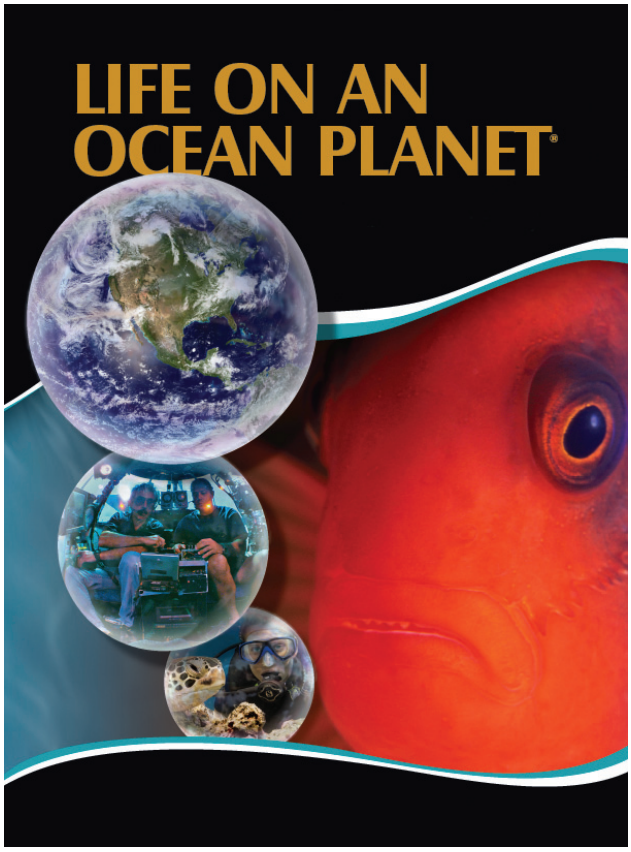
Impacts of the Ocean Literacy Principles

Ocean Literacy: The Essential Principles of Ocean Sciences K-12 (referred to as the Ocean Literacy Principles) has been a ground-breaking document, both as a product and because of its development process, both of which are creating a ripple effect across the entire ocean sciences education community and beyond. The Ocean Literacy Framework, comprised of the Ocean Literacy Principles and the Ocean Literacy Scope and Sequence, is the first consensus set of documents 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 Ocean Literacy Campaign. The Ocean Literacy Framework has been the foundation and/or inspiration for numerous significant accomplishments nationwide and in several other countries. Here we share a few of those high-impact accomplishments.

Life on an Ocean Planet: Current Publishing and the National Marine Educators Association (NMEA)

Life on an Ocean Planet is a nationally distributed high school marine science textbook that evolved from two years of research and alliance with many science and science education-based organizations such as NMEA, COSEE, NOAA, and the NMEA Ocean Literacy Committee. *Ocean Literacy: The Essential Principles of Ocean Sciences K-12* provided an early framework for Current Publishing to use in developing their curriculum content for *Life on an Ocean Planet*. Moreover, the development process has been a cross-disciplinary, team effort involving: eight NMEA members serving as the Current Publishing Ocean Literacy Advisory Team; the expert curriculum writing and development skills of marine science educators; and 22 classroom teachers and research scientists across the country who provided their pedagogical and scientific expertise as reviewers. Each chapter of the 2010 edition, which prominently acknowledges NMEA as a partner, is correlated with the Ocean Literacy Essential Principles and Fundamental Concepts. These chapter correlations document where specific ocean literacy concepts are introduced and taught. They are easily identified in chart format for teachers in the Teacher Curriculum Guide. The textbook is grade-level appropriate for high school students and written in a friendly, motivational style to enhance science learning. The content is balanced with student-tested investigations and hands-on activities to ensure students achieve science understanding. *Life on an Ocean Planet* uses an interdisciplinary approach to integrate the curriculum areas of reading, math, language, and social sciences into the marine science content. For more information, please visit the website (http://www.currentpublishingcorp.com).



