Public Ocean Literacy

Making Ocean Science Understandable

The results of a Workshop Organized & Facilitated by the Aquarium of the Pacific's Marine Conservation Research Institute

Co-sponsored by:

- **Consortium for Oceanographic Research and Education**
- **NOAA Coastal Services Center**
- **NOAA National Marine Fisheries Service**

March 15, 2006
MCRI Aquatic Forum Report
Reference Number 2006-2

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Contents

** Throughout this report, the terms "key concepts" and "sub-concepts" have been used based on the original publication of COSEE-NMEA's developed "Key Concepts: What People Need to Know About Ocean Sciences." The College of Exploration's publication refers instead to "Essential Principles and Fundamental Concepts". As used in this report, key concepts should be taken to mean the same as "essential princples"; and sub-concepts the same as "fundamental concepts".*

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The participants who came together from many disciplines, organizations, and agencies to identify and describe strategies, programs, and techniques that could take place in informal or free-choice learning centers to develop an "ocean literate" public.

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Introduction

Societies worldwide are in the midst of great change, directly tied to the shifting of world economies from ones that are industrially-based to information and knowledge-based. The learning strategy of choice for many people will be free-choice learning: self-directed, voluntary, and guided by individual learners' needs and interests.

– Lynn D. Dierking, Jessica J. Luke, Kirsten S. Büchner
International Journal of Technology Management (IJTM), Vol. 25, No. 5, 2003

As a society we need to recognize and support the vast, important and successful learning enterprise that takes place outside of schools and the workplace—learning from museums, libraries, the Internet, television, film, books, newspapers, radio and magazines. Collectively, these experiences encompass what is known as the "free-choice learning" sector.

- Institute for Learning Innovation

In the past several years a number of reports about the ocean and its problems and surveys on environmental literacy have pointed out that while people love the ocean, many neither know much about it nor believe that their actions affect its health. The U.S. Commission on Ocean Policy (USCOP) and the Pew Oceans Commission reports state a need to broaden ocean education and awareness at all levels of society from pre-schoolers to senior citizens so that, whether they live on the coast or in middle America, all will understand the impact the ocean has on them and the impact they have on the ocean. The goal—an "ocean literate" public. Ocean literacy is defined by the National Science Foundation's Centers for Ocean Sciences Education Excellence (COSEE) and the National Marine Educators Association (NMEA) as "understanding the ocean's influence on you and your influence on the ocean".

What ocean science does the public need to know and understand and what are the best strategies and methods for turning the science into messages and stories that make it not only memorable and understandable to the audience, but also result in stewardship of the ocean?

First, the science

In June 2005 a partnership between The Consortium for Oceanographic Research Education (CORE) and the Aquarium of the Pacific brought together 42 scientists to develop the first summary of what they thought the southern California pubic should know to be "ocean literate". In contrast to the K-12 target audience of COSEE and NMEA and most other programs, the focus of this workshop was pre-schoolers through senior citizens—the general public. The outcome of the workshop, a workbook titled, *Public Ocean Literacy: What Residents of Southern California Should Know*, was based on the key concepts developed by COSEE and NMEA. These were adapted and modified for the general public "learners".

Second, translating the science into understanding

In October 2005 the Aquarium of the Pacific held a follow-up workshop for informal science educators from aquariums, nature centers, museums, national wildlife refuges, media, etc. The focus of this workshop, sponsored by NOAA'S National Marine Fisheries Service, and supported by CORE, and NOAA's Ocean Services Center, was to use the output of the scientists' workbook to identify and describe the best strategies, methodologies, and modern technologies that would engage the public in wanting to learn about the ocean, come to understand it, and embrace stewardship of it.

The participants were divided into groups based on areas of interest and expertise: exhibit designers, informal science educators with expertise in onsite education and those with expertise in the use of outdoor experiences as learning strategies, ocean communicators (media specialists), and web designers. Their assignment was to develop models for conveying ocean science into messages and stories that would engage, motivate, and empower the general public into caring for the ocean. This workbook is the outcome of their efforts.

Why the focus on informal science educators?

John Falk has stated; "Learning is not a destination, but a lifelong journey, and we need to provide the best journey possible. However, that journey cannot, and should not, be limited to a stop-over in one educational way station—the schools—no matter how much time, money, and effort we invest in making that way station better." Dr. Falk has also said that 90 percent or more of a person's life is spent outside of school and "informal" or free-choice learning makes up a much larger share of what people know than formal schooling does.

Free-choice learning is learning that takes place when people choose what to learn, where to learn, and with whom to learn, for example, at an aquarium, museum, nature center, or on a guided beach walk. Collectively, these U.S. free-choice or informal learning centers attract nearly 100 million visitors each year. Just as formal educational institutions teach, free-choice institutions, and therefore, informal science educators, also "teach". While formal science education is based on national, state, and city based standards, visitors to informal education centers have opportunities to make their own choices about learning. Free-choice learning centers provide them with these opportunities that are developed by informal science educators.

Next steps

Each of the workshop groups concluded its report with recommendations. Action is already taking place on some of them. It is important to point out that, because of time constraints, each chapter of this workbook is the outcome of separate disciplines. The next effort needs to bring together representatives of the various groups as one to develop a model, key concept-based program that is a total package for reaching out to the general public. It should include storylines and messages, educational objectives, exhibit and web designs, media communication, and evaluation methodology—a challenging, but do-able step.

Several of the workshop groups recommended regional workshops on ocean literacy. On June 7-8, 2006, the Aquarium of the Pacific will organize and host a west coast regional workshop, one of five regional meetings that are to be held in conjunction

with the Washington, D.C. national Conference on Ocean Literacy (COOL). The conference is sponsored by NOAA and other federal partners. The regional groups will receive the programming from the national conference in real time. Their challenge will be to take the national messages and:

- Explore what they mean at the regional level, identifying opportunities and obstacles, and,
- Make specific recommendations to enhance ocean literacy of the general public and K-12 students and teachers.

Exhibits:

Images, Impressions, and Hands-on Interaction with Ocean Science

The works of artists and the didactic demonstrations of scientists and engineers combine to do more than show the sights. They alter, each in a characteristic mode, the way in which individuals perceive both their past and future experiences, and they make people aware of aspects of their surroundings that they have either learned to ignore or never been shown how to see.

– Frank Oppenheimer

The Exhibit Medium

Exhibitions have long been admired for their capacity to immerse the public in scientific, historical, and cultural subject matter and engage them directly with the material through hands-on interaction. The power of exhibits lies in the exhibit team's[1] ability to combine various kinds of perceptual, cognitive, and affective experiences as storytelling devices. Effective exhibitions provoke curiosity, raise questions, and provide information within an interpretive context that suggests meaning and helps visitors see the world in new and unexpected ways. Exhibits about the natural world have the potential to help people make personal connections to subject matter and may encourage environmental understanding and stewardship.

The exhibit team's goal may be to disseminate specific information or to engineer gestalts that inspire further inquiry. These two goals are quite different from each other, and they define the boundaries of a broad range of possible outcomes. Exhibit media are equally wide-ranging: from text to graphic images, sculpture, artifacts, lighting, video and animated programs, audio, digital interactive media, interactive machines, low-tech devices, immersive environments, live specimens, live presentations, and more.

1. For the purpose of this discussion, an exhibit team can include any number of players including an exhibit designer, exhibit developer or curator, evaluator, educator, and/or project manager to name a few. In the case of aquariums and zoos, animal care and life support staff would be additional team members. It is this team that is charged with the development and design of the exhibition.

Museum research indicates that hands-on interaction with exhibits and the ideas they express requires the kind of personal commitment on the part of a visitor that can lead to long-term retention and meaning-making experiences. Retention, and even actions that are based on new learning, are often goals and measures of an exhibition's success, yet exhibits are broadly varied in their selection of media. Combinations of interactive and non-interactive media are often used to create and enhance learning environments, emphasize important themes, establish lasting impressions, provide avenues for in-depth exploration, and accommodate a variety of different interests and learning styles.

There are no uniform solutions to effective exhibit development. Context; association with other experiences at or near an institution; pre- and post- visit curriculum at schools; family and social interactions at the exhibition; visitor background, knowledge, and preconceptions; and many other factors influence the exhibit experience. However, a set of guidelines can be developed to focus and facilitate ocean literacy exhibit development. This chapter will present such guidelines and offer several exhibit design concepts to illustrate their relevance.

Exhibit Types and Potential Venues

A fundamental distinction can be drawn between live exhibits, such as those found at aquariums and zoos, and those that do not involve living animals or

plants. Both types may be interactive, but in somewhat different ways. In the case of live exhibits, visitors may seek interaction with the animals and with their co-visitors, creating the same kind of personal investment sought by exhibit developers of non-living interactive science exhibits.

Exhibit venues can be varied. While live exhibits are found primarily at aquariums and zoos, non-living exhibits are developed for wide-ranging applications, including museums, interpretive centers, science centers, corporate visitor centers, commercial spaces (airports, shopping malls, etc.), and outdoor public spaces (parks, nature trails, seashores, etc.), and, of course, aquariums and zoos. Mobile "exhibits on wheels" can extend public outreach to include schools, festivals, fairs, trade conferences, and sporting events.

While exhibits are often thought of as stand-alone, visitor-actuated learning tools, many exhibits are also used as props or teaching tools by presenters of public programs. Defining the primary venue is an important aspect in developing effective and logistically practical exhibits.

Public Audiences

The public audience, as defined here, means everyone who is interested in attending an exhibition. Audiences include individuals (teens and adults), organized groups (tourists, seniors, and special interest groups), school groups of all ages, couples, multi-generational informal groups (families and groups of friends), and those with special needs (physically/mentally challenged, non-readers). These diverse audiences may experience exhibits in different ways.

The public also includes many different cultures, each with its own unique patterns of social interaction and relationship to exhibitions and exhibit technology. In fact, the efficacy of exhibit media, everything from interactive computer technology to text, is affected by differences in culture, age, and level of education. Designing for such diverse visitor demographics may lead to exhibitions that minimize text and avoid complicated interactions with software, yet another approach might be to include a variety of different media that target specific segments of the public.

Visitor Behavior at Exhibitions

An exhibition is not usually a linear medium. Many research and teaching scientists struggle with this single and very important characteristic. Unlike films or lectures, exhibits invite visitors to explore and learn in voluntary ways, paying attention when, where, and for how long they wish, and assembling ideas into more complex concepts if and when they please. A visitor may be drawn to the crowd at one exhibit piece or shy away, possibly returning later or simply moving on.

This non-linear characteristic gives exhibits much of their basic power. Through voluntary exploration visitors can choose to learn and, in many cases, make personal connections with scientific and environmental stewardship issues. Yet, the exhibit developer's desire to layer ideas sequentially in order to express or help visitors understand a body of material is often mitigated by visitor behavior. Layering ideas sequentially is possible in some instances given careful planning and design, but the outcome is seldom predictable. In fact, while some of the nation's leading informal science institutions develop exhibits around complex stories, others expressly prefer to let visitor understanding "bubble up" through each individual exhibit phenomenon. The former approach may direct visitors toward a specific body of understand-

ing, whereas the latter invites visitors to explore more freely. Many exhibit teams blend these two approaches. Defining a preferred approach to ocean literacy exhibits at all institutions is beyond the scope of this report, but developers should consider the tradeoffs inherent in either approach.

Streakers, Strollers, and Studiers

The streaker-stroller-studier typology of visitor behavior accounts for differences in pace and attention span among visitors. **Streakers** move quickly through exhibitions, scanning for points of particular interest, but rarely lingering for long. Since they pay little attention to details, they may form broad impressions or take in bold messages, or they may traverse an exhibition without being affected at all. **Strollers** move more slowly, paying more attention or less at various places. They are exposed to many more basic messages, and they may pick up details here and there. **Studiers** are conscientious and diligent exhibit visitors who move very slowly through a gallery, trying everything and reading all of the text. Studiers often linger at single exhibits for long periods of time.

Designing with all three behaviors in mind is an effective way of parsing high priority messages out of a topic. Streak-level messages or exhibits are those that the exhibit team believes everyone should absorb, no matter what else they may notice. Consequently, streak-level messages deserve the kind of prominence in design that will make their presence inescapable. Study-level messages can provide additional details to satisfy a more diligent audience. Of course, any given visitor may express different behaviors at various times, perhaps streaking through a gallery for orientation before selecting places to stroll or study, or streaking past some exhibits and stopping at other points of interest.

