to "broader impacts."



Cover page of *Education and Public Outreach: A Guide for Scientists*



INFORMAL EDUCATOR PROFESSIONAL DEVELOPMENT SERIES

A regional center first funded in 2002, COSEE-West serves the southern California area. This highlight focuses on the informal educator professional development series that COSEE-West has developed over the years. Started in 2003, these professional development retreats for informal science center staff were a way to provide more targeted information for the unique work of the staff at local southern California informal science education centers.

The retreats were initially conceived as one day workshops where the education staff at informal science centers could come together to hear from scientists about pertinent topics (e.g., ocean acidification and its affects on plankton), network with their counterparts at other institutions, and work together to create scientifically-based exhibits. Our informal education partners reach thousands of the general public and students each year. By helping them with their science content, the goal was to broaden the impact of a scientist's work by educating a large and diverse audience.

Over the years, COSEE-West has refined the format of these professional development workshops, based on feedback from our partners, such that now we run them in a series of shorter meetings geared towards a particular informal science center's needs. The focus of these professional development series shifts from center to center, depending on scheduling and need. Scientists still participate by giving a talk and answering questions, but in our new format, they are much more involved in helping formulate interpretives or hands-on activities alongside our informal science center staff. Our first such series occurred in Fall 2009, with a focus on the Santa Monica Pier Aquarium and how marine mammals would be affected by climate change.

According to survey data, this new format is much more helpful for our informal science center participants. Under the old format, 60% of respondents strongly agreed with the statement that the "retreat increased interest in linking scientific research with informal education exhibits." Under the new format, 100% of respondents strongly agreed with that statement. Under the one-day workshop format, 30% of respondents strongly agreed with the statement that the "retreat [was] effective in discussing ways to increase use, awareness of ocean sciences." With our new multi-day format, 71% of respondents strongly agreed with that statement. Products such as "Ocean Food Web Jenga" from our multi-day format in Fall 2009 have been heavily used by our informal science center partners and by COSEE-West at various events to great interest and success by our audiences.

By continuing to collaborate and support our local informal science education centers, COSEE-West furthers COSEE Network goals of forging partnerships and connections in pursuit of an ocean literate public. All of the resources and lectures from these informal science center professional development workshops are archived and online on COSEE-West's website for anyone to access.



The Ocean Food Web game developed at the Fall 2009 informal science educator professional development workshop, courtesy of the Cabrillo Marine Aquarium.



COSEE-WEST AND NASA/JET PROPULSION LABORATORY: CLIMATE DAY

A regional center first funded in 2002, COSEE-West serves the southern California area. This highlight focuses on a specific outcome of the especially productive collaboration between COSEE-West and NASA/Jet Propulsion Laboratory (NASA/JPL). “Climate Day” is a regional event for middle and high school students focused on connecting them with current scientific research on climate change, as well as an array of choices in how they can get involved in mitigating human impacts on our climate.

The inaugural joint Climate Day occurred in March 2008, with a one-day event geared towards high school students. Scientists from NASA/JPL and local meteorologist Rick Dickert (Fox News) gave talks about their work and COSEE-West and NASA/JPL staff organized exhibit booths, “Climate Theater” activities, hands-on activities and demonstrations, teacher resources, and panel discussions. The success of Climate Day 2008 paved the way for Climate Day 2010. This two-day event in March 2010 included a day for students and their teachers and a separate day for the general public. Activities included lectures by researchers from NASA/JPL, NOAA, and a number of southern California universities and hands-on activities, exhibit booths, and career information.



Students at the NASA/JPL and COSEE-West Climate Day learn about the effects of ocean acidification on marine organisms.

Attendance at both the 2008 and 2010 Climate Days was robust. The inaugural 2008 event saw about 1,000 students, while the student day for the 2010 event saw 1,100 school children. The 2010 Climate Day was also the catalyst for a unique collaboration between NASA/JPL, COSEE-West, and the southern California Air Quality Management District (AQMD). The AQMD was planning on a similar conference in May 2010 called A World We Can Change, an air quality and climate change conference for 8,500 high school students. Through a mutual connection among all three organizations, it was decided that NASA/JPL, COSEE-West and AQMD would have a presence at both events.

Survey data indicates that one- to two-day events such as these “Climate Days” are important in generating awareness in people and especially in under served populations. Of the students surveyed during the NASA/JPL and COSEE-West Climate Day, most were Hispanic/Latino, African American/Black, and Asian. None of the students surveyed had a great deal of knowledge about climate issues before Climate Day, but 69% responded that they had a great deal of knowledge about climate issues after Climate Day.

Through the strong relationships that COSEE-West has built with our partner organizations in the southern California area, we are able to leverage those relationships into opportunities that reach many different audiences. As with everything we do, the resources from the “Climate Day” events are online for the entire COSEE Network to utilize.



COSEE-WEST ONLINE WORKSHOPS

A regional center first funded in 2002, COSEE-West serves the southern California area. This highlight focuses on online professional development workshops, held at the College of Exploration's virtual campus. Started in 2004, this biannual, three-week workshop familiarizes formal and informal educators, administrators, policy-makers, researchers, and undergraduate and graduate students with a broad spectrum of ocean science related topics.

In keeping with COSEE-West's mission to reach a national audience with scalable educational models, our online workshops have grown above and beyond America's borders and reach a global audience on every continent but Antarctica. We are able to draw in researchers and scientists from around the country to provide science content and to interact with online workshop participants. Former scientist speakers include, but are not limited to, faculty from University of Southern California, the University of California system, the California State University system, and researchers from organizations such as the Jet Propulsion Laboratory and ORCA (Ocean Research and Conservation Association).

COSEE-West has several different formats of online workshop and this highlight will focus on our three-week courses. Each week of the three-week workshop focuses on topics put forth by one of our scientist speakers. The presentations are pre-recorded and put online for workshop participants. They view the lectures and then are able to ask questions and discuss their answers with the presenting scientist online. There are three pre-recorded lectures, one for each week of the workshop, and usually three separate scientists (who give the lectures) for online workshop participants to interact with. Resources, lesson plans and graduate credit from a California university are also available online.

Survey data indicates that people take these workshops for a number of reasons; they are especially important to those residing in land-locked areas. They also indicate that the interactions scientists have with participants helps them to adapt explanations of their work to a K-12 classroom and general public audience. Participants have told us, "...The range of experts cannot be duplicated in a regular graduate level classroom," "I was able to do this workshop online... if I had to travel to the ocean, it would have been impossible for me," and "...I enjoy interacting with others from all over the world and in a variety of fields and levels...everyone can share and gain from everyone else..."

Through COSEE-West's online workshops, a global community is able to come together to communicate and learn about ocean topics vital to continued life on this planet. All of the online interactions, lectures, resources, lesson plans, and pictures/images are available online for viewing.



Locations of participants in the COSEE-West online workshop, Weather, Sea Level Rise and Climate Change on November 3–23, 2008.



MARINE BIOLOGY HIGH SCHOOL COURSE

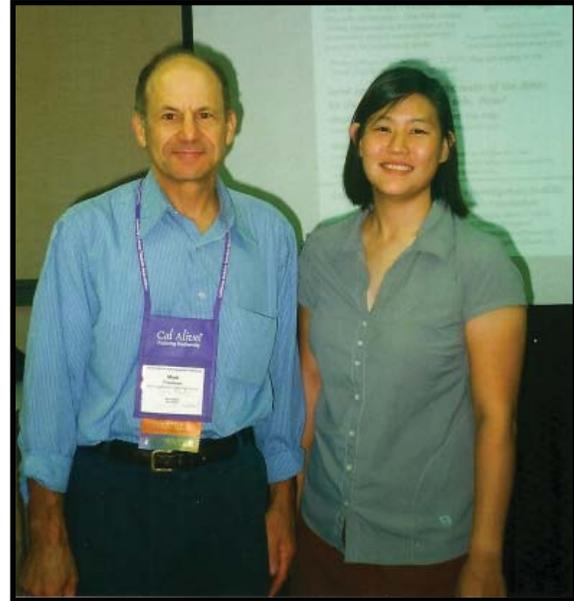
A regional center first funded in 2002, COSEE-West serves the southern California area. This highlight focuses on an effort begun in December 2007 by a group of Los Angeles-area high school teachers and COSEE-West staff to develop a marine-themed biology course that could be offered instead of a general biology course to teach all of the California Science Content (CST) Standards and meet University of California a-g entrance requirements. The standards include cell biology, genetics, ecology, evolution, physiology, investigation, and experimentation.

Using the idea that marine biology can act as a “hook” to draw in and keep students engaged in science, a working group consisting of local area high school science teachers and COSEE-West staff met to compile marine-related lesson plans, activities, quizzes, videos, and lecture slides, that teach the biology standards. They also identified gaps where more materials were needed. The gaps were filled by asking for help from the larger community of COSEE-West teachers.

The curriculum was then posted on the COSEE-West website for teachers to use in creating their own marine biology course or to incorporate parts of the curriculum into their general biology courses. Mark Friedman (Animo Leadership Charter High School – ALCHS), Gwen Noda (COSEE-West), and Todd Shattuck (University High School) presented the marine biology curriculum at the National Marine Educators Association (NMEA) conference in Asilomar, CA in 2009. Mark and Gwen presented this same session at the California State Teachers Association (CSTA) conferences in October 2009 (Palm Springs), 2010 (Sacramento) and will present it again in October 2011 (Pasadena). Mark presented the curriculum in November 2010 at the National Association of Biology Teachers conference in Minnesota. Lynn Whitley (COSEE-West) included this topic in her presentation on COSEE-West online learning and resources at NSTA 2010 in Philadelphia. Over 100 educators from various states attended these sessions. Teachers have informed us that they have taken steps to incorporate parts of this curriculum into their courses or have begun developing their own marine biology courses to teach in lieu of general biology.

As a result of the development of this course and the conference sessions, marine biology has been offered at schools as an alternative to biology in both coastal and inland states. Oscar Espinoza at King Drew High School in Compton, CA is one of several teachers who have received support to incorporate these lesson plans into their classes. Donna Keller from North Judson, IN is one of many who have taken this curriculum to their administrators and was granted permission to teach marine biology instead of biology. Having the curriculum online allows these teachers easy access and reaches teachers well beyond the immediate area served by COSEE-West.

Mark Friedman, one of the teachers spearheading this effort, has been using the marine biology curriculum in his classroom at ALCHS, a Title One, inner-city Los Angeles public charter school with 650 students (97% Latino and 3% African American) admitted by public lottery. In 2008, Mark’s students took the marine biology course prior to taking the Life Sciences or Biology California State Tests resulting in 96% and 97.7% of them passing at the level of basic proficiency or above.



Mark Friedman (ALCHS- teacher) and Gwen Noda (COSEE-West) presenting the marine biology curriculum at the California Science Teachers Association Meeting in Sacramento 2010.



COSEE-WEST AND SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT: AIR QUALITY-CLIMATE CHANGE CONFERENCE

A regional center first funded in 2002, COSEE-West serves the southern California area. This highlight focuses on the collaboration between COSEE-West and the South Coast Air Quality Management District (AQMD). AQMD hosted A World We Can Change, an air quality and climate change conference for 8,500 high school students at the Los Angeles Convention Center in May 2010. The conference focused on connecting students with current scientific research and policy issues related to air quality and climate change, and how to mitigate human impacts on air quality and climate change.

AQMD partnered with COSEE-West and NASA/Jet Propulsion Laboratory (NASA/JPL) in helping scientists give presentations, recruiting teachers and students to attend the event, and providing information about their education outreach programs in the exhibit hall. COSEE-West also provided a list of teacher resources on ocean acidification, sea level rise and global warming, and polar ecology that were posted on the AQMD conference website. Teacher resources included research articles, curricula, and hands-on activities aligned to California science content standards.

Teachers and students were surveyed about the conference following the event. Students reported that the conference was fantastic (35%) or above average (33%), and would recommend the conference to their friends (90%). Almost three-quarters of the students surveyed thought that all of the presentations were interesting, including the air quality panel (77%), Alliance for Climate Education presentation (75%), Kids vs. Global Warming/Rock the Vote presentation (71%), Dr. Donal Manahan's presentation (84%), and Dr. Joshua Willis's presentation (89%).

Seventy-seven percent of teachers gained a great deal of knowledge about air quality and climate change by attending the event. Over 75% of teachers reported that the conference met their expectations (85%), increased their knowledge about air quality and climate change (83%), planned to share information with other teachers and students (85%), and would attend future AQMD conferences (88%). Almost all of the teachers reported more concern about air quality (77%) and climate change (77%) after participating in the conference. Most of the teachers felt that presenters were knowledgeable (92%), interesting (81%), provided useful information (90%), and planned to use online teacher resources posted on the AQMD conference website (87%).

Scientists that participate in COSEE-West activities such as the AQMD conference have the opportunity to reach thousands of students thanks to the strong relationships that COSEE-West has built with our partner organizations in the southern California area. We are able to leverage those relationships into opportunities that reach many different audiences through a variety of ways.



AQMD staff utilize hands-on activities to teach high school students about air quality.



OCEAN OBSERVING SYSTEMS SUMMER TEACHER WORKSHOPS

A regional center first funded in 2002, COSEE-West serves the southern California area. This highlight focuses on the educator professional development program, “Ocean Observing Systems” (OOS), held at various venues throughout southern California. Started in 2008, this annual, week-long workshop familiarizes formal and informal educators with ocean-oriented remote sensing instruments, the data they produce, and the types of studies that typically utilize them.

In keeping with COSEE-West’s mission to bridge the ocean science research community and educators, faculty, and researchers from institutions such as the University of Southern California, the University of California Los Angeles, the University of Maryland, the Jet Propulsion Laboratory, and organizations such as TOPP (Tagging of Pacific Predators), actively participate and engage with our educators during OOS. COSEE-West also collaborates with other COSEE Centers (specifically Coastal Trends) and partners at the University of Colorado at Boulder, enabling us to draw in scientific expertise from around the country.



Educators on Ocean Institute’s R/V Sea Explorer about to launch a CTD probe into the waters off Dana Point, CA.

One day of the OOS workshop is devoted to autonomous underwater vehicles and the work of scientists in the Southern California Coastal Ocean Observing System (SCCOOS). A second day focuses on remotely operated vehicles, side-scan sonar, and CTD (conductivity, temperature, and depth) probes, while a third day centers on the drifters and drogues used to measure surface current speed and direction and the work of scientists on the east coast. A fourth day introduces educators to satellites, the observations they make of the ocean from space, and the work of researchers at the Jet Propulsion Laboratory, while the last day of the workshop highlights moorings and buoys and the work of scientists in the Santa Monica Bay.

Survey data indicates that these workshops are crucial to educators. An average* of 97% of workshop participants agreed or strongly agreed that sessions enhanced their professional expertise, while 91% of participants in 2009 (data unavailable for 2008) agreed or strongly agreed that speakers integrated practical application of content into their presentations. An average* of 95% of participants agreed or strongly agreed with the statement that they would implement what they learned in their schools and an average* of 100% of them agreed or strongly agreed that they would share that information with teachers/educators at their school.

Through COSEE-West’s collaboration with other COSEE centers and partners, educators on both coasts have been exposed to new and different ideas and expertise, while educators in land-locked states such as Colorado gain access to topics and resources that they might not otherwise have been exposed to. Resources and educator created lesson plans from the OOS workshops are posted on the COSEE-West website (<http://www.usc.edu/org/cosee-west/>) for anyone to use.



Educators at Cabrillo Marine Aquarium modeling how fluids interact with coastlines during a surface circulation activity.



STUDENT OCEAN AND ENVIRONMENTAL SCIENCE CHALLENGE PROGRAMS

This highlight focuses on Ocean and Environmental Science Challenge programs funded by corporate sponsors that have engaged COSEE-West and the USC Wrigley Institute for Environmental Studies (WIES). Following the establishment of COSEE-West, the QuikSilver Foundation funded the QuikScience Challenge in 2003 to recognize local southern California teachers and motivate students to engage their schools and communities in ocean sciences. Edison International followed in 2006 with the Edison Challenge on energy issues and the environment. Student team competitions spark interest in environmental science and the ocean and develop student environmental leadership.

In line with COSEE West's mission to facilitate linkages between ocean scientists, educators, students, and the community, these Challenge programs engage middle and high school students, teacher-advisors, and their communities with faculty, graduate students, and staff. QuikScience and the Edison Challenge improve science curriculum in the classroom.

Annual competitions for middle and high school students combine creating and teaching a lesson plan, a community service project, a "proposed" environmental solution, and multimedia presentations. The high school level competition also includes a research proposal. Faculty and graduate students from USC and corporate sponsors judge the student-led teams. Winning teams receive science immersion programs in ocean and environmental sciences at the USC Wrigley Marine Science Center (WMSC) on Catalina Island. USC staff, faculty, graduate students, corporate staff, and scientists work with the schools, teachers, and students using an effective model to motivate positive change in schools with diverse needs, create leadership in students, and raise the image of the sponsoring organizations. Edison Challenge includes a teacher professional development program to advance knowledge of energy conservation, environmental awareness, and stewardship and provide hands-on activities for classroom use. Teachers in the QuikScience Challenge receive peer-nominated teacher leadership awards for classroom materials and field experience opportunities for their students.