Cover of the *Life on an Ocean Planet* textbook from Current Publishing.

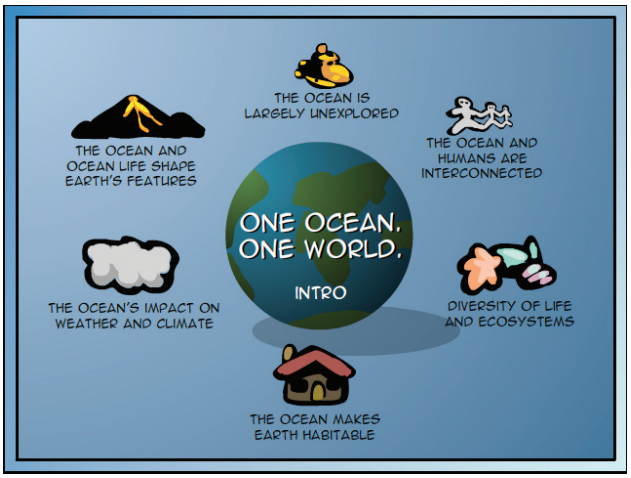
NOAA Environmental Literacy Grant-funded *Ocean Sciences Curriculum Sequences for Grades 3-5* and *6-8*: Lawrence Hall of Science, University of California, Berkeley; Rutgers University, Institute of Marine & Coastal Studies; and National Undersea Research Center, University of Connecticut

When focusing on standards-based content, achieving the "right" balance of depth and breadth in a curriculum is a challenge, one that teachers are often left to struggle with on their own. The *GEMS/MARE Ocean Sciences Curriculum Sequence for Grades 3-5*, funded by NOAA, brought scientists and educators together to discuss and suggest a balanced pathway through the body of ocean sciences content. *Ocean Literacy: The Essential Principles of Ocean Sciences K-12* and the Ocean Literacy Scope and Sequence for Grades K-12

formed the basis of this curriculum sequence. The curriculum sequence will also be aligned with the *National Science Education Standards* and the science standards of 20 states. Scientists and educators worked through a multi-step process drawing on current research in ocean sciences and science learning, to form the conceptual framework, the progression of concepts, and the unit topics. They applied their specialized expertise to identifying the Ocean Literacy and standards-based concepts worth more time in classrooms according to one or both of the following criteria: 1) they are concepts that underlie essential understandings of a discipline; and 2) they are concepts that need more classroom time and contexts for most effective learning by students because they are developmentally challenging to grasp. What resulted was a versatile curriculum sequence for grades 3-5, comprising 25 (60-minute) classroom sessions organized into three units of study: ocean circulation, diversity of life in the ocean, and human impact on the ocean. The curriculum sequence has been piloted, and the team made revisions in the light of those results. As of the writing of this report, the curriculum is undergoing a national field test in 70 classrooms across the country. The curriculum, which includes teacher guides, student readings, data sheets, and an instructional materials kit, will be revised further after the national field test; and by January 2011, will be available nationwide for schools to adopt from Carolina Biological. *Newsflash:* A new companion curriculum funded by NOAA, the *Ocean Sciences Curriculum Sequence for Grades 6-8* and based on the Ocean Literacy Scope and Sequence for grades 6-8, will enter into the development process in early 2010.

Ocean Literacy in New Jersey: COSEE Networked Ocean World (COSEE NOW) and Rutgers University's Institute of Marine & Coastal Sciences

