Science Content and Standards
for
Ocean Literacy:
An Ocean Literacy Update

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Acknowledgments

Cover photo by 4th-grade student Ben Brandes

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"School curricula, starting in kindergarten, should expose students to ocean issues, preparing the next generation of ocean scientists, managers, educators, and leaders through diverse educational opportunities." -- US Commission on Ocean Policy[1]

"Broaden ocean education and awareness through a commitment to teach and learn about our oceans at all levels." -- Pew Oceans Commission[2]

Executive Summary

For some time now, ocean literacy has been the focus of many institutions and individuals, some working collectively, some independently. The purpose of this report is to give an historic overview of progress to promote ocean literacy in our classrooms. It highlights previous ocean literacy projects and shows how they have merged to provide a community vision for ocean literacy.

The need for ocean literacy is simple. The most dominant feature on Earth is the ocean. Understanding the ocean is integral to understanding the planet on which we live. This understanding is essential to sustaining our planet and our own well-being. However, for many years core curricula for grades K-12 have not included ocean topics. In fact, in some cases, the oceans have been completely ignored in formal K-12 education. The challenge facing ocean literacy proponents has been how to incorporate concepts about the ocean into accepted curricula. In the last several years, several institutions have grappled with this challenge in a variety of ways.

It became clear that the community needed a process for communication and a way to build community consensus on ocean literacy. It was also recognized that agreement was needed on these fundamental issues: the need for ocean literacy, the definition of ocean literacy, identification of key ocean concepts for inclusion into the K-12 curriculum and alignment of these concepts to the National Science Education Standards (NSES).

To address this need, roughly 100 representatives with expertise in the ocean sciences, ocean education and/or education policy participated in a series of discussions beginning with an online workshop (which is the focus of this report) followed by face-to-face meetings and, finally, a public comment period. Through this extensive process, the input contributed by these individuals on behalf of their fields has resulted in the development of the ocean literacy definition, principles, and concepts that follow.

Ocean Literacy Tagline

Ocean literacy is an understanding the ocean's influence on you and your influence on the ocean.

Definition of Ocean Literacy

Ocean literacy is an understanding of the ocean's influence on you and your influence on the ocean. An ocean-literate person:
- o understands the fundamental concepts about the functioning of the ocean;
- o can communicate about the ocean in a meaningful way; and
- o is able to make informed and responsible decisions regarding the ocean and its resources.

Essential Principles

Every ocean literate person should know these essential principles:
1. The Earth has one big ocean with many features.
2. The ocean and life in the ocean shape the features of the Earth.
3. The ocean is a major influence on weather and climate.
4. The ocean makes the Earth habitable.
5. The ocean supports a great diversity of life and ecosystems.
6. The ocean and humans are inextricably interconnected.
7. The ocean is largely unexplored.

The seven essential principles and forty-four fundamental concepts were identified as those needed to support the definition of ocean literacy.

The workshop results demonstrated, for the first time, how the oceans can play a critical role in fulfillment of the NSES content standards by educators. It was also recognized that these fundamental concepts provide further coordination, consistency and coherence for ocean science education development overall. Finally, identifying this set of concepts was recognized as a major step toward empowering educators, scientists and policy-makers to turn an ocean literacy vision into reality.

Conclusions and Next Steps

This report represents the completion and documentation of the multi-phase, national effort to improve ocean literacy. The ocean sciences and education communities were able to come to consensus about what every person should know about the ocean in order to make wise and informed decisions about it and about our future. In so doing, the two communities have taken great and unprecedented strides toward becoming a single, more unified community. Though we are not naïve about the different worlds and cultures in which scientists and educators live, we are heartened that so many have worked together so effectively on this important issue. We also recognize that the inclusion of scientists in development of educational policy and resources is one that must continue.

Now that agreement has been reached on what must be taught and learned regarding the ocean, we can turn our attention to how to convey this information to a variety of

learners, audiences and interest groups that include teachers and teacher leaders, school and district administrators, pre-service educators, professional developers, standards committees, instructional materials developers, assessment specialists, textbook writers and publishers, exhibit designers and informal/free-choice educators.

This emerging voice and consensus on ocean literacy has already become an instrument of change. Demand for the Ocean Literacy brochure has been overwhelming; the first print run has been distributed with a growing demand for more copies. The definition, principles, concepts and alignment matrix are providing a framework for policy changes in several spheres of education both at state and national levels, guiding initiatives by government agencies, museums, aquariums, text book publishers and universities.

There are many activities and tasks still needed. Some are very specific and product-oriented, some are ongoing tasks that are less well defined and process-oriented. There is emerging agreement that several companion documents need to be developed to accompany the Ocean Literacy brochure. There is also emerging agreement there is a tremendous need for a strategy to influence collectively several key activities and events.

Some of the next steps that were identified as needs include:
- o Alignment of ocean literacy to all national and state education standards;
- o Development of resources such as an ocean literacy scope and sequence or a guide on how to teach ocean literacy;
- o Development of assessment tools to measure the impact and change in ocean literacy, i.e., influence state and national assessments or provide educators with classroom assessments;
- o Provision for professional development of educators in support of changing ocean literacy; and
- o Adaptation of the ocean literacy essential principles and fundamental concepts for use in free-choice learning media and venues.

Section I: Introduction

For some time now, ocean literacy has been the focus of many institutions and individuals, some working collectively, some independently. The purpose of this report is to give an historic overview of progress to promote ocean literacy in our classrooms. It highlights previous ocean literacy projects and shows how they have merged to provide a community vision for ocean literacy.

The need for ocean literacy is simple. The most dominant feature is the ocean. Understanding the ocean is integral to understanding the planet on which we live. This understanding is essential to sustaining our planet and our own well-being[3]. However, for many years core curricula for grades K-12 have not included ocean topics. In fact, in some cases, the oceans have been completely ignored in formal K-12 education. The challenge facing ocean literacy proponents has been how to incorporate concepts about the ocean into accepted curricula. In the last several years, several institutions have grappled with this challenge as follows:

- The National Geographic Society: In February 2002, the Geographic convened a virtual workshop to identify key ocean concepts that were then developed into an Oceans Scope and Sequence aligned to the National Geography Education Standards[4].
- The National Marine Education Association (NMEA): In July 2003, NMEA established an ad hoc committee to better define the important marine and aquatic science literacy concepts and to establish linkages to existing state and national standards that will strengthen science education. This committee was also charged with making recommendations on a series of actions for the NMEA Board of Directors and the National Council of the Centers for Ocean Sciences Education Excellence (COSEE) to promote an ocean literacy agenda.
- Dr. Robert Stewart, Texas A&M University, Department of Oceanography: In July 2004, Dr. Stewart and his colleagues presented a paper entitled "What Every Student Ought to Know about the Ocean: a Compilation of Key Concepts" at the NMEA annual conference[5].
- COSEE-New England: COSEE-New England, a partnership between the New England Aquarium, the Wood's Hole Oceanographic Institution and the University of Massachusetts-Boston, initiated an effort to strengthen the New England region's capacity to develop and provide high-quality ocean science education. As part of this effort, they developed a draft definition of ocean literacy.

Based on these projects, it became clear that the community needed a process for communication and a way to build community consensus on ocean literacy. It was also recognized that agreement was needed on these fundamental issues: the need for ocean literacy, the definition of ocean literacy, identification of key ocean concepts for inclusion into the K-12 curriculum and alignment of these concepts to the National Science Education Standards (NSES)[6]. The following sections of this report describe the actions that have resulted in a community-wide response to these challenges.

Mr. Gil Grosvenor, Chair, National Geographic Society

Mr. Grosvenor noted "the oceans belong to everyone." He emphasized their fragility and placed their future firmly in the hands of educators. "Teachers are the greatest natural resource we have on planet Earth," he says. "They are the ones who will ultimately save our oceans."

Adm. James Watkins, Chair, U.S Commission on Ocean Policy

Admiral Watkins seconds the importance of the oceans in our classrooms. "Understanding the ocean is vital to our life on Earth," he says. "It represents life–the origin of life–and we need to know about it."

Dr. Sylvia Earle, Explorer-in-Residence, National Geographic Society

Dr. Earle praises the initiative of teachers who bring the ocean into their classrooms. "The ocean is absolutely the cornerstone of our survival and our well-being...everything that relates to our future relates to understanding the ocean and relating it back to us."

Dr. Robert Ballard, Founder of the Jason program, National Geographic Society Explorer-in Residence and Member of the U.S Commission on Ocean Policy
"The oceans," Dr. Ballard said, "are all part of the total global system. Most of the insight "in understanding how the Earth works has come by going underneath the ocean."

Mr. Leon Panetta, former Clinton White House Chief of Staff, California Congressman, and Chair of the Pew Oceans Commission
Mr. Panetta agreed that education is critical in saving the ocean. "It won't always be there if we don't care for it," he noted. "We have got to treat it as a national trust."

Dr. Marcia McNutt, Director of the Monterey Bay Aquarium Research Institute
"Because children are innately interested in the natural world", said Dr. McNutt, "teaching about the ocean is a great way to teach how real systems work."

Adm. Conrad Lautenbacher, Department of Commerce Under Secretary of Oceans and Atmosphere and Administrator of the National Oceanic and Atmospheric Administration (NOAA)
"We are," Admiral Lautenbacher stated, "a world that is essentially illiterate in regard to the oceans." The present system of instruction is "very compartmentalized, which makes adding the ocean to the curriculum difficult."

Mr. Dan Basta, Director of NOAA's National Marine Sanctuary Program
Mr. Basta pointed out that "National Marine Sanctuaries are one focus–a way to bring the oceans into the classroom...that can reach the breakfast table in South Dakota."

Figure 1. Quotes from the online conference interviews that helped to articulate the relevance of the ocean to our lives and argue why ocean topics should be part of our education system.

Section II: Community Response to Ocean Literacy Challenges

In October 2004, a virtual workshop was sponsored by the National Geographic Society's Oceans for Life Initiative in cooperation with the National Oceanic and Atmospheric Adminstration (NOAA), the COSEE Network, NMEA and their partners. This workshop was convened to respond to the challenge both to better define issues relating to ocean literacy and to provide a platform for communication on these issues among the community. Approximately 100 members of the ocean sciences and

education communities participated in this workshop. The workshop was then followed by a face-to-face meeting of a smaller working group in Berkeley, California in February 2005. These two meetings resulted in a definition of ocean literacy, ocean concepts and an alignment matrix that were subsequently circulated for comment by key members of the ocean sciences community and then more broadly during an online review process during April 20-May 6, 2005.

As a result of this extensive development and vetting process, the community agreed on an ocean literacy definition, tagline, ocean concepts and an alignment matrix to promote ocean literacy. The seven essential principles and forty-four fundamental concepts were identified as those needed to support the definition of ocean literacy.