Social Interaction

A fundamental form of interactive learning is conversation. In exhibitions, interaction among family members, friends, or other social groups often enhances and helps personalize learning. Unlike conversations with on-site technical experts or volunteer/docents, interactions among visitor groups are inherently exploratory and seldom passive. Some of the most successful exhibits allow friends and family members to interact simultaneously, yet independently side-by-side, such that participants talk about the content and encourage one another to try new ideas.

A slightly different dynamic takes place in multi-generational groups. When computer-based interactive technology is combined with graphic images and printed text, teens and younger children tend to engage the technology and ignore the text, while adults tend toward the opposite behavior. Within family groups, children, teens, and adults often talk about different aspects of an exhibit with one another.

Science Exhibits at Aquariums and Zoos

One might think of aquariums and zoos not as places people visit primarily for science education, but as places visited in order to see and interact with and around animals, many of which seem exotic, scary, or beautiful. It is not entirely clear to what extent the public seeks science education at these institutions, or whether useful generalizations can be made about the role of science education at all aquariums and zoos. That said, many such institutions recognize their unique opportunity to help the public learn how wild species interact with humans and increasingly depend on human decisions for their own survival. This awareness is reflected in their exhibits.

Zoo and aquarium design has enhanced public interaction with live species dramatically in recent decades. Many institutions feature larger, more natural looking habitats and give visitors more dramatic perspectives from which to view than ever before. Opportunities for visitors to appreciate and feel affective connections with the animals are extraordinary in some facilities. As a result, the presence of live animals can create attractive environments in which visitors may be encouraged to experience other types of learning and interact with ocean science issues.

The appeal of live species also poses important challenges for exhibit teams. Animals are the stars of the show. They are great hooks for learning, but they are also very appealing distractions that may keep visitors from interacting with non-living science exhibits. If non-living exhibit elements are interspersed unobtrusively with live elements they risk not being noticed. If they are placed where they can't be missed, they may obscure or interfere with the affective view of the live exhibit. This conundrum is often encountered in regard to placement of text and photos interpreting the live exhibit, and extends to decisions about placement of computer interactives and other related exhibit elements or activities. As a result, evaluating how visitors interact with living and non-living exhibits becomes a significant part of the development and design process for aquariums and zoos.

Interactivity at aquariums and zoos is largely interpersonal. Visitors talk with their cohorts, observing, and exploring live exhibits together. Exhibit teams may be challenged to present physical and biological systems, individual phenomena, and/or other messages in ways that visitors will notice, interact with, and remember when interaction with the live animals is already very compelling. For example, time-consuming, in-depth interactive science exhibits might not work effectively if they are located in galleries that are already dominated by engaging live species exhibits. Even so, the presence of marine species in such institutions combined with an institutional focus on environmental stewardship makes these institutions critical and lively venues for ocean literacy education.

A number of different approaches might be considered when integrating non-living ocean science exhibits with live animals. For example, a variety of live species may present opportunities to relate engaging stories about their life histories, migration patterns, ecosystems, and much more. Different types of information, such as information about related species, ranges, or positions in food chains might be presented in consistent ways throughout an institution to help visitors orient themselves and map their learning.

The Public Ocean Literacy Report includes materials that can provide a basic orientation to the scope of the ocean and animal habitats, in addition to in-depth information about many complex systems and other topics. Exhibit teams are challenged to consider what kinds of information and experiences can be combined with live exhibits effectively, what types of exhibits might be appropriate for common spaces outside of themed galleries, and whether some topics are best suited for exhibition in galleries that do not feature live displays.

Potential Strategies for Institutional Implementation

Considering the relatively high cost of exhibit development, design, and production, some institutions may be challenged to make ocean literacy a priority in the near future. Unlike public education programs and mass media outreach, new exhibits invariably

require financial investments to build robust products for the gallery floor. Consequently, this report recommends a three-tiered approach that can help institutions incorporate ocean literacy content incrementally through ongoing exhibit development programs.

Retrofit Existing Exhibits

Many existing exhibits, whether live or otherwise, can be re-purposed or enhanced to convey ocean literacy themes and science content. Exhibit development may be limited to written labels and graphic images, or replacing video programs with animations that are available through public sources, such as NOAA, NASA, and USGS. Appropriate integration of new content into existing exhibits takes the context of those displays into account so that the new and existing components complement one another.

Complementary Exhibits

New exhibit components may be added to existing exhibits in a complementary manner. For example, the addition of a video monitor showing El Niño oscillations, plus supporting graphic images and text, might enhance an existing live display of species that are impacted by surface temperature changes in the equatorial Pacific. If species populations fluctuate with El Niño or animal populations migrate in search of food due to the temperature oscillations, such information might help visitors appreciate the global environmental impact of this recurring climate phenomenon.

New Exhibitions

Entire exhibitions might be created around ocean literacy content. Many topics in the Public Ocean Literacy Report are sufficiently complex to warrant such focused efforts. Traveling exhibitions, for example, might be developed about various ocean literacy themes, such as climate, regional ecosystems, food chains and the food supply, etc. Such exhibitions might be conceived as either stand-alone attractions or as re-development efforts for existing thematic galleries in aquariums and zoos.

Development Costs

The relatively high cost of exhibit development, design, and production can be mitigated in a variety of ways. At the higher end, mass-market computer gaming technology and software are dramatically reducing the cost of creating interactive exhibits that visualize or manipulate authentic data. On the other hand, the cost of producing mechanical interactive demonstrations continues to be driven by engineering, prototyping, and manufacturing costs for novel inventions. Since such efforts, although appealing, are not always needed to encourage effective learning, this report will demonstrate how a story can be told at three different cost points.

Low-Cost Exhibits

Simple, low-tech interactive devices, graphic images, and text can be produced relatively inexpensively. Low-cost does not necessarily exclude interactivity, nor does it preclude accurate representations of the science. Rather, resources can be focused on presenting authentic content through engaging, but simple tools.

Mid-Cost Exhibits

Technology varies widely at the mid-cost point because the cost of computers and mass-market software put interactivity within almost everyone's

reach. Earth imaging and mapping tools are readily available through public domain sources, and custom animations can be developed relatively inexpensively. Technology and interactivity vary in the mid-cost range, especially as technology is combined with simple mechanical devices, graphic images, and text. As with all interactive exhibits, access to the media does not ensure good results. Great care is required to design interfaces that help visitors interact and learn.

High-Cost Exhibits

Immersive environments, state-of-the-art interactive technology, custom video programs, enhanced lighting, object theaters, and unique mechanical devices become available at the high end. High costs are often driven by the need to prototype, test, and engineer novel machinery for exhibitions. Yet incorporating some of the same off-the-shelf tools used for mid-level exhibits allows developers to create more comprehensive and persuasive themed environments.

Ocean Literacy Exhibit Concepts

The Exhibit Development Process

Exhibit development and design is an inherently messy, iterative process in which concepts are proposed, designed, tested on target audiences, retooled, prototyped, engineered, fabricated, and then evaluated again. While often high, production costs are only one component in the overall process. Exhibit development and design includes establishing goals and project parameters, inventing interpretive approaches, and crafting and evaluating exhibit concepts. These tasks must take place before the eventual production all of the necessary text, scripts, descriptions, drawings, specifications, and production artwork—all of which can also require considerable time, money, and energy.

More importantly, the process of creating exhibits must be guided by all of the conditions already outlined in this chapter: everything from goals to venue, visitor demographics, budget, and relationship to other existing visitor experiences. Consequently, the exhibit concepts presented below are not intended to program any particular gallery; instead, they provide models for thinking about incorporating ocean literacy content at various cost points and with several different objectives in mind.

Evaluating what the public audience already knows, believes, and misunderstands at the front end before exhibits are developed can help exhibit teams identify educational priorities for their institutions. Similarly, summative evaluation and sharing of visitor responses to exhibits can help the entire informal education community make progress toward a more ocean-literate public.

Exhibit Approaches for Ocean Literacy

Science exhibits can present individual ideas and phenomena or complex systems, including any of the key concepts or sub-concepts identified in the Public Ocean Literacy Report. (See Appendix I for a list of the concepts). A map of possible exhibit approaches includes several specific exhibit goals and types, all of which will be illustrated with specific examples. These types include the following.

Exhibits That Illustrate Key Concepts

An exhibit might demonstrate one phenomenon or illustrate a single concept. For example, our adapted

Concept 1 states: "The Earth has one world or global ocean with many basins, seas, bays, lagoons, estuaries, and other features such as submarine canyons, seamounts, volcanoes, and marine ecosystems."

Exhibits That Layer Concepts to Address Complex Systems

Many themes and phenomena are inherently interrelated. For example, Sub-key Concept 1c states: "Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation, and water density differences," and is related to Sub-key Concept 3e: "The ocean acts as a global conveyor belt for heat, moderating our global climate."

Exhibits That Let Visitors Affect Systems and See Results

Letting visitors interact with complex systems allows visitors to understand how pressures impact those systems. For example, visitors could be invited to interfere with the global ocean circulation pattern identified in Sub-key Concepts 1c and 3e in order to stimulate the conditions described in Sub-key Concept 3g, which states: "Changes in the ocean's circulation have produced large, abrupt climate change during the last 50,000 years, which had far-reaching consequences for life on Earth."

Exhibits That Relate Global Issues to a Local Region

Bringing global issues closer to home can help visitors make personal connections by appreciating the impact of ocean systems on their own lives. For example, the global ocean circulation system described in Sub-key Concepts 1c and 3e, which are perturbed by circumstances described in Sub-key Concept 3g, may affect ocean circulation patterns and climate within the Southern California Bight. Exhibits might explore scientific projections about the impact of global systems on local environments.

Examples of signage relating concepts locally:

1. The Golden Shores Marine Biological Reserve, an eight acre restored wetland located in Long Beach at the mouth of the Los Angeles River, was formerly a boat ramp at a much degraded remnant of a once extensive saltmarsh. The ramp was removed and the reserve created as a mitigation project when a bay front development project was undertaken nearby. This signage is viewed by visitors enjoying an outdoor nature experience. (*See illustration, pg.8*)

   Key concept 5j: Coastal estuaries (where rivers meet the ocean) provide important and productive nursery areas for many marine species.

   Concept 6e: Humans affect the ocean in a variety of ways. "Wetlands are the nurseries of the ocean and serve as reststops for migratory birds. In California alone, 20% of our threatened and endangered wildlife depends upon wetlands, yet over 90% of the state's original wetland habitat has been lost to development. When wetlands disappear both wildlife and people are affected."

   Concept 6: The ocean and humans are inex tricably interconnected and the life of every human is affected by the ocean. “The Worth of Wetlands; Wet with mud and rich in life, wetlands support wildlife and people.”

   “Wetlands are important for many reasons. During heavy rains, they slow fast-moving floodwaters and trap the silt and sediment that are

This signage was developed for the Parks, Rereation, & Marine Dept. of the CIty of Long Beach by the Acorn Group in 2005 and is used with permission.

carried downstream. Some wetland plants even absorb toxic chemicals before they can contaminate water in a larger area."

The positive message: "Wildlife is beginning to return to this wet landscape. Goby and topsmelt swim in the shallows—food for the diving terns and herons that stand motionless in the water. During their spring and fall migrations, widgeon, scaup, and ruddy ducks rest and feed at Golden Shore. Sandpipers, willets, and other shorebirds probe with long bills, searching for a meal of snails and worms."

2. Prior to entering Aquarium of the Pacific, visitors can experience the Los Angeles-San Gabriel Rivers watershed and its flora and fauna from headwaters to the ocean through a fountain enhanced with a ceramic mosaic mural and signage that includes environmental messages. A series of panels covers mountain ridges and peaks, valleys and foothills, coastal plains, ending with this statement on Coast and Ocean; "Fresh water and urban runoff mix with tidal saltwater in bays, lagoons, marshes, rocky shores, and sandy beaches. A web of life, including salt-tolerant vegetation and shore and sea birds depends on these zones." (*See illustration, pg.9*)

3. Adjacent to the fountain the Long Beach Water Department has a series of panels that start with one about watersheds and Long Beach. "Water originates as rain and snowmelt in northern counties of California. The next panels illustrate subconcept 1f: The ocean is an integral part of the water cycle and is connected to all of Earth's reservoirs through water cycle processes including evaporation and precipitation. The last panel

asks the viewer this question: "If water covers 2/3 of the planet, why on earth do we have to conserve it?" And the answer given is "Because only deep groundwater and fresh water sources are available for our consumption and that is less than 1%."