COSEE NOW, with a focus on engaging ocean scientists in education and public outreach, challenged a number of ocean scientists to create a presentation or story about how they think about the content and concepts contained in the Ocean Literacy Principles. A resulting Ocean Literacy lecture series, called *Pulse of the Planet*, is held at the Liberty Science Center, the New Jersey state science museum with approximately one million visitors annually. COSEE NOW encourages scientists to tell their Ocean Literacy stories from their own perspective, highlighting their own expertise in the field, and helps scientists develop and revise their presentations for the public lectures. COSEE NOW also supports a biweekly podcast of scientists, explaining their science and its importance to society. In addition, Dr. Paul Jivoff of Rider University, New Jersey worked with COSEE NOW educators to develop the online interactive, *One World, One Ocean*. This series of animations explains each of the Ocean Literacy Principles in an engaging and comprehensible way. The COSEE NOW Director uses the seven Ocean Literacy Principles as the "ship's wheel" to guide decisions on how to spend time and resources in educational program development. *Ocean Literacy: The Essential Principles of Ocean Sciences K-12* is a mandatory handout given to scientists seeking advice and guidance about how they can write effective broader impact statements in their grant requests. (See http://coseenow.net/2008/11/ocean-literacy-interactive-animation/)



Flash animation for the Ocean Literacy Principles from COSEE NOW (see website address above).

***An Introduction to Our Dynamic Ocean:* COSEE Coastal Trends, including Laura Murray, Elizabeth Day-Miller, Angela Ward, and Kris Jensen with Queen Anne's County Public Schools (QACPS), Maryland**

COSEE Coastal Trends is partnering with Queen Anne's County Public Schools, Maryland to formalize a semester-long, entry level, secondary school ocean sciences course using the Ocean Literacy Principles as the foundation. During the summer of 2008, a course curriculum outline and associated lessons/activities based on the Ocean Literacy Principles were assembled. This course outline was tested with all incoming ninth graders in the two high schools in QACPS and in one Lee County High School in Alabama. The course curriculum was revised based on these teachers' feedback during the early summer of 2009. This revised curriculum included the integration of science-based, hands-on lab, field, and computer activities for each of the Ocean Literacy Principles. It also served as the basis of an implementation institute offered to 14 teachers in July 2009. These teachers will pilot *An Introduction to Our Dynamic Ocean* course curriculum during the 2009-2010 school year and provide feedback for the second revision. Once these revisions are made (summer, 2010), the curriculum will be posted on the COSEE Coastal Trends (http://www.coseecoastaltrends.net) website and disseminated through the COSEE network.

State Science and Environmental Education Content Standards

It is necessary for ocean sciences to be in national and state standards in order for ocean sciences to be taught in schools more broadly. The Ocean Literacy Framework is a tool that

Participants collect data on a field trip during the *Our Dynamic Ocean* Course Implementation Workshop.

standards committees can use to inform how they might include ocean sciences in the development or revision of their science or environmental education standards. Thus far, a handful of states have used these tools in such a way. For instance, Maryland, California, and Michigan have cited the use of the Ocean Literacy Principles in the development of their environmental literacy standards. South Carolina, Florida, and Georgia have used the Ocean Literacy Principles in the development of their science standards; and high school students in Georgia are now required to take an ocean sciences course. Finally, in New Jersey, committed ocean literate educators and science coordinators leveraged the Ocean Literacy Principles to play a key role when their state science standards underwent revisions. The new standards, which focus on Earth systems science and biogeochemical cycles, are a close match to the Ocean Literacy Principles 2, 3, and 6. New Jersey now has state science standards containing important concepts integral and relevant to ocean science. The Centers for Ocean Science Education Excellence (COSEE) Mid-Atlantic was integral in influencing the final document.