Some of the QuikScience Challenge team members participating in the QuikScience rally "Surfing Onto Solutions" for our ocean planet.



Edison Challenge student team member teaching younger students about local storm drains and the negative impact of marine debris.

Survey data reveal that both students and teachers gain knowledge, motivation, and leadership from their experiences. Scientists and graduate students improve their communication skills. Student teams were inspiring to the teachers, and motivated students to pursue careers in science. Participants have said, "The looks on their faces and the excitement about science and the environment made all the effort put into their project seem like nothing!" and "This trip definitely made me consider science as a career because it showed me the skills necessary to do scientific research through activities such as the transects, the labs, and the research presentation." This is a replicable model that can serve other COSEE centers.



MARINA DEL REY MARINE SCIENCE ACADEMY

A regional center first funded in 2002, COSEE-West serves the southern California area. This highlight focuses on the professional development program, “Introduction to Marine Science” at the Marina del Rey middle school Marine Science Academy. This multi-year, week-long workshop addresses science content standards for 6th, 7th, and 8th grades and incorporates teachers from all disciplines, not just the sciences.

In the fall of 2007, COSEE-West was approached by middle school teacher Leticia Escajeda, who had been very involved with previous teacher enhancement programs run by COSEE-West Co-PI Dr. William Hamner at UCLA. Her middle school was starting a marine science academy and their teachers, from all subjects, needed to be brought up to speed on the marine sciences. Because of her history with staff on the COSEE-West program, she knew the academy teachers would receive excellent instruction and contacts.

The first year of these week-long summer institutes focused on the 6th grade California science content standards, year two focused on 7th grade science content standards, and year three focused on 8th grade standards. Topics were taught with a marine emphasis and included evolution, physical sciences, and life sciences. Scientists from UCLA, USC, the California State University system and the Natural History Museum of LA County, as well as graduate students, have participated as either speakers or as instructors during these workshops.

Survey data indicates that these workshops are extremely important to the educators. 96% of respondents in years 2008 and 2009 agreed or strongly agreed that sessions enhanced their professional expertise, while 98% agreed or strongly agreed that workshop activities were helpful in presenting information to their students. In addition, students in the Marine Science Academy have outperformed their peers on standardized state tests and have used activities presented to their teachers during the workshop and incorporated them into a QuikScience project (COSEE-West related local science competition). Their project ended up winning the middle school division of the QuikScience competition.



Participants delve into science and policy of water quality in the Santa Monica Bay Game.



Educators collaborate in determining the slope of the beach at Playa del Rey.

All of the resources, lesson plans and activities from each year of the “Introduction to Marine Science” workshop are posted to the COSEE-West website (<http://www.usc.edu/org/cosee-west/>). Any educator will be able to teach their science subject with a marine theme and still meet California state science standards. This middle school curriculum is in addition to a high school curriculum on our website that enables high school teachers to teach biology with a marine science theme. The aim is to make it easier for educators to incorporate the marine sciences into their classrooms.

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DISTANCE LEARNING AND ONLINE RESOURCES

The COSEE-CGOM is a regional center, initially funded in 2002 and serves Florida, Alabama, Mississippi, and Louisiana. This highlight focuses on distance learning and online resources for the face-to-face and online components of the Summer Institutes. The Summer Institutes and Two-Day Workshops bridge the gap between ocean and coastal sciences research and its relevance to formal and informal educators.

COSEE-CGOM has been involved in distance-learning and online resources since 2002 through annual three-week Summer Institutes (one week face-to-face and an online component, offered over three weeks, with around 30 hours of technological engagement with six keynote scientists). The online component has evolved to contain multimedia (video clips, audio, and PowerPoint presentations provided by the scientists and interactive chat rooms for educators, scientists, and co-investigators). Two keynote scientists are featured each of the three weeks of the online component. The online scientists are usually engaged during the week they present and to a lesser degree in the following two weeks. All interactions with the keynote scientists, other participants, and the Center staff occur via Moodle, a learning management system customized for COSEE-CGOM needs.

The Summer Institutes are rotated annually, in LA and AL one summer and in FL and MS the following summer. All online presentations from 2002 through 2010 are archived on the COSEE-CGOM website at www.cosee-central-gom.org. All pre- and post-tests, Likert-scale evaluations, homework assignments, and lesson plans have been implemented for both components of the Summer Institutes. The cognitive evaluation results have always been at the 0.05 or 0.01 level of significance and Likert-scale evaluations average 89-94% Very Valuable/Valuable, 5-10% Average Value, and less than one percent at the Limited/Very Limited Value.

The COSEE-CGOM is a collaborative hosted by the University of Southern Mississippi (USM)-Gulf Coast Research Laboratory (GCRL) and its Marine Education Center and the MS-AL Sea Grant Consortium. Other partners include the Dauphin Island Sea Lab and its Estuarium in AL; Loyola University New Orleans (LUNO), and the Audubon Aquarium of the Americas in LA; the University of Florida (UFL) and its Natural Museum of History; the Florida Sea Grant College Program in Gainesville; Mississippi State University (MSU) and its Center for Education and Technology Training (CETT) in Starkville; and the Institute for Marine Mammal Studies (IMMS) in Gulfport, MS. It should be noted from October 2002 through September 2007, the LA Universities Marine Consortium (LUMCON) was the host for Louisiana and, from 2002-2006, the University of TX-Marine Science Institute (MSI) represented Texas in COSEE-CGOM.



Teachers working online, interacting with scientists, and preparing lesson plans. [Photo credit: Center for Educational and Training Technology (CETT), COSEE CGOM]

COSEE

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ENGAGING SCIENTISTS

The COSEE-CGOM is a regional center, initially funded in 2002 and serves Florida, Alabama, Mississippi, and Louisiana. This highlight focuses on distance learning and online resources for the face-to-face and online components of the Summer Institutes. The COSEE-CGOM staff members bring together research and education professionals in mutually beneficial ways to reach pre-college students and the public.

The face-to-face component of the annual Summer Institutes involves up to seven scientists, while the online component involves six different scientists and/or social scientists. In the two states not hosting the Summer Institutes, Two-Day Workshops for the engagement of scientists and formal and informal educators are implemented annually by three scientists and the PI, Co-Investigators, and/or educators in each of two states. The majority of the scientists are now fully engaged in the face-to-face component for three to all six days of the Institutes. For the last four summers, a paradigm shift has been occurring between the scientists and educators wherein the teachers are involved in enhanced content—based on sound science—and the scientists are gaining a more thorough understanding of instructional skills (pedagogy), the manner in which children learn, and the value of local, state, and national standards. A mutual, professional respect among scientists and educators is emerging.

All scientists involved in the face-to-face component of the Summer Institutes are interviewed by its external evaluator. The analyses of these data document that COSEE-CGOM is catalytic in helping scientists to enhance their broader impacts.

The COSEE-CGOM is a collaborative hosted by the University of Southern Mississippi (USM)-Gulf Coast Research Laboratory (GCRL) and its Marine Education Center and the MS-AL Sea Grant Consortium. Other partners include the Dauphin Island Sea Lab and its Estuarium in AL; Loyola University New Orleans (LUNO) and the Audubon Aquarium of the Americas in LA; the University of Florida (UFL), its Natural Museum of History, and the Florida Sea Grant College Program in Gainesville; Mississippi State University (MSU) and its Center for Education and Technology Training (CETT) in Starkville; and the Institute for Marine Mammal Studies (IMMS) in Gulfport, MS. It should be noted from October 2002 through September 2007, the LA Universities Marine Consortium (LUMCON) was the host for Louisiana and, from 2002-2006, the University of TX-Marine Science Institute (MSI) represented Texas in COSEE-CGOM.



Teachers and scientists conduct field work focusing on invertebrates living within sediments exposed at low tide.

COSEE Scientists Making an Impact
in Ocean Sciences Education

CASE STUDIES MAKING CONNECTIONS SCHEDULE

Bob Chen ~ The Urban Oceanographer

A chemical oceanographer with a research interest in organic geochemistry, Dr. Bob Chen is a professor at the Environmental, Earth, and Ocean Sciences Department of University of Massachusetts Boston. His research interests include:

- Dispersed organic carbon cycling in ocean margins
- Chromophoric (colored) dissolved organic matter sources and cycling in estuaries
- Time-resolved fluorescence spectroscopy for in situ measurements of systems
- Tracking sources and distributions of organic contaminants in coastal waters
- Applications of fluorescence spectroscopy to marine environmental problems
- Coastal environmental sensor networks

Bob's field work takes him and his graduate students out into the Neponset watershed, where he also deploys remote sensing devices. Explore the activities related to Bob's research in [At Work](#).

Bob's experience as co-PI (Principal Investigator) for COSEE New England gave him the opportunity to work with a balanced portfolio of partners to support capacity building, outreach, and program delivery. Using the knowledge he gained through working in COSEE - on how to build strategic collaborations, work with multiple disciplines, develop programs through research and development, and how to bridge cultural gaps - Bob has expanded both his reach as well as COSEE's.

Viewpoints
COSEE participants find value and excellence in their work in education and outreach. Explore a range of videos expressing both the advantages and the challenges that are inherent to this work.

Collaborations
COSEE scientists work with formal and informal educators, online communities, and the public. Explore a range of successful activities, programs and resources.

At Work
COSEE scientists are active researchers who publish, present, attract funding and form partnerships. Explore aspects of their work and its connections to education.

Scientist demonstrating the use of a balance for teachers needing to weigh samples for an experiment.

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PROFESSIONAL DEVELOPMENT PROGRAMS—INSTITUTES AND TWO-DAY WORKSHOPS

The COSEE-CGOM is a regional center, initially funded in 2002 and serves Florida, Alabama, Mississippi, and Louisiana. This highlight focuses on the distance learning and online resources for the face-to-face and online components of the Summer Institutes (SI).

The face-to-face component of the SI involves up to 12 educators, primarily in-service with some involvement by pre-service teachers. The four states also implement two-day professional development workshops for 40 formal and informal educators. The formal educators represent grades 5-9 and the informal educators represent museums, aquariums, science centers, state and federal agencies, and other non-profit or civic organizations. For the SI, participating pre- and in-service teachers are required to develop a group lesson plan for presentation to the class, and, upon return, each teacher presents this lesson plan as a professional development program in his/her respective school or school district. On occasion, some of the teachers' colleagues (fellow COSEE-CGOM scientists or teachers) join them for this professional development presentation. For the online component of the SI, 2-6 lesson plans are developed by each educator based on the enhanced content provided by the six online research or social scientists. Alternatively, they may produce 2-3 content-rich paragraphs about the world's ocean, coasts, watersheds, Great Lakes, or climate. These messages have been forwarded to Earth Gage for potential use by the Smithsonian Institution-Sant Ocean Hall's Ocean Today Kiosk "ticker-tape" header board. During 2010, Sant Ocean Hall had over five million visitors.



Scientists discussing an inland lake habitat in FL with formal and informal educators at the Mississippi, Two-Day Workshop. [Photo Credit: COSEE CGOM-MS]

The cognitive evaluation results indicate a 0.05 or 0.01 level of significance and Likert-scale evaluation



Ocean Acidification Activity being field-tested by formal and informal educators at the Mississippi Two-Day Workshop—conducted at Camp Timpoochee in Florida. [Photo Credit: COSEE CGOM-MS]

perceptions for these PD programs average 89-94% Very Valuable/Valuable and 5-10% Average Value. Three teachers are selected as "case studies" and interviewed by an external evaluator and "tracked" over the fall and spring semesters following participation to provide longitudinal data on the effectiveness of the SI. In addition, the evaluator collects data on classroom activities of the selected teachers to determine the impact on curricula and pedagogy. Interviews allow the evaluator to determine if participation in the SI has any impact on students' learning and whether partnerships formed between scientists and teachers during the summer continued through the following year.

COSEE

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PROFESSIONAL DEVELOPMENT PROGRAMS (“AT SEA”)

The COSEE-CGOM is a regional center, initially funded in 2002 and serves Florida, Alabama, Mississippi, and Louisiana. This highlight focuses the “At Sea” Professional Development Program. This is a once in a lifetime opportunity for formal and informal educators, and is currently open to at least one representative per COSEE and the CCO.

On occasion, usually in the summers, a U.S. Navy-supported partnership with COSEE-CGOM has been implemented which allows “up to” 14 educators to become part of the Sea Scholars Program aboard one of its 329-ft. T-AG-60 series oceanographic survey ships in the Atlantic, the Pacific, or the Gulf of Mexico. Six oceanographic surveyors are involved in providing instruction—focusing on geological, chemical, physical, or biological oceanography, to include acoustics, meteorology, and bathymetry. Three to four participants are placed in groups and work daily in three-hour blocks with oceanographic surveyors—recording bathymetry and making charts, taking cores and conducting sediment analyses, launching weather balloons, deploying CTD rosettes for measuring water quality parameters, evaluating acoustical water “noise,” making group journal entries each day and submitting this information log via the internet to students back home, making day and night plankton tows, identifying the captured phyto- and zooplankton and studying bioluminescence, and developing/revising lesson plans.



Teachers and surveyors prepare to deploy sediment grab equipment from the fantail of a U.S. Navy Oceanographic Survey Ship in the Pacific Ocean. [Photo Credit: Sea Scholar Participant]

All teachers are pre- and post-tested. The two-tailed, t-test analyses have always been at the 0.01 level of significance with all Likert scale evaluation being perceived at 94-96% Very Valuable/Valuable; 4-6% Average Value; and no perceptions of Limited/No Value. One to three COSEE will have two educator representatives. All COSEE will be notified by COSEE-CGOM when the Navy has shipboard time available for Sea Scholars’ implementation.

The COSEE-CGOM is a collaborative hosted by the University of Southern Mississippi (USM)-Gulf Coast Research Laboratory (GCRL) and its Marine Education Center and the MS-AL Sea Grant Consortium. Other partners include the Dauphin Island Sea Lab and its Estuarium in AL; Loyola University New Orleans (LUNO) and the Audubon Aquarium of the Americas in LA; the University of Florida (UFL), its Natural Museum of History, and the Florida Sea Grant College Program in Gainesville; Mississippi State University (MSU) and its Center for Education and Technology Training (CETT) in Starkville; and the Institute for Marine Mammal Studies (IMMS) in Gulfport, MS. It should be noted from October 2002 through September 2007, the LA Universities Marine Consortium (LUMCON) was the host for Louisiana and, from 2002-2006, the University of TX-Marine Science Institute (MSI) represented Texas in COSEE-CGOM.



Sea Scholar Teachers releasing a weather balloon from the fantail of an Oceanographic Survey Ship in the Pacific Ocean. [Photo Credit: Sea Scholar Participant]



COSEE SCIENTISTS MAKING AN IMPACT

The COSEE-CGOM is a regional center, initially funded in 2002 and serves Florida, Alabama, Mississippi, and Louisiana. The first goal of this COSEE-CGOM-American Recovery and Re-investment Act (ARRA)-funded effort is to engage representatives of all COSEE, the NNE, and the CCO as a Scientist Engagement Working Group (SEW-G) that will guide the production of exciting, engaging, and robust case studies of scientists' research and education programs. All SEW-G representatives have taken an active role in developing case study criteria—ethnicity, gender, ocean sciences disciplines, experience. They have interviewed featured scientists and their colleagues, undergraduate/graduate students, informal/formal educators, and the public.

The SEW-G has worked with each scientist and his/her nominating Center to produce a highly personalized and rich case study that documents the scientist's work in education and outreach as an extension of his or her research. Producing an engaging and highly personalized case study for each scientist has included several stages: 1) conversations between the scientist and production team, 2) creation of web elements and the draft case study, 3) interaction among the production team, the scientist, and SEW-G for review and revision of each case study to produce a final document to be posted on the NCN website.

Each case study has an area on the website, "Connections," composed of three COSEE components: 1) Viewpoints— participants find value and excellence in their work in education and outreach. Viewers explore a range of voices expressing the advantages and challenges that are inherent in this work; 2) Collaborations— scientists work with formal and informal educators, online communities, and the public; and 3) At Work— scientists are active researchers who publish, present, attract funding, and form partnerships. Viewers can explore aspects of scientists' work and its connections to education.

The outcomes of this process have been interactive case studies of six scientists to date, his or her education/outreach and research programs, and the contributions in ocean sciences research and education/outreach. Seven additional case studies are under development. The web pages for each case study have a consistent look. Each case study highlights the contribution of the COSEE that nominated the scientist. Evaluations will be based on numbers of visitors to the NCN website www.cosee.net which is housed on the COSEE-Ocean Sciences server.