The essential principles and fundamental concepts are described in more detail and aligned with the NSES's eight standards for science content in Sections II and III of this report. The alignment matrix shows how the oceans can play a critical role in fulfillment of NSES by educators. Additionally, the essential principles and fundamental concepts provide further coordination, consistency and coherence for ocean education overall. Finally, identifying this set of principles concepts is a major step toward empowering educators to turn an ocean-literacy vision into a reality.

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6. The ocean and humans are inextricably interconnected.
7. The ocean is largely unexplored.

Fundamental Concepts

Offered below each essential principle is a series of supporting fundamental concepts, which are analogous to the fundamental concepts and principles that underlie each content standard of the NSES.

1. The Earth has one big ocean with many features.

   a. The ocean is the dominant physical feature on our planet Earth–covering approximately 70% of the planet's surface. There is one ocean with many ocean basins, such as the North Pacific, South Pacific, North Atlantic, South Atlantic, Indian and Arctic.

   b. An ocean basin's size, shape and features (such as islands, trenches, mid-ocean ridges, rift valleys) vary due to the movement of Earth's lithospheric plates. Earth's highest peaks, deepest valleys and flattest vast plains are all in the ocean.

   c. Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation (Coriolis effect), and water density differences. The shape of ocean basins and adjacent land masses influence the path of circulation.

   d. Sea level is the average height of the ocean relative to the land, taking into account the differences caused by tides. Sea level changes as plate tectonics cause the volume of ocean basins and the height of the land to change. It changes as ice caps on land melt or grow. It also changes as sea water expands and contracts when ocean water warms and cools.

   e. Most of Earth's water (97%) is in the ocean and contains a constant proportion of dissolved salts (i.e. average salinity of 35). Seawater has unique properties: its freezing point is slightly lower than fresh water, its density is slightly higher, its electrical conductivity is much higher, and it is slightly basic. The salt in the water comes from eroding land, volcanic emissions, reactions at the seafloor, and atmospheric deposition.

   f. The ocean is an integral part of the water cycle and is connected to all of the earth's water reservoirs via evaporation and precipitation processes.

   g. The ocean is connected to major lakes, watersheds and waterways because all major watersheds on Earth drain to the ocean. Rivers and streams transport nutrients, salts, sediments and pollutants from watersheds to coastal estuaries (where rivers meet the sea) and to the ocean.

   h. Although the ocean is large, it is finite and resources are limited.

2. The ocean and life in the ocean shape the features of the Earth.

a. Many of the sedimentary rocks now exposed on land were formed in the ocean. Ocean life laid down the vast volume of siliceous and carbonate rocks.

b. Sea level changes over time have expanded and contracted continental shelves, created and destroyed inland seas, and shaped the surface of land.

c. Erosion–the wearing away of rock and soil–occurs in coastal areas as wind, waves, and currents in rivers and the ocean move sediments.

d. Most beach sand is carried to the coast by rivers and redistributed by waves and coastal currents. Erosion builds and destroys beaches. Winter storm waves carry sediments away from the beach and small summer waves carry sediments back onto the beaches.

e. Tectonic activity, sea level changes, and waves influence the physical structure and landforms of the coast.

3. The ocean is a major influence on weather and climate.

a. The ocean controls weather and climate by dominating the Earth's energy, water and carbon systems.

b. The ocean absorbs much of the solar radiation reaching Earth. The ocean releases heat by evaporation and this heat loss drives atmospheric circulation when heat released as water vapor condenses as rain. Condensation of water evaporated from warm seas provides the energy for hurricanes, cyclones and typhoons.

c. The El Niño Southern Oscillation causes the most important changes in global weather patterns because it changes the way heat is released to the atmosphere in the Pacific.

d. Most rain that falls on land originally evaporated from the tropical ocean.

e. The ocean dominates the Earth's carbon cycle. Half the primary productivity on Earth takes place in the sunlit layers of the ocean and the ocean absorbs roughly half of all carbon dioxide added to the atmosphere.

f. The ocean has had, and will continue to have, a significant influence on climate change by absorbing, storing, and moving heat, carbon and water.

g. Changes in the ocean's circulation have produced large, abrupt changes in climate during the last 50,000 years.

4. The ocean makes Earth habitable.

a. Most of the oxygen in the atmosphere originally came from the activities of photosynthetic organisms in the ocean.

b. The ocean is the cradle of life–the first life is thought to have started in the ocean. The earliest evidence of life is found in the ocean.

5. The ocean supports a great diversity of life and ecosystems.

a. Most life in the ocean exists as microbes, although ocean life ranges in size from the smallest virus to the largest animal that has lived on Earth, the blue whale.

b. Microbial organisms are the most important primary producers in the ocean. They not only are the most abundant life form in the ocean but also have growth rates that range from hours to days.

c. Most major groups of organisms (phyla) have many representatives living in the ocean.

d. Ocean biology provides many unique examples of important relationships among organisms (such as symbiosis, predator-prey dynamics and energy transfer).

e. There are examples of life cycles in the ocean that are not often seen on land.

f. The ocean is three-dimensional, offering a lot of living space from the surface through the water column to the seafloor. As a result, most of the living space on Earth is in the ocean.

g. Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substratum and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is "patchy".

h. There are deep ocean ecosystems that rely only on chemical energy to support life (such as hydrothermal vents, methane cold seeps and whale falls).

i. Zonation patterns of organisms along the shore are influenced by tidal ranges and waves.

j. Coastal estuaries (where rivers meet the ocean) provide important and productive nursery areas for many marine species.

6. The ocean and humans are inextricably interconnected.

a. The ocean affects every human life. It supplies freshwater (most rain comes from the ocean) and almost all Earth's oxygen. It moderates the climate and influences our weather.

b. From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security.

c. The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is an important element of our cultural heritage.

d. Most of the world's population lives in coastal areas.

e. Humans affect the ocean in a variety of ways. Wastes (such as trash, sediments and sewage) enter the ocean from run off (non-point source pollution) and dumping (point source pollution). The pollution leads to habitat degradation, development of harmful algal blooms, and depletion of oxygen, as well as the endangerment, depletion, and extinction of ocean species. Coastal development, such as building structures along coasts and damming rivers leads to loss of beaches and increased coastal erosion. Through fishing, humans have removed most of the large vertebrates from the ocean, either directly or by harvesting their prey.

f. Coastal regions (where most people live) are susceptible to natural hazards (such as tsunamis, hurricanes, cyclones, typhoons, and storm surges).

g. Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

7. The ocean is largely unexplored.

   a. The ocean is the last and largest unexplored place on Earth–less than 5% of it has been explored. This is the great frontier for the next generation's explorers and researchers, where they will find great opportunities for inquiry and investigation.

   b. Understanding the ocean is more than a matter of curiosity. Exploration, inquiry and study are required to better understand ocean systems and processes. Our very survival may hinge upon it.

   c. Over the last 40 years, use of ocean resources has increased significantly, therefore the future sustainability of ocean resources depends on our understanding of those resources and their potential.

   d. New technologies, sensors and tools are expanding our ability to explore the ocean. Oceanographers are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.

   e. Use of computer models is now an essential part of oceanography. They help us understand the complexity of the ocean and its interaction with Earth's climate. These models process observations and help describe the interactions among systems.

   f. Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, and physicists, and new ways of thinking.

Section III: Matrix of ocean-related content mapped to NSES content standards

Matrix of Ocean Literacy and NSES Concepts

The overview matrix and the corresponding essential principles and fundamental concepts show how the ocean literacy concepts address the fundamental concepts of the NSES content standards. The seven essential principles run horizontally across the top of the matrix; the ocean literacy essential principles are numbered while the letters below them correspond to ocean literacy fundamental concepts. Refer to the principles and concepts in Section II of this report to find descriptions of each concept. The eight NSES content standards and 69 sub-categories run vertically along the far left column. Grade spans are identified by color (see below). This matrix will continue to evolve. A more dynamic chart is available at www.coexploration.org/oceanliteracy.

Elementary
Middle
High
All

Because of the size of this matrix, it is broken into two parts in this report. The first part covers the alignment of ocean literacy fundamental concepts contained in the first four essential principles with the 69 sub-categories of content standards in the NSES.

Part 1: Alignment of Essential Principles 1, 2, 3 and 4 and the corresponding fundamental concepts.

UNIFYING CONCEPTS AND PROCESSES	1. Earth: one big ocean, many features						2. Ocean shapes Earth					3. Influence on weather & climate								4. Habit- able	
	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	3d	3e	3f	3g	4a	4b
1. Systems, Order and Organization	x	x	x	x	x	x	x	x						x	x	x	x	x	x	x	x	x
2. Evidence, Models, and Explanation														x	x	x	x	x	x	x	x	x
3. Change, Constancy, and Measurement	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
4. Evolution and Equilibrium	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5. Form and Function	x	x	x	x	x	x	x	x													x	x

	1. Earth: one big ocean, many features								2. Ocean shapes Earth					3. Influence on weather & climate							4. Habit-able	
EARTH AND SPACE SCIENCE	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	3d	3e	3f	3g	4a	4b
6. Properties of Earth Materials	x			x	x				x			x									x	
7. Objects in the Sky				x										x	x							
8. Changes in Earth and Sky		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x		
9. Structure of the Earth System	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	
10. Earth's History		x	x	x		x	x		x	x	x	x	x			x			x	x	x	x
11. Earth in the Solar System			x	x		x								x	x		x		x			
12. Energy in the Earth System	x	x	x	x										x	x	x		x	x	x		
13. Origin and Evolution of the Earth System	x	x	x	x		x			x	x	x		x	x	x	x	x	x	x	x	x	x
14. Origin and Evolution of the Universe																						
15. Geochemical Cycles	x		x		x	x	x	x					x			x		x	x		x	
LIFE SCIENCE	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	3d	3e	3f	3g	4a	4b
16. Characteristics of Organisms	x					x	x							x		x	x		x	x	x	x
17. Life Cycles of Organisms																						
18. Organisms and Environments	x		x	x			x	x					x		x	x		x	x	x	x	x
19. Structure and Function in Living Systems																						
20. Reproduction and Heredity																						
21. Regulation and Behavior																						
22. Populations and Ecosystems	x		x	x				x								x	x	x				
23. Diversity and Adaptations of Organisms										x			x						x	x		x
24. Interdependence of Organisms			x					x			x							x	x	x	x	
25. Behavior of Organisms																						
26. Matter, Energy and Organization in Living Systems	x		x	x		x		x								x		x	x	x		
27. Biological Evolution	x							x														x
28. Molecular Basis of Heredity																						
29. The Cell																		x			x	