Informal Science Education Institutions and the Ocean Literacy Principles

- **The Aquarium of the Pacific** in Long Beach, California has taken a pro-active role in addressing the need for ocean literacy among the public. Starting in 2005, the Aquarium brought together influential stakeholders throughout the region to discuss how informal education centers can tackle the educational goals outlined in the Ocean Literacy Principles. Through this initial gathering and subsequent conferences and workshops, such as the California Conference on Ocean Literacy (CoOL Conference), the Aquarium has produced consensus documents, summarized from participating experts, which serve to inform others on best practices for using the Ocean Literacy Principles (www.aquariumofpacific.org/downloads/CACoOlReport.pdf). The Aquarium's Educational Programs and exhibits also reflect the goals outlined in the Ocean Literacy Principles. While most aquariums address the "low hanging fruit" of Principle 5, the Aquarium of the Pacific has strived to incorporate as many of the other principles as possible into its programs and exhibits. For example, the *Oceans on the Edge* gallery features exhibits on One World Ocean, Principle 1, and on Energy from the Sea, Principle 6. Through past exhibits on waves, and through current ones on El Niño and plankton, the Aquarium of the Pacific continues to utilize the guidance outlined by the Ocean Literacy Principles to bring a more holistic and broad view on how aquarium visitors impact the ocean and how the ocean influences their lives. (See also http://www.aquariumofpacific.org/newsevents/newsdetail/the_coastal_america_ocean_art_contest/ and http://www.aquariumofpacific.org/education)

The Sant Ocean Hall at the Smithsonian Institution.

- **The Smithsonian's Sant Ocean Hall** (SOH), the largest addition to the Smithsonian Institution Museum of Natural History since its opening, uses the Ocean Literacy Principles as a guide for all its public and educational programs. The Principles serve as the basis for many of the messages the Institution is focused on sharing with the public. The Principles are also incorporated into the SOH docent training program to help docents guide discoveries and answer questions in the Ocean Hall. In addition, the Ocean Literacy Principles are used to determine the content and lessons selected for inclusion in The Ocean Portal, a web-based resource dedicated to providing scientific information about the ocean. A portion of The Ocean Portal will also serve as a resource where K-12 educators can visit for assistance in developing lesson plans about ocean-related topics. All of the objectives of SOH are cross-referenced with the Ocean Literacy Principles (see Table 1).

Sant Ocean Hall Objectives	Ocean Literacy Principles
To inspire awe for how vast, diverse, and unexplored the ocean is, and for how fundamentally different it is from land.	**Principle 1.** Earth has one big ocean with many features.
To provide a unique and engaging experience that demonstrates how the ocean works and how it is interconnected with other global systems.	**Principle 2.** The ocean and life in the ocean shape the features of Earth. **Principle 3.** The ocean is a major influence on weather and climate.
To demonstrate how life evolved in the ocean over billions of years and changed dramatically over time.	**Principle 4.** The ocean makes Earth habitable.
To instill in students an awareness of the great diversity of ocean habitats and ocean life, and of how much is still being discovered.	**Principle 5.** The ocean supports a great diversity of life and ecosystems. **Principle 7.** The ocean is largely unexplored.
To inform students about the exciting technologies and other approaches used by scientists and ocean explorers to uncover the ocean's mysteries.	**Principle 7.** The ocean is largely unexplored.
To inspire and empower students to make the connection between the ocean and their daily lives, and to encourage them to continue exploring the ocean and to help conserve it.	**Principle 6.** The ocean and humans are inextricably linked.

Table 1. Cross-referencing Sant Ocean Hall objectives with the Ocean Literacy Principles.

Banana Slug String Band Music Group

The renowned children's music group, The Banana Slug String Band (http://www.bananaslugstringband.com), is producing a new album, *Only One Ocean*, entirely focused on the content found in *Ocean Literacy: The Essential Principles of Ocean Sciences K-12*. The CD is being produced with financial contributions from 10 Centers in the National COSEE Network and from the National Marine Educators Association (NMEA), the NOAA Office of Exploration and Research, The College of Exploration, and Dr. Sue Cook. The CD, available to the public in early 2010, will feature several well-known guest artists who have contributed their time to the project. Some of the artists on the CD include: Brett Dennen; Zach Gill (pianist for Jack Johnson); Grammy Award winning Michael Doucet and the band, Beausoleil; Barry Phillips (performed at the George Harrison memorial concert at the Royal Albert Hall with the surviving Beatles and Eric Clapton); and Victor Wooten (two-time winner of the Nashville Music Awards' Bassist of the Year, and member of the Grammy Award-winning supergroup, Bela Fleck and the Flecktones). Banana Slug albums have won 16 state and national awards for excellence. Thousands of Banana Slug CDs are sold each year through eight distributors such as Amazon.com, Acorn Naturalists, and Kaplan Early Learning, and as downloads through iTunes and other MP3 sites. In addition, the band plays over 20 major concerts and dozens of smaller shows each year. *Only One Ocean* will bring the importance of the ocean to a large audience of parents and children not previously reached by the Ocean Literacy Campaign.

