

CAN YOU BE SCIENCE LITERATE WITHOUT BEING OCEAN LITERATE?

BY CRAIG STRANG, ANNETTE DECHARON, AND SARAH SCHOEDINGER

While marine educators have always known that many important science concepts can be taught through ocean examples, and that the ocean provides an engaging context for teaching general science, a more compelling credo now guides that work: "Teach for Ocean Literacy." Many ocean sciences concepts are more than engaging examples of general science; they have intrinsic, essential importance. Therefore, one cannot be considered "science literate" without being "ocean literate." Two of the earliest and most influential documents in the science reform movement, *Science for All Americans* and *Benchmarks for Science Literacy* [2,3], state "the science-literate person is familiar with the natural world and recognizes both its diversity and unity." Research consistently affirms the ocean's vital role in maintaining the unity of our world. Without its vast ocean, Earth could be inhospitably cold like Mars or a stifling greenhouse like Venus. On the other hand, the interconnectedness of the ocean and the atmosphere has had negative impacts. Ocean waters absorb airborne industrial chemicals which are carried thousands of miles from their source to the Arctic region. These pollutants are found in the bodies of top predators such as polar bears, which absorb the chemicals through their diet of fish and seals. Whether we live on the coast or inland, eat seafood or not, humans are inextricably tied to the ocean. Thus the scientifically literate citizens we grow in our schools must become familiar with ocean issues that may or may not be happening "in their own backyards."

The impact of the Ocean Literacy Campaign, supported by COSEE, National Marine Educators Association (NMEA), National Oceanic and Atmospheric Administration (NOAA), College of Exploration, National Geographic Society, and University of California, Berkeley's Lawrence Hall of Science, has been widespread among ocean scientists and ocean sciences educators across the country. A published resource from this campaign, *Ocean Literacy: The Essential Principles of Ocean Sciences K-12* [4], has been presented at dozens of conferences, and has been the subject of whole conferences (CoOL: Conference on Ocean Literacy, June 2006; and the New England Ocean Science Education Collaborative [NEOSEC] Ocean Sciences Literacy Summit, October 2006). These Principles have influenced the development of a statewide media campaign ("Thank You, Ocean") in California, and the development of a new textbook, *Life On An Ocean Planet* [1]. They are guiding the priorities of major funding agencies such as NOAA and the National Science Foundation (NSF). Curricular materials, museum and aquarium exhibits and programs, and teacher workshops nationwide are being redesigned to incorporate those ideas about the ocean that our community has come to agree upon as being truly "essential." Together, these small and large accomplishments have brought ocean sciences back into—and in some ways to the forefront of—

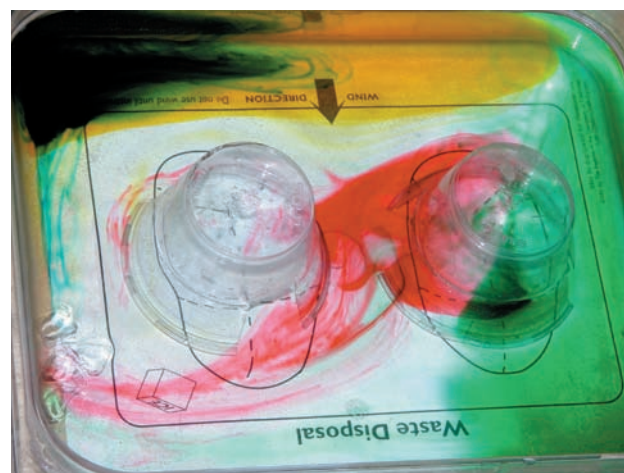
mainstream science education. Perhaps most significantly, the Ocean Literacy Campaign has changed the way educators think about ocean sciences education: teaching ocean sciences is not just enrichment, but is essential to science literacy.