PHYSICAL SCIENCE	1. Earth: one big ocean, many features						2. Ocean shapes Earth					3. Influence on weather & climate									4. Habit-able	
	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	3d	3e	3f	3g	4a	4b
30. Properties of Objects and Materials		x		x	x	x			x			x					x					
31. Position and Motion of Objects			x	x							x	x										
32. Light, Heat, Electricity and Magnetism																						
33. Properties and Changes of Properties in Matter			x		x	x																
34. Motions and Forces		x	x				x		x			x								x		
35. Transfer of Energy	x		x	x	x								x	x	x	x		x	x	x	x	
36. Structure of Atoms																						
37. Structure and Properties of Matter				x	x													x				
38. Chemical Reactions																						
39. Motions and Forces			x		x							x										
40. Conservation in Energy and Increase in Disorder				x		x									x	x			x	x		
41. Interactions of Energy and Matter		x	x	x	x						x	x	x									
HISTORY AND NATURE OF SCIENCE	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	3d	3e	3f	3g	4a	4b
42. Science as Human Endeavor K-12																						
43. Nature of Scientific Knowledge 5-12																x			x			
44. History of Science													x									
45. Historical Perspectives													x									

PERSONAL AND SOCIAL PERSPECTIVES	1. Earth: one big ocean, many features						2. Ocean shapes Earth					3. Influence on weather & climate									4. Habit-able	
	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	3d	3e	3f	3g	4a	4b
46. Personal Health K-8															x				x		x	
47. Characteristics and Changes in Populations																						
48. Types of Resources								x									x				x	
49. Changes in Environments				x			x	x			x	x				x			x	x		
50. Science and Technology in Local Challenges													x			x						
51. Populations, Resources and Environments								x														
52. Natural Hazards		x		x							x	x	x	x	x	x			x			
53. Risks and Benefits																						
54. Science and Technology in Society													x			x						
55. Personal and Community Health																x						
56. Population Growth								x														
57. Natural Resources								x														
58. Environmental Quality						x	x	x							x	x					x	
59. Natural and Human-Induced Hazards				x							x	x	x	x	x				x			
60. Science and Technology in Local, National & Global Challenges				x							x	x	x			x			x			
SCIENCE AND TECHNOLOGY	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	3d	3e	3f	3g	4a	4b
61. Abilities to Dist Between Natural Objects & Objects Made by Humans																						
62. Abilities of Technological Design K-12																						
63. Understanding About Science & Technology K-12																						
64. Abilities of Technological Design K-12																						

	1. Earth: one big ocean, many features								2. Ocean shapes Earth			3. Influence on weather & climate									4. Habit-able	
SCIENCE & TECHNOLOGY (cont.)	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	3d	3e	3f	3g	4a	4b
65. Understanding About Science & Technology K-12																						
66. Abilities of Technological Design K-12																						
67. Understanding About Science & Technology K-12																						
SCIENCE AS INQUIRY	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	3d	3e	3f	3g	4a	4b
68. Abilities Necessary to Do Scientific Inquiry K-12																						
69. Understanding About Scientific Inquiry K-12	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Part 2: Alignment of Essential Principles 5, 6 and 7 and the corresponding fundamental concepts.

	5. Ocean supports great diversity of life & ecosystems									6. Interconnectedness							7. Ocean is unexplored					
UNIFYING CONCEPTS AND PROCESSES	5a	5b	5c	5d	5e	5f	5g	5h	5i	6a	6b	6c	6d	6e	6f	6g	7a	7b	7c	7d	7e	7f
1. Systems, Order and Organization										x	x	x	x	x	x	x						
2. Evidence, Models, and Explanation																	x	x	x	x	x	x
3. Change, Constancy, and Measurement	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						
4. Evolution and Equilibrium	x	x	x	x	x	x	x	x	x													
5. Form and Function	x	x	x	x	x	x	x	x	x													
EARTH AND SPACE SCIENCE	5a	5b	5c	5d	5e	5f	5g	5h	5i	6a	6b	6c	6d	6e	6f	6g	7a	7b	7c	7d	7e	7f
6. Properties of Earth Materials					x	x					x								x			
7. Objects in the Sky																						
8. Changes in Earth and Sky											x				x					x	x	
9. Structure of the Earth System		x									x						x	x			x	
10. Earth's History			x		x	x					x										x	
11. Earth in the Solar System																						
12. Energy in the Earth System																			x		x	x

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	5. Ocean supports great diversity of life & ecosystems									6. Interconnectedness							7. Ocean is unexplored					
EARTH AND SPACE SCIENCE	5a	5b	5c	5d	5e	5f	5g	5h	5i	6a	6b	6c	6d	6e	6f	6g	7a	7b	7c	7d	7e	7f
13. Origin and Evolution of the Earth System																		x		x	x	x
14. Origin and Evolution of the Universe																						
15. Geochemical Cycles																				x	x	
LIFE SCIENCE	5a	5b	5c	5d	5e	5f	5g	5h	5i	6a	6b	6c	6d	6e	6f	6g	7a	7b	7c	7d	7e	7f
16. Characteristics of Organisms	x		x	x		x		x		x							x					
17. Life Cycles of Organisms		x		x					x													
18. Organisms and Environments	x	x		x	x	x	x	x	x					x		x		x	x			
19. Structure and Function in Living Systems	x	x																				
20. Reproduction and Heredity		x	x	x																		
21. Regulation and Behavior																						
22. Populations and Ecosystems		x		x	x	x	x	x	x	x	x			x					x			
23. Diversity and Adaptations of Organisms	x	x	x	x		x	x	x	x													
24. Interdependence of Organisms		x		x	x		x		x					x		x			x		x	
25. Behavior of Organisms				x																		
26. Matter, Energy and Organization in Living Systems					x	x	x	x	x													
27. Biological Evolution	x	x	x	x		x	x	x	x								x					
28. Molecular Basis of Heredity																						
29. The Cell		x																				
PHYSICAL SCIENCE	5a	5b	5c	5d	5e	5f	5g	5h	5i	6a	6b	6c	6d	6e	6f	6g	7a	7b	7c	7d	7e	7f
30. Properties of Objects and Materials																						
31. Position and Motion of Objects																						
32. Light, Heat, Electricity and Magnetism																						

	5. Ocean supports great diversity of life & ecosystems									6. Interconnectedness							7. Ocean is unexplored					
PHYSICAL SCIENCE (cont.)	5a	5b	5c	5d	5e	5f	5g	5h	5i	6a	6b	6c	6d	6e	6f	6g	7a	7b	7c	7d	7e	7f
33. Properties and Changes of Properties in Matter																						
34. Motions and Forces																						
35. Transfer of Energy		x		x		x	x															
36. Structure of Atoms																						
37. Structure and Properties of Matter																						
38. Chemical Reactions							x															
39. Motions and Forces																						
40. Conservation in Energy and Increase in Disorder																						
41. Interactions of Energy and Matter																						
HISTORY AND NATURE OF SCIENCE	5a	5b	5c	5d	5e	5f	5g	5h	5i	6a	6b	6c	6d	6e	6f	6g	7a	7b	7c	7d	7e	7f
42. Science as Human Endeavor K-12											x	x	x			x	x	x	x	x	x	x
43. Nature of Scientific Knowledge 5-12												x					x	x		x	x	x
44. History of Science												x							x			x
45. Historical Perspectives							x												x			x
PERSONAL AND SOCIAL PERSPECTIVES	5a	5b	5c	5d	5e	5f	5g	5h	5i	6a	6b	6c	6d	6e	6f	6g	7a	7b	7c	7d	7e	7f
46. Personal Health K-8										x	x	x		x			x	x				
47. Characteristics and Changes in Populations													x									
48. Types of Resources										x	x	x		x		x	x	x				
49. Changes in Environments													x	x	x	x	x	x				x
50. Science and Technology in Local Challenges							x							x		x				x	x	x
51. Populations, Resources and Environments											x			x					x			
52. Natural Hazards													x	x	x				x		x	
53. Risks and Benefits														x	x	x		x		x	x	

PERSONAL AND SOCIAL PERSPECTIVES (cont.)	5. Ocean supports great diversity of life & ecosystems									6. Interconnectedness							7. Ocean is unexplored					
	5a	5b	5c	5d	5e	5f	5g	5h	5i	6a	6b	6c	6d	6e	6f	6g	7a	7b	7c	7d	7e	7f
54. Science and Technology in Society											x			x		x	x	x	x	x	x	x
55. Personal and Community Health											x			x	x	x						
56. Population Growth											x		x	x						x		
57. Natural Resources										x	x	x	x	x					x	x		
58. Environmental Quality					x			x		x	x			x		x			x	x		x
59. Natural and Human-Induced Hazards											x			x	x		x	x	x			
60. Science and Technology in Local, National & Global Challenges											x			x	x	x	x	x	x	x	x	x
SCIENCE AND TECHNOLOGY	5a	5b	5c	5d	5e	5f	5g	5h	5i	6a	6b	6c	6d	6e	6f	6g	7a	7b	7c	7d	7e	7f
61. Abilities to Dist Between Natural Objects & Objects Made by Humans														x								
62. Abilities of Technological Design K-12																	x			x	x	
63. Understanding About Science & Technology K-12																	x	x	x	x	x	x
64. Abilities of Technological Design K-12																	x			x	x	
65. Understanding About Science & Technology K-12																	x	x	x	x	x	x
66. Abilities of Technological Design K-12																	x			x	x	
67. Understanding About Science & Technology K-12																	x	x	x	x	x	x
SCIENCE AS INQUIRY	5a	5b	5c	5d	5e	5f	5g	5h	5i	6a	6b	6c	6d	6e	6f	6g	7a	7b	7c	7d	7e	7f
68. Abilities Necessary to Do Scientific Inquiry K-12												x					x	x		x		x
69. Understanding About Scientific Inquiry K-12	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Section IV: An Overview of the 2004 Virtual Workshop on Ocean Sciences Literacy

Part 1: A History of Ocean Literacy Efforts

In recent years, there have been a number of efforts underway to define ocean literacy, assess what the public knows about the ocean and redress the lack of ocean-related content in state and national science education standards and assessments.

In 2002, a similar virtual conference was convened with approximately 30 to 40 people, comprising scientists, educators, classroom teachers, and policy makers. Using the National Geography Education Standards as a model, the goal was to define what ocean content needed to be taught in the schools. That effort was just the beginning of a much longer process linking ocean content to other education standards. At the time it was recognized by all involved that simply linking ocean content to standards was not enough. Criteria to assess student understanding and define what an ocean literate person should know at the end of this process were also required.

The 2002 ocean literacy conference lasted over three weeks and resulted in four simple statements about what an ocean literate person should understand, which are:
- Without the oceans, there would be no life on earth;
- The oceans are a complex system;
- People and oceans are interconnected; and
- The oceans are finite.

These four concepts were developed, not to be all-inclusive and not to be exclusive, but to be examples of what an ocean literate person should understand.

The next task in the 2002 conference focused on aligning the ocean concepts to the National Geography Standards. Geography standards are organized around six Essential Elements. These elements were redefined in terms of the ocean. For example, the ocean relates to the Essential Element called the World in Spatial Terms because space, time and maps define almost everything in the ocean. At the time, it was also recognized that a comparable exercise was needed with regard to science education standards.

The 2002 conference and a subsequent conference later that year also focused on educational assessment. This focus was recognized as the next step in ensuring that the alignment of ocean content to geography standards would become part of the U.S. education system because that system is driven by testing and will likely continue to be into the foreseeable future. Including ocean content in educational assessments will also allow us to measure the impact of our efforts in ocean literacy.

