Preface by Dr. Sylvia A. Earle
Two great truths about the ocean emerged from the 20th century, the first as the result of decades of unprecedented exploration. First, the ocean came into focus as the cornerstone of Earth’s life support system, vital for the survival and well being of humankind and all other living things. The search for life elsewhere in the universe, and for water -- the single non-negotiable thing life requires -- brought new attention to the significance of Earth’s water – 97 per cent of it ocean.

The second great truth was more shocking, and came about as a consequence of unprecedented exploitation. That is, the sea is not infinitely resilient. Only as the 20th century gave way to the 21st did news of collapsing populations of fish, dying coral reefs, the appearance of dozens of massive “dead zones”, increasing toxic algal blooms and proliferation of waterborne diseases begin to awaken an awareness of how vulnerable the ocean is to what we put into in and what we take out.

Though some are keenly aware that our continued prosperity depends on protecting the ocean, there is widespread complacency and indifference, largely borne of ignorance. There is no guarantee that people will care if they know what’s happening, but it is certain that they cannot care if they do not know.

It is vital that human society become knowledgeable about the importance of the sea, about why we should care and about what actions we can take that will enable us to secure a healthy ocean – and a healthy future for ourselves. Ocean literacy is the key. Francesca Cava, author of the following article, offers solutions to the challenges of communicating -- and transforming the way people think about themselves and the ocean. She has said, “Give us one generation. We can develop a new ethic, an informed, knowledge-based ethic that will inspire new ways of taking care of the ocean – that takes care of us.”
Introduction

Over 100 years ago, the National Geographic Society brought to life the importance of National Parks for the American people through its dramatic photography, stories and exploration of these national treasures. Today, the Geographic is seeking to use its multi-media reach to expand its role to improve worldwide conservation through its education and exploration projects. A major focus of this conservation initiative has been to partner with the National Oceanic and Atmospheric Administration (NOAA) and others to promote the importance of the ocean and its role as our "life support system."

One of the biggest challenges of ocean conservation is the general lack of understanding by the public of basic fundamentals relating to the ocean. This has occurred in part because the National Education Standards at the K-12 level do not include the oceans as required areas of study.

This omission has resulted in a dearth of marine-focused textbooks and little incentive for teachers to routinely include ocean topics in their classes. Paradoxically, studying the oceans is, by definition, an inherently interdisciplinary process that integrates the physical and natural sciences with environmental, social, cultural, historical and policy issues. Incorporating ocean content into the classroom has the dual benefit of providing a way to make complex topics more easily understood as well as providing fundamental knowledge that everyone should know about life on Earth.

The challenge, however, is communicating this information to the education community in an effective and meaningful way, and, in the context necessary to allow its formal inclusion in the classroom. Teachers can be easily overwhelmed by the quantities of data available and may not have the time or expertise to use raw data sets that are available on the Web. They also may not have the tools to link ocean content to the requirements set by current testing protocols or education standards. As a result, most high school graduates do not know the fundamentals of how the ocean affects every part of their life, from weather and climate, to food and other essential resources, to cleaning the very air we breathe. Nor are high school graduates prepared to cope with the growing societal issues, such as marine resource sustainability and management, global change, and increasing ocean pollution that face our country’s citizenry.

In 1994, the National Geographic Society developed Geography for Life: National Geography Standards 1994. This two-year effort acted as a "vital contribution to the achievement of the goals enunciated in the Education America Act that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our Nation’s modern economy..."1 Using Geography for Life as a model, the Geographic and NOAA have launched an effort to identify ocean concepts that should be used in the Scope and Sequence for geography standards. The goal of this effort has been to infuse the national geography standards scope and sequence matrix with

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ocean content to illustrate how information on the ocean can be included in the classroom. Infusion of ocean content into national standards is also aimed at integrating multiple disciplines such as science and geography.

**Linking the Ocean to National Geographic Standards.**

A virtual Ocean Literacy Conference was convened from January 14th - February 1st, 2002, to begin the process of linking ocean content to geography standards by using a scope and sequence matrix developed for these standards. This three-week conference used Internet-based technology to convene 30 educators and scientists to discuss how to bring ocean literacy into the schools and how to tie an ocean curriculum to existing national geographic standards. The entire conference has been archived on-line for future research and reference.