This grassroots Campaign to define and promote Ocean Literacy is spearheaded by an eclectic collection of individuals, organizations, and agencies. The Campaign is distinguished by a national commitment to collaboration and inclusiveness, and a universal agreement that the credibility of the work takes strong priority over credit for any individual institution. Without the burden of institutional or agency agendas, a consensus quickly emerged that resulted in a definition of ocean literacy supported by seven essential principles and 44 fundamental concepts that can be used in existing school curricula, free choice learning environments, and large-scale public education efforts.

COSEE AND NMEA: AGENTS FOR CHANGE

For many years, members of the ocean sciences and education communities have expressed concern about the lack of ocean content in academic standards [6,8]. Likewise, the need for an ocean-literate public has been recognized by two national commissions, which called for inclusion of ocean concepts and topics in K–12 curricula [7,9]. The creation of the National COSEE Network in 2002 established a mechanism with financial and human resources to activate NMEA members and ocean scientists to address this challenge. It is doubtful that a campaign would have proceeded with such alacrity without COSEE.

The COSEE Network provides ocean scientists, educators, and their professional societies with regional and national access



Lab activity illustrating Ocean Literacy concept 1c.



Teacher holding a fat inkeeper worm, illustrating Ocean Literacy concept 5c.

to the discussion, ensuring that the vision of ocean literacy is co-constructed and embraced by the broadest community possible. This nationwide process was initiated in July 2004, when the COSEE Council formally endorsed and acted upon the recommendations of the NMEA Ad Hoc committee charged with addressing the lack of ocean concepts in science standards. Individual COSEE Centers also have made considerable contributions to the Campaign in a variety of ways (see sidebar for examples). Centers contribute copious personnel time for participation in workshops, meetings, and document review.

THE OCEAN IS AN ENGAGING CONTEXT FOR TEACHING SCIENCE STANDARDS

At the 2006 NEOSSEC Ocean Sciences Literacy Summit, a panel of experts concluded that science literacy can and should be improved using the ocean as an integrating context. *Ocean Literacy: The Essential Principles of Ocean Sciences K-12* [4] has been aligned with the *National Science Education Standards (NSES)* [5] using a concept matrix. This approach is designed not to add more content to existing standards, but rather provide an avenue for teachers to address the NSES using relevant ocean examples. The alignment matrix illustrates that over half of the Standards can and should be taught using ocean examples. For example, it should be generally recognized that one *cannot* effectively understand:

- climate without teaching about the ocean's role in climate variability and cycles
- productivity without marine photosynthesis and chemosynthesis
- plate tectonics without seafloor spreading
- biodiversity without marine ecosystems
- geography without seafloor bathymetry.

NEXT STEPS IN THE OCEAN LITERACY CAMPAIGN

To achieve the long-term goal of creating an ocean-literate society, COSEE and its partners must exert strategic influence in the revision of the NSES and state science standards, along with development of corresponding large-scale assessments and ocean sciences instructional materials. In the shorter-term, several companion resources are needed to augment the Ocean Literacy Principles [4]. COSEE plans to lead or assist in the development of these critical supporting documents.

1. Alignment with State and National Science Education Standards, to elaborate relationships between the fundamental concepts of ocean literacy and various standards to explain the meaning of each "x" in the Ocean Literacy brochure standards matrix
2. Scope and Sequence K-12, to illustrate how the fundamental concepts develop and build across all grade spans (K-2, 3-5, 6-8, 9-12)

SELECT COSEE NETWORK INVOLVEMENT IN OCEAN LITERACY EVENTS

- | | |
|--------------|---|
| 2003: | Development of initial definitions – NE |
| 2004: | NMEA Ad Hoc Committee – CA
COSEE Strategic Planning – CA, CGOM, & NOAA
Ocean Literacy Through Science Standards Virtual Workshop – CA (co-lead), CGOM, FL, MA, NE, SE, West, NOAA (co-lead) |
| 2005: | Follow-up to Virtual Workshop – CA & West (co-leads), NOAA
Aquarium of the Pacific's Public Ocean Literacy Workshop – CCO, West, CA, NE |
| 2006: | Scope & Sequence – CA, SE, & West (co-leads)
Conference on Ocean Literacy – CA, CCO, CGOM, GL, MA, NOAA, NSF, OLC, West
Ocean Sciences Literacy Summit – NE & OS (co-leads) |
| 2007: | International Pacific Marine Educators Conference – CA |



A mola mola, illustrating Ocean Literacy Principle 5: "The ocean supports a great diversity of life."