In addition to the 2002 conference that focused on geography standards, members of an ad hoc committee of the NMEA recommended a series of actions intended to result in greater infusion of ocean-related content into formal and informal education. Two recommendations focused on identifying key science concepts about the ocean, coasts and Great Lakes and articulating how those concepts meet the content standards of the NSES. These two objectives were viewed as the initial steps necessary to achieve greater integration of ocean content into K-12 classrooms.

In response to the NMEA ad hoc committee's recommendations, Dr. Robert Stewart of Texas A&M University and several of his colleagues identified – from a scientist's perspective – what an ocean literate person should know. This effort was described in a paper presented at the 2004 NMEA annual conference, entitled "What Every Student Ought to Know about the Ocean: a Compilation of Key Concepts."

COSEE-New England had developed a draft definition of ocean literacy to guide their efforts to strengthen the New England region's capacity to provide high-quality ocean science education.

Finally, both the Pew Oceans Commission and the U.S. Commission on Ocean Policy noted a dearth of ocean literate citizens and called for stronger public education about the ocean our nation's coasts.

Through these previous efforts to define ocean literacy and with the attention ocean education was receiving from both commissions, it was apparent by July 2004 that the ocean sciences and ocean education communities were finally ready to reach consensus on a definition of ocean literacy and identify the science content that translates into ocean literacy.

Part 2: Virtual Workshop Purpose, Goals and Process

The purpose of the 2004 online workshop was to describe and document the science content and processes related to the ocean, coasts and Great Lakes that should be included in all future science education standards at the local, state and national levels. In order to do this, the workshop organizers attempted to involve a representative sample of teachers, scientists, informal educators, policy makers and parents committed to the idea of creating an ocean literate society. This group was asked to come to consensus on a definition of ocean literacy and what it means for any adult to be "ocean literate." It was hoped that through this line of inquiry, the big ideas or enduring understandings would be identified that people need to know about the ocean in order to be ocean literate. Then using a process somewhat akin to backwards design[7], the concepts and standards would also be identified as being needed to teach and learn at various grade spans to attain the enduring understandings.

Another goal of the workshop was to identify products that teachers, parents, administrators, scientists, informal educators and policy makers can use to influence the development of future science standards. The primary focus of this workshop was the formal K-12 educational system. However, it was (and still is) expected that these same tools and products, especially the descriptions of ocean literacy and enduring understandings, can be of used to guide and influence development of educational efforts in informal and free-choice learning environments.

Workshop Background and Assumptions

Among all disciplines of science, ocean and aquatic sciences are inexplicably and idiosyncratically underrepresented in K-12 education. Concepts and topics about the ocean, coasts and Great Lakes are rarely taught in K-12 schools and seldom appear in K-12 curriculum materials, text books, assessments or standards. This is true despite the fact that the ocean covers most of our planet, is home to most of the life on Earth, regulates our weather and climate, provides most of our oxygen, and feeds much of the human population.

Educational standards are the strategic point of leverage for bringing about significant systemic change in the content of science education. Our current educational system is defined by the goal of "alignment." The content of curriculum, instruction and assessment are all derived from agreed upon standards. Therefore, if ocean sciences are not present in science standards, efforts to include ocean sciences in curriculum, texts and assessments will perpetually be marginalized and "out of the mainstream." Conversely, if ocean sciences are present in the science standards of the future, they will naturally and automatically be incorporated by textbook publishers, curriculum developers and assessment specialists.

Those concerned about science education and about the future health of our "ocean planet" must be poised to influence the development of science standards by local educational agencies (school boards; school districts), state departments of education and professional societies and associations. In order to be effective, we must document agreed-upon science content and processes related to the ocean, coasts and Great Lakes.

Workshop Process

The virtual conference center had four distinct places for meetings and discussions. The Reception area was just that, a place for orientation to the conference center and the workshop purpose, agenda and process. This is where everyone started. The Meeting Room was the main area for discussions, which have been developed into workshop products, such as this report. The Resources Room was the location for background materials (print documents, interviews, videos, websites, etc.) to help inform participants, as well a place

where participants could post pertinent resources they had. The Oceanside Room was the area for relaxing, musing, sharing stories, music and pictures about the ocean. Within each room or area were a list of items for discussion and information and a tally of participants' comments.

The workshop opened on Friday, October 15, 2004 for introductions and orientation. Discussions began on Monday, October 18. This virtual workshop was hosted online by the College of Exploration. The discussions were asynchronous, i.e., invited guests participated at a time convenient to them. There are 92 invited participants, 84 of whom actually logged in, and 33 observers. (Observers could view the process in a "read only" format.) Participants and observers included teachers, curriculum developers, scientists, informal educators, policy makers and parents. The workshop closed on October 31, 2004.

The workshop discussion spanned two weeks. During Week 1, participants' discussions were focused on defining ocean literacy and identifying the content that people need to know to be ocean literate. During Week 2, the plan included reviewing the draft literacy definition(s) and concepts/content, and then benchmark the concepts to the appropriate grade levels, i.e., what gets taught when to whom.

At the start of the workshop the hosts asked participants to complete a brief survey regarding their expertise, to react to several ocean literacy definitions currently in use, to rate a listing of ocean concepts, and list professional development needs. The final weekend provided the organizers an opportunity to gain feedback and final thoughts on the progress and products. The workshop officially closed on October 31, 2004. After that date participants and observers could login to review materials, but were not be able to add anything new.[*]

Participants were expected to login each day and consult the agenda for that day's activities, which usually include reviewing background material and commenting on any of the topics up for discussion.

As part of the survey at the beginning of Week 1, the workshop organizers presented to participants three ocean literacy definitions currently in use or development, and asked them to rate their agreement/disagreement with each. The survey results are summarized in Section IV, Part 5 of this report.

The second week of the workshop opened with an e-mail to all participants on Monday, October 25, 2004, encouraging a review of the Week 1 Summary and inviting contributions to the task of collecting "…examples of topics, subjects, concept, issues, etc., that enable science standards to be met using ocean content."

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[*] The web site is still available as an archive.

The Week 1 Summary (posted in Room #12), included a summative definition of ocean literacy and participants continued that discussion with 31 additional comments.

To aid the discussion during Week 2 and familiarize participants with the current national science education standards, workshop hosts offered an Introduction to Science Standards (Room #11) and set up a meeting room for General Discussion on Concepts and Issues (Room #10).

Hosts also provided two organizing schemes for imbuing national science standards with ocean content. One was organized by grade-bands: Grades K-4, Grades 5-8 and Grades 9-12; the other followed the National Science Education Standards (NSES) content categories: Unifying Concepts & Processes, Science as Inquiry, Physical Science, Life Science, Earth & Space, Science & Technology, Personal & Social Perspectives, History & Nature of Science, plus an Other Topics category. Both organizing schemes led to a "box" for each NSES category where participants could add ocean-related content.

On the last day of the workshop, participants received a final e-mail announcing the rapidly approaching close and a last chance to add/prioritize ocean content. The e-mail also asked participants to complete a short survey on their satisfaction with the workshop and offer recommendations for next steps.

Part 3: Virtual Workshop Agenda, October 15 - October 31, 2004

The workshop site opened on October 15th, to allow pre-workshop review of the reading materials, with discussion beginning on Monday, October 18th. Participants were asked to complete the pre-workshop survey, as the responses were fed directly into the online discussions.

Ocean Literacy Workshop Agenda

October 15 - October 31, 2004

WEEK 1:
Agenda for this week will include getting to know each other, learning to navigate the online workshop site, identifying ocean content for science standards and defining ocean literacy.

Day 1-3 (October 15-17)
- Introduce yourself to the other workshop participants and post your workshop expectations.
- Navigate the workshop web site. Review the web site tips.
- Complete online survey (if you have not already done so).

- Read through the agenda, introduction, and other "must-read/must-view" background materials.

Day 4 (Monday, October 18)
- Complete any unfinished tasks from Days 1-3.
- Post any comments or suggestions you might have on the workshop's agenda.
- Watch interviews of James D. Watkins and Gil Grovenor. These video clips can be downloaded from the "video theatre" section of the web site.
- Read summary of the survey responses on ocean literacy definitions.

Day 5 (Tuesday, October 19)
- Review Day 4 postings.
- Post comments on ocean literacy definitions after reading survey summary. (Think not only about the content of the definition we need, but also scale of the definition. In other words, how broad or detailed does this definition need to be. Do we need several definitions at different scales of detail? If so, what would those be?)

Day 6 (Wednesday, October 20)
- Read Day 5 summary/postings.
- Review the list of ocean concepts that people have suggested be taught at some point in a K-12 classroom. (The concepts are those found in the several documents that were part of the required reading, i.e., "Oceans for Life" matrix, Bob Stewart's white paper and list of concepts, New England COSEE's working definition of Ocean Literacy. Visit the workshop "resources" section for more information.)
- Identify any missing concepts from these documents.
- If you are currently teaching in a K-12 classroom, list any concepts that are taught. Do they overlap with the ones identified already?

Day 7 (Thursday, October 21)
- Read Day 6 postings.
- View presentation on the National Science Education Standards by Elizabeth Stage of the Lawrence Hall of Science. (This presentation can be found in the "Presentations" section of the web site.)
- Review the National Science Education Standards and Benchmarks for Science Literacy. Links to these documents are provided the "resources/reading room" on this web site.
- Post any questions you might have on either science standards or scope and sequence of concepts.
- If you are teaching grades K-12 please tell us if you are using the scope and sequence of any science standards in your classroom. If you aren't using science standards in your classroom, please indicate why.

Day 8 (Fri., October 22)

- Review Day 7 postings.
- Post any final comments on draft definition(s) of ocean literacy.
- Post comments on proposed key concepts. Consider which concepts are most important in light of what you learned about standards yesterday. How many should we have? What level of detail is appropriate? Which ones are most likely to help one achieve ocean literacy?

Days 9-10 (October 23-24)

This time is available to review discussions during Week 1 and to read-ahead for Week 2.

WEEK 2:

This week we plan to focus on aligning ocean concepts identified last week as important to K-12 science education standards. All participants (regardless of professional expertise) will be asked to choose a grade-band (K-4, 5-8, 9-12) for the purposes of this week's discussions. You may also choose to observe several groups in order to identify connections among grade bands.

Day 11 (Monday, October 25)

- Watch interview of Marcia McNutt. This video clip can be downloaded from the "Video Theatre" section of this web site.
- Read summary from Week One discussions.
- Comment on draft definition(s) of ocean literacy that are the result of last week's discussions.
- In your discussion group, begin to develop what the ocean "scope and sequence" might be for your grade group.
- Post your findings in "break-out room" for your grade band.

Day 12 (Tues., October 26)

- Review Day 11 postings within your group.
- Continue discussions about scope and sequence for your grade group.
- Post any additional findings for your grade band.