Key concept 1g: The ocean is connected to the land's drainage system including waterways by the the watersheds that carry the drainage's flow to the ocean.

Key concept 5: The ocean supports a great diversity of life and ecosystems….The ocean is connected to the land's drainage system including waterways by the watersheds that carry the drainage's outflow to the ocean.

Exhibits That Provide Decision-Making Tools

Exhibits can stimulate visitors to think about personal and public policy choices and some of the tradeoffs involved in environmental stewardship. Key Concept 6 states: "The ocean and humans are inextricably interconnected and the life of every human is affected by the ocean". Such exhibits may pose challenging situations in which none of the visitor's options are consequence-free. Their choices can then be compared to those made by other visitors. Since decision-making exhibits generally express interconnections between various systems, they often build upon concepts presented elsewhere in an institution and they are often useful as summary experiences.

Sample Exhibits

The following descriptions and sketches illustrate a range of possible options for developing new exhibits about ocean literacy themes. (*Illustrations for exhibits are by Ed Hackley and used with permission*). Attempting to place these concepts within larger exhibitions, or relating these exhibit concepts to an institution's existing exhibits is beyond the scope of this report. The short workshop precluded the possibility of suggesting exhibit concepts of each type and addressing all themes at every cost point.

Exhibits That Illustrate Key Concepts

Key Concept 1: The Earth has one world or global ocean with many basins, seas, bays, lagoons, estuaries, and other features such as submarine

Source: Aquarium of the Pacific

canyons, seamounts, volcanoes, and marine ecosystems.

Sub-concept 1a: The ocean is the dominant physical feature on planet Earth covering about 71%

Low-Cost Exhibit: A Walk-around Ocean

A map of the Earth, showing land masses and the ocean, is painted on a gallery floor. Visitors are invited to try to walk the ocean without setting foot on dry land. Sectional diagrams of the ocean that reveal bathymetric information might complement the map of the planet Earth.

Mid-Cost Exhibit: Global Aquarium

A spherical aquarium is built to show Earth's landmasses and ocean. Only the ocean contains water, providing a continuous habitat in which aquarium fish can swim around the world. (Note: no attempt is made in this description to address concerns about the appropriateness of an aquarium species being present in various regions of the world or the issues related to life-support for the species.)

High-Cost Exhibit: Internal Projection Sphere

One of several off-the-shelf internal projection spheres can be programmed to show global topography without seawater. The imagery demonstrates the relative height of mountains on land, seamounts, islands, and other undersea features. Filling the ocean with water demonstrates the continuous nature of the global ocean. (Note: No attempt is made in this description to address the optical distortion involved in projecting 3D imagery, from mountain tops to ocean depths onto the inside of a spherical surface.) *See On-site Experiences for additional information.*

Exhibits That Layer Concepts to Address Complex Systems

Key and sub-key Concepts: Various interconnected systems can be depicted in this exhibit.

High-Cost Exhibit: Interconnected Systems Environment

A simplified interactive simulation environment allows visitors to explore interconnections between systems. For example, the impact of El Niño oscillations on regional food chains and fish supplies can be used to demonstrate how ocean temperature affects regional ecosystems. The same El Niño oscillations can also be shown to affect weather in the coffee growing regions of Latin America, which ultimately affects coffee prices in the coffee growing regions of East Africa and Southeast Asia. Such an exhibit can demonstrate how a natural phenomenon impacts both wild animals and human throughout the world.

In a similar way, visitors might view systems' interconnections on a set of globes. Each globe would demonstrate conditions within a single system. In the El Niño example, one globe might depict surface ocean temperatures worldwide, another might show global weather conditions, and a third might depict economic data from various regions of the world. Visitors could be encouraged to select a variety of naturally occurring changes to one of the systems and see how the systems interact.

Exhibits That Let Visitors Affect Systems and See Results

Key Concept 1: The Earth has one world or global ocean with many basins, seas, bays, lagoons, estuaries, and other features such as submarine canyons, seamounts, volcanoes, and marine ecosystems.

Sub-key Concept 1c: Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation, and water density differences.

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

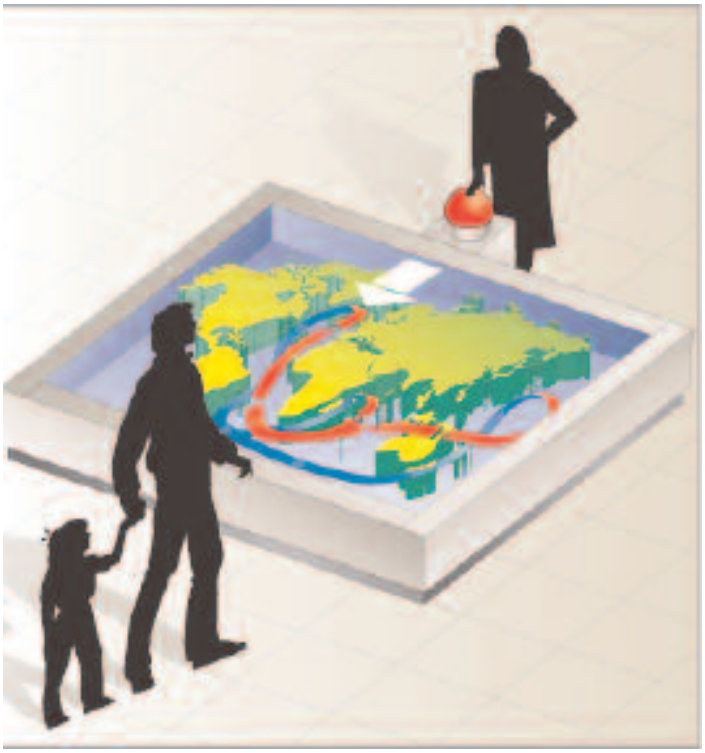
*Sub-key Concept 3*e: The ocean acts as a global conveyor belt for heat, moderating our global climate.

Sub-key Concept 3g: Changes in the ocean's circulation have produced large, abrupt climate change during the last 50,000 years, which had far-reaching consequences for life on Earth.

High-Cost Exhibit: A Climate Pump

The ocean "conveyor belt" circulates between the warm tropical regions and cold polar waters. Climate scientists project the possibility that massive outflow of fresh water into the North Atlantic due to the melt-

ing ice cap could change ocean density and interrupt the conveyor belt, potentially bringing long episodes of cold temperatures to North America, Europe, and Asia. In this exhibit, visitors might be invited to attempt to interrupt the conveyor belt by sending enough fresh water into a simulated North Atlantic. Visitors would learn how interrupting the conveyor belt might affect the climate worldwide, with special emphasis on their own regions.



Exhibits That Relate Global Issues to a Local Region

Key Concept 1: The Earth has one world or global ocean with many basins, seas, bays, lagoons, estuaries, and other features such as submarine canyons, seamounts, volcanoes, and marine ecosystems.

Sub-key concept 1c: Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation, and water density differences.

Sub-key Concept 1g: The ocean is connected to the land's drainage system including water ways by the watersheds that carry the drainage's outflow to the ocean.

Local Application: The Southern California Bight (SCB)

Low-Cost Exhibit: A Wall Map of the SCB

A topographic wall map, possibly of very large size, can orient visitors to key features of the SCB. By using a variety of illustration techniques, such as shading of topographic forms, translucent seawater, perspective arrows, and color-coding, etc., such a map does more than introduce visitors to this region. Depending on the systems illustrated, the map can also show underwater and dry land topography, where human population is concentrated, ocean currents, marine ecosystems, watershed drainages, and more.

Mid-Cost Exhibit: A Model of the SCB

Converting the map described above into a 3D model gives an added sense of scale to Earth topography and creates opportunities for animation and interaction. For example, ocean currents can be illustrated by recreating them using carefully baffled and channeled water, or by programming overhead projections or fiber-optic lighting. Similarly, the watershed's outflow to the ocean can be illustrated using color-coding, animated fiber-opting lighting, or by draining colored fluids across the map surface.

High-Cost Exhibit: SCB Fly-Through

Imagine an interactive virtual environment in which visitors can explore the SCB. Using any kind of control interface, such as popular game controllers, visitors can fly through an SCB that is void of seawater

in order to explore canyons and mountains that are both visible to us and otherwise submerged. Human features, such as cities, offshore oil platforms, and shipwrecks that are popular SCUBA diving destinations might be visible, as might various habitats and vegetation zones. As water is added into the virtual model, visitors might discover and track fish species as they traverse the bight, find currents, and experience wind patterns around the local mountains.

Exhibits That Provide Decision-Making Tools

Key Concept 1: The Earth has one world or global ocean with many basins, seas, bays, lagoons, estuaries, and other features such as submarine canyons, seamounts, volcanoes, and marine ecosystems.

Sub-key Concept 1g: The ocean is connected to the land's drainage system including water ways by the watersheds that carry the drainage's outflow to the ocean.

Key Concept 5: The ocean supports a great diversity of life and ecosystems (e.g. kelp forests, coral reefs, and hydrothermal vent communities).

Sub-key Concept 5d: Ocean biology provides many unique examples of important relationships among organisms such as symbiosis, predator-prey dynamics, and energy transfer.

Sub-key Concept 5j: Coastal estuaries (where rivers meet the ocean) provide important and productive nursery areas for many marine species.

Key Concept 6: The ocean and humans are inextricably interconnected and the life of every human is affected by the ocean.

Sub-key Concept 6d: Most of the world's population lives in coastal areas.

Sub-key Concept 6e: Humans affect the ocean in a variety of ways.

Sub-key Concept 6g: 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.

High-Cost Exhibit: Watersheds and Pollution

In a multi-step experience, visitors visualize toxic runoff from an everyday activity, such as washing a car on the street, as the car-washer says,"this is only one car". Through a series of scaled visualizations, visitors then learn about the impact of this singular activity on a local, then regional, then national, and finally global scale. The visitor is then faced with a set of personal and public policy choices that involve appropriate tradeoffs, such as costs, convenience, environmental impact, etc. As visitors explore alternatives, their choices can be collected and shown in comparison to other visitors.

Recommendations

In many ways, creating ocean literacy exhibit experiences will be an institution-specific undertaking in order to make the most of existing resources. Unfortunately, the financial and creative resources necessary to develop such exhibits may not be available to everyone. Therefore, the following recommendations are offered in an effort to help the largest possible number of institutions participate.

1. **Develop an Ocean Literacy Exhibits "Cookbook".** The exhibit concepts illustrated in these pages suggest a few of the many possibilities for exhibit experiences across a wide range of cost and content parameters. An exhibits cookbook would help institutions find existing resources and generate new exhibit components without having to start from scratch. The cookbook would survey existing exhibits at a variety of aquariums, zoos, museums, NOAA entities, and other institutions and federal/state agencies; web cams; data sets; graphic images; animations; and other resources that can be incorporated whole or adapted for ocean literacy education. A selection of new exhibit concepts would also be included, complete with descriptions, key messages, schematic diagrams, and suggestions for labels.

2. **Develop and Test a Set of Exhibits at an aquarium.** A selection of exhibits, ranging from single message to systems to decision-making tools, should be developed and installed at an aquarium. Front-end, formative, and summative evaluation should be gathered throughout the process and reported to the professional community. Selection of key messages and exhibits should emphasize:

   1. Coherent themes,
   2. A variety of learning styles,
   3. A variety of cost points, and
   4. A variety of locations within the aquarium.

3. **Report Ocean Literacy Progress at Appropriate Professional Conferences.** In an ongoing effort to encourage development of ocean literacy exhibits, progress on a variety of fronts should be reported at periodic professional conferences, such as the American Zoo and Aquarium Association, Association of Science and Technology Centers, American Association of Museums, and to relevant agencies, such as NOAA and CORE.

4. **Seek Appropriate Funding.** The coordinated efforts outlined in these recommendations will require significant funding over a period of five to seven years. Development, design, and production of exhibits is likely to take one to two years, leaving an additional three-to-five years for visitor testing, revisions, and reporting to the broader community.