The screenshot shows a web page titled "COSEE Scientists Making an Impact in Ocean Sciences Education". The page is divided into three main sections: "Viewpoints", "Collaborations", and "At Work". Each section has a small thumbnail image and a brief description. Below these sections is a video player showing a man on a boat, with the title "Bob Chen ~ The Urban Oceanographer". Under the video, there is a paragraph of text about Bob Chen's research interests and a list of bullet points detailing his work. At the bottom, there is a small photo of a group of people and a paragraph about Bob's role as a co-PI for COSEE New England.

This image depicts the three components of Making Connections: Viewpoints, Collaborations, and At Work. [Photo Credit: COSEE CGOM-SEW-G]



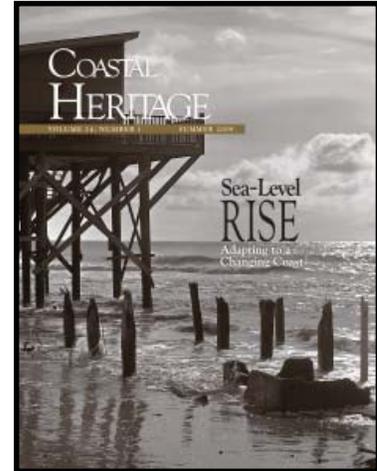
CLIMATE CHANGE OUTREACH TO EDUCATORS AND INFORMAL INSTITUTIONS

COSEE-SE, a regional center funded in 2002, serves North Carolina, South Carolina, and Georgia. This highlight focuses on the initiative to increase climate literacy within the region. The climate change educator-scientist community of practice initiated through professional development events and continually introducing emerging high-quality resources is an innovative strategy to build strong communication with scientists. Climate change became a COSEE-SE theme in 2008, based on its advisory board recommendations. The series of efforts associated with climate change education meet the COSEE-SE objectives: increasing scientist-educator interaction; disseminating high quality resources; and, providing high quality professional development programs.

In 2009 and 2010, COSEE-SE addressed climate change topics during residential Ocean Sciences Education Leadership Institutes. Scientists presented general information and specific research findings on paleoclimate proxies, ocean acidification impacts, sea surface temperature increase, hurricane development and sea level change. The past two Institutes had over 25 regional and climate scientists—representing more than 15 university and research institutions—and 35 educators present.

South Carolina Sea Grant Consortium has published five issues of Coastal Heritage magazine with articles related to climate change since 2008. Each issue was supplemented by the on-line education resources, Coastal Heritage Curriculum Connection, aligned with SC science standards for grades K-12, and provided regionally relevant science based resources. Transfer strategies included pre-Institute webinars, panel discussions, lectures, field trips and lab/classroom activities. During the 2010 Institute, problem-based learning exercises provided the pedagogical framework for a realistic and holistic approach to climate change issues. Following the Institutes, the participating educators coordinated, in partnership with local informal education centers, an Ocean Awareness Day (OAD) in over 14 SEPORTs: aquariums, museums and science education centers. The OADs provide a vehicle through which the Institute educators transfer climate science, materials, and resources to peers. Through these extensions, over 200 additional teachers have been introduced to climate concepts and resources.

The impact of a climate change focus from two years of evaluation of the participants reveals a significant gain in knowledge content in climate literacy, as well as an increase in confidence to extend this information to students and colleagues. One outcome is the establishment of a climate change community of practice, which provides a foundation for continued communication and learning between scientists and educators. A web-based Climate Change Forum is a site for marine and climate scientists, educators, and students to ask questions, engage in discussions, and share resources/opportunities. One metric is that the number of hits to the website for the Coastal Heritage Curriculum Connection increased—probably correlated with increasing interest in and use of climate change information for educators. Other anecdotal evidence is that other educators use COSEE-SE resources in their professional development workshops.



UNC-CH Scientists use a barrier island system to illustrate effects of sea level rise to educators.



COSEE-SE LEADS THE OBSERVING EDUCATION INITIATIVES IN THE SOUTHEAST

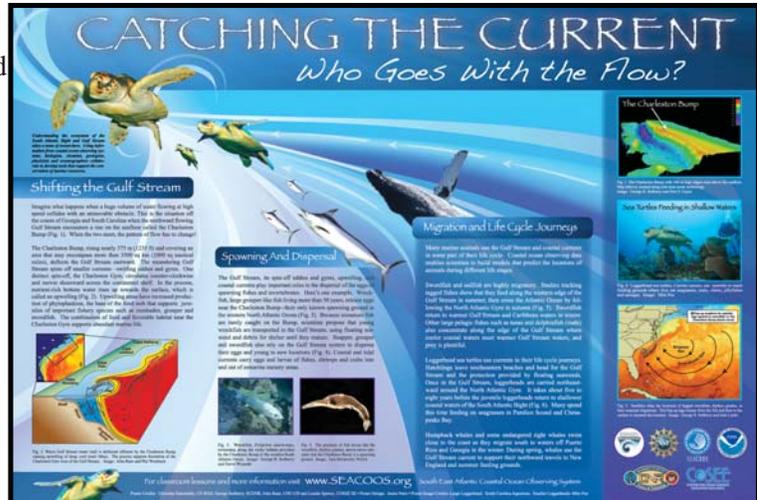
COSEE-SE, a regional center first funded in 2002, serves North Carolina, South Carolina and Georgia. This highlight in about an innovative STEM initiative that has enabled COSEE-SE to engage scientists with educational outreach through the partnership with the South East Coastal Ocean Observing Regional Association (SECOORA) and the research program, South East Atlantic Coastal Ocean Observing System (SEACOOS).

COSEE-SE and COSEE-FL developed all of the education outputs in observing for the region from 2003-2005. This included lessons, videos, and posters for educators. Each thematic poster was a collaboration between researchers and education specialists that was supported by online lessons and web based resources. In 2005, OCEAN US, COSEE-SE, and the Consortium for Oceanographic Research and Education (CORE) hosted a national symposium at the NOAA Coastal Services Center that resulted in a publication for strategies in observing education. Print and online proceedings allowed the strategies to be nationally disseminated. COSEE-SE continued to provide education initiatives for SECOORA to present.

Catalytic programs with COSEE-Mid-Atlantic and later COSEE-Coastal Trends brought their professional development workshops on ocean observing and real time data applications to the region in 2007 and 2009. COSEE-SE modified the resources to reflect southeastern situations and technology. Later, these concepts were extended to formal and informal systems. For example, the Roper Mountain Science Center, Greenville, SC, developed an exhibit area around coastal ocean observing, including a 5-ft model buoy, and interactive kiosk.

With a partnership with Dr. Doug Levin, then of the NOAA Chesapeake Bay Office and now NOAA IOOS, COSEE-SE introduced the Basic Observation Buoy (BOB), an operational, but scaled-down, instrumented buoy project to the region. Three workshops in 2009 and 2010 focused scientists on design, instrumentation, and research potential. These coupled with over four national conference presentations have extended the concept to influence programming for students at an HBCU summer camp, informal science centers, undergraduate and graduate courses, and estuarine monitoring studies, funded by US EPA and NOAA NERRS.

SECOORA has adopted the BOB project as its signature STEM education effort; this constitutes a major impact for the COSEE-SE and it is shared with the National COSEE Network. The National Federation of Regional Associations (NFRA) education and outreach committee is interested in dissemination of the program to their eleven regional associations.



Scientist-educator-designed poster on Gulf Stream current information derived from observational data.



Camp director from Savannah State University launches his own BOB at SkIO, GA.



INCREASING SCIENTIST ENGAGEMENT—OPPORTUNITIES AND BENCHMARKS

COSEE-SE, a regional center funded in 2002, serves North Carolina, South Carolina, and Georgia. This highlight focuses on the continuing processes that COSEE-SE has used to increase scientist engagement in outreach and the efforts to establish benchmarks for success.

The Southeast has a powerful suite of universities, most hosting coastal marine laboratories, and many state and federal agencies whose research staff address regional and global marine issues. COSEE-SE has made major efforts to be a regional center, and has rotated the locations of its activities, such as professional development programs, in these regional institutions and agencies. As a result of this innovative approach COSEE-SE has been able to recruit scientists broadly from many different disciplines within the ocean sciences. Many scientists who have had the opportunity to work with COSEE-SE have in turn asked for assistance in developing broader impact plans for NSF proposals.

Recently, the emerging SouthEast Governors' Alliance has acknowledged COSEE-SE as an important member of the ocean and coastal community in the region. The Southeast Coastal Ocean Observing Regional Association (SECOORA) has depended on COSEE-SE for education leadership. This type of acknowledgement validates COSEE-SE as a high quality program and partner for ocean scientists. Credibility and name recognition takes time and continued high quality response to requests.

In order to ascertain what impact COSEE-SE has had on the ocean science community, a survey instrument was designed in 2008 to identify the (1) outreach capability of the scientists—barriers and successes, (2) what they needed to provide appropriate strategies for broader impacts, and (3) their awareness of COSEE-SE.

Over 350 scientists were identified by the COSEE-SE team who conducted some marine research in the region. Results are posted online and were sent back to the participating scientists. The results provided the first benchmarks in the National COSEE Network as 109 people (29%) responded. Of these, 72% were located in universities and 14% in state or federal government. About half worked on regional investigations and about half aligned their research with climate change. Over 90% percent of the scientists stated that they are currently involved with education outreach, ranging from presenting in classrooms, career days, public lectures, friendly website, participation in the National Ocean Science Bowl and engaging precollege students or teachers with their research. Over 51% indicated a collaboration with COSEE-SE. In addition, 43% believe that COSEE-SE would be most helpful to them in designing programs with more effective communication for educators and/or the public. This information provides a benchmark on which to gauge additional impact of future efforts in the region.



Marine geologists from University of South Carolina collect data on salt marsh productivity.



Marine Ecologists from Kennesaw State University building ROVs with teacher.



BROADENING PARTICIPATION AND AWARENESS OF OCEAN SCIENCES IN THE SOUTHEAST

COSEE-SE, a regional center first funded in 2002, serves North Carolina, South Carolina, and Georgia with a demographic that is over 30% non white. This highlight focuses on the efforts to provide inclusive programming that engages underrepresented populations in the ocean sciences and to establish benchmarks that will identify changes in the ethnic/racial diversity of the regional ocean sciences workforce. COSEE-SE has led the National COSEE Network in overt efforts to broaden participation in all aspects of its programs and activities. COSEE-SE has addressed the NSF challenge to broaden participation by boldly developing and implementing non-traditional strategies to increase diversity in all programs and activities. Matt Gilligan of Savannah State University, stated that “traditional methods result in traditional outcomes” in regard to diversity initiatives. COSEE-SE sponsored a 2003 charrette, Multicultural Pathways to Ocean Sciences Education, which was in itself an innovative format, resulting in online proceedings of personal histories and existing initiatives and an extensive bibliography of resources, plus recommendations for new approaches to being inclusive.



Coastal Legacy teacher on US Corps of Engineers Duck Research Pier.

The early focus on the traditional coastal knowledge and culture of the Gullah-Gitchee people led to two very non-traditional and quite successful professional development workshops (2004-2005). Later a new series of workshops focused on science-technology-society (STS), such as the impacts of growth and development of tidal creeks and estuaries and dynamic coastal geology of NC’s Outer Banks. One workshop used the reputation of the Outer Banks, as the “Graveyard of the Atlantic,” to integrate the historical accounts of the Pea Island Life Savers—the only all black life saving unit in the U.S.—with research from coastal geologists and engineers who provided the context for information on hurricanes, coastal changes, and physical and geological oceanography. In another effort to increase black awareness of careers in informal education, partnership with Savannah State University enabled COSEE-SE to support the development of and stipends for an innovative summer short course on interpretative methods in natural sciences for undergraduates who coordinated a 2-day camp for young children on Sapelo Island, GA as a culminating project. One participant soon went to the Shedd Aquarium as an educator.

COSEE-SE uses recommendations and personal recruitment practices to recruit African American formal and informal educators. All teacher participants are selected from schools with predominately diverse students populations. The impact of the increased effort resulted in increased diversity in all COSEE-SE events, including leadership—over 16% of the participants are not white.

In 2008-2009 efforts were made to establish benchmarks for the racial/ethnic diversity of the ocean sciences workforce in the COSEE-SE region ocean science workforce. Over 15 state and federal agencies and 23 universities with ocean sciences research interests responded to an online survey. The results show that over 90% of all professional staff in both agencies and institutions are White or of European descent.



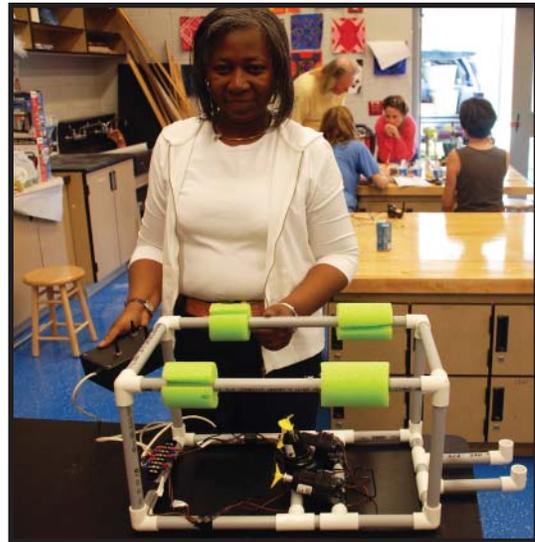
Sapelo children learn about their island from Savannah State University undergraduates.



COSEE-SE COMBINES STEM EDUCATION WITH UNDERSEA TECHNOLOGY AND RESEARCH

COSEE-SE, a regional center first funded in 2002, serves North Carolina, South Carolina and Georgia. This highlight focuses on a four year project to use professional development programs to combine the research and technology of undersea investigation with an innovative STEM program in which teachers and students construct Remotely Operated Vehicles (ROVs).

Based on an initial exploratory workshop in 2005, COSEE-SE and the MIT Sea Grant Sea Perch ROV program began a partnership that resulted in two Ocean Sciences Education Leadership Institutes in 2007 and 2008 and a continuing focus on undersea research and technology. This enabled COSEE-SE to engage NOAA National Undersea Research Program at UNC-W, NOAA Ocean Explorer Education, NOAA Gray's Reef National Marine Sanctuary, and regional scientists with formal and informal educators. During the fall and winter after each Institute, the educator participants extended the ROV concept to over 20 informal science centers during a 6-hour Ocean Awareness Day professional development event. Evaluation of participants revealed significant gain in perceived knowledge about the topic and confidence in their ability to teach about it.



Institute participants construct the Sea Perch ROV.

Impacts of this initiative include the adoption of the ROV project by 3 school districts, Coastal Carolina University for freshman orientation, and the SC Maritime Foundation. Educators working the tall ship, Spirit of South Carolina, conduct high school workshops in the area and used their training from COSEE-SE to introduce ROVs. Also, a high school student team partnership with SC Department of Natural Resources to investigate the success of diamond back terrapin excluder device for crab pots, based on the introduction to ROV to the science teacher. This led to a science fair award and regional participation in the MATE International ROV competition. Four SEPORT informal science centers have used the ROV in student programming. The availability of new resources about the South Atlantic Bight (SAB) cold water corals, such as the South Atlantic Marine Fisheries Council video, SC Sea Grant Coastal Heritage issue, and NOAA OE lessons has enabled educators to continue teaching about undersea topics. In addition, participant teachers have engaged in NSF Broader Impact initiatives working undersea research scientists in the SAB, New Zealand, and off California. Their prior experience with COSEE-SE provided them with awareness of research technology and some of the investigation objectives.



Teachers create their own ROV design.



SEPORTs—AN INNOVATIVE STRATEGY TO EXTEND THE PROFESSIONAL DEVELOPMENT EVENTS

COSEE-SE, a regional center first funded in 2002, serves North Carolina, South Carolina, and Georgia. This highlight focuses on the professional development program that rotates geographic sites, addresses a multi-year theme, recruits for racial/ethnic diversity of participants, engages scientists and implements an innovative outreach extension model.

The Ocean Sciences Education Leadership Institutes, initiated in summer 2003, have provided the opportunity for scientist-educator interactions. Each Institute takes place on a university campus or marine laboratory, e.g., UGA and SKIO, UNC-W, USC Belle Baruch Marine Field Station, NCSU and UNC-CH Institute for Marine Sciences. The one week residential programs have focused on the following themes: estuarine and ocean shorelines; habitats and natural hazards; undersea research and technology; and climate change—extending research from the South Atlantic Bight, the backyard ocean for COSEE-SE. Participants include scientists, formal educators, and non formal educators. The most effective and research-based educational strategies are applied and modeled.



Institute participants practice inquiry-based lessons.

During the fall and winter after each Institute, the participant-educators are required to conduct a 6-hour Ocean Awareness Day (OAD) professional development event at their local informal science center. These centers—SEPORTs (South East Portal of Ocean Research for Teachers)—are fiscal and knowledge partners with COSEE-SE. Each Ocean Awareness Day (OAD) agenda is created to extend resources, lessons, and concepts from that year's Institute to a local audience of peer teachers. Scientists are invited to share their research and findings at this event. The OAD multiplies the effort of the Institute and reaches a more diverse audience. Up to 14 SEPORT OAD events annually. Simple survey evaluation of the OAD reveal that the participants learn at least one new ocean science concepts and are willing to use to the new resources in their classrooms.