Day 13 & 14 (October 27-28)

- Review the results from other grade groups and compare to your findings.
- Is there a "threaded" link between the topics suggested throughout grades K-12?
- Make recommendations for follow-up to this workshop.

Day 14 (Fri., October 29)

- Review draft workshop proceedings.
- Post your feedback on proceedings.

- Post your feedback on this workshop.

Day 15-16 (October 30-31)

- Post feedback on proceedings and workshop if you did not do so on Friday.

Note: After October 31st, you will be able to login to review the material, but will not be able to add any new material. The workshop proceedings are open indefinitely for reading and anyone can join as an observer by visiting http://www.coexploration.org/oceanliteracy.

Part 4: Workshop Participants Closing Thoughts and Recommendations for Next Steps

The following comments are the individual postings made by participants regarding their recommendations for next steps toward an ocean literate public. "Item" refers to a new section for posting comments and individuals responses are identified in the order in which they were posted.

Item 16 Peter Tuddenham *Oct 29, 2004 12:35*
Thank you all for your participation. We are planning on closing this workshop at 5pm Eastern on Sunday 31 October for active participation. Everything with remain open for reading only.

We would be grateful if you would complete a short survey to give us some feedback on the workshop. http://www.betaresourcesinc.com/nc/olit2004eval

Please add any recommendations for next steps here as responses to this item.

Response 16:1 Margaret Gorcyca *Oct 29, 2004 13:09*
It would be better if you give us a survey to see if we were able to meet your needs. You had us fill out a survey at the beginning and now you want to see what we learned.

Response 16:2 Peter Tuddenham *Oct 29, 2004 13:40*
There is a short survey at http://www.betaresourcesinc.com/nc/olit2004eval which does help us do that Margaret.

Response 16:3 Dean Allen *Oct 29, 2004 14:56*
I just completed the survey form, but wanted to add that I think the information shared and the expert opinions provided by the participants were to the point and extremely valuable in accomplishing the workshop goals during a limited 2 week timeline.

Moving forward, I hope we will continue to be updated on future discussions and actions taken.

Thank you again for inviting me to be part of this important Ocean Literacy Workshop. I only regret that my travel and work schedule did not allow me to devote more time to the discussions.

Response 16:4 Lynn Whitley *Oct 29, 2004 15:47*
I also just completed the survey form and put all my thoughts in there. wish I had copied it! But in a nutshell----this was a wonderful and I think, a very successful workshop. The sharing and --by having this format---the documenting of the ideas were excellent. I think we have made a very solid first step along the path of defining ocean literacy and weaving ocean content into existing standards. I would welcome continuing this process in future online workshops or in a small group face to face workshop that builds on this work. It was wonderful to be involved with such a knowledgeable, passionate, and interesting group of people who took the time to contribute and be an intergral part of this important process. I enjoyed it and learned a lot, too, can't ask much more than that!

Response 16:5 Gene Williamson *Oct 29, 2004 16:04*
I've learned a great deal, and I'm encouraged by what is coming out of this effort. For those of you who are not members of the National Marine Educators Association, I encourage you to think about joining us. There is strength in numbers. . .and of course next summer the conference is on Maui. No time like the present. :-)

Response 16:6 William Bragg *Oct 29, 2004 16:49*
Good thought, Gene! Here is the link: http://www.marine-ed.org/

Response 16:7 Fritz Stahr *Oct 29, 2004 20:42*
I would like to see an executive summary of the workshop (basic conclusions, status of process, etc.) from the conveners that we could pass around to those who didn't participate to encourage more thought on this from others. Is there a plan for such? Also, if this site can be left up in read-only mode for longer than just through Dec it might be useful in fostering whatever group wants to take next steps. Thanks for the work in putting this on!

Response 16:8 Beth Jewell *Oct 30, 2004 11:38*
Have enjoyed this experience, I would like to see a venue where this can be discussed further. Would like to see an opportunity to get some teachers together to dive into some of the thoughts. Maybe a session in Maui?

Response 16:9 Tom Greene *Oct 30, 2004 11:47*
The NY State Dept. of Education approved a standards based marine science curriculum with mandatory labs ,which is offered in schools throughout the State of New York.
NOAA and NMEA needs to keep the momentum going by crafting a "marine science" or "oceanography" curiculum from all recommendations made here and send it to the Federal and State Education departments for inclusion into the schools.If this is not done marine education as we know it, will at best, be taught piecemeal in only some schools.

Response 16:10 Paula Keener-Chavis *Oct 30, 2004 16:47*
Although I am not quite finished with the workshop and will try to jump back in today and some tomorrow before it closes, from what I have seen it has been most productive and I only wish my schedule would have enable me to participate more than it has. Would love to see some follow-ups on this. Although the def of ocean literacy has closed out (I think), as I read through all of the iterations that were discussed last week, I kept thinking about the fact that ocean literacy to me should somehow encompass not only all the things you all discussed and came to some concensus on, but also possibly an acknowledgment of just how much we don't know about the world ocean.

Response 16:11 Mellie Lewis *Oct 30, 2004 16:58*
Beth - will you be writing an abstract for Maui like you did for NSTA Richmond? Sounds
like a great idea to me, but I would really like to see us keep the momentum going and
meet/discuss/plan/ whatever before July.

Response 16:12 Laura Francis *Oct 30, 2004 19:10*
Thanks for the opportunity to participate. The discussions have been excellent and
thought-provoking. I hope that this is just the beginning and we all continue to work
towards achieving ocean literacy. I look forward to seeing a final report and strategy with
next steps and actions so we can keep the momentum going.

Response 16:13 Melissa Demetrikopoulos *Oct 31, 2004 01:06*
This has been very informative. I, too, put my comments in the survey. Perhaps they
could be moved to the public area. One thing that I will remention is that I believe this
process could have benefited from a conference call after the first week and a follow up
conference call. Perhaps the follow up call can still be arranged.
I am not sure that we have come up with a short list of essential items that every person
MUST know about marine science. I would like to see this short list developed in
addition to ideas of how to incorporate ocean science into the standards. Thanks so
much for including me in this process!

Response 16:14 Francesca Cava, Nat. Geo. Society, Santa Barbara, California *Oct 31,
2004 08:18*
Thanks again to all of you for your time and thoughts. I believe the workshop did help us
continue the discussion on what we mean by ocean literacy and many excellent
suggestions have been made on how we continue to mount our Ocean Literacy
campaign.

There will be an executive summary of the workshop available next week posted on this
site. We will keep this site open as a "read only" reference. There will certainly be a
session on our efforts at NMEA next year.   I encourage you to let us know what the best
format and content would be for that session.
Thanks again for all your contributions and Happy Halloween!!

Response 16:15 Sarah Schoedinger *Oct 31, 2004 10:07*
I'd like to echo Francesca's thanks to you all for your willingness to contribute your time
and thoughts to this effort. We are definitely interested in your feedback on this
workshop so please take the time to fill in the survey at:
http://www.betaresourcesinc.com/nc/olit2004eval

Response 16:16 Sharon Walker *Oct 31, 2004 11:31*
I can only echo many of the Ocean Literacy Online Workshop participants' accolades
stated thus far. This has been an extremely successful dialogue in providing a general
consensus concerning the definition of ocean literacy and the general concepts needed
to become ocean literate. Further, I believe, once an Executive Summary or similar
document is developed based on everyone's input, we can collectively begin our next
and Herculean tasks in establishing the ocean concepts/case studies (to be incorporated
in the NSES) needed at the three different grade levels for a precollege graduate to be
considered "ocean literate!" Lastly, I also appreciate everyone's passion for education,
particularly achievement in ocean sciences education!

Response 16:17 Frank Muller-Karger *Oct 31, 2004 11:39*
Thank you for inviting me to participate in this workshop.
I found the format interesting. I wish I could have put in more time, but I personally believe that the format did not provide the best venue for me to immerse as a participant. I may be one of those people that serves best when cloistered and retained captive (I should not be telling you this). This interface allowed for too much distraction (doing other things and getting to it as an afterthought at the end of the day); this made it difficult for me to find everyone's nuggets and keep them in mind. Especially when absences for more than a day occur, and in my case these were necessary. Typing all input also may not be the most effective for me.

I wonder if another format would be more useful for me, i.e. one that helps provide more up front and in-depth review of what concepts already have been floated to match which standards, and also helps to provide a more truly interactive experience (over perhaps a shorter but dedicated period of time). I believe that this can still be done electronically.

I do hope that the organizers found my input helpful. My closing comment is that we do need to keep the horizon broad (not just ocean centric). More importantly, we really need to energize our leaders on general education. It is not just science. I am appalled that so much has been lost and we continue to lose, while our leaders seem to state that all is great and that they do so much for education. In Florida, for example, we continue to be at the bottom of the pile, even after 20++ years of statements that education is a priority. It is not quite clear to me what the problem is - "money not where mouth is" seems to be one obvious one. On standards: Did earlier generations have so many standards? Why did they do better at science, math and engineering? Do other societies that seem to be overtaking ours in technology base their learning on standards - or do they have other education paradigms? Is it just an issue of injecting oceans into the classroom, to get children excited about learning? Honestly?

I would like to remain engaged in this effort.

Response 16:18 Kate Madin *Oct 31, 2004 13:35*
I also hope to remain engaged in this effort, and also want to echo Frank's thought that it was difficult for me to read everyone's initial and previous comments and relate them to the current stage of discussions. Possibly a dedicated in-person meeting of the people and groups represented here would allow more clear agreement on a statement, list of concepts or whatever the form is to be.

Response 16:19 Rebecca Bell *Oct 31, 2004 14:23*
Thank you so much for inviting me to participate. I learned a great deal that helped me in my work in developing our state curriculum examples and, by participating in this discussion, called attention to oceans to our curriculum director who is now very excited about including ocean topics in the state curriculum.

Response 16:20 Julie Lambert *Oct 31, 2004 15:15*
I laughed when I read Frank's. I too can contribute more when held captive in person. I found it a little difficult to follow along and know what would be valuable enough to contribute once a few days went discussing a topic. But there is a lot to learn from this format too. Perhaps something like this prior to a "face to face" meeting would be very beneficial to producing a tangible outcome.
I think this experience reminded me of doing qualitative research - I really hope that someone will be analyzing our discussion for themes and future work and then getting

our feedback. I'd even volunteer because I think the discussions were so beneficial and it was clear how much everyone cares about promoting ocean literacy. Thank you for the opportunity to participate. I too wish I had had more time, but I'm very willing to continue working on this.

Response 16:21 Paula Keener-Chavis *Oct 31, 2004 15:29*
The guilt is overwhelming and I am so comforted by the comments about the "captive audience format." As I sit here in the last hour and a half of the workshop, knowing hardly anyone will see these comments, my soon-to-be 8-year-old son (like tomorrow) is making a green tree frog out of model magic for his science project all by himself listening to the CD Holes in the kitchen calling my name CONSTANTLY and I know the trick or treaters will be knocking at the door any minute and I have one to get dressed, AFTER we construct the food web for the green tree frog. I just need to be held captive to focus on something of this magnitude and importance and will do whatever is needed to help move the next level forward. This is one of the most important things I have had the opp to be involved in the past three years and I just have not had the time to commmit to it that I thought I would or that I wanted to. Thanks to all for FINALLY pulling all of this together....after all, it is the most important thing we can do for the little boy that will be a cowboy in about an hour an a half and all the other children around the world.....ohmygosh....I forgot we have to carve the pumpkin...arghhhhgggggghhh!!!!!