Exhibits Group

Beth Redmond-Jones, Aquarium of the Pacific (Co-captain)

Tom Bowman, Bowman Design Group (Co-captain)

Ilan Chabay, The New England Curiosity Shop

Ed Hackley, Ed Hackley Design

Bruce Stewart, Birch Aquarium at Scripps Institute of Oceanography

Ocean Communication:
Working with Mass Media

Television and radio have a negative influence on knowledge holding... Newspapers and the Internet have a positive overall influence on knowledge holding...

– Brent S. Steel et al.

Introduction

The media is a critical component in the task of creating a more ocean literate pubic. Through broadcast, print, films and the Internet, media has the capacity to reach nearly the entire base of the general public. This expands the boundaries of an ocean literate public beyond those who specifically seek information through education, field experiences, or free-choice learning institutions.

Beyond the numbers of people reached every day, the business of the media is to translate data into understandable information. This is true when reporting on policy formation in government, brush fires in the hills, or research in the ocean. The media takes the core data and recomposes it in common language geared toward a broader common denominator audience than fellow scientists and researchers. In addition to translation, media often imposes its own perception of relevance to a story. Properly enlisting and utilizing media can result not only in wider distribution of ocean literacy information, but also positive shaping of opinion and calls to action.

While a powerful tool, the media has no inherent stake in advancing ocean literacy. The media with the greatest reach is driven predominantly by economics, what sells and what can be acquired with the least expenditure. It presents what it believes to be of greatest interest and relevance to the public. It also presents what is most readily accessible. "News" can be viewed as open source content. Access to brush fires, shootings, political press conferences, sporting events, and all the other stories that dominate the news require, at most, a press pass. Point a camera, roll tape, scribble notes and it's a story for that afternoon's broadcast, the morning paper, or a blog with nearly no delay or filter.

The media is also competitive. There is constant competition for the best content delivered most quickly. The smaller amount of time required to acquire, translate, and transmit a story the greater its value to a time-crunched member of the media. Reputable content is essential, but in a 30-second story, how much content is really needed? The central idea modified or illustrated with one or two examples is sufficient. A member of the media will often bypass a story if the process of acquiring the central idea is too lengthy.

With so much open source material available to the media and the time crunch of competition as a constant driver, any impediment to acquisition of data and information is a huge roadblock to getting coverage of ocean literacy stories. Therefore, the ocean communication working group decided to create three ways to speed and improve access by media to ocean community sources:

1. Development and distribution of an **Ocean Media Directory**
2. Development and distribution of **ocean literacy story hooks and pitches;**
3. Organization of and management of a **one day media response session** for the members of the CORE Public Ocean Literacy Workshop par-

ticipants (scientists) as well as other key ocean community contacts.

Ocean Media Directory

Unlike a brush fire or a press conference, ocean literacy stories require a member of the media searching for and finding the appropriate source. Our own workshop provided an example. We wanted to verify the proper contact for whale stranding. What agency was going to act as the joint information command? Even though the person making the call was very familiar with all of the various agencies and organizations in the Southern California Bight, it took four calls and 15 minutes just to verify the proper contact. A reporter with no familiarity or phone numbers is going to have a much more difficult time finding a proper information source.

The OMD-listed contacts would be media and communication professionals, not researchers and scientists. This was the preference stated by some media working group members for two reasons:

1. A member of the media is not always certain from whom information is required. Guessing which expert is appropriate wastes time. An information specialist can properly identify the contact and facilitate access, and
2. Our media members stated that researchers and scientists do not always place a priority on responding to the media. An OMD contact who has media relations as part of their job description will always make that a priority.

Examples of OMD listings:

1. *Aquarium of the Pacific*
   100 Aquarium Way
   Long Beach, CA 90802

Source: Aquarium of the Pacific

   Cecile Fisher
   Vice-President of Communications and Marketing
   Office: 562-951-1676
   Cell: 562-833-1234
   E-Mail: cfisher@lbaop.org

   Expertise:
   - Pinnipeds: Seal and sea lion behavior
   - Shark behavior

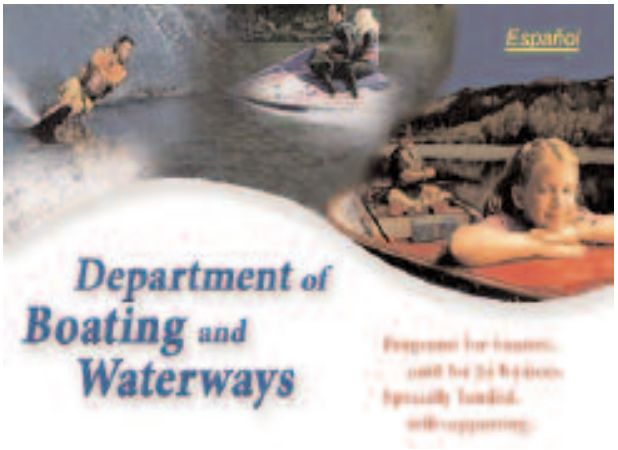
   Resources:
   - Access to live animals, crowd scenes

   NOAA Office of National Marine Sanctuaries- West Coast/Pacific
   4 Alicante Aisle
   Irvine, Ca 92614

2. Sarah Marquis
   West Coast Media Coordinator
   Office phone: 949-222-2212
   Cell: 949-300-1322
   E-Mail: marquispr@earthlink.net

   Expertise:
   - Channel Islands, Monterey Bay, Farallon

RMS Shearwater
Source: NOAA



Source: CA Dept of Boating & Waterways

Islands and Cordell Bank Marine Sanctuaries.

Resources:

- Research Vessels
- Access to restricted areas

3. *California Department of Boating and Waterways*
   2000 Evergreen St, Ste 100
   Sacramento, CA 95815-3888

   June Iljana
   Public Information Officer
   Office: 916-263-0788
   E-Mail: jiljana@dbw.ca.gov

   Expertise:
   - Beach Erosion
   - Marine Pollution-Recreational Boating

   Resources:
   - Airboats and Water Harvesters
   - Brazilian waterweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes*) control and removal

In addition to the contacts at the institutions, a full list of emergency contacts for breaking stories should be provided.

Example of Emergency Contacts:

Whale strandings: NOAA Fisheries Service (initial contact)

Boating accidents, water-based airplane crashes, oil spills: These involve a "Joint Information Command," or JIC. The JIC is a central informa tion source representing all agencies involved. The Coast Guard is the "lead" contact of many West Coast JIC operations, and all agencies provide information to the JIC to incorporate into a central press release. All media inquiries, press releases and communications about the issue or event must go through the JIC.

OMD Resource list

A second element of the OMD is a resource list. The media often look for resources for stories. They know what they are looking for, but not where those resources can be found. While part of the listing for each media contact includes resources available through their respective organization, providing media with a listing by resource expedites the search.

The resource list should be alphabetical by topic. It is

proposed that the list be broken into these catgories:

- Animals
- Data
- Graphics
- Locations
- Research Technology
- Vessels
- Video and Stills

It is important for the ocean community to recognize the value of its resources. This is true for the day-to-day media as well as for documentary and feature films.

One of our workshop participants was the U.S. Navy liaison for Hollywood. Any film or television show producer who wants access to U.S. Navy equipment, personnel, or installations must go through his office. While the Navy is very accommodating, each script is reviewed to make sure that the portrayal of the U.S. Navy is appropriate and accurate. Resource requests are denied when scripts do not fit the guidelines. Productions can continue without the Navy's assistance but at greater cost and lesser verisimilitude. In most cases, the scripts are revised to comply with the Navy's guidelines. The production is better for it and the Navy is represented factually.

The ocean community has to derive similar leverage from its resources. The animals in an aquarium's collection, a space on a research vessel, a trip to a difficult to reach island, and the latest results from a deep water dive—all have values that can be packaged. These resource packages are not necessarily for sale, at least in terms of monetary return. Much of what the Navy provides is done at no charge. The return value comes in the wide distribution of information about the Navy. The ocean community can "sell" its resources in exchange for the same wide distribution of reputable information.

OMD Glossary

Messages spread faster when the language used by all members of a community is consistent. If every newscaster used phrases and terms provided by the ocean community, it would speed adoption of those same phrases and terms by the general public. A shared language would contribute significantly to achieving ocean literacy.

A glossary of terms should be a section of the OMD. It would serve several purposes:

1. Familiarize the media with the most important terms in ocean literacy;
2. Provide the media with "public-friendly" definitions of difficult scientific terms;
3. Expand the vocabulary of the media and make them "look smart". A member of the media who can work terms such as abiotic and bight into a story will feel somewhat superior. And that's just fine. Making media look good is one of the responsibilities of the ocean community.

The seismic community does an excellent job of educating the media on language and terms related to its field. Caltech and the U.S. Geological Survey issue a yearly Earthquake Coverage Survival Guide. The title is a little hyperbolic, but it captures what the media wants as well as speaking in a language that lets them know that Caltech understands their business. The FAQs and terms section enables all the media in Southern California to inform the public with language that comes from the seismic experts. The ocean community can benefit similarly from providing the vocabulary of ocean literacy to the media for transmission to their audiences.

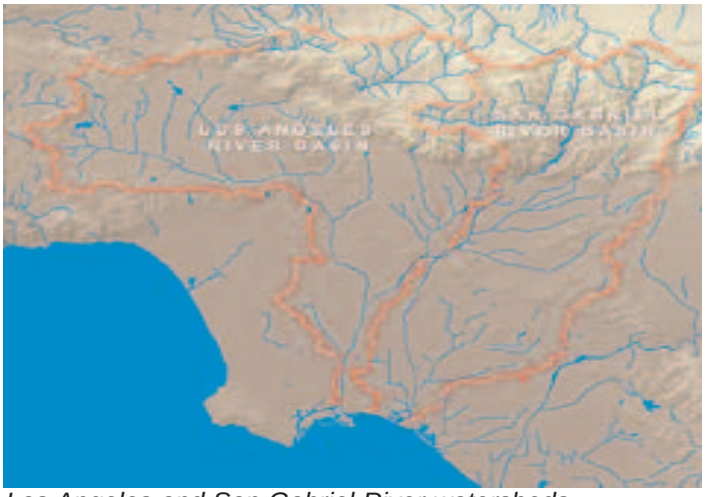
Example of Glossary:

Abiotic: Nonliving; usually applied to the

physical characteristics of biological systems such as moisture, nutrients, soils, solar radiation, etc. Nonliving environmental examples are rocks, minerals, soil, water, and climate.

Bight: A broad bay formed by a concave (inward) curve or indentation in a coastal shoreline. The Southern California Bight extends from Point Conception north of Santa Barbara southeast to Cabo Colnett (just below Ensenada, Baja California Norte, Mexico).

***Watershed**: Area of land that drains water, sediment, and dissolved materials to a common outlet. Example: the Los Angeles and San Gabriel River basins.*



Los Angeles and San Gabriel River watersheds.
Source: Aquarium of the Pacific

OMD and Recommended Websites

The final element of the OMD is a list of recommended Websites. It is important to provide this list to media to prevent misguided "Googling". There is an incredible amount of material available on the web, much of which is incorrect, outdated, or unrelated to the topic in which an Internet user has an interest. A list of recommended sites will assist media in getting to trusted and verified sources, reduce the likelihood of a misdirected search, and increase the likelihood of media referencing the same sources that are used by the ocean community. And, it will reinforce the messages we are trying to deliver through the media to the public.

The responsibility of this media working group to compile a first edition of the OMD that will follow all the guidelines stated above. Currently, the plan is for a notebook format with removal pages. This will reduce printing costs, delivery time, and make updating easy and inexpensive.

Example of where a Google search can lead a user:

One of the members of the media group did a search on the word "watershed". Ten listings came up on the first page with the top one a conference and event venue in Bristol, UK. Two listings were for EPA sites, two for a watershed project at Purdue University, two for watershed advocacy groups, one for a watershed game created by the College of Natural Resources, and the final two, promotions for the musical group "Watershed".

Ocean Story Hooks and Pitches

The contacts and resources provided in the OMD will be useful to media members when they are researching stories in which they have an interest. Many of these stories will be generated by natural events such as sea lion strandings, extreme weather conditions, or sightings of unusual species such as the summer 2005 jellies "invasion" in Southern California.

There are far more stories to tell than those that are sparked by a "news" event. These are stories that would qualify as enterprise or evergreen stories, i.e., stories that go beyond an immediate reaction and provide deeper understanding and background on ocean issues. This type of story is one that must be packaged and pitched by the ocean community.