Evaluation of the Institutes has shown that the participating educators have significant gain in perceived content knowledge of the theme and research technology and methods and also significant gain in perceived ability to teach about this theme. Outcomes include the multiplication of effort from one Institute that engages about 20 educators to over 500 regional educators annually; a recruitment base for future workshops based on new SEPORT participants; leadership opportunities for teachers; and strong partnerships with the informal science centers. Other outcomes include the opportunities for scientists to communicate their research and experience “broader impacts” events and build long term partnerships with COSEE-SE. COSEE-SE team members and participants have presented information from the Institutes at state and national conferences. The major impact is the development of a COSEE-SE Informal Education Network in which information and resources can be distributed regionally through the science education institutions. COSEE-SE has shared resources from its Institutes to the Network and its SEPORT model for regional outreach via the web and Council meetings.



Scientists lead educators in field experiences.



NEOSEC: A LEGACY OF COSEE

Founded by COSEE-NE in 2005 and now sustained through ongoing grants, the New England Ocean Science Education Collaborative (NEOSEC) is a regional collaboration focused on ocean science literacy. NEOSEC's mission is "to leverage New England's extraordinary assets, to engage the public in understanding the vital connections between people and the ocean." NEOSEC now encompasses 43 institutions including aquariums, museums, universities, and science and research centers (www.neosec.org).

NEOSEC is led by a Governing Council representing each member organization. Paid staff provide coordination and produce its biweekly e-newsletter and blog, NEwswave (reaching 1135 subscribers). NEOSEC has been instrumental in bringing the Ocean Literacy principles to New England through a variety of joint programmatic activities including:

The Ocean Literacy Summit is a biannual conference that brings together informal/formal educators, scientists, science writers/filmmakers, and outreach specialists. The Census of Marine Life leveraged the 2010 Summit's focus on OL Principle #5 ("The ocean supports great diversity of life and ecosystems") to present the results of their 10-year, worldwide effort to New England audiences.

Summer Science in New England summer camps are held in Massachusetts, Rhode Island, Connecticut, New Hampshire, and Maine, collaborating to train camp counselors in field science, and scientists in field education. Teenage campers collect near-shore biodiversity data according to a Census of Marine Life protocol, which is then uploaded to an international database. Participating teens, educators, and scientists share their findings at regional forums.

Science centers in Massachusetts, New Hampshire, and Connecticut are providing professional development to middle- and high-school teachers each summer through the Get WET in New England program. Teachers develop a class field trip in coastal conservation, and share their programs at regional conferences.

Families by the Seaside facilitates project teams of community-based organizations and science centers in Massachusetts, Connecticut, and New Hampshire to conduct focus groups to learn what families want to see and learn when they visit the shore, and then develop coastal field experiences with learning activities that serve people of all ages.

NEOSEC is working with COSEE-Ocean Systems to increase scientists' involvement in NEOSEC and member programs; support member efforts to assist NSF-funded ocean scientists in expanding their education and outreach efforts; employ COSEE-OS content resources and concept mapping tools; and document and disseminate our collaborative model.

The Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) is partnering with NEOSEC to promote application of ocean observing data in ocean science education, tapping our collective expertise and regional reach.



Informal educators working together on a concept mapping activity in a breakout session at the NEOSEC summit.



Teacher educators from different institutions collaborate on designing activities for the GET WET program.



TELLING YOUR STORY

COSEE-NE developed, tested, evaluated, and disseminated Telling Your Story, a workshop designed to help scientists develop skills for working with K-12 teachers and students. TYS was developed in collaboration with TERC, a science education non-profit, and presented by a team composed of a scientist, a science educator, a science communication specialist, and a science teacher.

TYS workshops provide research scientists with specific guidance on how to work with teachers to plan, conduct, and follow-up on a classroom visit. They are intended to:

- broaden and deepen scientists' understanding of the benefits for students, teachers, and themselves in visiting K-12 classrooms
- improve scientists' ability to be effective in classrooms and make their visit valuable through a set of strategies and approaches including: learning to use concept mapping to think in new ways about science content they want to convey and how to make it engaging to students; understanding the importance of pre-visit planning and learning how to plan ahead with teachers; considering how to tell stories effectively by focusing on their research, their career path, or their institution; learning how to follow-up after the visit; and learning about resources available to help connect them with classroom teachers
- help scientists realize that “science learning” is not the sole purpose of their visits
- increase scientists' motivation and confidence in their ability to make a classroom visit
- increase the number of teachers and students who benefit from communication with ocean scientists.

Over time, we revised the TYS program based on participant feedback and to address the specialized needs of new audiences. Key improvements included involving educators as well as scientists as participants to provide opportunities for each to learn from the other and share expertise, and establishing teacher/scientist teams during the workshop and providing time for teams to plan school visits.

A total of 89 scientists, 15 formal educators, and 9 informal educators participated in TYS workshops during 2003-07. Evaluation indicated that scientists gained information and strategies that increased their interest in visiting classrooms and their confidence in doing so. Several scientists that participated in the workshop visited classrooms for the first time; others felt more prepared to revisit schools they had been to before; and a few cited interest in developing a longer-term relationship with a teacher or local school.

Some scientists who came to early workshop sessions attended later workshops as contributing speakers to discuss their experiences visiting classrooms, and several also participated in the more intensive Ocean Science Education Institutes. A TYS handbook is posted on the COSEE-NE website to enable facilitators to conduct TYS workshops on their own.



A scientist illustrating wave motion during a classroom presentation.



OCEAN SCIENCE EDUCATION INSTITUTE

COSEE-NE developed, tested, evaluated, and disseminated the Ocean Science Education Institute (OSEI), a model for school districts to engage scientists in curriculum and teacher professional development in order to bring current ocean science research into middle school classrooms. Week-long summer institutes included research talks by scientists, classroom and field investigations, and collaborative lesson planning. Participants met prior to the institute and again in the winter and spring to discuss their experiences, evaluate their work, and plan for revisions and dissemination.

The first two Institutes were led by COSEE-NE. Participants shared resources and expertise; learned about middle school ocean sciences curriculum and instructional practices; developed research-based units for classroom use; implemented lessons; posted their projects on the COSEE website; co-presented their work at regional/national conferences; and developed a supportive network.

To expand regional impact, COSEE-NE solicited proposals for additional institutes sharing the same goals and intended outcomes. Funded Institutes included: 1) a partnership between scientists participating in the Plum Island Ecosystems Long Term Ecological Research Network, MA Audubon's Salt Marsh Science Project, the Gulf of Maine Institute, and teachers from local public school systems, 2) a partnership among Bridgewater State College (BSC), Plymouth Public Schools, Captain John Boats, and WHOI ocean scientists, and 3) a collaboration between Northeastern University's Marine Science Center Outreach Program and members of Nahant and Swampscott Public Schools K-6 Science Departments.

COSEE-NE offered a final Institute involving facilitators and scientists from UMass Boston, Tufts University, and Blue Hill Observatory as well as teams of teachers from public schools in Boston and Milton, and two Boston-area private high schools.

A total of 49 research scientists, 110 formal educators, and 16 informal educators participated in the Ocean Sciences Education Institutes during 2003-08. While the focus of each Institute varied, all engaged scientist and educator teams to 1) identify areas of interest that fit with schools' science learning standards and address one or more Ocean Literacy Principles, 2) design and conduct class and field investigations using a range of measurement tools, 3) develop age-appropriate units of study for classroom use, and 4) secure the materials required for student investigations and pilot the units with students.

In addition, the most successful OSEIs also involved a team of educators from a school system, with overt support from district administrators, enhancing the likelihood of sustainability. These OSEIs integrated their studies into existing district curricula materials, replaced existing units with locally-based investigations, developed resources to complement existing science units, disseminated their work through conferences, COSEE-NE website, and/or journal articles, and designed replacement units for FOSS Diversity of Life and Ecosystems Modules.



A scientist participating in a hands-on activity at an Ocean Science Education Institute.



Students using microscopes to identify plankton after bringing plankton net samples on board.



ADDRESSING BROADER IMPACTS REQUIREMENTS WORKSHOP

COSEE-OLC, a regional center first funded in 2005, serves Washington State. This highlight focuses on the 2010 professional development workshop, “Addressing Broader Impacts Requirements,” as an innovative model for increasing E&O capacity among practicing oceanographers and marine researchers.

The intent of this workshop is to broaden participation of scientists in an ocean learning community. The goal was to engage ocean scientists within the University of Washington (UW), and other local research institutions, who want to increase their proposal success rate by focusing on new and innovative ways to demonstrate broader impacts of their research.



Graduate students and SACNAS members greet Dr. Alberts.

The organizers provided multiple sessions on a variety of topics in a convenient location. The workshop opened with an evening keynote presentation at the Seattle Aquarium by biochemist Dr. Bruce Alberts, editor of the journal *Science*, titled *Redefining Science Education and the Roles That Scientists Play in Society*. Over 200 people, including UW faculty, graduate students, local educators, and marine volunteers attended this evening program. Prior to the talk, a small group of graduate students gathered for dinner with Dr. Alberts, specifically some from the local chapter of the Society for Advancement of Chicanos and Native Americans in Science (SACNAS), and others who have worked on broader impact programs.

The workshop gathered over 150 participants, including scientists, faculty, staff, educators (formal and informal), and graduate students. Workshop sessions were held throughout the day, with some repeated so attendees could choose to drop in as their schedule allowed. Most of the sessions were panel-style, while a few were presentations of a program or results. The session leaders and members included experts ranging from Pulitzer Prize-winning journalists to a Washington State Governor’s Office Policy Executive, and from practicing learning and ocean scientists to current graduate students involved in outreach. The institutions represented ranged widely as well, including all those in the COSEE-OLC partnership: Washington Sea Grant, the Pacific Science Center, the Seattle Times, the UW Institute for Science and Math Education, the Port Townsend Marine Science Center, and more.

Post-event survey results showed that participants gathered both specific and general knowledge to improve their broader impacts plans, statements, and practices during the research process. All felt that their time was well spent and 97% of survey respondents asked for, or would come to, another such event and that the workshop’s organization lent itself to ease of participation by those with crowded schedules, including teaching responsibilities.

COSEE

OCEAN LEARNING COMMUNITIES

CONNECTING MARINE VOLUNTEERS AND SCIENTISTS: A MARINE VOLUNTEER OCEAN LEARNING COMMUNITY

This COSEE-OLC highlight concerns a series of events and workshops that model strategies for a) connecting scientists and informal educators such as marine volunteers, b) professional development for informal educators, c) broader impacts opportunities for scientists and d) a portal to communicate ocean science to the public.

Hundreds of citizens throughout the Puget Sound and Washington's outer coast volunteer with organizations focused on restoring and preserving marine and freshwater environments or interpreting beach ecosystems to the public. Starting from the Seattle Aquarium's connections with these volunteers, COSEE-OLC launched a marine volunteer learning community (MVC) by hosting a series of workshops and events. The events are unique broader impact opportunities for scientists to share current research with marine volunteers who, in turn, have shared the research with the thousands of citizens they interact with through their work. This learning community has grown to more than 700 individuals, representing over a hundred institutions/organizations. Outcomes include:

- Sound Conversations is a lecture series at the Seattle Aquarium co-hosted by COSEE-OLC. Scientists engage the public in interactive discussions about ocean science and the health of ocean/marine life. Most recently, UW oceanographer, Dr. Richard Keil excited the audience with findings from his SoundCitizen project. Participants took 118 citizen sampling kits at the event and in the following week the project enjoyed an uptick of 64 kit requests over normal.
- Family Science Weekend at the Seattle Aquarium (Fall 2009) provided hands-on learning about ocean science for hundreds of families. The event was a positive E&O opportunity for nearly two-dozen UW graduate and undergraduate ocean and learning scientists
- Exploring the Spectrum of Citizen Science Workshop (Spring 2009) focused on how to engage citizens in ocean/marine science research. The event expanded the learning community to include dozens of agency-based researchers, and increased the capacity of marine volunteers and scientists to engage in citizen science efforts. Recent data show citizens are applying strategies learned.
- Two events expanded volunteers' knowledge of learning sciences. Dr. John Bransford, author of *How People Learn*, gave the keynote introduction at the *Creating Connections: Bringing Together Ocean Scientists and Marine Naturalists Workshop* (Fall 2007). The *Communicating Ocean and Marine Sciences Workshop* (Fall 2008) featured Dr. Phil Bell, a UW learning scientist, who gave volunteers information about the 4 Strands of Science Learning, which MVC use in giving useful feedback to the ocean scientists' panel and poster presentations.



University of Washington graduate student sharing her research poster with marine volunteers at the Communicating Ocean and Marine Sciences Workshop, 2008.



Scientist working with members of the marine volunteer community to collect data on an Ocean Inquiry Project research cruise in the Puget Sound, 2007.

COSEE

OCEAN LEARNING COMMUNITIES

THE SOUNDCITIZEN HIGH SCHOOL APPRENTICESHIP PROGRAM FOR MINORITY YOUTH

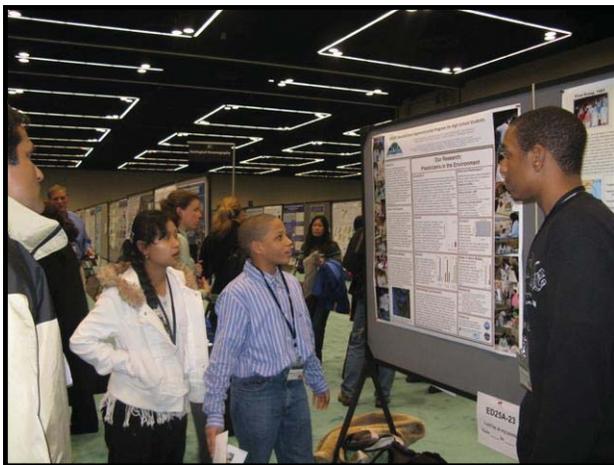
COSEE-OLC, a regional center first funded in 2005, serves Washington State. This highlight focuses on SoundCitizen and its High School Apprenticeship Program as an innovative model for broadening participation in ocean sciences. SoundCitizen is a student- and citizen-based research enterprise that investigates linkages between land and sea. It focuses on multiple processes including natural and anthropogenic transfer of carbon between environments. Since ‘springing from’ COSEE-OLC in late 2008, SoundCitizen has engaged more than 1000 K-12 students and adult volunteers to help collect water samples and data, and their research has resulted in multiple peer-reviewed publications.



Apprentices participated in a research trip and Ocean Inquiry Project cruise, one of the COSEE-OLC experiences.

A partnership between SoundCitizen and the Institute for Science and Math Education at the University of Washington (UW) established SoundCitizen Science Apprenticeship Program (SCSA) for underrepresented youth with funding from NSF’s Geosciences Opportunities for Expanding Diversity in the Geosciences (OEDG) program. It leverages COSEE-OLC activities to broader audiences and expands COSEE-OLC’s work in education and scientist engagement. Apprentice activities include cutting-edge geosciences research and mentorship experiences for first-generation immigrant, Latino, and African American youth. The program is designed to: (1) interest and retain minority youth in geosciences research, and (2) diversify perspectives in ocean and education research. The goals are for apprentices to: (1) learn aquatic and marine geochemistry through authentic scientific inquiry and (2) assume leadership roles within their community. A key strength of SCSA is the mutually beneficial partnership between the UW’s School of Oceanography, the UW Institute for Science and Mathematics Education and two youth groups in Seattle—Passages Northwest and YMCA BOLD.

The apprentices worked in the lab with UW undergraduates—who taught them lab techniques and served as models. They collaborated with scientists to identify researchable questions, which last year focused on



A highlight for the apprentices was presenting their research findings at the 2010 Ocean Sciences Meeting in Portland, Oregon.

plastics and plasticizers in the environment, and in formulating hypotheses about how these pollutants might be moving through the region’s waters. The compounds they chose to pursue were Dibutyl Phthalate (DBP), Diethylhexyl Phthalate (DEHP), and Bisphenol A (BPA), all known contaminants with unknown concentrations and sources to local marine waters. The apprentices collected samples and engaged in lab analysis and data interpretation. They noted several key findings (presented at the Ocean Sciences Meeting): (1) there was sufficient BPA in fresh and salt water (part-per million levels) to potentially cause endocrine disruption in aquatic organisms, (2) DEHP was abundant in drinking water, hypothesized to be due to leaching from household PVC pipes.



EXPLORING THE SPECTRUM OF CITIZEN SCIENCE AND THE OCEAN INQUIRY PROJECT

COSEE-OLC, a regional center first funded in 2005, is focused on connecting marine volunteers with ocean and learning scientists as a way of building a learning community. This highlight focuses on an event aimed at building the capacity of marine volunteers to engage in high quality, rigorous, citizen science projects.