Response 16:22 Kate Madin *Oct 31, 2004 16:32*
Just wanted to say that Paula isn't the only one who has had to tune in too late, and I understand her guilt!

Response 16:23 Mellie Lewis *Oct 31, 2004 16:34*
Thank you Sarah and Francesca for inviting me to participate in this stimulating conference. I learned a great deal. I'm hoping to have the opportunity of working more with Rebecca Bell in bringing ocean topics into our Maryland State Curriculum. I hope many of us will get together at NSTA Richmond and at the NMEA Conference next July. If we plan early enough, we could possibly plan to meet as a group either before or after these conferences and continue this dialogue.
Happy Halloween!

Response 16:24 Peter Tuddenham *Nov 09, 2004 18:16*
This is a note from the whole organizing team.

Thanks to all of you who participated in this workshop. We believe that with your help we were able to meet our workshop goals and certainly extend the conversation on ocean literacy to a wide and diverse audience. Special thanks are also in order to the groups and organizations that allowed us to review and comment on their ocean literacy-related efforts: the Northeast COSEE, Dr. Robert Stewart and his colleagues, the National Geographic Society and NOAA. Lastly, Dr. Elizabeth Stage provided valuable insight about U.S. education policy and national standards through her overview of the National Science Education Standards and how they relate to teaching about our oceans, coasts and Great Lakes.

What did we accomplish?
The conference enabled us to look at the progress underway by various organizations, to take a snapshot (captured in the graphic overview of the workshop process) on where we stand with defining ocean literacy, to add this workshop to the continuum of needs to promote ocean literacy and most importantly to help build consensus in the community

on what is needed to define ocean literacy, to identify the most important ocean concepts to include in the classroom, and to begin to align these concepts and topics to national science education standards.

In addition, the online format of the workshop allowed a large, diverse group of people to participate in a very cost-efficient manner and will provide an archive for future use and reflection. The amount of information gained over the two-week period far exceeded our expectations and will take some time to analyze. With that in mind, we plan to have a final report on the workshop available for your review and comment in early 2005. Summaries of Week 1 and Week 2 of the workshop, along with some raw survey results are also available online. The following paragraphs highlight what we see as the key findings of the entire workshop.

Workshop Results

With a number of entries over the two-week workshop, participants came close to consensus on the definition of, and tagline about, ocean literacy, which are stated as follows:

Definition: Ocean literacy is the awareness and understanding of fundamental concepts about the functioning of the ocean-atmosphere-earth system. An ocean-literate person recognizes the influence of the ocean on his/her daily life, can communicate about the ocean in a meaningful way, and is able to make informed decisions to ensure the ocean continues to sustain a habitable planet.

Tagline: Ocean literacy is understanding the ocean's influence on you and your influence on the ocean.

In addition, although we identified a number of models for how to align ocean content to the standards, a major workshop recommendation, which was especially endorsed by the K-12 teachers, was to align ocean content with the current National Science Education Standards (NSES). The collective discussion also suggested the following directions for promoting ocean literacy:
- Start with NSES (upon which many state standards are based) and align ocean content to current standards.
- Be prepared for a future revision of the NSES (and state standards) with ocean literacy standards/statements/examples. Test questions, and then textbooks, might then follow.
- Develop activities/lessons/examples that help teachers cover science standards (as well as reading, writing and math) using ocean content.
- Provide teacher professional development/workshops (pre-service and in-service) on ocean content to get them enthusiastic about teaching science, as well as showing them how ocean content helps meet all content standards (not just science).
- Engage education professors/science methods professors in the use of ocean content to enliven teacher preparation.
- Promote research findings and/or support research to show the positive impact of ocean content on learning reading, writing, math and/or science content/standards.

During the workshop, several participants offered lists of "fundamental concepts" that an "ocean literate" person would know. These were offered to create a bridge between the definition of ocean literacy and the alignment of ocean content with national and state

science standards. The following lists are succinct examples of key concepts about which there was general agreement from the participants.

From response 10:34:
Grades K-4
◊   *Ocean is big.*
◊   *Ocean affects us.*
◊   *Ocean life is fascinating.*
◊   *Coasts are important.*

Grades 5-8
◊   *Ocean affects weather.*
◊   *Organisms adapt to their environment.*
◊   *Organic matter can be formed by photosynthesis or chemosynthesis.*
◊   *Mankind is affecting the ocean.*
◊   *Water has unique properties.*

Grades 9-12
◊   *Life evolved in the ocean.*
◊   *The ocean plays a critical role in climate change.*
◊   *Ocean resources are limited.*
◊   *Technology allows us to "see" (or observe) the ocean better.*

Another way of stating these concepts was offered in 10:37 as follows:
Grades K-4:
♦   *The ocean covers 3/4 of the Earth's surface and has a variety of names.*
♦   *The ocean is a source of life ranging in size from whales to plankton and many microscopic life forms.*
♦   *There are consequences in the misuse of the ocean in the forms of pollution, mismanaged fishing and hunting, and destruction of food chains.*
♦   *The ocean affects weather and climate.*

Grades 5-8:
♦   *Oceans have physical and biotic characteristics which are used to define habitats and regions.*
♦   *Organisms adapt to their environment.*
♦   *Physical processes drive global systems in which oceans are fundamental (this includes weather and climate).*
♦   *Humans affect all marine ecosystems.*

Grades 9-12 (Basically concepts above but with more detail, such as):
♦   *Ocean life is microbe- based.*
♦   *Changes in the ocean's circulation can cause climate change (and how that circulation works).*
♦   *Organic matter can be formed by photosynthesis or chemosynthesis.*
♦   *Life evolved in the ocean.*
♦   *Ocean resources are limited.*

In addition, there were many valuable entries that identified specific ocean concepts that align well with existing science education standards and for which ocean-relate concepts

are essential to meeting the content standard. It became obvious that this particular step was much more complex then envisioned and needs additional work. Nevertheless, the workshop did provide a proof-of-concept for the idea that ocean content can be aligned to the NSES and other standards.

Next Steps:
The most important next step will be to digest all the material generated by the workshop, both in the meeting rooms and in the pre- and post-workshop surveys. The workshop has certainly given us the initial data to align ocean content to the NSES and one option will be to work with a "standards expert" to synthesize this information into a first draft for further review and comment. Once that synthesis is completed, the information can be put into "final" form and shared with educators at national educational meetings.

Also, the workshop highlighted the need to continue to share information on what various organizations are doing to promote ocean literacy and to leverage our joint efforts. This information sharing should be a priority for NMEA 2005 and could perhaps be identified by grouping such presentations in a conference strand.

Lastly, we want to continue to engage you in the process of helping to promote ocean literacy. We hope to do that through the release of this workshop's final report, solicitation for comments on the report, synthesis of recommendations for next steps identified in the workshop, and continued discussions at professional meetings. As the workshop organizers, we have been very encouraged by the dialog of this workshop and will continue to look for more opportunities to bring the community together.

Sincerely,
Craig, Francesca, Peter and Sarah

Part 5: Analyses of Pre- and Post-workshop Surveys
Analyses of Pre- and Post-workshop Surveys by Howard D. Walters, Ed.D., Ashland University and Kristina O. Bishop, Ed.D., College of Exploration

Participants in the National Geographic-implemented, Ocean Literacy Online Workshop in fall, 2004, completed both pre-workshop and post-workshop surveys designed to gauge perceptions of the accomplishments, strengths, weaknesses, and overarching reactions to the workshop. The survey responses were provided in raw form to an external evaluation team which has a significant background in monitoring discussions and programs associated with ocean science education to develop this data summary. The evaluation team also had access to the workshop and to the planning (greenroom) space used by the workshop leadership team. The pre-workshop survey was completed by approximately 67 participants—some fluctuation exists in the count due to voluntary completion of survey items. There were several distinct constituencies who participated in the online workshop and who completed pre- and post-workshop surveys: scientists, teachers—both from formal and informal education, policy makers, conservationists, and interested citizens. The range of interests and motivations among the participants resulted in multifaceted views and perspectives on ocean literacy and its educational and curricular implications. This fact created

complexity and cognitive tension in the discussions as participants moved toward consensus–which seems to be a very healthy and positive feature of this workshop.

There was strong agreement among the participants with respect to an initial statement on the importance and relevance of ocean literacy (85% Strongly Agree and 15% Agree to the importance) (Figure 1). There were no negative perceptions vocalized.
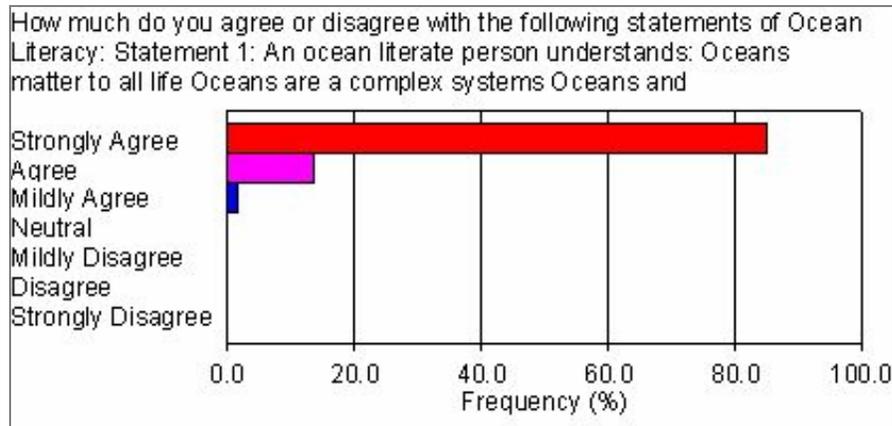

FIGURE 1

The respondents were invited to consider three statements concerned with ocean literacy and its characteristics. These statements were presented to capture strength of agreement or disagreement, as well as open-ended narrative commentary. A strong majority of participants suggested wording changes to the ocean literacy statements in the initial survey, and this engagement carried over into the workshop discussions themselves–producing at times and almost micro-specific level of analysis which seemed to challenge the program facilitator. Interestingly, the more specific the initial literacy statements became (observed in Figure 2), the more broadly the agree-toward-disagree continuum manifested in the reactions. This would suggest that there is broader
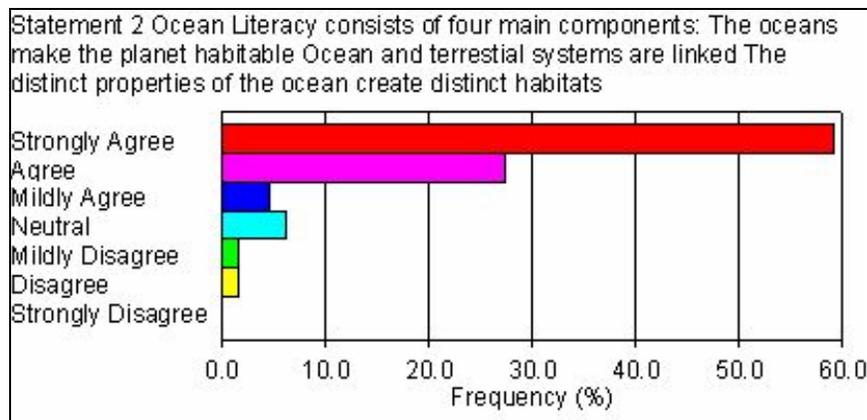

FIGURE 2

agreement at the conceptual level than at the content level for consideration of ocean literacy. This observation continues in the statement regarding ocean literacy and the individual (Figure 3). To the degree this is an accurate interpretation of these data, this observation would possess strong policy implication for future efforts of those engaged in the ocean literacy and ocean science education content/standards discussions.