Packaging and pitching are not dirty words. As noted above, most media are in a time crunch. Beyond that, they are swamped daily with stories from organizations and individuals seeking coverage. The most relevant and compelling stories are the ones that get picked up. A good hook or catchy phrase that stands out and compels the recipient to read further and then follow up is essential to cut through the clutter received by the media.

Creating hooks for stories does not marginalize the underlying science. The structure of the story pitches is to go from a catchy hook to a key concept. Media is more apt to pick up a story that has relevance and meaning. A good hook can grab attention, but it is the key concept that makes it worth pursuing.

The Media Working Group "Pitches" Key Concepts

The media working group has created a pitch for each of the seven key concepts. These are general and are examples of how the ocean community can attract interest and coverage from the media. The structure is 1) a hook line, 2) the key concept, 3) a brief explanation of that concept, and 4) potential sources of visuals. Some stories are evergreen: others are tied to regular occurrences.

These seven story ideas that follow and the Ocean Media Directory would be delivered to selected members of the media. A quarterly or bi-annual web based brainstorm session would be conducted by the Ocean Communicators—the media working group—to generate additional ideas. The stories do not need to be picked up immediately to be effective. They can serve as a resource and a reminder to media.

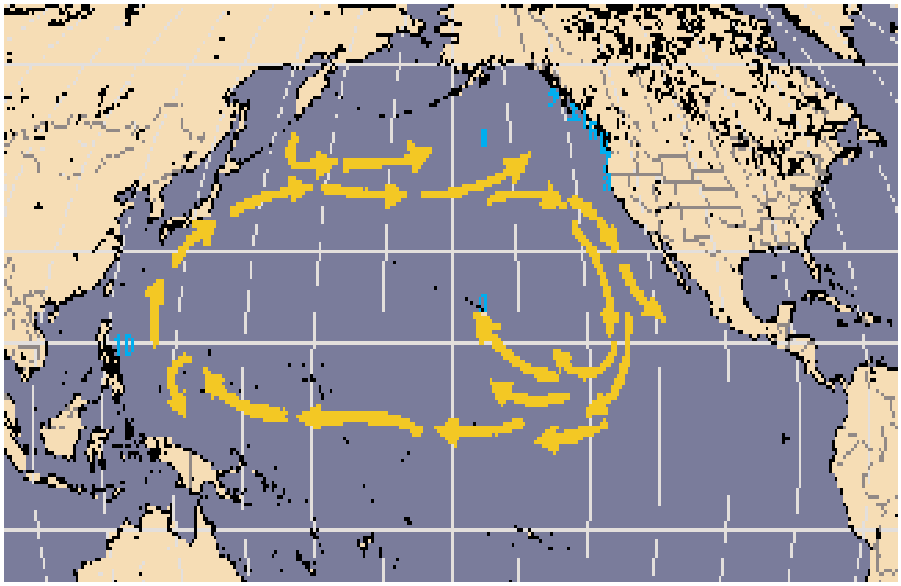
Key Concept 1c

The hook: Sailors regularly go shopping at a mid-Pacific Ocean Walmart…for free.

The concept: Throughout the ocean there is one interconnected circulation system.

The explanation: Items that are lost at sea, specifically those that are lost from container vessels, aren't lost. Many circulate around the globe and end up on land far from where they went overboard. One area where many of the "lost" items end up is the North Pacific Gyre (NPG). Sailors have fished items out of the NPG that would normally be found on the

North Pacific Gyre
Source: NOAA



shelves of local department stores.

Visuals: container vessels, trash or other items on beaches, Curtis Ebbesmeyer type collection, graphic of NPG Note: CBS News did a story on the NPG in January, 2004. (*http://www.cbsnews.com/stories/2004/01/06/eveningnews/main591770.shtml*)

Key Concept 2c

The hook: The need to annually replenish beach sand is the result of upstream damming or river containment.

The concept: Most beach sand is carried to the coast by rivers and redistributed by waves and coastal currents.

The explanation: Each year millions of dollars are spent to import sand to replenish Southern California beaches. The need for this expensive importation is the result of up-river damming or containment that captures eroded sediments that would normally be deposited and distributed. Protection from inland flooding is endangering homes built on the coast.

Visuals: large steam shovels depositing sand, homes close to the water being battered by waves, and concrete rivers.

Note: The media group came up with this hook on October 12, 2005. The next day, (October 13), two reports from Scripps Institute of Oceanography regarding bluff erosion and sand replenishment were released and picked up by media. (*http://www.signonsandiego.com/uniontrib/20051013/news_7m13bluff.html*)

Key Concept 3

The hook: Is this first big storm produced by El Niño or something worse?

The concept: The ocean is a major influence on weather and climate.

The explanation: Southern California had its second wettest season ever in the 2004-2005 season. When the first significant storm of the 2005-2006 season hit, the question was, "Is this an El Niño year or is the wetter, more severe weather part of a larger, more significant climate change?"

Visuals: heavy rain, flooding, large waves, and heavy surf.

Note: This story is pitched to media meteorologists.

Key Concept 4b

The hook: Every other breath you take comes from the ocean.

The concept: Half of the oxygen in the Earth's atmosphere is produced by photosynthetic organisms in the ocean, making the ocean the "lungs of the planet".

The explanation: Understanding the role of terrestrial plants in the production of oxygen is fairly widespread. The photosynthetic process is taught, but the aquatic photosynthetic organisms are ignored. Damaging the ocean damages the lungs of the planet. While deforestation is easy to see, damage to the aquatic phytoplankton organisms is not.

Visuals: rainforests contrasted with plankton, photoplankton research.

Key Concept 5d

The hook: Reintroduction of sea otters means you're going to be able to brush your teeth.

The concept: Ocean biology provides many unique examples of important relationships among organ-

isms such as symbiosis, predator-prey dynamics, and energy transfer.

The explanation: Sea otters are not just charismatic, cute, furry mammals. They are part of a food web that provides important raw materials for a number of production processes. One food source for otters is urchins. Urchins eat kelp and in the process destroy the plants. Kelp is used in the production of a variety of consumer products including ice cream, beer, shampoo, and toothpaste. If urchin populations are not checked in part by sea otters, kelp forests are reduced. Maintaining a population of sea otters helps to keep urchin populations in check. The result? Kelp is available for your tooth-brushing pleasure.

Visuals: Images of charismatic sea otters, kelp forests, consumer products that include kelp.

Key Concept 6b

The hook: Is the cure for Avian flu in the ocean?

The concept: From the ocean, we get foods, medicine, mineral, and energy resources.

The explanation: A significant number of medicines and products used in industry have been derived from aquatic plants and animals. Today marine scientists are actively investigating aquatic species in efforts to identify chemical compounds that can be used as pharmaceutical. The known and unknown species in the ocean could provide an enormous storehouse of life-saving treatments. Biological materials from a number of marine animals (such as sea hares, sponges, bryozoans, snails, sea slugs, etc.) are on the market, in clinical trials, or under development for use as anti-cancer agents.

Visuals: images of hospitals, deep sea ROV, plant and animal species, and industrial, cosmetic, and pharmaceutical products.

Key Concept 7d

The hook: The Mars rovers are tinker toys compared to the vehicles used for ocean exploration.

The concept: We know the surface of the moon better than the floor of the ocean. Enhanced and new technologies are expanding our ability to explore and understand the ocean and its resources.

The explanation: Manned and unmanned exploration of the ocean is an incredibly exciting pursuit. The technology employed in the oceans is at least equal to that used by NASA. The ocean community launches “down” on a far more frequent basis than the space community launches “up”. And the discoveries made in aquatic explorations are likely to have as great an impact as those made on an inaccessible planet hundreds of millions of miles distant have had.

Visuals: Images from a submersible, conversion of NOAA's newest research vessel, a tiny dot of Mars in the sky vs. the massive world ocean.

In September 2004, NOAA converted a former Navy survelliance ship to explore and research Earth’s largely unknown ocean. Source: NOAA

Recommendation for Media Communication and Accomodation

The ocean communicators group recommends that a one day "training" session be held that would assist participants in interacting effectively with the media. The participants would include the scientists who attended the CORE Public Ocean Literacy Workshop (the scientists' workshop), participants from organizations and institutions that are involved in the ocean literacy campaign, and who have responsibility for interacting with the media. Sessions could be done on a sub-regional basis so as to ensure appropriate and valuable coaching and instruction.

Suggested format for the session:

It is recommended that the focus of the session cover three areas, the first two outreach to the media with the third turning toward members of the ocean community who will be utilized by media for their expertise on, and understanding of, ocean issues. It is very important that when media makes a decision to present an ocean-based story, they be provided with cogent and compelling information from engaged (and preferably engaging) members of the ocean community. Key members of this community need to be identified and tasked with the responsibility of functioning as spokespersons on whom the media can rely for a prompt and reliable response.

1. **Communicating in a language the public understands.** This track will assist researchers and scientists in the development of formats for the presentation of information that will be readily understood by the general public. June Iljana, a member of the media working group, has conducted similar training for the staff of the California Department of Toxic Substances Control. The purpose of her sessions was to teach scientific staff to limit clinical and scientific language and use more common vernacular.

Communications training prepares scientists for media interviews. Source: Sarah Marquis, NOAA's NMSP

2. **General media training.** While the information given to media in an interview is of great importance, how that information is conveyed is of equal or even greater importance. Concise answers. Common language. Clear concepts. This applies to print and broadcast. Session participants would be supplied with tools that would assist them making as certain as possible that the most important information is received and incorporated into the media report.
3. **Breaking down barriers.** Beyond the language used, one of the key messages of the session will be availability and response. Much of the media input from the workshop focused on the difficulty of identifying and reaching correct sources. Additional feedback was on challenges in overcoming institutional and professional barriers. There is a strong reluctance on the parts of both institutions and individuals to comment on or provide even the most basic information if they

were not the source of primary research. Part of the session must address the issue of how to break down the barriers of institutional and professional reticence so as to better accommodate the media.

An example is the difficulty encountered by one of our group in confirming the name of the Davidson Current for use in an article he was writing. The writer knew it existed and wanted to make certain he identified it correctly. Although this is established information, it took two days before he could find someone in the ocean community who was willing to confirm the name. Why? Because none of the contacts was the primary researcher! While not nearly as extreme, this is a little like having to find Balboa to confirm that it is indeed the Pacific Ocean.

Ocean Communicators Group

Bill Lewis, Aquarium of the Pacific (Co-captain)
Sarah Marquis, NOAA's National Marine Sanctuary Program (Co-captain)

Bob Anderson, U.S. Naval Office of Information

June Iljana, California Dept. of Boating and Waterways

On-Site Experiences:

Informal Science Educators—Liaisons between Scientists and the

The mind is not a vessel to be filled, but a fire to be ignited.

– Plutarch

Introduction

The U.S. Commission on Ocean Policy report stated that a knowledgeable public is essential to generating the kinds of political and financial support needed to reverse declines in coastal resources and promote ocean stewardship with these words: "Strengthening the Nation's awareness of the importance of the oceans requires a heightened focus on the marine environment, through formal and informal education efforts…informal education aimed at the entire population is needed to foster lifelong learning."

What is Informal education or free-choice learning? John Falk and Lynn Dierking define it as "the learning people do when they get to control what they learn, when to learn, where to learn, and with whom to learn". They also stated that: "Free-choice learning is the single most dominant form of learning".

Now what is "on-site education"? In general, it is both formal and informal learning opportunities and/or experiences that take place at a location that provides entertainment, education, and recreation. Such locations include but are not limited to, aquariums, zoos, nature centers, science centers, museums, and outdoor areas with interpretation. On-site education often starts inside a facility and moves to the outdoors to reinforce the visitor's indoor experience with one in the natural world, or vice-versa. Educators start with whatever experiences visitors bring with them and build on that foundation from the most basic to the most complex, by connecting with what they already know. We may start with what they have seen at the beach or what happens when it rains in their neighborhood, then talk about how that relates to the concepts we want to communicate.

Informal science educators:

1. Serve as a liaison between scientists and the public, translating research and/or findings, and explaining topics for which scientists still have no answers, and
2. Engage visitors in conversations that are understandable and presented in a manner that enables them to connect with, find value in, and recognize the need to support ocean scientific research.