Francesca Cava, conference director, identified the following conference goals:

1. To identify the "scope" of ocean content that should be taught in our schools.

What should every high school graduate in the United States know about the importance of the ocean to our life on earth? How should that information be "sequenced" through elementary, middle and high school to allow a learning experience that is threaded throughout the pre-college experience?

2. To determine how to "map" those topics into the national geography standards.

The National Geographic brochure entitled *Path Toward World Literacy - A Scope and Sequence in Geographic Education K-12* served as a guide for the process. The mapping of ocean content to national geography standards is essential to insure formal inclusion of ocean content into our educational system.

An on-line video theater set the stage for the conference through a series of thought-provoking interviews on the relevance of the ocean to our daily lives and why ocean topics should be part of our education system (see sidebar).

**Creating a Scope and Sequence in Geographic Education Focussed on the Oceans**

The most tangible result of the three-week conference was development of a draft matrix that divides ocean topics by grade level, each mapped to the six geography components, below. This draft matrix is currently under review; however, it reflects the personal thoughts and practical experience of conference participants committed to the importance of the oceans in today’s education curricula.

The six "essential elements" of geographic education are:
Essential Element 1: The World in Spatial Terms. Geography studies the spatial relationships among people, places, and environments. Maps reveal the complex spatial interactions that touch the lives of all citizens.

Adm. James Watkins, Chair, National Ocean Policy Commission
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 National Ocean Policy Commission
“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 current Chair of the Pew Charitable Trust Ocean 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, Under Secretary of Oceans and Atmosphere and Administrator of 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 the NOAA 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.”

Today, air and water pollution and the management of solid waste and hazardous materials are serious problems. The physical environment affects human activities as
well. Soil types and water availability help to determine which crops will prosper. More dramatically, natural hazards (e.g., earthquakes, hurricanes, and floods) have resulted in substantial loss of life and property.

Essential Element 6: The Uses of Geography. Understanding geography content and how to use the tools and technologies available for geographic study prepares citizens for life in our modern society. Individuals, businesses, and government entities use geography and maps of all kinds on a daily basis. Geography students have a wide choice of interesting and rewarding career opportunities.

A partial section of this matrix is included below to illustrate how ocean content can expand topics included in the original scope and sequence matrix to enrich both the teaching and learning environments. Space limitations preclude printing the entire matrix here, but it is available from the author by request. Current plans are to complete a “final” version of this matrix by early 2003.

Content of Grade 9-12 Program for Element 1, “The World in Spatial Terms”

<table>
<thead>
<tr>
<th>Original Scope of Geography Element</th>
<th>Additional Oceans Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Map, globe and atlas use (e.g., observing and analyzing relationships)</td>
<td>• Mapping skills (e.g., observing and analyzing ocean relationships)</td>
</tr>
<tr>
<td>• Expanding locational technology (including remote sensing, GPS, GIS)</td>
<td>• GIS/GPS skills (e.g., using technology to map local watersheds, to understand distribution of biomass, changes in shorelines, animal migration)</td>
</tr>
<tr>
<td>• Map projections for specific applications</td>
<td>• Use of other ocean measurement technology (e.g., underwater acoustics to measure global and physical parameters)</td>
</tr>
<tr>
<td>• Location/allocation situations (e.g., the best location for a fast food outlet and the extent of its market area, the best location for a hospital and the area it serves.)</td>
<td>• Vertical mapping, zonation patterns and the physiochemical characteristics of the ocean (e.g., oxygen minimum layer, calcium carbonate)</td>
</tr>
<tr>
<td>• Mental maps and spatial relationships</td>
<td></td>
</tr>
</tbody>
</table>

One of the main refinements necessary to hone the draft matrix is to clarify the placement of select topics. The topic of ecosystems, for example, should be covered in Physical Systems as a system; if the characteristics of ecosystems and their description were the foci, the subject would be part of Places and Regions. Biomes would be best approached through Physical Systems. Also, the matrix needs a student focus rather than being descriptive of curriculum or an activity.

Some of the specificity necessary in the matrix involves clarifying which grade level is most appropriate for a particular topic or making the topic more specific. For example, Global Positioning Systems/Global Information Systems (GPS/GIS) appears for grades 6-8 and grades 9-12 of the draft matrix in “The World in Spatial Terms.” Fisheries topics appear for grades 9-12 in both Human
Systems and Environment and Society. Further reflection is needed to add more specificity to a topic or move the topic from one grade level to one that is more appropriate within the existing curriculum. Furthermore, specific grade level decisions are probably best made by individual educators based on state standards and curricula.