COSEE-OLC hosted Exploring the Spectrum of Citizen Science (Spring 2009). Dr. Bruce Lewenstein, co-chair of NRC's study on Learning Science in Informal Environments gave the keynote, giving guidance about how to conduct rigorous citizen science programs that result in publishable and dependable data. Panel sessions by ocean research scientists, agency scientists, and marine volunteer program providers further developed marine volunteers' understandings about needs for data rigor, current data gaps, and examples of existing high quality citizen science programs.

In connection with the workshop, direct experience with ocean research occurred through an Ocean Inquiry Project (OIP) research cruise. Marine volunteers took CTD data from two sites, gathered water quality data, measured currents and turbidity, and collected plankton samples. Data are kept as part of a longitudinal study by OIP to extend and elaborate on existing research about Puget Sound.

The impact from this event is best shared through this email comment from a participant:

"I was fortunate to attend the citizen science workshop over in PT last spring and went to the monitoring section, and listened closely. Particularly about volunteers who do monitoring, most often directed by others, and then never, or rarely hearing back the results of their sampling, or what difference it might have made. There were some upset folks in the room. People who thought they had not been heard, or valued, by those in charge of the monitoring. We had an on-going volunteer monitoring (3 people) looking at a long-term fecal bacteria problem in a small river system in Skagit County. We had data, and we mostly managed the program, and sampling, ourselves, as volunteers. We came up with a different way of reporting information, both to our now somewhat larger group of volunteers, to county and state officials, and to the neighbors. The state health department has been using our results to help manage the century-old commercial shellfish industry in Samish Bay. Solid data provided "real-time" (i.e., the day samples are read out of the incubator), provided back to the volunteers, agencies, and larger community. Our distribution list grows, and now includes you. There is a pdf I would like to send you showing how we did this. See, someone was listening to what was discussed in that room that afternoon. Thanks for putting on the workshop. Worked for us."



Marine volunteers work with ocean scientists to collect data for SoundCitizen on an OIP cruise.

COSEE

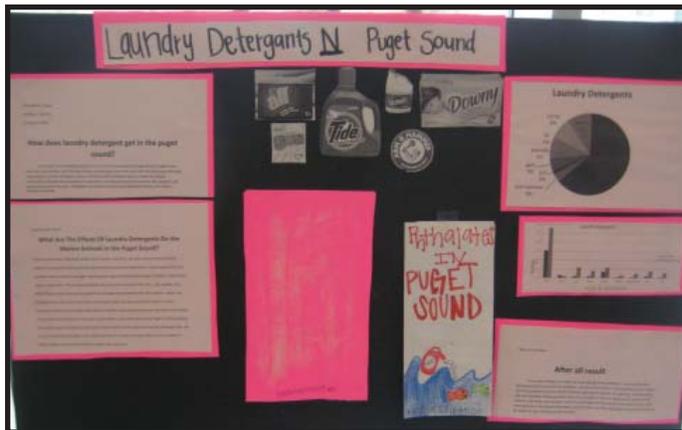
OCEAN LEARNING COMMUNITIES

MY PLACE IN PUGET SOUND: A PLACE-BASED HIGH SCHOOL CURRICULUM ON OCEAN SCIENCE TOPICS

COSEE OLC, a research center first funded in 2005, is focused on bringing cutting-edge research about the ocean out of the laboratory and into learning communities that can put that knowledge to work so that citizens become better stewards of our marine and aquatic environment. This highlight focuses on the curriculum design work coming out of the center that is a collaboration between learning scientists, ocean scientists, and teachers and graduate students participating in the Ocean and Coastal Interdisciplinary Science (OACIS) GK-12 program. The pilot test and evaluation of the curriculum with six classes ran in the 2009-2010 school year and the second enactment will occur in the fall of 2010 (Tzou & Bell, 2010).



Student action project presented to scientists, college students, peer, and community members.



Student action projects allowed students to pursue a personally meaningful marine science topic.

With a leading focus on broadening participation in the geosciences, learning scientists, ocean scientists, and high school science teachers collaborated to develop a place-based, environmental education curriculum for high school students typically underrepresented in the sciences. The curriculum, My Place In Puget Sound, focused on ocean science concepts, grew out of graduate student research, and leveraged culturally responsive approaches. Students conducted investigations related to watershed dynamics, endocrine disruptors, and chemical products in wastewater. They also developed science-informed actions plans to positively impact Puget Sound health.

Significant outcomes included:

- Student presentation of their action plans to scientists, college students and community members at the University of Washington
- Professional development for the teachers in ocean science topics and culturally responsive science instruction
- SoundCitizen data collection as part of Ocean Inquiry Project research cruises for OACIS GK-12 graduate students, teachers, and their students.
- Collaboration with the NSF-funded GK-12 OACIS program; graduate student fellows made contributions to the science, helped develop the curriculum, and supported classroom implementation
- Involvement of GK-12 OACIS teachers in field-testing of the curriculum.



GREAT LAKES LITERACY PRINCIPLES

COSEE-GL serves eight states along the North Coast of the U.S. This highlight focuses on the development of Great Lakes Literacy Principles as a means of comparing the oceanic attributes of the lakes with the well-established Ocean Literacy framework, so that Great Lakes educators and scientists would think of the Great Lakes in parallel with the oceans. Work began in 2009; a brochure and website were completed in 2010.

The Great Lakes Literacy effort had its origins in Ocean Literacy, principles and concepts, that provided guidance for teaching about the marine environment. Most of the concepts were easily transferable to Great Lakes teaching as well, but educators using Ocean Literacy in the Great Lakes found themselves stretching to say “ocean” while they were teaching on a lake. Environmental educators along Lake Erie’s coast identified a need for a place-based literacy framework and began development of Lake Erie Literacy Principles using the Ocean Literacy Principles as a guide. Concurrently, COSEE-CA, a leading force in the Ocean Literacy movement, recognized the need to expand the utility of the Ocean Literacy Principles for the Great Lakes region.

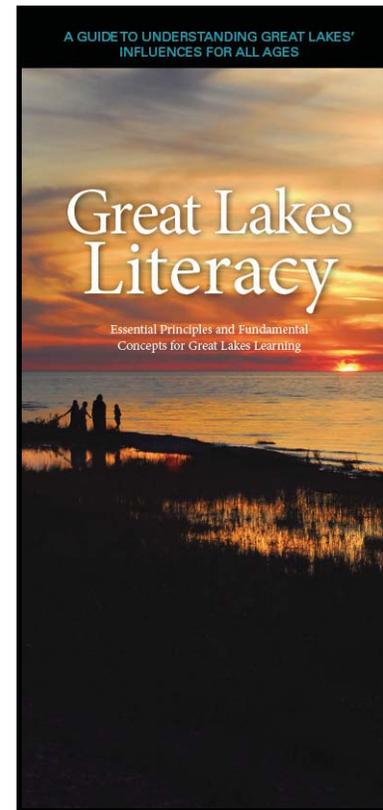
With the support of COSEE-CA, COSEE-GL education leaders in the Great Lakes Sea Grant Network examined Ocean Literacy and Lake Erie Literacy documents and drafted a baseline set of concepts. The principles and concepts were edited by over 80 scientists and educators in Great Lakes states. Ohio Sea Grant educators synthesized and organized the best ideas from examiners and oversaw a final review. While the concepts of Ocean Literacy were followed as closely as possible, developers saw a need to say more about connections of humans with the lakes than was encompassed in ocean literacy principle #6. Adding an eighth principle allowed for greater inclusion of the environmental history of the lakes and their role in the development of the region’s culture, economy, and regional identity.

The ocean sciences community now has literacy principles for all of North America. The COSEE Network has been enhanced by the addition of critical freshwater components through the inclusion of



Great Lakes educators drafting the Great Lakes Literacy Principles.

the Great Lakes. Great Lakes Literacy: Essential Principles and Fundamental Concepts for Great Lakes Learning, a publication similar to the Ocean Literacy brochure, was introduced at the 2010 National Marine Educators Association’s annual conference. The website (www.greatlakesliteracy.net) contains Great Lakes information and instructional materials, along with links to ocean literacy resources. Educators around the Great Lakes have begun using the framework to encourage more Great Lakes content in curricula and to focus state agency efforts toward education that is recognized for relevance to Great Lakes science.

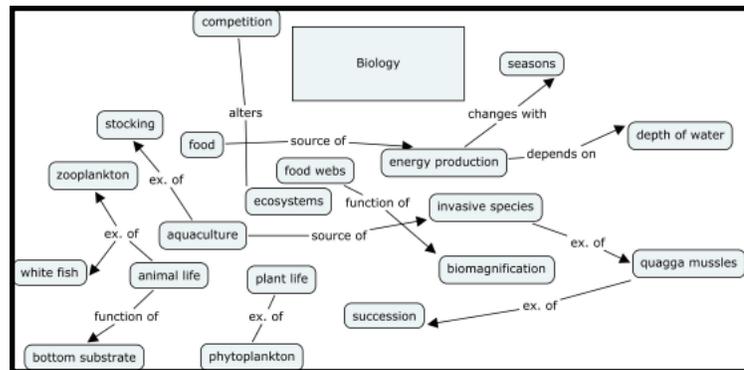


Great Lakes Literacy Brochure.



CONCEPT MAPPING: MEASURED CONCEPTUAL CHANGE AMONG EDUCATORS

COSEE-GL personnel piloted, validated, and implemented a concept-mapping procedure based on the innovative CMap software developed at the Institute for Human and Machine Cognition. The procedure was designed to monitor the increase in content knowledge and complexity of understanding of that knowledge among formal and informal educators participating in field, classroom, and ship-board workshops in years 2-5 of the project.



Concept map example for Lake Michigan biology.

Project leadership, working with an educational researcher serving as the project external evaluator, incorporated a highly-structured, concept-mapping procedure to measure increases in content knowledge among educators participating in three distinct models of professional development (the pedagogical model served as the independent variable for comparison). Educators in a week long, traditional workshop, in a ship-based workshop, and in a mixed ship and laboratory-based workshop led by research scientists, completed a series of concept maps following recognized procedures. The advantage of mapping over criterion testing was that content of each workshop could vary without instrument redesign. Additionally, a trained science educator could implement the procedure, even in the absence of a testing and measurement specialist.

Statistical comparisons of learning across the three types of workshops produced several key findings. First, educators in the COSEE-GL workshops finished their formal instruction with statistically significant greater content knowledge for ocean and Great Lakes. Second, the ability to organize this knowledge into increasingly complex units of thought was enhanced. Third, learning benefits of each type of formal training program were measured for the groups of participants, suggesting that contextual differences, (i.e., availability of ships and research platforms, types of laboratory facilities, and the specific training of instructional personnel) need not be viewed as limiting factors for enhancing the knowledge and capability of the nation's educators to provide subsequent instruction to their students on the ocean and Great Lakes' literacy principles. Finally, the mapping procedure yields both quantitative and qualitative data useful for mixed methods analysis. In this vein, the qualitative data are useful for monitoring the content covered through education programs for curriculum monitoring overall, and for subsequent program planning purposes.



Educators discuss conceptual linkages as they create maps.

The need for enhanced, cost-effective psychometric instruments that are highly portable, easy to learn and use, and interchangeable across multiple content programs is critical. The mapping and analysis procedure, having now been validated and published, is available for use without charge as a paper developed by COSEE-GL. The ability of COSEE-GL to combine data from multiple, dissimilar workshops into single data sets for analysis could be easily scaled up to multiple COSEE sites or to a national dataset for comparison of other sub populations and pedagogical designs.



COSEE GREAT LAKES—CURRICULUM HIGHLIGHTS

COSEE-GL has a strong focus on marine/freshwater education in Great Lakes classrooms, while bringing the vital contributions of the Great Lakes to marine education nationally. Curriculum objectives include enhancing teacher capabilities for accessing science information and integrating ocean and Great Lakes research into existing high quality educational materials. We target educators of grades 4-10 through relevant and timely lessons for under served populations in both metropolitan and rural settings, coastal and inland. Three products provide regional, oceanic, and data-driven curricula.

1) Greatest of the Great Lakes contains exemplary Great Lakes lessons. These 41 innovative activities were assembled from regional Sea Grant education programs and the Alliance for the Great Lakes. Topics address Life in the Water, Habitats, Climate & Weather, Hydrology, Coastal Processes, and Issues. This collection meets teachers' needs for classroom utility, quality, and topic coverage, and serves as a starting point for curriculum exploration rather than as a definitive end point.



Students engage in a hands-on GOGL activity simulating the invasion of aquatic species.

2) Fresh and Salt, a collection of activities connecting Great Lakes and ocean science topics is designed to be used by teachers in grades 5-10. This collection seamlessly blends both Great Lakes and Ocean Literacy Principles to enhance teacher capabilities for accessing and integrating science information. Fresh and Salt comprises a comprehensive range of instructional modes--data interpretation; experimentation; simulation; interactive mapping; and investigation/decision-making. Fourteen lessons were developed by national and regional agencies, institutes, organizations, and universities. Pilot testers evaluated materials for appropriateness of the grade level, reliability, accessibility, functionality, and relevance to literacy principles. One reviewer said: "I like ...Density: Sea Water Mixing and Sinking, because it both reviews concepts like density, volume, mass, and also has them attempt a new graphing skill. I will use this in the future with all classes. It's a good way to teach a physical science concept through an environmental venue."

Dissemination is through hands-on training at National and State Science Education Conferences and in state-based workshops, COSEE websites, and listservs for teachers and environmental educators. Lessons are provided to all educators who have participated in COSEE-GL workshops.



Teachers obtain data and plan classroom lessons using the Teaching with Great Lakes Data website.

3) Teaching with Great Lakes Data. This curriculum is based in partnerships with the Great Lakes Observing System (GLOS), a NOAA Environmental Literacy grant, NOAA's Great Lakes Environmental Research Laboratory, and regional universities. Lessons connect educators and students to authentic data collected throughout the Great Lakes and help students develop higher-level thinking skills through guided inquiry, data analysis, trend mapping, etc. Students (grades 5-12) explore dead zones, climate and weather, fish habitat, water density, and seasonal turnover. Data for the web-based curriculum has been compiled from buoys, satellites and other monitoring devices.

COSEE

GREAT LAKES

COSEE-GL PARTNERSHIP WITH USEPA

When the COSEE-GL proposal was submitted in 2005, with a supportive letter from the Great Lakes National Program Office [GLNPO] of EPA, the COSEE team hoped to place up to five educators aboard the R/V Lake Guardian to participate in water quality monitoring on research cruises in the Lakes. With great enthusiasm, GLNPO seized the opportunity to have a much broader impact than that: the agency dedicated a week of vessel time and crew services each year so 15 educators could learn first hand the importance of monitoring and how the variables of lake system science were interrelated. In 5 years, each of the Great Lakes was explored in a Shipboard and Shoreline Science Workshop.



Educators bring in water from different depths using a rosette sampler.



Educators and scientists work in the ship's lab analyzing biological samples.

A key mission of COSEE-GL is to create dynamic linkages between the education and research community. Our first two proposal objectives were 1) to facilitate collaboration between Great Lakes researchers and educators, and 2) to assist research scientists to gain better access to education. For Shipboard and Shoreline Science, 15 educators share crew space and responsibilities for a week with up to 6 researchers -- two EPA scientists and others doing their own studies of lake biology, hydrology, or chemistry. Host scientists engage the educator teams in forming hypotheses about relationships among parameters the ship can measure. Based on their hypotheses, educator teams can request sampling sites, so to the extent possible, they drive the science of the vessel.

Evaluation data are overwhelmingly positive from both educators and researchers. As high school teacher Ron Pilatowski wrote, "Science is all about looking at data, finding patterns, and providing possible explanations. Our experience on the Lake Guardian offered an ideal opportunity to develop a great activity for our students [on water quality parameters] with the added bonus of being able to actually relate to our students how the data was actually gathered." Likewise, scientists came away impressed with the quality of teachers in today's classrooms, with ideas of how to work with them, and with greater confidence in their own ability to contribute to ocean/lake science education. Dr. Greg Boyer, lead scientist on three of the COSEE cruises, said: "Educators have a big picture outlook, and they want to know more about how things fit together. I think the most useful thing as a scientist on COSEE cruises is that it grounds our research. Funding agencies are constantly pushing for collateral benefits and broader impacts from our work and this provides it. In addition to the obvious educational impacts (and the fact that it is fun), the educators ask questions of you. Many times these questions are basic, so it forces you to go back and rethink some of the basic tenets of your work."

The Lake Guardian and its supportive EPA scientists are a unique resource for the Great Lakes region; the partnership demonstrates a replicable vehicle for satisfying broader impacts.