Recognizing that the absorption of scientific information can take place in all types of settings, informal educators must be prepared and equipped to make the most of "teachable moments" as they present themselves.

Science is much more than a collection of principles, a set of tools for measurement, or processes that prove a body of facts. Science is all around us. Scientific exploration can begin by learning from the world and progress to discussing a new experience, asking questions, and sharing experiences and memories. By examining the world using inquiry-based learning, we begin with a question, spark curiosity, and invite investigation. Inquiry into the natural world takes a wide variety of forms. It can range from a child's question about an oceanographer's quest to solve the mysteries of the deep to that of an adult asking for an explanation about global climate change. Today new scientific discoveries, population density increases, and complex alterations to the environment are changing our world. Someone who

is ocean literate needs to be able to make and evaluate decisions that require questioning, searching for evidence, and using critical reasoning. Informal science educators are in a position that enables them to interact with the public in such a way that their ocean literacy is enhanced as their acquisition of new knowledge helps them to better understand the ocean and what is needed to protect it for generations to come.

Informal educators have the ability to create unique learning opportunities. They are cognizant of the benefits of hands-on, multi-sensory educational experiences. Their teaching tools move beyond textbooks and the learning environments they use as they substitute a typical classroom situation with untraditional settings that are often learner-driven, i.e., a free-choice learning experience.

Free-choice learning is the education available to the public of all ages, interests, cultures, etc., through various forms of media including other humans. "Lessons" can be transmitted through a sensory experience out in the natural world, newspapers, books, television, radio, the internet, podcasts, a conversation, a visit to an aquarium or nature center, or interacting with informal educators at such facilities. These educators can enhance free-choice learning experiences by identifying the audience and its needs and delivering relevant content with inventive approaches. But there is a challenge—the wide diversity of ages, cultures, educational background, learning styles, environmental awareness, and concern about the ocean and its resources. All contribute to the complexity of delivering the message or the story.

On-site education harnesses the energy of informal educators who are typically characterized by their passion, commitment, and willingness to share what they know. Informal educators have enthusiasm for the subject they are sharing. They often have reciprocal exchanges with free-choice learners, many of whom are motivated and eager to learn more about Planet Ocean.

Informal educators dynamically teach by utilizing a variety of teaching tools which can include, live animals, props, biological and artificial artifacts, costumes, characters, cartoons and a myriad of other creative teaching paraphernalia. These tools can help make the subject come to life and enhance the learning experience by accommodating different learning styles, making use of a variety of accommodations, translating challenging concepts, being sensitive to cultural needs, and providing intergenerational learning opportunities. Informal educators can make learning personal and relevant and are skilled at developing programs that are flexible and adapted to their audiences. As a result of customizing the learning experience, free-choice learning can be, and often is, meaningful, personal, and fun.

Think left and think right and think low and think high. Oh, the thinks you can think up if only you try!
–Theodor Seuss Geisel

Basic Guidelines

As a byproduct of this workshop some basic guidelines for on-site education were developed that include the following best practices for informal education. This list is not all-inclusive. It is simply a starting point that offers some steps for creating a productive learning environment regardless of the key concept being made understandable. Areas of focus include recommendations for educators, comments regarding methodologies, information to consider about the audience, and suggested activities.

I. Best Practices from the Educator to the Team Effort

A. Educators should:

1. Have enough knowledge about the subject to be comfortable in reaching out to visitors and answering their questions.

2. Be trained in effective teaching methodologies including how to involve the visitor and how to evaluate the experience to determine if it needs to be modified or enhanced.

3. Be able to weave in current and mass media events to set the stage for discussion about the reports including scientific evidence if applicable and bringing up issues of concern that we have or responding to those that visitors who bring their experiences to the process have. To do this educators must know what resources and facilities are available and work to incorporate them. Our on-site "learners" need to recognize that science does not occur in a certain building but everywhere and learning extensions or ways to get involved can help make this connection.

It is also important that educators create a learning environment in which visitors do not become so overwhelmed with the problems of the ocean environment that they come to the conclusion that solving the problems is a hopeless task and whatever they do to try and help will not make a difference.

4. Tailor the message or story to be presented in user-friendly language, defining concepts and terms as they are presented, modifying them for the specific audience and learning environment. Whenever possible, hands-on or experiential learning should be used. This can be facilitated by using science's tools and applying scientific methods during the learning process.

B. Administration needs to view education as an institutional priority beyond its revenue producing capability.

C. Volunteers should be trained, evaluated, utilized, and supported to enable the organization to not only reach a much larger audience, but also to create a learning environment in which both visitors and volunteers have a positive experience.

D. Collaboration and networking with other organizations and agencies that have the same common goal—an ocean literate public—is critical to success. Achieving this goal can happen only if there is a team effort in which ocean literacy messages have a common theme adapted to the user organization's unique environment.

II. Methodology

While informal science educators do not have the luxury of being able to plan their programs around learning styles of individual visitors, they can incorporate educational taxonomies into their program design as a way to help define the objectives and learning outcomes that will help achieve the goal of an ocean literate public; meet the public's need from those who know very little about the ocean to those who are stewards; and keep the big picture in focus while avoiding getting lost in small details. Simply mouthing words or phrases from memory such as "biodiversity" or "watershed" about an intellectual discipline is not fluent ocean literacy, but it is a start, the first step in the learning hierarchies described next.

Ocean Literacy and Education Taxonomies

Being able to parrot facts about the ocean may be a useful skill in Trivial Pursuit games but individuals

who “think” about the ocean are more likely to be ocean literate. In 1998 in *Teaching Thinking*, Fisher wrote: ”A good teacher makes you think even when you don't want to.”

And there is a Chinese proverb that reads: “He who learns but does not think is lost.”

Objectives-based programs that are designed following the hierarchical steps of an educational taxonomy are more likely to result in our achieving our goal of public ocean literacy than those that are not.

I. Bloom's Original Taxonomy

Cognitive Domain

The cognitive domain is knowledge or mind based. Messages in this domain are typically related through a "live" lecture/presentation but may be made available through e-Learning or podcasts. There are three practical levels useful for planning ocean literacy messages or stories—fact, understanding, and application. The fact level is a single concept and uses verbs like define, identify, and list. The understanding or comprehension level puts two or more concepts together. Typical verbs for this level include describe, compare, and contrast. The application level puts two or more concepts together to form something new. Typical verbs at this level include explain, apply, analyze. The simpler levels require less in the way of thinking skills. As one moves up the hierarchical scale, the activities require higher level ones. A 2001 revision of the original is described in II. Bloom's Revised Taxonomy. Bloom's original taxonomy as described here is the most widely applied and often cited reference in education today.

Knowledge: remembering, memorizing, recognizing, recalling identification, and recall of information

- Who, what, when, why?
- Identify
- Match

Comprehension: interpreting, translating from one medium to another, describing in one's own words. organization and selection of facts and ideas

- Retell...
- Explain the meaning of…
- Describe

Application: problem solving, applying information to produce some result, use of facts, rules and principles, using abstractions in concrete situations

- How is...an example of...?
- How is...related to...?
- Why is...significant?

Analysis: subdividing something to show how it is put together, finding the underlying structure of a communication, identifying motives, separation of a whole into component parts

- What are the parts or features of...?
- Classify...according to...
- Outline/diagram...
- How does...compare/contrast with...?
- What evidence can you list for...?

Synthesis: creating a unique, original product that may be in verbal form or may be a physical object, combination of ideas to form a new whole

- What would you predict/infer from...?
- What ideas can you add to...?
- How would you create/design a new...?
- What might happen if you combined...?
- What solutions would you suggest for...?

Evaluation: making value judgments about issues, the merits of ideas, materials, or phenomena, resolving controversies or differences of opinion, development of opinions, judgments or decisions

- Do you agree...?

- What do you think about...?
- What is the most important...?
- Place the following in order of priority...
- How would you decide about...?
- What criteria would you use to assess...?

Affective Domain

This taxonomy is based on principles of internalization and emotional impact, the process whereby a person's affect toward something such as the ocean passes from a general awareness level to a point where the affect is internalized and consistently guides the person's behavior, i.e., the individual becomes a steward for the ocean. Affective domain addresses interests, attitudes, values, opinions, and motional sets, and also the development of appreciation. In designing a program that reflects the stages of the affective domain, the educator may state objectives that emphasize a feeling tone, an emotion, or a degree of acceptance or rejection. Developed to organize levels of commitment, this domain is especially applicable to programs in free-choice learning centers where visitors come because they want to.

Receiving: Being aware of or sensitive to the existence of certain ideas, material, or phenomena and being willing to consider or reject them. This simplest level of affective domain involves the willingness of the participant to engage in a particular behavior or activity, acquiescence of a particular request, and the participant's satisfaction when engaging in a particular behavior or activity.

- to differentiate, accept, listen (for), respond to, enjoy, seek information, derive satisfaction, engage in

Responding: Committed in some small measure to the ideas, materials, or phenomena involved by actively responding to them. Involves willingness of the visitor to receive or tolerate a given situation rather than to avoid it and selection by him/her of a particular stimulus for attention.

- to comply with, follow, commend, acclaim, volunteer, spend leisure time in, steward

Valuing: Willing to be perceived by others as valuing certain ideas, materials, or phenomena. Involves the learner's acceptance of a particular value as his/her own preference for a particular value, or commitment to a particular value.

- to increase proficiency in, relinquish, subsidize, support, debate, prefer.

Organization: Relating the value to those already held, bringing it into a harmonious and internally consistent philosophy. Involves the conceptualization by the visitor of his/her totality of values into an ordered value system. It includes an understanding by the individual how a value is related to those already held to new ones that the individual is coming to hold.

- to discuss, theorize, formulate, balance, examine, defend, judge, formulate

Characterization: Acting consistently in accordance with the values the individual has internalized. The most complex level involves the development by the participant of a value orientation that enables him/her to reduce and order the complex world around the individual and to act consistently and effectively at a personal level.

- to revise, require, be rated high in value, avoid, resist, manage, resolve, adjust to, verify, differentiate, discriminate, develop.

II. Bloom's Revised Taxonomy

In the 2001 revision of the original taxonomy nouns

were changed to verbs, knowledge became remembering; comprehension became understanding; synthesis became creating; and creating replaced evaluation as the highest level. Knowledge was divided into four dimensions, factual, conceptual, procedural, and meta-cognitive. Although the original taxonomy is still widely used, in the case of informal learning, it is believed that the revision is aimed at a broader audience and is a better tool for program planning, instructional delivery, and assessment of effectiveness. The new terms are defined as:

Remembering: Recalling or recognizing spe cific information from memory.

- Listing, describing, tabulating, naming, finding, recognizing
- The educator directs, tells, shows, examines, questions, evaluates.

Understanding: Explaining concepts or ideas

- Interpreting, paraphrasing, classifying, explaining, summarizing, comparing, explaining, inferring
- The educator demonstrates, listens, questions, compares, contrasts, examines.

Applying: Using strategies, concepts, principle, and theories in new situations

- Implementing, carrying out, using, executing, experimenting, calculating
- The educator shows, facilitates, observes, evaluates, organizes questions.

Analyzing: Breaking information down into its component parts, determining how the parts relate to one another and to an overall structure or purpose

- Differentiating, organizing, comparing, interrogating, finding, debating, thinking deeply, discussing, inquiring
- The educator probes, guides, observes, evaluates, acts as a resource, questions, organizes, directs.

Evaluating: Judging the value of new ideas, materials, and methods by developing and applying standards and criteria. Justifying a course of action or decision.

- Checking, hypothesizing, critiquing, experimenting, judging, taking action
- The educator clarifies, accepts, guides.

Creating: Putting together ideas or elements to develop an original idea or engage in creative thinking. Reorganizing elements into a new pattern or structure

- Planning, producing, designing, inventing, composing, formulating, modifying
- The educator facilitates, extends, reflects, analyses, evaluates.

Example of an application of Bloom's Revised Taxonomy

After listening to an educator make a presentation about the El Niño phenomenon at the digital video globe station, and a self-guided tour on global climate change supplemented with a guide or audio device, the visitor should be able to do the following.

Remember: Recall some event that occurred during an El Niño year such as the number of abandoned malnourished seal and seal lion pups treated at marine mammal rehabilitation centers.