Reviewing the draft matrix will allow educators to attain another important goal of the Ocean Literacy Conference—how to best sequence information through the grades so that a topic is woven through a student’s entire K-12 learning experience. The watersheds concept may be introduced in Kindergarten, for example, and enhanced appropriately to the other grade-level learning each successive year.

Consensus Findings Identified During the Conference

The web-based format of the conference over a three-week period, facilitated an immense amount of discussion among participants across time zones and at any time convenient to the participants. Some of the highlights of these comments included:

- The consensus of the first week of the Ocean Literacy conference was that participants should focus on pinpointing concepts to be taught rather than compiling a laundry list of points to be included. Perhaps broad and general topics can be used as unifying strands across grade levels. Understanding relationships is particularly important at the high school level. A first step is to start with linking ocean content to the National Geographic Standards and the National Geographic Society Scope and Sequence matrix.

- The K-4 group agreed that what is taught about the ocean needs to be connected to what is already taught, “weather” as an example. Some existing topics in the National Geographic Scope and Sequence matrix are ocean related. Others, like weather, are so closely related that it would be a simple matter to include an ocean module. To build an ocean matrix we need to note the ocean-related topics in the Geographic matrix, determine other ocean-related topics that need to be covered, and identify how to bring them into the classroom.

- Many good resources exist to foster interdisciplinary study of the oceans, but they are not found in any one place and teachers now must be resourceful. The oceans need a committed sponsor, in the same way as NASA has been the driving force for space related education.

- One participant emphasized the value of the conference in saying “It helped me to appreciate the challenges and difficulties encountered when gathering, combining and integrating the content of one field into a pre-defined structure designed to accommodate the content of a different, but related field.”

Additionally, it was noted that in order to develop a realistic Scope and Sequence matrix, educators must distinguish between knowledge statements—what
students should know, skills—what students can do, and integrated knowledge and skills—what students know and are able to do. Participants discussed various ways to present ocean topics in classes and developed numerous activities to enhance learning. For example, they suggested creating maps of the ocean floor using a sonar technique and the speed of sound to discuss bathymetry. Teachers stressed the importance of using the scientific inquiry process in the classroom. Having students ask questions and develop hypotheses has resulted in stimulating their interest and lends itself to learning about the ocean. Participants agreed on the need to align the ocean literacy content determined in the conference with the Geography Scope and Sequence and the Benchmarks for Scientific Literacy. Participants look forward to developing specific benchmarks from the ocean sciences content to measure knowledge of specific concepts at strategic times.

In overview, participants agreed that to be “ocean literate” pre-college graduates should:
- Be aware of issues concerning the usage and sustainability of the oceans as a finite resource;
- Be cognizant of both global and local environmental issues and the interconnectedness of all species;
- Be knowledgeable of technological impacts on oceans.
- Be able to diagram ocean problems, policies, and issues.
- Be aware of the importance that oceans serve in our daily lives.
- Be knowledgeable of the enormity and complexity of oceans.

In an end-of-conference survey, conference participants indicated the virtual experience was extremely valuable and that they would be interested in continuing this type of interesting technology-enriched experience. Although the “time factor” between comments and responses was sometimes noticeable, everyone appreciated the on-line format because it allowed educators from varying time zones to participate cooperatively, and also allowed time on the weekends or in the evenings for response.

The following instructional strategies were collectively suggested to enhance ocean literacy:
- Preparation of a kit for teachers that would include "hard copy" lesson plans,
- Providing on-line activities accompanied by an expert who could answer questions, and,
- Teaming classrooms located geographically near oceans with landlocked classrooms so students and teachers could share experiences.

Next Steps in Promoting Ocean Literacy

Participants enthusiastically endorsed the need for continued work in promoting ocean literacy to follow on from this outstanding initial conference. Specific recommendations for future efforts included:
• Co-alignment of ocean literacy content gathered in this conference to both the National Geographic Scope and Sequence matrix and the Benchmarks for Science Literacy;
• Development of benchmarks developed from ocean content and identification of specific concepts a student should be expected to know at the end of each grade or grade cluster; and,
• Development of Ocean Literacy Performance Indicators.