Statement 3: An ocean literate individual: Has a basic oceanic vocabulary Is able to converse, read, and write coherently, using oceanographic terms in perhaps a non technical but meaningful way Knows
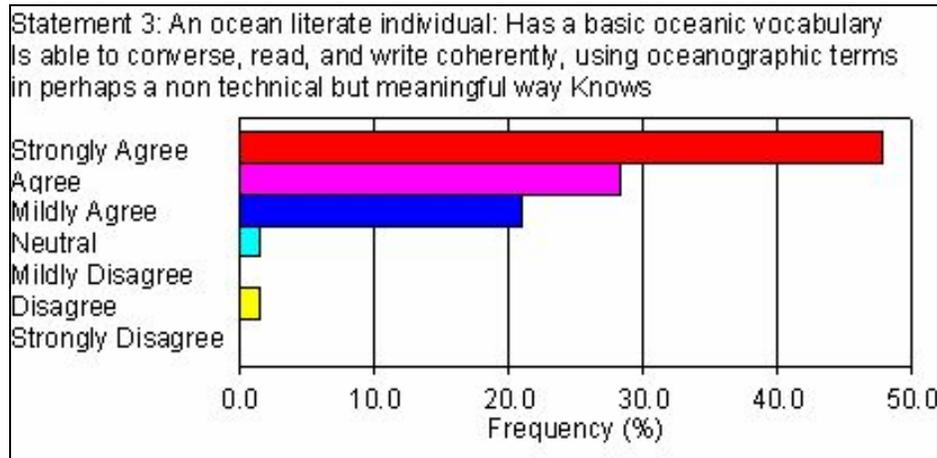
FIGURE 3

Finally, the respondent reactions to the curriculum and professional development questions (Figures 4 and 5 below) diverged in a noteworthy manner, which is further articulated in the narrative responses. There is a perception that adequate materials probably exist to prepare and support teachers' classroom efforts, but a dearth of training opportunities are available to ensure teachers understand the science content to lead serious classroom inquiry in these areas. More problematic, a strong theme emerges from the narrative that while a plethora of materials exist–they are in practical terms not accessible to teachers for a variety of reasons. These reasons include lack of organization along themes, standards, and infused in core curricular areas to facilitate use. With respect to professional development, emergent themes from the narrative suggest that the visibility of existing workshops could be enhanced through better communications structures, but that funding levels for professional development are generally too low to accommodate the large numbers of teachers. Nevertheless, the lack of curricular framework and standards support
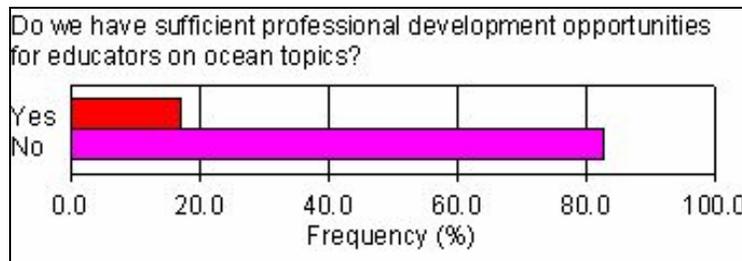

Do we have sufficient professional development opportunities for educators on ocean topics?

FIGURE 4

Are there enough materials and resources available to teach ocean topics to K-12 students?
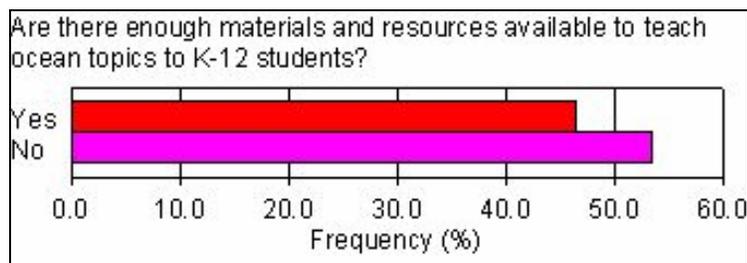
FIGURE 5

for ocean sciences content further serves as an impediment to teacher participation in ocean-centered workshops for many respondents. Finally, it seems clear that many teachers remain disconnected from the ocean science content that is presented through professional development due to lack of motivation, lack of effective communication to increase awareness of available training, or lack of geographically and socio-culturally distributed program offerings.

The workshop post-survey was completed by forty of the participants, or approximately two-thirds of the number who had completed the pre-workshop survey. This decline is expected and typical for similar workshop responses. The post-workshop survey respondents were nearly equally distributed among university faculty (one-third), classroom teachers/informal educators (one-third), and curriculum developers, scientists, and government agency personnel (one-third) (Figure 6). The approximately 31% of respondents who indicated "Other" affiliation beyond the primary categories were subdivided into Other Educators (7.7% of total), Government employees or Scientists (12.9% of total), and Professional Development Organizers (5.1% of total).

Of this group sixty percent are members in the National Marine Educators Association, an entity which continues to emerge as strongly engaged in the various regional and national ocean science education and policy initiatives.
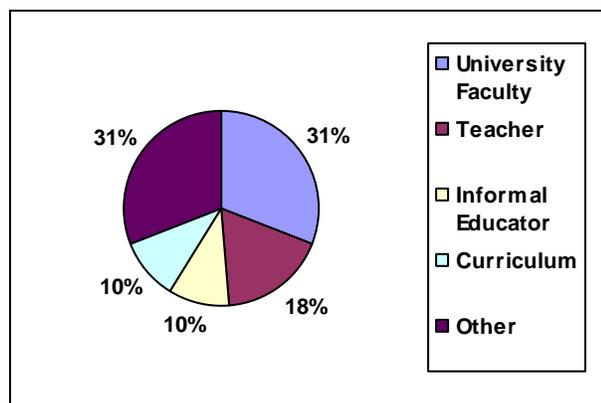

FIGURE 6. Primary work affiliation of respondents.

More than half of the respondents (55%) indicated they engaged with the workshop greater than 10 hours weekly, with 25% of the respondents indicating they engaged more than 15 hours weekly. This observation suggests a strong commitment to
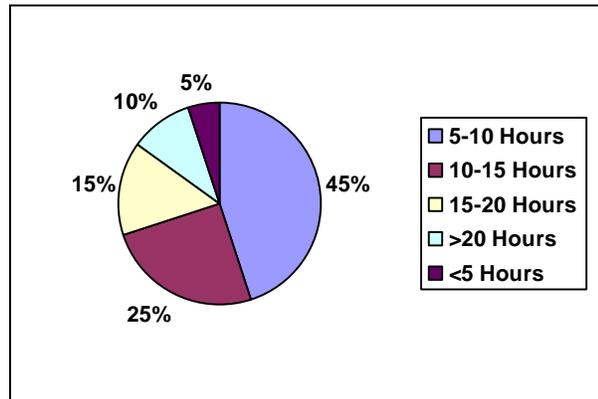

FIGURE 7. Time spent in workshop by respondents.

the success of the workshop and its overarching goals and objectives, as well as the topic area of interest, i.e. ocean sciences education. The overall perception of the respondents to the degree to which the workshop met their goals and expectations is somewhat lower than what the evaluator has typically observed in similar workshops–although still quite high overall, with 70% indicating they Strongly Agreed or Agreed to the prompt. The slight shift down in response to this item seems linked to the open-ended conclusion of the workshop and lack of a concrete product "in hand" at the end of the two week period. It does not appear from workshop organizational materials that there was an intent to produce such a product–therefore the desire to have that should not be viewed as a negative with respect to the workshop success, but as a possible "next step" for the workshop leadership to consider now that the workshop is concluded.

The narrative responses to the survey were numerous and guided by a series of open-ended prompts to solicit overall perceptions of workshop quality, accomplishments, challenges, and structure. Six overall themes emerge from the narrative based on a heuristic comparative analysis process. These will be discussed as follows.

First, the workshop produced a large quantity of appropriate content through linked materials, discussion, and participant postings. The quantity of materials and online postings and responses created a time pressure for participants to fully capture and engage with the discussions. However, this emerging sense of time limitation has been observed in other similar workshops and should be viewed as linked to the nature of the internet–where there will always be a capability of providing more content than is manageable regardless of the

workshop facilitation and timetable. This does, however, lead logically to the second emergent theme.

The second theme from the response narrative is a desire, either in a past tense observation of the workshop or a future desired action step, to have the content of the workshop reduced to written summary or product different from the weekly summaries which were provided to the participants. This theme was expressed with respect to the workshop structure as a desire that the workshop facilitator had more frequently provided "in stream" summaries of the postings and commentary as it emerged, as somewhat of a "morning briefing" to the participants. While this would have leveraged the available time the participants had to engage—it is unlikely such a step could have overcome the natural threats to validity produced through such a system, i.e. the participants would not be reacting to each others comments, but to the facilitator's summary of the comments. This summary would be subject to interpretive bias and would ultimately interfere with the social connectivity of the participants.

A third theme which emerges from the respondent narrative is a desire for continuation of the discussions which began in the online workshop. Whether these continued meetings are preferable online or "face to face" seems secondary to having the conversation continue—although some participants who regularly attend various science conferences offered suggestions that strands be implemented at those conferences. There is a sense that more respondents would be capable of continuing in online format than through face to face meetings based on time constraints and funding.

A fourth theme that emerges is the strong desire to have a tangible product that links the online discussions of a definition of ocean literacy and its relevance to the National Science Education Standards, to a set of concept clusters that would be overarching the entire K-12 continuum, and a set of grade specific content statements which are linked to these broader conceptual renderings, i.e. what does ocean science literacy "look like" at each grade level, with example lessons and prerequisite content understandings for teachers. Such a document could further provide guidance to the professional development needs further explicated in the respondent narrative. This fourth theme is embedded with the fifth theme which also emerges in the narrative—that as positive as the dialog from this workshop and the perceptions of workshop accomplishments were, there is much work remaining to close the gap between the current formulation of ocean sciences education and the level at which other science disciplines are represented in the broader curriculum. This theme seems linked to the necessity of continued work in smaller, grade specific groups of participants who could make progress toward the richer structure detailed above.