Understand: Use a comparison of seawater temperature changes that occur in El Niño years and those in non-El Niño years to explain the impact of the rmer El Niño year waters on the pinniped population.

Analyze: Differentiate the impacts of El Niños on the

U.S. west coast, east coast, and in Peru and Ecuador.

Evaluate: Assess the concerns of the scientific community that global climate change (rising atmospheric temperatures) are causing El Niños to occur more frequently.

Create: Compose a letter to his/her legislative representatives supporting legislation to reduce carbon emissions, i.e., become a steward for the environment.

III. Audience

The most important goal of education is to serve our audience. In doing so we must acknowledge its diversity and incorporate the teaching approaches that best serve different audiences. Visitor surveys and evaluations should be done so we can respond to the needs and interests of our visitors. Our programs cannot be static. New programs must be designed and old ones adapted and revised if we are to stay current with the interests of changing audiences and a changing world and incorporate new scientific research and discoveries.

As informal educators we can help develop ocean literacy by first making ocean science available to the public and then helping them to understand how and why it is relevant to their lives and those of their children and grandchildren. Anatole France said "The whole art of teaching is only the art of awakening the natural curiosity of the mind for the purpose of satisfying it afterwards". If informal educators can achieve this and provide free-choice learning opportunities that awaken a natural curiosity, we can contribute to knowledge acquisition, raise ocean environmental literacy, and motivate stewardship.

Example of How To Reach the Audience

Based on the results of the August 2005 CORE-sponsored workshop that developed the first summary of what a group of ocean scientists thought that all citizens should know to be "ocean literate", the on-site education team selected key concept 5 to illustrate how it might be presented to the public. Concept 5 and the sub concepts 5a-5j provide a wealth of potential information to enhance the public's understanding and strengthen their ocean literacy.

The following summary provides the scientists' comments, education learning objectives, vocabulary, methods and techniques to reach the audience, discussion threads and hands-on activities. It concludes with ways to make a difference, i.e., encourage stewardship.

Key Concept 5: The ocean supports a great diversity of life and ecosystems (e.g. kelp forests, coral reefs, and hydrothermal cent communities).

a. *Most life in the ocean exists as microscopic organisms, however, ocean life ranges in size from the smallest virus to the largest animal believed to have lived on Earth, the blue whale.*

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

c. *Most major groups of organisms 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 great deal 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 ocean life is not evenly distributed temporally or spatially, i.e., it is "patchy" in time and space.*

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.*

The diverse interconnected communities that the ocean supports can be illustrated by introducing the idea of food webs and chains and providing examples of how interdependent groups of organisms create diverse and distinct communities to visitors. This would provide them with an opportunity to first learn the basic concepts of the transfer of energy in one environment and then apply it to a variety of other environments. This method uses the present knowledge visitors bring with them about predator/prey food chain relationships on land and introduces organisms in the ocean that serve the same roles. The following could be transformed into learning objectives by basing them on a taxonomy to make them behavioral. It is essential that the visitor's guide or audio device programming used in the self-guided tour include content that allows the user to compare his/her observations with the anticipated responses.

Learning Objectives Based on a Follow-up Self-Guided Tour:

- A community such as a kelp forest, sandy beach, tidepool exhibit is defined by its living and non-living parts.
- There are many factors that influence all aspects of the community that are similar to a city or neighborhood.
- Living organisms depend upon energy (food source), and space (room to grow, shelter) for survival. These needs are met within their distinct communities.

Prior to beginning any informal learning activity, educators need to be clear on the use and definition of terms. This list of defines some of the key words that would be used in this story.

Abiotic – Non-living; usually applied to the physical characteristics of biological systems, such as moisture, nutrients, soils, solar radiation, etc.

Autotroph –(also called primary producer) An organism that can manufacture its own food from inorganic compounds through photosynthesis or chemosynthesis. Autotrophs include green plants, algae, some Protista, and some bacteria.

Biodiversity – The variety of life in all its forms, levels and combinations. Includes ecosystem diversity, species diversity, and genetic diversity

Biogeochemical cycles – The cycling of chemicals such as carbon, oxygen, phosphorous, nitrogen, and water within (intrasystem nutrient cycles) or between ecosystems (intersystem nutrient cycles) and throughout the biosphere. The compounds are assimilated and broken down over and over again by living organisms.

Biotic – Concerning or produced by living organ-

isms, such as environmental factors created by plants or microorganisms.

Community – All the groups of organisms liv ing together usually in the same area

Consumer – An organism that ingests other organisms, either living or dead. All animals and most microorganisms are consumers (herbivores, carnivores, parasites, and detritivores).

Decomposer – An organism that derives its nourishment from dead organic matter (animal and plant bodies), breaking down the complex molecules into simpler organic molecules into simpler organic molecules. Decomposers include earthworms, mushrooms and other fungi, and bacteria. Also called microconsumer, detritivore, saprobe, or reducer.

Diversity – The number of different species, and their relative abundance, in an area. Diversity is a measure of the complexity of an ecosystem, and often an indication of its relative age. Newly established communities are low in diversity; older, more stable communities usually have high diversity.

Ecosystem – A functioning unit of nature that combines biotic communities and the abiotic environments with which they interact. Ecosystems vary greatly in size and characteristics.

Food chain – The system of feeding (trophic) levels found in any biotic community. Members of one level feed upon members of the level below, and are in turn eaten by organisms in the next level above. The lowest trophic level in any food chain ultimately contains plants, which fix inorganic compounds into plant tissues that can be digested by animals. Food chains may also be fueled by dead organic matter originating from photosynthesis outside the community; organisms dying within the community serve as a source of energy for decomposing or reducing organisms.

Food web – A complex feeding system comprised of linked food chains in a particular ecosystem.

Habitat – The place where an animal or plant normally lives or grows, usually characterized either by physical features or by dominant plants.

Interdependent – Describing the condition in which different elements in any system interact and depend on each other, as opposed to being completely separate (independent) or having a one-way (dependent) relationship.

Predator – An animal that hunts and kills other animals for food.

Prey – An animal that is killed and eaten by a predator.

Transfer efficiency – The percentage of energy that is passed along through various stages in a food web, or through the different trophic levels of a community.

Zonation – The occurrence of distinct distributions of different species, forming recognizable (usually parallel) bands of characteristic vegetation, along ecological gradients.

With a solid understanding of the key vocabulary, learning outcomes can be created to support the informal learning activity. Each individual and audience will bring personal experiences and prior knowledge with them that are inherently unique, therefore it is important to select learning activities that are flexible, modifying the presentation to deal with different levels of learning and, as much as possible, learning styles. Preferred methods for reaching the

informal audience include hands-on interactivities that involve the visitor. Live collections create memorable learning experiences but props, models, and demonstrations can also supplement verbal presentations effectively. Using examples based on familiar concepts ("in my backyard") will help make connections to ocean counterparts.

These examples could bring key concept 5 to life.

Introductory Lesson or Presentation:

- Initially the investigation includes identifying what the visitor's daily survival needs are and describing how they can be met. (In some cases it might be better to look at how a land animal, such as how a bird's needs are met.) These are then matched to a common ocean environment like a kelp forest. The roles and needs of the ocean organisms are matched to the same roles found on land, including energy source, producers, consumers, etc.
- Once this is applied to one environment another can be compared, such as a tidepool, by replacing the old organisms with new ones that fill the same role.
- When the concept is understood, the next step would be to introduce controlling factors such as temperature, salinity, wave action, tides, and pollution. Visitors can participate in the "Food Web: Who's Connected" (see below) to demonstrate how everything is connected and then show what happens with the different influencing factors (increased temperature results in lack of kelp reproduction, which results in lack of food for urchins and snails, which in turn results in lack of food for otters and sea stars, etc.
- The last step is to raise the visitor's awareness of what he/she can do to reduce human impact on the environment and to help restore it where it is in trouble. Activities that help protect diverse marine habitats include: visiting natural habitats, aquariums, and science centers to become more knowledgeable, staying informed and voicing an opinion on local and national issues that effect these habitats, practicing the four "Rs"—reduce, reuse, recycle, and restore—whenever possible and in so doing protect these habitats with daily choices.

Following this lesson, a visitor would ideally participate in a self-guided exploration of a live collection to discover the same connections that were presented in the storytelling i.e., “follow a trail”. A printed guide or audio programming such as a podcast can help the traveler conduct his/her investigation. (The use of quality controlled podcasts and vodcasts incorporating ocean literacy messages is in use or development in several organizations and agencies represented in our group). Another proposal was to create a computer kiosk with software programmed to demonstrate to the visitor how his/her manipulation of the food web affected predator/prey relationships, the food web hierarchy, and how human pressures on the web changed it.

Multigenerational Participatory Activity:

Informal learning centers are valuable assets to supplement formal education. Institutions offering school programs structure their classes so that they meet the federal and state mandated educational standards as defined for various grade levels. Activities and content are geared toward the abilities of the students to understand the content. Similarly the needs of non-formal education visitors have to be met with programs for adults accompanied by children of various ages, a wide age range of adults, and adults who cover the gamut from those whose interest in becoming ocean literate range from those

with little interest to those who are literate to some extent to those or are already stewards of the ocean.

The activity below is for a multi-generational group that could be adapted for use with visitors of different ages.

The Food Web: Who's Connected?

This activity demonstrates that in diverse ocean communities, each organism has a niche as part of the food web and there is interdependence among organisms. It can also demonstrate that human actions impact the food web.

1. Select a specific habitat and have participants make food chain links by using strips of paper to show organisms and their predator/prey relationships. List each link on a separate strip of paper. For example: | sun |-| phytoplankton |-| zooplankton |-| sardine |-| mackerel |-| dolphin|
2. Give each participant a piece of a chain. Have participants work together to put themselves in the order of the chain (food source next to predator).
3. Have them demonstrate the interrelationships among food chains by playing a food web game.

   a. Make additional links of plants and animals for the specific habitat selected, including all levels of the food web (sunlight, nutrients, phytoplankton, zooplankton, predators, scavengers, and decomposers/nutrients).

   b. Pass one link out to each person in the group. Have the group make a large circle.

   c. Using a ball of yarn, have participants pass the ball from prey to predator connecting each predator/prey relationship. Continue until the entire group members have been connected.

   d. Discuss what would happen if one organism were eliminated. Have one participant lower his/her yarn and then have the others report who felt the effect.

   e. Discuss what would happen if a specific article of trash were introduced into this marine habitat (plastic pellets, fishing net, plastic bags). Again have the targeted participant lower his/her yarn in response to the item and discuss the effect.

This activity is not original, but one that has been successfully tested at a variety of informal learning institutions that were represented in the on-site education group. It works best when conducted in a group setting and can accommodate visitors of varying ages and abilities.

S3: Science to Stories to Stewardship

Stories about our ocean are more "complete" than simple facts. Stories provide a context in which the public can connect new knowledge to what they already know. Journalists write "news" stories, advertisers tell "product" stories. Biographers tell "life" stories; novelists write about intrigue, mystery, romance, etc. Explorers tell stories about their adventures. What stories do informal ocean science educators tell?

If our stories are to compete with the many others that are presented to the public each day, ours must grab and hold the attention, be fascinating as they unfold, and contain a take-home message about needed stewardship from an "in my backyard" and regional focus. They must also be viewed as coming from a credible source.

Our stories should have a plot and characters that fascinate, action that surprises or excites, dramatic conflicts or crises, and a happy or poignant ending.

They should present verifiable, not junk, science. They may be "chapters" in a longer or more complex series. While dissonance (which is critical to behavior change) does not have to be part of the story, the story must be distinct from commonly held beliefs or myths if it is to affect change. Our stories should include impacts on society and societal issues. Stories should be short enough and memorable enough that the public can easily retell them to others, i.e., "talk the talk."

A story must be conveyed in a way that the listener—the public—perceives to be a shared story, not one coming from an authority figure who is commanding compliance. Shared stories about experiences can result in empathy or mutual enthusiasm. The public generally rejects sales pitches from unknown story tellers because they perceive them to be self-serving, sermons, or not credible. Stories cannot come across as dogma or requirements. We can share stories about common experiences and perspectives that have a local focus, but we cannot "teach" a story.

Our stories should end with a present status summary, details about solutions to current problems, and needed care and protection for the ecosystem. We need to send the visitor home with an understanding of what science tells us we must do to mitigate, restore, enhance, and protect our ocean.