USEPA's R/V Lake Guardian



COSEE GL HIGHLIGHT NOAA PARTNERSHIP

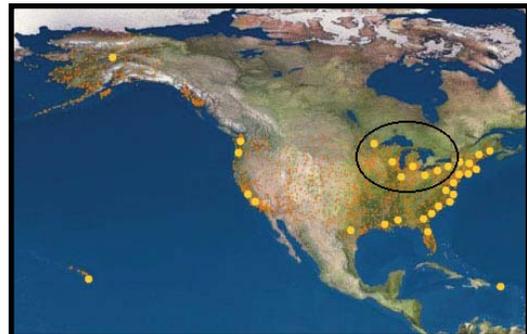
COSEE-GL brings the North Coast, inland sea, perspective to the COSEE Network in its 2005-2010 programming. It is safe to say that there would have been no COSEE-GL program without the support of NOAA's Office of Sea Grant. The basis of the COSEE-GL program is a staff that serves as education and outreach (E&O) personnel in the seven Sea Grant programs of the region. Sea Grant is a state-based program of marine research and extension education, with research programs selected for application to real-world issues and clear expectation that public benefit will ensue from research findings and applications. E&O staff are experts at taking research results directly from scientists to that public beneficiary; this includes bringing the emerging science to state educators.

It was thus natural to engage the expert E&O staff of the states when NSF offered the opportunity for regional efforts in ocean science education. NSF can act regionally where Sea Grant typically could not. In recognition of this unique opportunity, funding for COSEE-GL is 50% from NSF and 50% from Sea Grant. Sea Grant's 50% is augmented by an additional 25% in local/state match, per the Sea Grant national model, thus providing additional COSEE support.

Significant outcomes from this partnership have been measured in collective opportunities:

- As a COSEE center, the GL states reviewed and assembled the best existing curricula and distributed the 41 lessons as the Greatest of the Great Lakes.
- Science talent was pooled regionally to produce three online workshops that enrolled over 800 educators, scientists and resource managers in learning about regional geology, ecosystem dynamics and interdisciplinary sciences of climate and water quality.
- A model for educators' professional development in ocean/GL science was developed regionally and passed "downstream" from lake to lake, 5 lakes in 5 years.
- COSEE-GL shares COSEE Network information and opportunities with the Sea Grant Educators Network, and vice-versa.
- Educators used a small grant from COSEE-CA to modify the Ocean Literacy principles for the Great Lakes context, and promoted the two literacy efforts simultaneously to impact curriculum and the scope of science in regional partnerships. Sea Grant will support GL Literacy when COSEE ends.

Network level impact derives from all of COSEE-GL participation. By name and early definition the COSEE Network focused on the "salty" coasts until COSEE-GL joined and brought the richness of the North Coast perspective. Collaborative efforts with 5 other COSEEs shared freshwater coastal information and broadened definitions of ocean science even before the language of the 2010 National Ocean Policy included the Great Lakes. The COSEE Network will remember its Great Lakes partner!



Locations of Great Lakes Sea Grant institutions that support 50% of COSEE GL.



COSEE O'LAKERS: HANDS-ON SCIENCE FOR STUDENTS AND 'FILLING THE \$400 GAP'

The COSEE-GL O'LAKERS program, (Ocean/Lake Aware Kids Engaged in Relevant Science), was created to facilitate direct student connections to Great Lakes/ocean science experiences. Over the course of five years, this program has supported first hand experiences for hundreds of Great Lakes' students in grades K-16 throughout the Great Lakes basin. Activities supported by O'LAKERS have included field trips to facilities and programs such as:

- Research labs at Ohio State's F. T. Stone Lab and the Regional Science Consortium at the Tom Ridge Environmental Center (TREC) in Erie, PA
- Great Lakes Science Center in Cleveland, Ohio
- Duluth Aquarium and Aquarium of Niagara in Niagara, NY
- Natural areas such as the Indiana Dunes and Reinstein Woods Nature Preserve in Depew, NY
- Student research summits in Buffalo and on Lake Superior in alternate years.



Students check the pH of a Lake Erie water sample.

The O'LAKERS program has funded student participation in multiple school-ship programs in several states aboard the S/V Denis Sullivan, Wisconsin's flagship, the L.L. Smith in Duluth, Inland Seas Education Association vessels, the Spirit of Buffalo, and the Brig Niagara which is based out of Erie, PA. Activities aboard ship included collecting, recording and analyzing data samples gathered while under sail. These activities encouraged students to deepen their understanding of the interrelationships between living and nonliving components of the Great Lakes ecosystem. COSEE-GL specifically targeted underserved groups such as inner city youth and Native American students.

O'LAKERS Programs that include science, history, math, and technology are an outstanding supplement to classroom lessons that bring the Great Lakes alive through personal experience. Often teachers are



Students assist with data gathering aboard the S/V Denis Sullivan.

prepared with experiences and materials for instruction about oceans and the Great Lakes, but are then sent back to the classroom without the resources necessary to provide their students with relevant field experiences. The O'LAKERS program has filled that '\$400 gap' between the excellent experiences their teachers have had and experiential learning for students by covering costs of travel, admission, materials and scholarships.



GREAT LAKES "SCHOOL FOR SCIENTISTS"

COSEE-GL is a regional Center serving the eight-state Great Lakes region. This highlight is on a professional development program, "School for Scientists" conducted in partnership with the International Association for Great Lakes Research (IAGLR) at its annual meetings in May of 2007 and 2009. IAGLR is a organization of researchers studying the Great Lakes, other large lakes of the world, and their watersheds. IAGLR members encompass all scientific disciplines with a common interest in the understanding and management of large lake ecosystems. Hundreds of scientists and other professionals attend IAGLR's Annual Conference on Great Lakes Research.

COSEE-GL's 'School for Scientists' was conceived as a professional development experience for researchers seeking to enhance their capability in educational outreach to achieving broader impacts. A survey (Kim & Fortner, 2007) launched by COSEE-GL at the 49th annual IAGLR Conference revealed significant communication barriers to achieving meaningful collaboration. School for Scientists (SfS) sessions at IAGLR's 50th and 52nd annual conferences (half day and full day respectively) were designed to bridge this communications gap, assisting scientists in use of appropriate pedagogy and familiarizing them with opportunities, tools, and techniques for improved educational outreach.

The SfS programs consisted of 11 presentations with scientist-participants free to come and go between presentations. About 50 participants attended each program offering; roughly 1/3 were graduate students. In a follow-up survey, 92% of scientists participating in workshop sessions reported that participation in the SfS increased their awareness of information or resources to help with their education and outreach efforts; 58% of participants reported moderate to substantial increased awareness of pedagogy and techniques for designing and delivering educational programs, and 25% indicated they would develop an education initiative as a result of participating in the SfS. Many participants indicated they attended to hear a colleague present on an educational topic, or that they themselves presented and then stayed through other sessions. Over 80% of survey respondents were able to identify a colleague or peer with whom they intended to share specific information they acquired in the School for Scientist programs.

Engaging scientists in professional development in conjunction with their research conference has the potential to reach many scientists with education and outreach training in a short time. Since participants can select sessions that match their own interests and needs, their time is used effectively. Having sessions taught by their peers is an especially powerful model. COSEE-GL continues to work with IAGLR to move toward longer, more interactive sessions, to allow for individual assistance and thoughtful discussions of opportunities for education and outreach.



Scientists shared education tips with other scientists.



SCIENTIST DIRECTED PROFESSIONAL DEVELOPMENT

The Education Aquanaut project was conceptualized by Drs. Russell Cuhel and Carmen Aguilar, advisors to COSEE-GL and staff scientists at the University of Wisconsin-Milwaukee, Great Lakes Water Institute. This project is a collaborative extension to COSEE-GL for three years beginning in summer 2009.

Drs. Cuhel and Aguilar direct numerous NSF, NOAA, and State of Wisconsin-funded research projects, primarily investigating the distribution and life cycle of invasive mussels in Lake Michigan from aboard the R/V Neeskay. For one summer week they are joined by 8-10 educators from the Great Lakes states for a COSEE workshop. Teachers live on campus and work directly with the researchers. After an introduction to the Great Lakes system, to laboratory and field procedures and safety, the educators participate in authentic field data collection and laboratory analyses, learning first-hand how to perform biological research in the lake. Since their data are incorporated into ongoing scientific studies, the research questions and data collection are subject to revision annually. Later in the workshop, education specialists from the University of Wisconsin assist educators to integrate the scientific processes and analysis techniques with their own classroom instructional needs.



Educators learn mapping skills to select sampling sites.

As a collaborative activity of COSEE-GL, the evaluator for the broader program developed an integrated evaluation plan for the Aquanaut project to best leverage the investment for the larger effort. Consequently, formative and summative survey instruments were adapted from COSEE-GL to allow comparisons of demographics of participants in the Aquanaut project. The geographic location of the Aquanaut project, fixed in Milwaukee—a city with a significant Hispanic population—has produced higher participation for ethnic minority educators than in the overall program. Further, the evaluation utilized concept mapping analysis to monitor the increase in content knowledge and in complexity of concept understanding by the educators. Preliminary analyses for 2010 conceptual maps suggests that the teachers in this scientist-led workshop have a measurably higher content knowledge and complexity score at the end of the week than at the beginning. Further, and with important implications, the growth in the content knowledge for teachers in the scientist led workshop seems comparable to that of teachers in educator-led workshops.



Researcher Aguilar discusses sampling methods with educators.

While sample sizes for this pilot effort in researcher-led professional development are small (eight in year 1, and seven in year 2), implications of the content knowledge changes are important to the network. Findings support the role and effectiveness of scientists in broader impact activities. COSEE-GL has moved past working with scientists to design and implement broader impacts education activities and is now measuring their effectiveness is a unique contribution, which will provide useful information to the broader COSEE Network.



CONNECTING RURAL/INLAND AUDIENCES WITH OCEAN SCIENCE AND SCIENTISTS

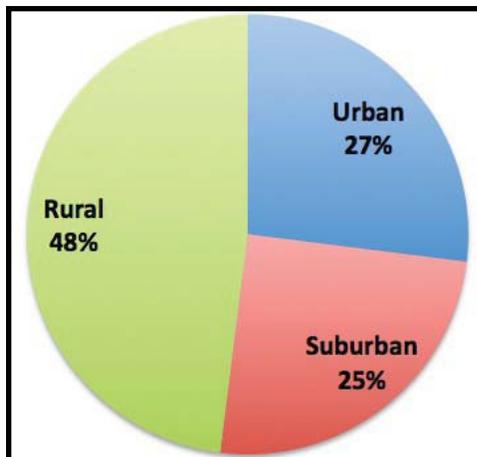
COSEE-OS was formed as a thematic center in 2005 with the goal of engaging scientists and educators to bring ocean science to rural and inland audiences. This highlight shows the various ways COSEE-OS has been reaching those audiences through a combination of in-person and on-line events. Examples of how ocean science content can be infused into existing curricula are also mentioned. COSEE-OS has reached 27 states and the District of Columbia with workshops and webinars and users in all 50 states have accessed OS online tools. Nearly half the educators who participated in OS workshops teach in rural school districts, and 41% of webinar attendees are from rural or inland communities.



COSEE-OS has reached 27 states and the District of Columbia with its workshops and webinars.

Through conferences, webinars, and workshops, COSEE-OS provides guidance for infusing marine science content into non-marine science classes by replacing terrestrial examples with those from the ocean. For example, at the NSTA conference in March, 2010, OS staff conducted two activities illustrating transferability between ocean and standard physical and environmental science content. The first activity came from a COSEE-OS publication, *Teaching Physical Concepts in Oceanography* (Karp-Boss et al., 2009). Participants observed effects of temperature and salinity on density and stratification. This demonstration was augmented by visualizations of the “global conveyor belt,” linking a simple tabletop process to ocean circulation and, ultimately, climate. Another activity showed how marine scenarios can be used to illustrate ecological principles usually taught through land-based models. Participants created concept maps based on two short readings on trophic cascades in marine and terrestrial environments.

In 2010, COSEE-OS launched a successful webinar series featuring ocean science researchers and in-service teachers. The design of these webinars was based on feedback from the 2009 network-wide Educator Survey. COSEE-OS educators had strong interests in: 1) scientist presentations on research topics and 2) learning how other educators use concept mapping. The webinar series’ goal was to allow participants from across the country to interact directly with scientists and educator colleagues outside their direct professional settings.



Nearly half the educators who have participated in COSEE-OS workshops teach in rural areas.

Leveraging marine science networks and listservs, almost 200 educators, college faculty, and teacher-trainers attended the COSEE-OS webinars. The series included scientist presentations on the Gulf of Mexico oil spill impacts, hydrothermal vent ecosystems, sequestered carbon and the carbon cycle, iron fertilization and climate intervention, among others. Of the 65 participants who completed post-webinar surveys, 92% stated that they are more comfortable with science topics presented. They also learned about ways to use concept mapping to teach ocean and other science topics from practicing educators. Of the survey respondents, 85% felt the educator presentations were “useful” or “very useful.”



TEACHING PHYSICAL CONCEPTS IN OCEANOGRAPHY: COSEE-OS PUBLICATION & COURSES

COSEE-OS is a thematic center that has engaged scientists, educators and education experts to create college courses and a publication that connects the core concepts of physical sciences to those fundamental to oceanography. The publication, “Teaching Physical Concepts in Oceanography: an Inquiry Based Approach” (Karp-Boss et al., 2009), is a 52-page supplement to Oceanography that contains a collection of hands-on activities for teaching physical concepts through inquiry and is available at http://tos.org/hands-on/teaching_phys.html.

The activities included in the booklet were developed, tested, and refined as part of OS collaboration between scientists and education specialists. This publication was developed, in part, through the participation of 58 educators from 17 states attending one of four “Teaching Sciences by Ocean Inquiry” workshops held in 2006-2008. Over each five-day workshop, educators learned to explore the dynamics of teaching physical science using marine examples and developed teaching materials focused on the links between oceans and climate. Teachers worked closely with program instructors to develop hands-on activities, teaching materials, and means of assessment (e.g., to address educational standards).

“Teaching Physical Sciences by Ocean Inquiry” was taught at the University of Maine (UMaine) in Spring of 2007 and 2008. This course was co-developed by UMaine faculty in the School of Marine Sciences and the College of Education; instructors used an inquiry-based instructional approach to teach about physical sciences content using ocean-based examples. Immersed in a variety of instructional strategies, students experienced current best practices and innovative pedagogical methods modeled using physical and biological marine science content. Approaches such as concept mapping using software like the OS-developed Concept Map Builder, computer modeling, visualizations and inquiry-based techniques that can be applied in field settings. Classes focused on learning scientific content using cooperative groups, hands-on lab activities, and discussion of relevant pedagogical strategies that are effective in teaching. The course structure was designed to enable students to reinforce their content knowledge, organize it, decide on key concepts, and enlist the methods they could use to teach that content. In Spring 2010, the UMaine undergraduate course was transferred to the University of New Hampshire. “Exploring Informal Science Education Through Ocean Inquiry” was augmented to include direct interactions with informal educators (e.g., Museum of Science - Boston) and additional marine biology content.

The publication, workshops, and undergraduate courses offer appealing ocean and climate contexts for teaching physical sciences concepts without having to add new content to existing curricula. Using the ocean as a platform for teaching physical concepts provides environmental relevance valued by many students. In addition, these resources can be used to infuse physical and chemical subject matter in marine education and outreach programs that are heavily focused on biological content.



An undergraduate explores salinity and density.



IMPACT ON GRADUATE, UNDERGRADUATE AND HIGH SCHOOL STUDENTS

COSEE-OS was formed as a thematic center in 2005. It engages scientists and educators in bringing ocean science to rural and inland audiences. COSEE-OS has been expanding its work to engage graduate, undergraduate, and high school students.

COSEE-OS seeks to teach younger science learners pedagogical tools and skills; build a pipeline of scientists engaged in broader impacts and public outreach; and support students in their own unique developmental needs. To ensure broad accessibility, the products and outputs of these students are made available on the COSEE-OS website.

Graduate students' collaborations with OS have been rich and varied. In response to science faculty recommendations, OS offered a Faculty-Graduate Student Collaborative workshop that coached graduate students in techniques to deconstruct and communicate complex science. Fifteen students from Waterville Senior High School in Maine were invited to serve as a "test audience" for graduate student presentations of maps illustrating ocean science concepts. The high school students shared their insights about the format and content of the presentations. Thus the interaction was mutually beneficial: high school students were exposed to cutting-edge science and they provided feedback about the graduate students' presentation skills. Graduate students rated interactions with the high-schoolers 6.4 on a 7-point Likert scale, the highest value of any workshop component.

Several graduate students, including Carrie Armbrecht and Beth Campbell, have participated in multiple OS educational events. Bangor High School chemistry teacher Michele Benoit invited Carrie to demonstrate OS web-based software to her 11th and 12th grade classrooms. Thirty-nine students employed the tools with ease and each developed a concept map on the topic of their choice. Beth also presented how she uses concept mapping in her marine sciences research program during an October 2010 webinar that was attended by 34 participants in 20 states.

In October 2010, OS-trained graduate students coordinated a University of Maine seminar to improve communication and outreach skills. Of the 19 graduate students who responded to the post-seminar survey, 63% rated it as 6 or 7 for usefulness (on a 7-point Likert scale). Three of the attendees contributed a blog to the OS website reflecting on ways to talk about their work with non-scientists.