The sixth theme which emerges, though with far less narrative, is the size of the workshop seemed large with respect to the perception of involvement of the respondents. The large number of comments and postings, within large group rooms, with limited opportunity for smaller group discussions, was viewed as

sometimes counter-productive. An expressed desire for continuation of the discussion, but in grade specific small-groups, is seen as a possible mechanism to continue movement toward the concrete product desired by many and described above.

The final theme which emerges, and with strong and frequent narrative, is the perception that the workshop was an overwhelmingly positive experience, that it accomplished its primary objectives notwithstanding any of the perceived weaknesses which may have been verbalized by respondents. This sense of accomplishment is paralleled with a stated desire to continue the relationships established through this workshop through follow-on workshops, or other meetings wherein the discussion could continue.

In general, the evaluators conclude, given *participant-perceived* quantity and quality of workshop content, the workshop produced a focused definition for ocean literacy—and *in the view of the participants*, laid the foundation for continued dialog and discussion moving toward a stronger curricular framework in the ocean sciences built around this shared definition of ocean literacy.

Part 6: List of Participants in 2004 Ocean Literacy Workshop

Participants		Institution/Organization
Dean	Allen	Current Publications
Sarah	Bednarz	Texas A&M University
Becky	Bell	Maryland State Department of Education
Rita	Bell	Monterey Bay Aquarium
Wolf	Berger	Scripps Institution of Oceanography
Tina	Bishop	College of Exploration
William	Bragg	College of Exploration
Francesca	Casella	JASON Foundation for Education
Francesca	Cava	National Geographic Society
Valerie	Chase	National Marine Educators Association
Bob	Chen	University of Massachusetts-Boston
Bob	Collier	Oregon State University
Joe	Cone	Oregon Sea Grant
Sue	Cook	Consortium for Oceanographic Research & Education
Beth	Day	NOAA - National Sea Grant Office
George	DeBoer	AAAS - Project 2061
Melissa	Demetrikopolous	Institute for Biomedical Philosophy
Sonya	Dhyrman	Woods Hole Oceanographic Institution
Patricia	Dubose	Camden County High School
Jonna	Engel	NOAA – Channel Islands National Marine Sanctuary
Melissa	Feldberg	Oregon Sea Grant
Rebecca	Fenwick	Scripps Institution of Oceanography
Laura	Francis	NOAA – Channel Islands National Marine Sanctuary
Robin	Goettel	Illinois-Indiana Sea Grant Program
Mark	Gold	Heal the Bay
Margaret	Gorcyca	North East Independent School District
Tom	Greene	Kingsborough Community College
Stacy	Halboth	Rancho Santa Fe Elementary School
Marlene	Hilkowitz	School District of Philadelphia
Dionne	Hoskins	Savannah State University

Liesl	Hotaling	Stevens Institute of Technology
Mike	Hughes	Key Largo School
Atziri	Ibanez	NOAA - National Estuarine Research Reserve System
Beth	Jewell	West Springfield High School
Gabrielle	Johnson	Laguna Blanca School
Dave	Karl	University of Hawaii
Paula	Keener-Chavis	NOAA - Office of Ocean Exploration
Julie	Lambert	Florida Atlantic University
Judy	Lemus	University of Southern California Sea Grant
Mellie	Lewis	Altholton Elementary School
Jerry	Lieberman	State Education and Environment Roundtable
Eric	Lindstrom	NASA - Earth Science Enterprise
Carmelina	Livingston	South Carolina Aquarium
Kate	Madin	Woods Hole Oceanographic Institution
Jaime	Malwitz	Wisconsin Academy Staff Development Initiative
Michiko	Martin	NOAA - National Marine Sanctuary Program
George	Matsumoto	Monterey Bay Aquarium Research Institute
Jean	May-Brett	Louisiana State Department of Education
Andrea	McCurdy	EnterACKed
Janice	McDonnell	Rutgers, The State University of New Jersey
Erika	McPhee-Shaw	Moss Landing Marine Laboratories
Bill	Mott	The Ocean Project
Frank	Muller-Karger	University of South Florida
Dave	Niebuhr	Mote Marine Laboratory
Chuck	Niemeyer	NOAA - Office of Education & Sustainable Development
Chris	Parsons	WordCraft
Mike	Perfit	University of Florida - Gainesville
Al	Plueddemann	Woods Hole Oceanographic Institution
Nancy	Rabalais	Louisiana Universities Marine Consortium
Eric	Reinhard	American Zoo and Aquarium Association
Elizabeth	Rhodes	College of Charleston
Elizabeth	Rogers	South Carolina Sea Grant Consortium

Sarah	Schoedinger	NOAA - Office of Education & Sustainable Development
Margaret	Sedlecky	Weeks Bay National Estuarine Research Reserve
Karina	Serrano	Central Elementary School
Eric	Simms	Rutgers University, The State University of New Jersey
David	Smith	U.S. Naval Academy
Matt	Smith	University of Florida - Gainesville
Susan	Snyder	National Marine Educators Association
Lundie	Spence	South Carolina Sea Grant Consortium
Fritz	Stahr	University of Washington
Bob	Stewart	Texas A&M University
Craig	Strang	Lawrence Hall of Science
Pam	Stryker	Barton Creek Elementary School
Margaret	Tower	Foreman High School
Peter	Tuddenham	College of Exploration
Sharon	Walker	University of Southern Mississippi
Steve	Webster	Monterey Bay Aquarium
Gerry	Wheeler	National Science Teacher Association
Lynn	Whitley	University of Southern California Sea Grant
Allison	Whitmer	University of California - Santa Barbara
Gene	Williamson	National Marine Educators Association
Bob	Wohlers	Current Publications
Gary	Wolfe	Eau Gallie High School and Rollins College

Below is the breakdown of all 92 invited participants by primary area of expertise and/or experience.

Category of Expertise/Experience	n	Portion of Total
Scientific research	24	21%
Policy	22	19%
Education with Science or Policy	19	16%
K-12 Teacher	14	12%
Informal Education	11	9%
Workshop Team	6	5%

Curriculum development	5	4%
Education Program Coordination	5	4%
Outreach/Communications	4	3%
Educational Assessment and Evaluation	1	1%
None identified	5	4%

Note: n is greater than the total because some participants are identified by more than one category

Below is the breakdown of the 63 participants who introduced themselves during the online workshop by area of expertise and/or experience

Category of Expertise/Experience	n	Portion of Total
Scientific research	17	22%
Policy	14	18%
Education with Science or Policy	13	16%
K-12 Teacher	12	15%
Informal Education	9	11%
Workshop Team	6	8%
Curriculum development	3	4%
Education Program Coordination	3	4%
Outreach/Communications	2	3%
Educational Assessment and Evaluation	1	1%

Note: n is greater than the total because some participants are identified by more than one category

Section V: Conclusion and Next Steps toward Ocean Literacy

This report represents the completion and documentation of a multi-phase, national effort to improve ocean literacy. The ocean sciences and ocean sciences education communities were able to come to consensus about what every person should know about the ocean in order to make wise and informed decisions about it and about our future. In so doing, the two communities have also taken great and unprecedented strides toward becoming a single, more unified community. Though we are not naïve about the different worlds and cultures in which scientists and educators live, we are heartened that so many have worked together so effectively on this important issue. We also recognize that the inclusion of scientists in development of educational policy and resources is one that must continue.

Now that agreement has been reached on what must be taught and learned regarding the ocean, we can turn our attention to how to convey this information to a variety of learners, audiences and interest groups that include teachers and teacher leaders, school and district administrators, pre-service educators, professional developers, standards committees, instructional materials developers, assessment specialists, textbook writers and publishers, exhibit designers and informal/free-choice educators.

This emerging voice and consensus on ocean literacy has already become an instrument of change. Demand for the Ocean Literacy brochure has been overwhelming; the first print run has been distributed with a growing demand for more copies. The definition, principles, concepts and alignment matrix are providing a framework for policy changes in several spheres of education both at state and national levels, guiding initiatives by government agencies, museums, aquariums, text book publishers and universities.

There are many activities and tasks still needed. Some are very specific and product-oriented, some are ongoing tasks that are less well defined and process-oriented. There is emerging agreement that several companion documents need to be developed to accompany the Ocean Literacy brochure. These include (in no particular order):

1. Ocean Literacy and State and National Science Education Standards: This document will further elaborate the relationship between the fundamental concepts of ocean literacy and the fundamental concepts found in various standards, i.e., it would explain the meaning of each "x" in the standards matrix found in Section III.
2. Ocean Literacy Scope and Sequence: This document will "unpack" the fundamental concepts of ocean literacy and show how they develop and build across grade spans (K-2, 3-5, 6-8, 9-12). Most of the concepts in the Ocean Literacy brochure are appropriate for the higher grades, but component parts of the concepts will need to be introduced at earlier grades.
3. Teachers Guide to Ocean Literacy: This packet will include the previous two documents plus examples of inquiry-based activities that teachers can use to teach the various concepts.
4. Assessment Item Bank: This data base will include a variety of assessment items for each concept. Item types will need to include: multiple choice, justified multiple choice, open-ended and performance tasks. Items will be made available to state and national test development committees and contractors.
5. Analysis of Existing Ocean Sciences Curriculum Materials: A comprehensive survey of existing instructional materials needs to be done, and the most widely used materials need to be cross-referenced to the ocean literacy essential principles and fundamental concepts. Though many collections of activities and local teacher resource materials exist, there are few "adoptable" ocean science curriculum materials that align to standards, are commercially available, professionally produced, include kits, etc.

There is also emerging agreement that in addition to producing a series of tools or products like those described above, there is a tremendous need to focus on the strategic intervention and influencing of several key activities and events:

1. Development and revision of state standards, starting with science standards.
2. Revision of National Science Education Standards or Benchmarks for Science Literacy.
3. Development and revision of National Assessment of Educational Progress and state assessments and the "content framework" on which they are based.
4. Development and revision of inquiry-based instructional materials to ensure the inclusion of ocean science, e.g., materials developed by, Lawrence Hall of Science, National Research Council, Education Development Center, Biological Science Curriculum Study and TERC.
5. Continually provide professional development to teachers and prospective teachers.
6. Continually provide technical assistance to informal/free-choice educators to assist them in design of exhibits and programs.

Going forward, our greatest strength and greatest challenge, remain the remarkably diffuse, grass roots nature of our "organization." This work is the result of collaboration of dozens of institutions, organizations, networks and individuals. Though there has been tremendous leadership, there is no home for this project, no scope of work, no budget, no personnel assigned to carry it forward. The work, the products, and the decisions about prioritizing next steps are all owned by the entire community involved. This is perhaps not the most efficient means to operate, but in trade, it has resulted in considerably greater consensus. This continued consensus will be increasingly necessary as the challenge of implementation grows.

Section VI: References

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