The Banana Slug String Band.

National and International Conferences

There have been at least nine conferences (six in the U.S., one in Australia, one in Japan, and one in Chile) entirely devoted to discussing and reflecting on the Ocean Literacy Framework and/or the Ocean Literacy Campaign.

- Public Ocean Literacy (2005-Long Beach, California)
- CoOL: Conference on Ocean Literacy (2006-Washington, D.C.)
- International Pacific Marine Educators Conference (2007-Maui, Hawaii; 2008-Townsville, Australia)
- New England Ocean Science Education Consortium Conference on Ocean Literacy (2007; 2008)
- Japan Ocean Literacy Symposium (2008-Tokyo, Japan)
- Primera Feria Educativa del Océano (2008-Santiago, Chile)
- Ocean Literacy Summit—Beyond the Brochure (2009-Newport, Oregon)

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

Federal Funding

At least three grant programs in two large federal agencies, NOAA and NSF, require that proposals for projects focusing on the ocean as a part of the Earth System must address the Ocean Literacy Principles in order to be considered for funding.

- NOAA Office of Education: Environmental Literacy Grant (ELG) awards support formal and informal education projects. The informal education awards support education projects designed to engage the public in activities that increase ocean and/or climate literacy and the adoption of a stewardship ethic. They support projects that involve: community outreach, citizen science, civic engagement, social networking, media campaigns, professional development for educators, interpretative training, building networks of aquariums, high-level data visualization systems, and live video feeds. The awards for formal education promote changes in K-12 education to expand the amount of Earth System Science taught in the classroom and improve student learning and application of that subject. Successful projects catalyze change in K-12 education through development of new programs and materials and/or revision of existing programs and materials and/or by supporting transformative methods that expand or lead to the expansion of the use of Earth System Science in K-12 classrooms.

- NOAA Office of Education: Bay-Watershed Education and Training (B-WET) program provides grants in support of locally relevant experiential learning through meaningful watershed educational experiences in the K-12 environment. Funded projects provide meaningful watershed educational experiences for students and related professional development for teachers in support of regional education and environmental priorities.

- NSF, Directorate for Geosciences, Ocean Science Division (OCE) Centers for Ocean Sciences Education Excellence (COSEE) provides grants to support the COSEE Network, which consists of 12 coordinated COSEE Centers, fosters the integration of ocean research into high-quality educational materials; enables ocean researchers to gain a better understanding of educational organizations and pedagogy; provides educators with an enhanced capacity to understand and deliver high-quality educational programs in the ocean sciences; and provides material to the public that promotes a deeper understanding of the ocean and its influence on each person's quality of life and our national prosperity.

Thank You Ocean Campaign

A widespread media campaign to raise awareness about the ocean has been initiated by the State of California, the NOAA Office of National Marine Sanctuaries, and the Ocean Communicators Alliance. The resulting Thank You Ocean Campaign provides videos, Public Service Announcements, podcasts, billboards, and a web presence, all based on the Ocean Literacy Principles.