Students from Waterville Senior High School listen and provide feedback during graduate student presentations.

"I think this [software] needs more advertising.... I would like to see more initiatives that allow grad students to use Ocean Climate Interactive as a means of improving teaching and communication of their results to a more general audience."

-Participant in Faculty-Graduate Student Collaborative Workshop



Undergraduate student, Andrew Millar, helps K-5 Workshop participants create concept maps.

Undergraduates have also interacted with COSEE-OS as students in OS-facilitated courses, as assistants in workshops, by featuring OS processes and tools in senior capstone projects, and by coauthoring COSEE-related posters presented at conferences. One undergraduate, Jennifer Graves, assisted with the first COSEE-OS Scientist-Educator Collaborative workshop in November 2008, co-authored three COSEE-related posters and, in Fall 2009, enrolled in the UMaine Master's degree program.



TRANSFERRING WORKSHOPS BETWEEN CENTERS: A "SCIENTIST-EDUCATOR COLLABORATIVE" EXAMPLE

COSEE-OS, a thematic Center, creates innovative models for scientist and educator engagement that are designed for transferability to other Centers. This highlight focuses on the successful transfer of the Scientist-Educator Collaborative (SEC) Workshop model to a workshop for informal educators piloted by COSEE Pacific Partnerships at the California State Polytechnic University, San Luis Obispo, in May of 2010.

During the Center-to-Center transfer process, COSEE-OS realized the need for detailed documentation and thus compiled a "case study" describing the flow of information and key decision points before, during, and after the workshop.

The following steps were crucial to the successful transfer of the SEC model: 1) Providing the piloting Center with all key workshop materials and templates; 2) Communicating regularly throughout the workshop transfer process; and 3) Using online tools to remotely train new workshop facilitators.

Prior to the transfer to Pacific Partnerships, COSEE-OS had extensively documented its processes in anticipation of the model's eventual transfer to other Centers. These materials were assembled in Google Docs, along with representative evaluation instruments and workshop communications templates (e.g., event announcement emails, recruitment letters for scientists, etc.). Additional documentation from previous workshops -- including background information, videos, concept maps, and evaluation results -- had already been made publicly available on the COSEE-OS website. Standing weekly teleconferences allowed for ongoing discussion of the workshop, including strategies for participant recruitment, modification of specific components of the agenda, and delegation of tasks. SEC workshop facilitators must be proficient with specific COSEE-OS software tools (i.e., "Ocean Climate Interactive" and "Concept Map Builder"). Thus screen sharing software (i.e., WebEx) was employed to demonstrate software functions to the new facilitators, emphasizing the areas where workshop participants would likely need the most assistance. New facilitators and their target audiences also took advantage of published online tutorials and user manuals for COSEE-OS software.

An important aspect of the workshop transfer process is coordinating evaluation efforts to meet the needs of participating Centers. At the end of the May, 2010, COSEE Pacific Partnerships workshop, facilitators from both Centers conducted an on-site debriefing for reflection and discussion of outcomes. Within days, participant pre- and post-workshop evaluation data were downloaded from online survey software and summarized as a written report. The COSEE-OS external evaluator, Dr. Ted Repa, also conducted follow-up interviews with the new facilitators. The collective feedback from the debriefing, surveys, and interviews has informed the refinement of future workshop materials and processes. This case study has helped to streamline future transfers of COSEE-OS workshop and other models throughout the Network.



Research scientist Nikki Adams (right) collaborates with informal educators at the SEC workshop held in San Luis Obispo (2010).



COMMUNICATING OCEAN SCIENCE WORKSHOP

COSEE Alaska, a regional and thematic center funded in August 2008, focuses on people, oceans, and climate change, weaving together traditional knowledge and western science about ocean climate change in northern seas. This highlight features one of our signature programs, the Communicating Ocean Science Workshop, which links ocean scientists with educators and journalists to showcase best practices in outreach and communicating science with diverse audiences. In 2009 and 2010, the week-long Alaska Marine Science Symposium (AMSS), attracted more than 750 marine scientists and educators from the U.S., Canada, and Russia to share ocean research ongoing in Alaska's seas. This free annual symposia is a regional Ocean Sciences/American Geophysical Union type of conference, with scientists often reporting they hear research findings here first that are later repeated at national science conferences.

COSEE Alaska, partnering with the North Pacific Research Board and the Alaska Ocean Observing System, held Communicating Ocean Science Workshops (COSW) on the first day of the conference, drawing scientists, graduate students, community members, and media. Invited speakers shared experiences and highlighted "best practices" of national, regional, and local ocean education programs, including scientists sharing experiences with new media, the use of concept maps, working with teachers-at-sea and a scientist's experience partnering with an elementary teacher from a remote island in the Bering Sea in a year-long activity bringing real-time ocean research into the classroom and curriculum. Other speakers included an Alaska Native sharing guidelines and best practices for scientists sharing research with Alaska Native communities, and the COS/COSIA courses developed by COSEE California. The Communicating Ocean Sciences Workshop included approximately 120 scientists, students, and informal science practitioners who gathered to hear about efforts to bring ocean science understanding to the public. Findings from the workshops show that COSEE Alaska effectively identifies areas of interest and need for the audience and provides programming that is useful and likely to be used. All the sessions were interesting to the participants, but in 2010, the Pribilof Islands-Fur Seal research involving an ocean scientist, a teacher, and an Alaska Native students was most captivating and compelling to the audience. Among survey respondents, 81% rate having educators and scientists collaborate in this manner as having "Vast" value (the highest rating option). The COSW is an education and outreach model that can be widely shared with the COSEE Network.

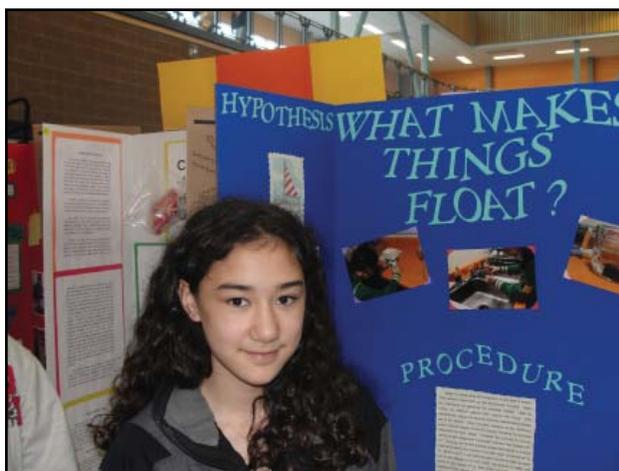


Marine mammal scientist, Dr. Andrew Trites talks with 4th-5th grade students on St. Paul Island in the Bering Sea during his year-long partnership with teacher Tonia Kushin to bring real-time fur seal research into the classroom and curriculum. They shared their project at the 2010 Communicating Ocean Science Workshop.



OCEAN SCIENCE FAIRS IN COASTAL COMMUNITIES

COSEE Alaska, a regional and thematic center funded in August 2008, focuses on people, oceans, and climate change, weaving together traditional knowledge and western science about ocean climate change in northern seas. This highlight focuses on our initiative to increase participation of under served and underrepresented audiences in ocean sciences by helping rural coastal school districts in Alaska organize regional science fairs around themes related to local knowledge of oceans, fisheries and marine environments in a changing climate. COSEE Alaska's ocean science fair initiative has been coordinated through the Center for Cross-Cultural Studies (CXCS)/Alaska Native Knowledge Network (ANKN) housed at the University of Alaska Fairbanks. In 2009 and 2010, planning workshops catalyzed a series of local and regional science fairs incorporating ocean science themes in coastal school districts, many with large populations of Alaska Native students. Projects were judged by scientists and elders for scientific rigor and cultural relevance. Top projects entered the Alaska State Science Fair in Anchorage with COSEE Alaska financial support for one student and one teacher from each participating district. Some rural students in remote communities also participated through "cyberfairs," using digital media and the internet. Inupiaq graduate student Wilma Osborne in Nome, one of the first graduate students in the new UAF Indigenous Studies program, provided training and support in the Inupiaq region of northern Alaska and served as the judge of cultural and community relevance at the State Fair. She assisted retired teacher Alan Dick in helping school districts and teachers organize the COSEE Science Fairs, providing workshops for participating teachers, developing ideas for ocean-oriented science fair projects, preparing video samples of exemplary science fair projects, and organizing/implementing an ocean science theme for the annual Alaska State Science Fair. Guidelines



The first place middle school award went to Charity Haskins of Unalaska for her project on corrosion of boat bottoms.



The first place award for a high school project went to Philip Sittichinli from Barrow who posed the question about the effect of a warming climate on bacterial growth on muktuk (whale blubber) in siqluaq (ice cellars) traditionally dug down to permafrost.

and resources for the science fairs were posted on the web at <http://ankn.uaf.edu/Curriculum/COSEE/> and published in a COSEE Science Fair Handbook posted on (<http://ankn.uaf.edu/Curriculum/COSEE/COSEEBook.pdf>). More than 50 projects were judged at the statewide Science and Engineering Fair using the two types of criteria (western science and cultural relevance/traditional knowledge), a significant increase over the number of projects judged in 2009. COSEE Alaska featured ocean science fairs in the Network newsletter, and is co-hosting a traditional knowledge session at the 2010 American Geophysical Union conference. PI Dr. Ray Barnhardt co-authored a book published with COSEE supplemental funds, Alaska Native Education: Views from Within.



PROMOTING RESEARCH INVESTIGATIONS IN THE MARINE ENVIRONMENT (PRIME)

COSEE-PP, a regional center funded in 2007 serving Oregon, Washington, California, and Hawai'i, has a strong focus on engaging community college faculty and students. Community colleges have become an important pathway for students intending to complete a baccalaureate degree, and students at these institutions have few opportunities to engage in science research experiences. This highlight focuses on an innovative internship program that provides community college students with opportunities to experience research by working with scientists based at marine laboratories.

"PRIME was most certainly the best of my community college experiences. Through it I was able to learn practical and technical skills in experimentation, to delve into a more advanced level of research before moving on to university, to make connections in the scientific community, and to have a great summer related to my course of study" – 2009 Intern

The goals of the Promoting Research Investigations in the Marine Environment (PRIME) program are to increase community college students' understanding of marine science content, the scientific process, science communication skills, and awareness of careers in marine science. Secondly, through this program, we are determining if community college students are an appropriate group for a research experience internship and whether marine lab scientists see value in the PRIME program.

The first internships were offered at the University of Oregon's Institute of Marine Biology and Oregon State University's Hatfield Marine Science Center in 2008. In 2009, PRIME included internships at the Western Washington University's Shannon Point Marine Center, and, in 2010, at University of Hawaii's Kewalo Marine Laboratory. Faculty mentors are recruited and project topics are determined in advance of the PRIME internship. The program has provided 20 internships and 16 marine lab scientists have acted as mentors. Students are provided with a modest stipend and housing to live at the marine labs during the eight-week internship conducting research, working on weekly journal assignments; attending seminars, and participating in other activities that show the broad spectrum of research and education that take place at marine labs and associated informal science education institutions.



PRIME intern researching flow patterns of native oysters.

In 2010, interns blogged about their research and experience as PRIME interns. Interns give a final presentation on their work that has taken a variety of forms including presentations to school children, a display at a county fair, leading behind-the-scenes tours of aquaria, and participation in formal research presentations. Interns are encouraged to use their experience to further their careers. For example, one intern, now a junior at Oregon State University, presented a poster on her research and experience in PRIME at the 2009 Coastal and Estuarine Research Federation conference. Another intern presented at the 2011 Pacific Estuarine Research meeting.

Evaluation of the PRIME program shows that this is a valuable experience for community college students, that faculty mentors are very receptive to the opportunity, and that this type of distributed intern network is replicable. The major impact of PRIME is broadening the participation of underrepresented groups in science.



PRIME intern and graduate students conducting research on juvenile salmon in the surf zone.



COASTAL MASTER NATURALIST PROGRAM

COSEE-PP, a regional center funded in 2007, has been building capacity for volunteer organizations in the Pacific Northwest by developing the Oregon Coastal Master Naturalist Program (CMNP). Modeled on successful similar programs nationwide, the CMNP seeks to develop highly trained volunteers engaging in ocean sciences education, stewardship, and citizen science. This effort dovetails with a larger effort in Oregon to create a statewide Oregon Master Naturalist Program developed around five bioregions, the coast being one of them.

COSEE-PP has taken the lead in a partnership with regional volunteer-based organizations to support the development and implementation of a CMNP for Oregon by working with scientists to develop a modular curriculum that incorporates current knowledge of the ocean and the ocean literacy principles.

In 2010 we identified scientists who piloted several modules of the CMNP curriculum and presented material to adult participants, some of whom are currently volunteers in marine and aquatic education and stewardship programs coast-wide in Oregon. These pilots were evaluated for 1) a fit with and coverage of the proposed COSEE-PP CMNP curriculum, 2) the perceived value of this effort to the scientists, 3) the scientist's use of active teaching techniques, and 3) the perceived usefulness and value to the participants.

The 41 participants who attended the first pilot ranked it as useful (average 3.71 out of 4) and inspiring (3.73 out of 4). They ranked the instructor highly (3.85 out of 4), with high marks for preparation, clarity of purpose, and enthusiasm. Follow up interviews with participants from all pilots in Winter 2011 will help establish longer-term content learning from this and the other pilots. The instructor of the



Dr. Cynthia Trowbridge provides instruction on rocky shore habitats to volunteers in the coastal master naturalist program.



Dr. Stewart Schultz and volunteers in the coastal master naturalist program explore organisms of the sandy shore.

introductory module, an ocean scientist working at University of Oregon, reported that the experience was quite positive and valuable to her in terms of helping to practice and improve communication with non-expert, non-undergraduate audiences.

Scientist involvement in the training of volunteers who can communicate effectively about the ocean to a variety of audiences has long-term implications. Programs such as the CMNP are replicable nationwide and could contribute to building capacity for ocean education.



PROFESSIONAL DEVELOPMENT OPPORTUNITIES FOR COMMUNITY COLLEGE FACULTY

COSEE-PP, a regional center funded in 2007 serving Oregon, Washington, California, and Hawai'i, has a strong focus on engaging community college faculty and students. This highlight focuses on an innovative professional development program whose goals are to increase the ability of community college (2YC) faculty to learn about and use current ocean science information in their teaching activities and build a community of 2YC faculty and scientists to support learning in the community colleges.

The science faculty at community colleges play an important role in providing ocean science education for undergraduates. The 2YC science curriculum serves a large number of non-science students and a smaller number of students who enter the ocean science work force. Community colleges provide access to a diverse audience; nationally 53% of Hispanics, 45% of African Americans, 52% of Native Americans and 40% of first generation college students in higher education are enrolled at community colleges. Classes that include ocean science topics are taught in a variety of departments by faculty who may or may not be ocean scientists. Since 2009 COSEE-PP has been working with 2YC faculty and ocean scientists to improve the quality, and increase the quantity, of ocean science content of 2YC courses by providing professional development opportunities for 2YC faculty.

In summer 2009 and 2010, three week-long workshops for 2YC faculty were held at marine laboratories in Oregon and Washington. Eighteen senior and junior scientists from Oregon State University, University of Oregon, and Western Washington University have provided current science information and resources on topics useful for 2YC science courses (e.g., ocean acidification, plastic in the ocean, invasive species, hypoxia, ocean observing systems). The scientists and 2YC faculty also piloted and discussed curricular ideas and teaching pedagogy. During the 2008–2010 academic years a similar one-day workshop structure was offered three times at venues attended by the 2YC faculty such as the Northwest Biology Instructors and the Oregon Academy of Sciences meetings.



Dr. Angel White and community college faculty gathering nurdles (pre-production plastic pellets) on the beach during a COSEE – PP workshop where she presented on her research on plastic distribution in the north Pacific gyre.

"Based on Dr. Angel White's presentation on the Pacific garbage patch I plan to revise the presentation of plastic pollution in next edition of my textbook." -

-Al Trujillo, author "Essentials of Oceanography," a text book widely used in introductory oceanography courses.



Dr. Alan Shanks demonstrating ocean stratification to community college faculty at a COSEE – Pacific Partnerships workshop.

Survey data indicated 2YC faculty and scientists had highly positive responses to the workshops. Longitudinal studies of the 2009 2YC faculty indicate that most are using information from the workshops in their courses. These resources are currently being prepared for web distribution. The national coverage and regional nature of the COSEE centers makes them ideally suited for partnerships with community colleges. It allows for the development of opportunities that connect ocean scientists with community college faculty who are often placed-based with large teaching loads and few resources for professional development.



ENGAGING SCIENTISTS AT MARINE LABORATORIES IN COSEE – PACIFIC PARTNERSHIPS ACTIVITIES

COSEE-PP, a regional center funded in 2007 serving Oregon, Washington, California, and Hawai'i is centered at two west coast marine labs: the University of Oregon's Institute of Marine Biology and Oregon State University's Hatfield Marine Science Center.