3. Teachers Guide, which would include the previous two documents plus sample unit outlines and inquiry activities to teach ocean literacy concepts
4. Assessment instruments, including benchmark assessments for each grade span; items would be available to test development committees and contractors
5. Inventory of curricular materials, including all relevant instructional materials, with the most widely used materials cross-referenced to the Ocean Literacy Essential Principles and Fundamental Concepts.

The Ocean Literacy Campaign has gained remarkable momentum in a short time. This is the result of collaborations between dozens of agencies, institutions, organizations, networks, and individuals. Although leaders have emerged, ocean literacy has no headquarters, no defined scope of work, budget, or personnel to carry it forward. It is crucial that the broad community embrace not only the ideal of an ocean-literate society, but also the hard work required to reach this goal. This "consensus-building" approach will prove invaluable to the goal of creating an ocean-literate society.

REFERENCES

1. Alexander, L., D. Desonie, C. Kelchner, et al. (2006). *Life on an Ocean Planet*, Current Publishing Corp.: Rancho Santa Margarita, CA.
2. American Association for the Advancement of Science (1990). *Science for All Americans*, Oxford Univ. Press: New York, NY, 271 pp.
3. American Association for the Advancement of Science (1993). *Benchmarks for Science Literacy*, Oxford Univ. Press: New York, NY, 418 pp.

4. COSEE, National Geographic Society, NOAA, College of Exploration (2005). *Ocean Literacy: The Essential Principles of Ocean Sciences Grades K-12*, a jointly published brochure, URL: www.coexploration.org/oceanliteracy/documents/OceanLitConcepts_10.11.05.pdf.
5. National Research Council (1996). *National Science Education Standards*, National Academy Press: Washington, DC.
6. Ocean.US (2005). *Promoting Lifelong Ocean Education: Using the Integrated Ocean Observing System (IOOS) to Shape Tomorrow's Earth Stewards and the Science and Technology Work Force*, Report from the IOOS-COOS and Education Workshop held Charleston, South Carolina March 22-24, 2004. Ocean.US Publication No. 4, 47 pp.
7. Pew Oceans Commission (2003). *America's Living Oceans: Charting a Course for Sea Change. A Report to the Nation*. Arlington, VA, 166 pp.
8. Schofield, O. and M. Tivey (2004). *Ocean Research Interactive Observatory Networks (ORION): A Report of the Workshop Held January 4 - 8, 2004*, San Juan, Puerto Rico, 148 pp.
9. U.S. Commission on Ocean Policy (2004). *An Ocean Blueprint for the 21st Century: Final Report*, Washington, DC, 676 pp.

CRAIG STRANG is Associate Director, Lawrence Hall of Science, University of California, Berkeley; Director, MARE (Marine Activities, Resources & Education); Director, COSEE California; and was the first chair of the National COSEE Council. cstrang@berkeley.edu

ANNETTE DECHARON is Senior Marine Education Scientist, University of Maine School of Marine Sciences; and Director, COSEE Ocean Systems. annette.decharon@maine.edu

SARAH SCHOEDINGER is Program Officer, National Oceanic & Atmospheric Administration's Office of Education; Ex-officio member, National COSEE Council; and was part of the founding team for the COSEE Central Coordinating Office at CORE. sarah.schoedinger@noaa.gov

PHOTO CREDIT

All photos: Courtesy of Craig Strang.