Beyond Ocean Literacy Principles

What started as a good idea for ocean sciences has turned into a great idea that other disciplines of science have adopted. It is becoming apparent that educators and scientists across many disciplines recognize the significance and value of having a consensus document that articulates, organizes, and presents the critical ideas of their respective fields. To date, there are several science literacy frameworks that have been inspired by the Ocean Literacy Principles, and are based on conversations and cooperation between scientists and educators in multiple institutions and organizations. These include:

1. **The Essential Principles and Fundamental Concepts of Atmospheric Literacy**

   The Atmospheric Science Literacy Framework is intended to provide guidance to educators and the public on the big ideas of atmospheric science so that they may be able to communicate about the Earth's atmosphere in a meaningful way, and be equipped to make informed and responsible decisions about activities that impact the Earth's atmosphere. Approximately 60 participants, including diverse teachers, scientists, informal educators, and policy makers, took part in the Atmospheric Science Literacy Framework Workshop (formerly Atmospheric Sciences and Climate Literacy), which convened in November 2007 to develop this framework. NSF and NOAA provided funding for the workshop; the National Association of Geoscience Teachers (NAGT), National Earth Science Teachers Association (NESTA), American Geophysical Union (AGU), and American Meteorological Society (AMS) co-sponsored the event; and the University

Corporation for Atmospheric Research (UCAR) and Cooperative Institute for Research in Environmental Studies (CIRES) hosted it. UCAR's multimedia services enabled the workshop to offer a live and archived webcasts of the plenary presentations and discussions, as well as a simultaneous video conference of the workshop with other sites around the nation. (For more information, please visit their website, http://eo.ucar.edu/asl/index.html)

2. Climate Literacy: The Essential Principles of Climate Science

As part of a community effort to promote climate literacy, current climate scientists, formal and informal educators, and representatives of a range of U.S. agencies participated in developing and vetting a list of the most important concepts in climate science. Substantial development of the document included individuals who participated in the Framework for Climate and Weather Education Workshop, cosponsored by NOAA and AAAS Project 2061; and the Atmospheric Science and Climate Literacy Workshop, sponsored by UCAR, AGU, and CIRES, with funding from NSF and NOAA. Additionally, discussions at numerous public presentations and a period of formal review led to the final version of the document. (For more information, please visit their website, http://www.climate.noaa.gov/index.jsp?pg=/education/edu_index.jsp&edu=literacy)

3. Earth Science Literacy Principles

The primary outcome of the Earth Science Literacy Initiative is a community-based document that clearly and succinctly states the underlying principles and ideas of Earth science across a wide variety of research fields. Development of this document was an iterative process that began with a 12-day online workshop, May 2008, involving more than 350 participants from the Earth science research, education, and policy communities. Participants communicated through an asynchronous online environment in an effort to generate and organize the "Big Ideas" and supporting concepts in Earth Science. The organizing committee took the ideas and discussions from the online workshop and organized them into a structure that was useful for a writing workshop, which comprised of 36 individuals from the committee and online workshop. The committee coordinated public reviews to inform revisions of the document until its completion in May 2009. NSF provided funding support. (For more information, please visit their website, http://www.earthscienceliteracy.org/)

4. *Neuroscience Core Concepts:* The Essential Principles of Neuroscience

The Public Education and Communication Committee of the Society for Neuroscience is responsible for providing outreach activities that connect scientists, K-12 educators, media, and the general public with the advancements in understanding and research in neuroscience. In 2007, this committee led a development team involving hundreds of neuroscientists and educators nationwide to consult, review, and refine a consensus document. What resulted were the *Neuroscience Core Concepts*, which offer K-12 teachers and the general public the most important insights gained through decades of brain research and spotlight promising research paths. (For more information, please visit their website, http://www.sfn.org/index.aspx?pagename=core_concepts)

5. Key Concepts in Microbial Oceanography

The Education and Outreach Program of the Center for Microbial Oceanography: Research and Education (C-MORE) is focused on promoting scientific literacy in microbial oceanography among students, educators, and the general public. It was recognized that a first step toward promoting microbial oceanography literacy was to define the key concepts. C-MORE identified six key concepts after conducting lengthy conversations with scientists and educators, within and outside C-MORE. (For more information, please visit their website, http://cmore.soest.hawaii.edu/education.htm)

The Ocean Literacy Principles inspired other science disciplines to identify and organize their big ideas.