In order to further promote further discussion on ocean literacy, the results of this conference, along with the draft ocean matrix, will be presented at the following conferences:

• July 22-26, 2002: National Marine Educators Association Annual Meeting, New London, CT
• October 16-19: National Council for Geography Education, Philadelphia, PA
• October 24-27, California Science Teachers Association Annual Conference, San Francisco, CA

A new virtual teacher workshop series is also planned for January 2003. The National Geographic Society’s Geography Education Foundation and NOAA’s Office of Exploration will co-sponsor a yearlong series of on-line interactive teacher workshops, entitled Classroom Exploration of the Ocean (CEO). CEO will provide materials and instruction for K-12 teachers using the excitement of ocean exploration to identify how ocean content can enhance learning in the classroom. Drs. Sylvia Earle and Bob Ballard, Society Explorers-in-Residence, will introduce these workshops and provide inspiration to hundreds of teachers on the importance of ocean education. Teachers will also meet other scientific experts who will interact with them by giving on-line presentations on ocean exploration topics. An open dialogue of questions and answers will be provided for an exchange of ideas.

This series will be based on Sylvia Earle’s "Atlas of the Ocean Teacher’s Guide" and promote the ocean matrix linked to the geography scope and. CEO will also draw on dramatic video images drawn from National Geographic television series, such as the "Shape of Life." These images combine both cutting edge scientific research with blue-chip natural history filmmaking and photography. New cinematic techniques can reveal the bizarre and often surprising details of life around us—bringing to life secrets from the ocean that few can ever see first hand and allowing us to better understand the astonishing diversity of plants, animals and other organisms that live in our oceans.

**Conclusion**

Increasing accessibility to ocean content for teacher’s use in the classroom has multiple goals and potential benefits. It will help teach complex topics in a way that captures students’ imagination and enhance learning. It can integrate topics such as science, geography, history, and others. It can provide a portal for introduction of cutting edge science and technology into the classroom.
Through development of a "Scope and Sequence in Geographic Education related to the Oceans" we will also be able to begin to look at the big picture of marine education in the United States. Currently, there are many local, regional or topical centers of excellence on ocean topics. But these programs are rarely linked to each other and do not consider the entire scope of knowledge students need to know and understand by the time they graduate from high school. Additionally, many programs offer teacher or student activities on popular subjects such as coral reefs, for example, but do not address the full range of ocean topics that would give full comprehension of the subject. Lastly, without a complete understanding of what should be taught about the oceans, textbook publishers and others cannot provide the educational support needed to meet the needs of ocean literacy.

Teachers are the change agents for our society and can ultimately bring about a next generation of ocean literacy if ocean content is infused into national education standards and teachers are given the tools and training to implement new curricula. The National Geographic Society and NOAA are partnering to achieve some first steps to improve ocean literacy in our country and seek the input of teachers and other professionals nation-wide to help us with this effort.

In closing, Dr. Sylvia Earle sums up our need to reach our goal for ocean literacy when she states, "The ocean is vital to life on Earth, including the survival and well-being of humankind. Pollution and large-scale extraction of wild creatures in recent years are causes for concern, but as we understand more about the ocean, we will be better able to take care of the natural systems that ultimately take care of us."  

Acknowledgements

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Junior High), George Matsumoto (Monterey Bay Aquarium Research Institute), Sarah Schoedinger (Consortium for Ocean Research and Education), Paul Spring (Grants Pass High School), Peter Tudenham (College of Exploration), Sharon Walker (Outreach Institute of Marine Science), and Lynn Whitley (University of Southern California Sea Grant).

The keynote speakers, Mr. Gil Grosvenor, Chairman of the National Geographic Society; Admiral James Watkins, Chairman of the National Ocean Policy Commission; Dr. Sylvia Earle, National Geographic Society Explorer-in Residence; Dr. Robert Ballard, Founder of the Jason program, National Geographic Society Explorer-in Residence and Member of the National Ocean Policy Commission; Mr. Leon Panetta, former Clinton White House Chief of Staff, California Congressman, and current Chair of the Pew Charitable Trust Ocean Commission; Dr. Marcia McNutt, Director of the Monterey Bay Aquarium Research Institute; Admiral Conrad Lautenbacher, Under Secretary of Oceans and Atmosphere and Director of NOAA; and Mr. Dan Basta, Director of the NOAA National Marine Sanctuary Program, are also gratefully acknowledged for their personal views on the needs for ocean literacy.

References