Marine laboratories are a dispersed network with the capacity to reach a wide variety of populations. Marine laboratories are linked in a national network, the National Association of Marine Laboratories (NAML), and also regionally through chapters within NAML. During the first two years of operation COSEE-PP has developed and tested a number of programs and approaches that can be exported to other marine labs. As a test of this dispersed network, COSEE-PP activities were expanded in 2010 to three additional marine laboratories. Each of these labs is engaging scientists in their region to develop programs tailored to their specific needs, often using COSEE Network developed products that support COSEE-PP goals. The expansion of our activities to these marine laboratories serves as a model for further engagement of marine laboratory scientists in the COSEE Network. Below we detail the specific activities that each marine laboratory is undertaking.

Western Washington University – Shannon Point Marine Center (SPMC)

SPMC faculty has hosted community college student interns in the Promoting Research Investigations in the Marine Environment (PRIME) program, and offered a week-long workshop on current oceanographic topics with their scientists and local community college faculty. SPMC has strong connections with the Northwest Indian College and the Padilla Bay National Estuarine Research Reserve and is engaging both institutions in their activities. They are currently developing a Communicating Ocean Sciences for Informal Audiences (COSIA) course.

University of Hawai'i – Kewalo Marine Laboratory

This summer scientists at the Kewalo Marine Laboratory hosted three PRIME interns. They are also conducting a needs assessment with Hawaiian and Micronesian community college science faculty and administrators to plan activities for community college faculty who teach ocean sciences and have planned a week long workshop focusing on marine microbiology for summer 2011.

Humboldt State University Marine Laboratory

Scientists, graduate students and informal education partners are working together to develop a COSIA course at HSU and generate new opportunities for faculty and graduate students at HSU to work directly with regional informal education audiences.



Dr. Ed Dever demonstrates use of a CTD during a COSEE Pacific Partnerships activity.

COSEE

PACIFIC PARTNERSHIPS

PACIFIC PARTNERSHIPS PROGRAMS TO ENGAGE SCIENTISTS AND ASSIST WITH BROADER IMPACTS

Since its inception in 2007 COSEE-PP has focused on developing multiple ways to engage scientists and assist them in undertaking successful broader impacts. We have offered a series of workshops and conference presentations aimed at engaging scientists in ocean science education and outreach and have helped scientists in developing and implementing the broader impact sections of their grant proposals.

Six workshops and five conference presentations provided opportunities for ocean scientists to become better communicators, improve public presentation skills, and build partnerships for broader impact and outreach. A seventh workshop partnered COSEE-PP with COSEE Ocean Systems to bring scientists and informal educators together to create communications projects together bringing COSEE OS's innovative concept mapping workshop format to the west coast.

Over 70 scientists representing five universities and three federal agencies attended COSEE-PP workshops, including NOAA, EPA, Oregon State University, Portland State University, California Polytechnic University - San Luis Obispo, and University of Washington - Vancouver. Workshops range in length from four hours to 2-½ days and stress action plans and products for communication and education. Approximately 170 scientists attended shorter workshops at the 2009 Coastal and Estuarine Research Federation, 2010 American Association for the Advancement of Science, and the 2010 Ocean Sciences meetings. We have also worked directly with 25 scientists on developing opportunities that could be implemented with COSEE-PP assistance for the broader impacts of their grant proposals.

Workshop evaluations have been overwhelmingly positive, with 95% participants saying that the workshops were relevant to their work, well organized and paced, and worth recommending to others. 94% of participants also indicated that they would be interested in a follow up course or workshop in a similar topic. Three scientists who participated in a COSEE-PP scientific posters workshop received awards for posters developed at a COSEE-PP workshop. New partnerships that have emerged from the

workshops include the development of a COSIA class at California Polytechnic University and the development of new public displays for the Hatfield Marine Science Center.

Few ocean scientists receive education or professional development in research-based methods for communicating their work. As the COSEE network develops models for such professional development, it fills a gap for scientists and creates opportunities for educators and scientists to work together in mutually beneficial ways that impact public ocean literacy.



Dr. Chris Langdon, discussing his work on ocean acidification effects on the local oyster industry at the Hatfield Marine Science Center.



Teams of scientists and informal educators work together at a COSEE-PP and COSEE-OS sponsored workshop to plan for scientist engagement in outreach projects.



PROFESSIONAL DEVELOPMENT FOR VOLUNTEERS AND DOCENTS IN OCEAN SCIENCES EDUCATION

Since 2008, COSEE-PP has been developing, piloting, and researching effective techniques for professional development of volunteers in ocean education, stewardship, and research. This work has been applied in the design and evaluation of volunteer trainings at the Oregon Coast Aquarium and the new Oregon Master Naturalist Program. To date, COSEE-PP has offered 130 hours of volunteer training to over 200 volunteers.

Volunteers and docents play an integral role in interpreting science to the public in informal science education institutions (ISEIs). With regard to ocean science education, ISEIs such as aquariums are important players in increasing national ocean literacy. Nationally, the majority of staff in ISEIs who interact directly with the public are volunteers who are vital to communicating conservation messages and ocean sciences content to a wide range of audiences. Such volunteers must be able to communicate effectively with a wide variety of audiences. Ocean scientists increasingly wish to engage the public through participation in science research or stewardship activities. Few scientists, however, are equipped to train citizen scientists, public educators, or environmental stewards. For this reason, COSEE-PP is testing techniques for preparing scientists to work with volunteers and has created and is testing professional development curriculum for preparing ocean and science literate adult volunteers to be stewards, educators, or citizen scientists working with our partnering scientists and informal science educators.



Volunteer training at the Oregon Coast aquarium.

Much volunteer training nationally is didactic in nature focusing on content delivery. COSEE-PP spearheaded a volunteer training redesign at Oregon Coast Aquarium based on the successful Communicating Ocean Sciences to Informal Audiences curriculum, which delivers ocean sciences content and effective communications techniques through modeling the facilitation of hands-on learning. Formative and summative evaluation of the redesigned 40 hour volunteer trainings at Oregon Coast Aquarium indicate that when ocean sciences content are delivered by modeling research-based effective communication and interpretation strategies, volunteers are more likely to use those strategies with visitors. Volunteers in training are also more likely to begin volunteering earlier and be more comfortable talking with public audiences. Lessons from these evaluations were used in designing training for Oregon Master Naturalist volunteers.



Learning about salt marsh organisms in the volunteer training program at the Oregon Coast aquarium.

Nationally volunteers in ocean sciences communication, stewardship and research represent a vast and under-tapped audience for professional development around current ocean sciences research. Developing an ocean literate and science literate volunteer force nationally through ISEI volunteer training and naturalist programs will create a talented pool of adult life-long learners committed to ocean sciences education, stewardship, and research.



SCIENTIST-EDUCATOR PARTNERSHIPS

COSEE-CT, both a thematic and regional center first funded in 2007, serves Maryland, Delaware and Virginia. This highlight focuses on our Scientist-Educator Partnership program, which creates partnerships among scientists, educators, and students to help advance teacher understanding of science concepts, to improve scientists' communication skills, and to develop classroom and field applications that build on research experiences.

We select scientists associated with research that addresses current and relevant ocean science topics and meets the goals of the Ocean Literacy Essential Principles and Fundamental Concepts, the COSEE-CT ocean science curriculum, and the National Science Education Standards. The program teams an ocean scientist, a graduate student, an educator, and an underrepresented college student. This four member team works together for six weeks during the summer to improve scientist communication/pedagogy skills, help scientists meet education and outreach requirements for research proposals, and help advance teacher/student understanding of ocean science research.

As part of the experience, the Scientist-Educator Partnership teams assemble a web-based education module, which serves as an essential communication tool for the diverse team members to “gather up” and discuss ocean science research in general, the research topic specifically, communication of the research topic to formal and informal audiences, classroom pedagogy skills and processes, and how to make the content relevant to broad audiences (specifically those underrepresented in science). Module development thus becomes a mechanism for team work, collaboration, and focus for the Science-Educator Partnership. The final product becomes part of what the scientist can use to meet the “Broader Impacts” element of their grants or grant proposals.



Scientist-Educator Partnership Seagrass team on location in the Virginia coastal bays seagrass bed. [Photo credit: Laura Murray]



Hampton University undergraduate Scientist-Educator Partnership Seagrass team member, Carissa Wilkerson, explaining her award winning poster at the ASLO conference in France. [Photo credit: Peter Tuddenham]

Evaluation data indicates that each team member benefits from participating in the Scientist-Educator Partnership program. Scientists create Broader Impacts for their research programs and gain increased understanding of education techniques and communicating complex concepts to non-science audiences. Graduate students gain science communication skills as well as early career education experience. Teachers develop ocean science content knowledge and an increased understanding of the scientific research process, resulting in enhanced preparation for teaching ocean science concepts in the classroom. Undergraduates gain research experience and learn to work in a team-oriented environment as well as developing valuable professional contacts.

COSEE

NETWORKED OCEAN WORLD

OCEAN GAZING PODCAST

COSEE-NOW, funded in 2007, is a thematic center dedicated to finding ways to foster partnerships among scientists and educators and increasing the utility of Ocean Observing Information and Data for public audiences. This highlight focuses on the Ocean Gazing podcast, a product aimed at exhibiting scientists and communicating their research to informal and formal audiences.

The Ocean Gazing podcast brings science and scientists to the public by capturing the personal stories of scientists and their work and assisting in teaching the nature and process of science. Hosted by Ari Daniel Shapiro, it is one of COSEE-NOW's primary educational outreach tools. Scientists tell their stories about ocean science and the broader impacts that science has on people beyond academic institutions. In each biweekly episode, Ocean Gazing integrates interviews, ambient sounds gathered in the field and laboratories, music, audio recordings from listeners (from children to adults), and the unveiling of a mystery sound. Additionally, to make the podcasts more relevant to classrooms, the first 26 podcast episodes were matched to classroom lesson plans and placed CD-ROM entitled Ocean Gazing: Volume 1. A second volume of lesson plans is currently in production and expected to be released in the fall 2011.

As of March 2011, COSEE-NOW has produced and posted 50 unique episodes, with roughly 300 downloads for each episode. These podcasts are advertised and promoted through the use of a website (www.oceangazing.org), Facebook page, iTunes presence, and links from other university and research group websites. Feedback and comments from listeners have helped shape the format of the podcasts and has even provided the content for subsequent podcasts. Meanwhile, the scientists involved have said they enjoy participating in the podcast as a mechanism for making their science accessible and promoting the work they do in an engaging and accurate manner.



The Ocean Gazing podcast is a forum for people to share their science and stories about the ocean.



Sample covers from Ocean Gazing podcasts.



IMPROVING THE BROADER IMPACTS OF OCEAN SCIENTISTS WITH COSEE NOW

NETWORKED OCEAN WORLD

COSEE-NOW, funded in 2007, is a thematic center dedicated to fostering partnerships among scientists and educators involved in the ocean observing systems (OOS) network. This highlight focuses on our center's efforts to support ocean scientists' involvement in broader impact in the form of education and public outreach.

COSEE-NOW is designed to foster a collaborative community of educators and scientists through a social networking website (<http://coseenow.net>). Our metrics of success include: 1) the level of participation and engagement of scientists and 2) the degree to which educators and scientists collaboratively develop resources, lesson plans, and proposals as a result of professional development and networking through COSEE-NOW.



Scientists Matthew Bickerton and John Cambridge lead a program for middle school students focusing on their research.

To assess scientists' engagement in ocean education and public outreach, COSEE-NOW has conducted an annual scientist survey. In 2009, in collaboration with the American Society of Limnology and Oceanography (ASLO), COSEE-NOW surveyed ocean scientists and found that: 54% considered themselves participants in COSEE activities (by attending or participating in one or more activity, program, event, etc.), 32% acted as COSEE resource scientists (making resources, facilities, and/or funds available), and 20% acted as partners (working "shoulder-to-shoulder" with this COSEE Center to create new products or opportunities).

Scientists' involvement in COSEE-NOW has resulted in: 1) fifty (as of March 2011) Ocean Gazing podcasts, each downloaded approximately 300 times; 2) the production of five audio slide shows (i.e. <http://coseenow.net/antarctica/>) translating scientific research for public audiences; and 3) the participation of scientists in education and public outreach, including COOL Classroom (<http://new.coolclassroom.org>), Bridge Data Tips (<http://vims.edu/bridge>), and collaborations with community college faculty (MATE Drifter Project).

COSEE-NOW has also provided assistance to university faculty for NSF, NOAA, and NASA grant proposals, aiding in the development of approximately 50 broader impact statements over three years. Reviews of broader impact statements contributed by the COSEE-NOW team are generally well reviewed by NSF panels (see excerpt below).

"The project contains a significant educational componentwith graduate and undergraduate students participating through workshop and research activities. Overall, I find the outreach component of this proposal to be the most worthy activity. The set of research and educational activities described here suggests a rather nicely integrated project. I have rated this proposal Very Good ...as a whole has considerable merit both from the scientific research perspective and just as important from promising educational activities and collaborations with a fairly broad spectrum of participants.

-Excerpt from a review of a scientist's proposal receiving support from COSEE NOW

COSEE

NETWORKED OCEAN WORLD

LINKING OCEAN SCIENTISTS AND EDUCATORS IN THE VIRTUAL WORLD

COSEE-NOW, funded in 2007, is a thematic center dedicated to fostering partnerships among scientists and educators involved in the ocean observing systems (OOS) network. This highlight focuses on the COSEE-NOW website and its associated resources (i.e. webinars and education projects) and our success in using the site as a mechanism by which scientists can connect with educators to collaborate with one another and others on transformative ocean education projects.

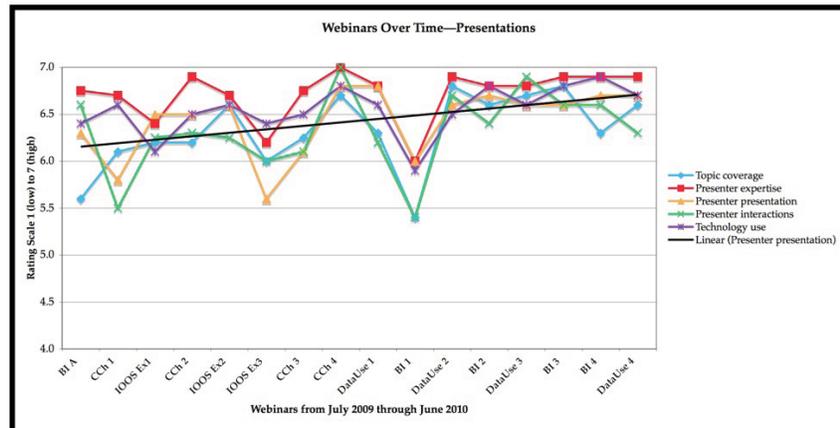
In an effort to expand the virtual collaboration capabilities of its members, the COSEE-NOW's web

site (<http://coseenow.net>), provides: 1) membership profiles that allow users to search for colleagues and potential collaborators, 2) "friending" capability to highlight collaborative activities, 3) community blogs on subjects and resources relevant to specific sub-interests, and 4) topical workgroups (public and private) where users can participate in forum discussions, share resources, send email alerts of notable news, and create a group blog. As of March 2011, 2010, the web site had 399 registered users, including approximately 100 scientists.

In addition to using the website as a platform to encourage discussion and interaction, COSEE-NOW has also conducted or hosted 24 webinars and web-based meetings to provide members with relevant ocean science content. Topics included climate change education, visualization of real time oceanographic data from ocean observing systems, identifying effective practices in scientists' engagement in education and outreach, and informal exhibit design and development. Webinars (3-4-session series) offered multiple perspectives on these topics of interest to science researchers and/or science educators and encouraged the formation of workgroups to further discussion and collaboration.

COSEE-NOW conducted a formative evaluation at the conclusion of each webinar (78% response rate). Ninety one percent of survey respondents indicated that our webinars met their needs (55% "yes, definitely" and 36% indicated "mostly"). 81% said they would be very likely to participate in another COSEE-NOW webinar. Figure 2 shows that the webinar presentations and value improved over time as the COSEE-NOW team improved technological techniques and speaker coaching.

Through the website, we will continue to investigate how collaborations among scientists, educators, and others are established and reinforced. COSEE-NOW will continue to monitor the shape of our web based network as it evolves over time and adapt the website and webinars to meet the needs of the scientists and educators.



This shows the average ratings of four sets of webinars through time. These webinars were geared towards informal educators associated with 4-H Youth Development (CCh), educators and scientists associated with the Integrated Ocean Observing Systems network (IOOS), formal and informal educators interested in developing or expanding their use of real time data (DataUse), and scientists wishing to improve their response to NSF Criterion II for Broader Impacts (BI). The y-axis illustrates the respondents' ratings (1 [low] - 7 [high]). The black trendline indicates that the presentations have improved over time.