Hopefully, when the story has ended, the visitor who shared in its telling will not only want to tell it to others, but also want to take the steps necessary to "walk the talk", i.e., become a steward for the ocean.

Live presenters tell stories: some examples

Using live presenters to introduce a story, answer questions, respond to comments, and provide next steps is an effective way to promote ocean literacy. Visitors appreciate opportunities to dialogue with staff. The attention makes not only the guest feel important, but also makes the story topic seem more important. A "live" voice can add credibility to the story in which key concepts are part of the message. Live telling of an outlined story should be supplemented with artifacts, maps, objects that illustrate the three dimensional ocean, handouts, etc.

One-on-one and small group storytelling

One-on-one learning through interactive presentations can be provided in a variety of onsite settings such as the storyteller roaming through the institution's halls or strolling along the trails and pausing to engage visitors in front of an exhibit with: "Did they notice that…?; "Are you aware of…?": "Have you ever…?", etc. The stories can be small learning blocks that the storyteller supplements with a backpack of illustrative materials such as maps, artifacts, and handouts.. The interaction can also take place by a fixed graphic display as shown in the photo.

> *Key concept 1f*: The ocean is an integral part of the water cycle.

In a behind-the-scene tour, a presenter ties together these two concepts with water quality and source for the Aquarium of the Pacific's habitats. Source: Aquarium of the Pacific

Key concept 6a: The ocean and humans are inextricably interconnected and the life of every human is affected by the ocean.

Small group

Interactivities can also take place in front of portable poster type displays that can be set up anywhere a group of people can gather with the storyteller giving a five-minute presentation that meets the criteria described above. As an alternative, mobile carts equipped with artifacts, photos, memorabilia, anatomic models, and a microscope if applicable, can be stationed throughout the facility where different stories are told, each with appropriate key concepts. Carts featuring whales, sharks, otters or plankton are some examples.

Small group around the "shark cart".
Source: Aquarium of the Pacific

Large Groups

For those guests seeking a more in-depth learning experience, scheduled 10-20 minute presentations can be done in settings that accommodate a larger audience, such as an outdoor theater or before large exhibits equipped with audio devices. The same topics presented in the five-minute format can be expanded. Efforts should be made to make the presentations interactive, not a one person dialogue.

The on pg. 16 shows a scheduled presentation in front of the Aquarium of the Pacific's pinniped exhibit in which a mammalogist and a volunteer discuss the training of the seals and sea lions and address the stated concepts. The volunteer interacts with the audience at the conclusion of the training to answer questions.

Key concept 3d: The El Niño-Southern Oscillation phenomenon is one of the most powerful forces driving global weather.

Key concept 6e: Humans affect the ocean in a variety of ways.

Key concept 6g: Everyone is responsible for caring for the ocean.

The El Niño weather pattern is related to changing food availability and the survival of pinniped pups. Eutrophication (overgrowth of phytoplankton) resulting from non-source land runoff is believed to be one of the main causes for harmful algal blooms (HABs) that can produce harmful toxins that accumulate throughout the food chain, ultimately affecting ocean mammals such as seals and seal lions.

Ocean science and multi-media digital video globes

Few visitors to institutions that focus on the ocean have ever taken an oceanography course. How can these key concepts about "Planet Ocean" be demonstrated to the public in such a compelling way that they can begin to better understand ocean science? How can we compress slow processes and fluctuations that occur over great expanses of time into a short, punctuated experience? Equally challenging is the question of how we show the ocean's three dimensions without getting wet!

Key concept 1: The world has one world ocean.

> *Key concept 1b:* An ocean basin's size, shape, and features…are shaped by movements of Earth's lithospheric plates.
>
> *Key concept 1c*: Throughout the ocean there is one interconnected circulation system powered by water density, wind, tides, and the Earth's rotation.
>
> *Key concept 3:* The ocean is a major influence on weather and climate.
>
> *Key concept 3e:* The ocean acts as a global convey or belt for heat, moderating our global climate.
>
> *Key concept 3d*: The El Niño-Southern Oscillation phenomenon is one of the most powerful forces driving global weather.
>
> *Key concept 5f:* The ocean is three-dimensional, offering a great deal 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.

A number of organizations and agencies are using a multi-media digital video globe called Magic Planet® to make it easier to tell stories to the public in a way that both spark's their imagination and helps them understand dynamic global systems. The Magic Planet StoryTeller™ software coordinates global visualizations with audio and on-screen information, in either fully-automatic or interactive modes. Active displays can reflect data from NOAA, NASA, and other agencies. Used interactively with a presenter personalizes the experience for the viewer. Depending on the size of the globe, the audiences can be large or small.

Magic Planet® at The Ocean Institute.
Source: Global Imagination

The Aquarium of the Pacific is developing programs for its two Global Imagination® Magic Planets systems, a 16-inch portable Magic Planet® globe that can be used in the Aquarium's classrooms or taken offsite to schools, exhibits, and community events and a second two-foot stationary Magic Planet® that will be placed in the Aquarium's Great Hall where a presenter will interact with visitors. Birch Aquarium uses the Magic Planet® to facilitate visitor understanding about plate tectonics and the relationship between seismic activity and plate boundaries NOAA has developed a set of lesson plans for use with digital video globes such as the Magic Planet®. The Ocean Institute's Magic Planet® is the centerpiece in it's Beneath the Sea 3D exhibit and teaching station. And there are many other organizations successfully using this format to help visitors understand ocean science, i.e., to improve their ocean literacy.

Free-Choice Learning Centers as Promoters of Ocean Stewardship

Ocean literacy is not just understanding ocean science. It includes an individual taking the additional

steps necessary to become an ocean steward by becoming aware of human impacts on the ocean and doing what an individual can do to help the ocean environment. If informal education centers are to promote environmentally conscious messages and activities, then they need to serve as a leadership example for visitors to emulate. By serving as a role model organizations are practicing what they preach to others. They must:

- Weave environmental stewardship into all programs
- Adopt a policy of presenting ways the public can help the ocean in terms of "Do", not "Don't"
- Involve partners, including media, in conducting programs
- Work together with fellow informal education centers to champion ocean literacy and create public awareness
- Provide a forum for formal and informal educators to develop and exchange strategies to encourage ocean literacy
- Take advocacy positions on environmental issues to the extent that is legal, educating their memberships about the issues
- Publicize environmental success stories to balance the stories about the lack of success
- Participate in Earth-friendly and green behaviors such as recycling, setting up carpooling programs, using sustainable materials etc.

A Concluding Message

The ocean and humans are interconnected and everyone is affected by the ocean and the health of the ocean affects all life on earth. The sooner we begin to establish the connection that even when you do not live by the ocean, you still live in a watershed and depend on the ocean, we will begin to develop a greater respect and stewardship for the ocean, its inhabitants, and ecosystems.

This is only the beginning of opportunities for informal education to attempt to reach out to our visitors and communities to develop greater public ocean literacy. For some time we have all included conservation messages in our programs—yet conservation is only a very small segment of ocean literacy. Now we must broaden our messages and tell new stories, not just present facts.

Recommendations

1. This chapter has been prepared from the viewpoint of informal science educators focusing only on their role in increasing public ocean literacy; however, our existing programs are not standalone. They do, and must, include input from exhibit and web designers and ocean communicators. Additionally, outdoor experiences are often a part of an on-site experience. When a new exhibit is being planned, a team effort is involved that often ranges from what appears on the signage to the training the volunteers will need to be knowledgeable enough about the subject to be able to interact with visitors. Planning a comprehensive ocean literacy program has to be a team effort of all groups if success is to be achieved.

Recommendation: A group of individuals selected from each group form a team to develop a model ocean literacy program focused on several key concepts that:

a. Includes self-guided and guided on-site and outdoor experiences, e-Learning and web design, publications, podcasting, volunteer

training, communicating with the media, exhi bitions, etc.

b. contains content and methodology for meeting the needs of different visitor populations including multigenerational, young adults, seniors, etc.

2. Key concept 1h: *Although the ocean is large, it is finite and its resources are limited.*

   Overfishing is one of the most noticeable human acts on the ocean and efforts are being made to educate consumers about the contribution they can make to keep this ocean resource sustainable by purchasing herbivorous fish and fish that come from well-managed fisheries of sustainable stocks. Such education primarily takes the form of printed seafood purchase guides.

Recommendation: The on-site education group recommends that the informal science educators work with the ocean communicators to develop a "sustainable ocean" guide (Tips to Help Take Care of the Ocean). This guide, distributed by informal learning centers, would deliver a consistent message that would help unify ocean stewardship efforts.

3. Organizations represented in the on-site experiences group all rely heavily on volunteers in their programs. Most volunteers do not have marine biology backgrounds. Few have taught in formal education centers and are familiar with teaching methodologies. There needs to be a training program for volunteers themselves to become ocean literate if they are to be involved in a public ocean literacy program.

Recommendation: The on-site group should develop a taxonomy based volunteer training program focusing on several key concepts that could serve as a model for creating ocean literacy training programs for volunteers involved in either on-site or outdoor experiences activities. The program should include a variety of experiences to meet the learning styles and background knowledge that volunteers bring to an organization such as classroom and outdoor experiences, e-Learning, podcasts, videos, etc.

On-site Education Group

Amy Coppenger, Aquarium of the Pacific (Co-captain)

Linda Chilton, Cabrillo Marine Aquarium (Co-captain)

Leah Young, Aquarium of the Pacific (Co-captain)

Tim Anderson, Friends of the Seal Beach National Wildlife Refuge

Stephanie Barger, Earth Resources Foundation

Kristin Evans, Birch Aquarium at Scripps

Kaniesia Evenso, SBMNH Ty Warner Sea Center

Jennifer Liebeler, Aquarium of the Pacific

Mark Moss, West Basin Municipal Water District

Kathi Stopher, USFWS San Diego Complex

Tara Trieber, Santa Monica Pier Aquarium

Rick Wilson, Surfrider Foundation

Outdoor Experiences:
The Natural World—A Route to Ocean Literacy

The sea, once it casts its spell, holds one in its net of wonder forever.

– Jacques-Yves Cousteau

In every grain of sand there is a story of earth.

– Rachael Carlson

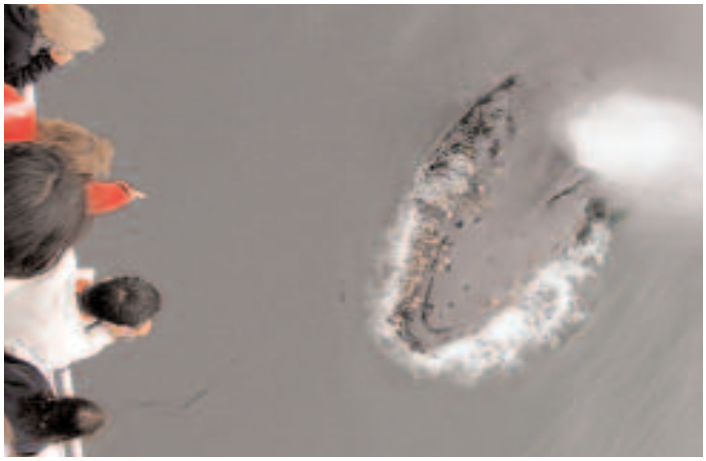
Introduction

This chapter summarizes the work of a group of individuals with expertise in informal science education and outreach who looked for ways to improve public ocean literacy in out-of-doors or natural settings. This working group focused on identifying and describing strategies that would develop the public's understanding of the ocean, its impacts on their lives and their impacts on the ocean, and provide motivation for them to become stewards of the ocean planet.

Three strategies were developed: self-guided excursions, volunteer or docent-led programs, and a commercial network representing an intersection of commercial activities with the ocean. The group thought that organizations and agencies could incorporate these examples into their existing programs or be included in them. It was the opinion of the group that working with organizations such as the Power Squadron or Coast Guard Auxiliary could be an effective way to reach a general public already interested in and/or connected to the ocean.

What are outdoor ocean experiences?

Outdoor ocean experiences are infinite and varied in number. Some examples include: walking out on an ocean pier, strolling along a coastal beach or bluff, building a sand castle, exploring a tidepool, watching an ocean sunset, quietly sitting on the beach watching the surf, swimming, surfing, snorkeling, boating, fishing, birding, whalewatching, or visiting a harbor. These are experiences that provide the public with the ability to relate to, and with, the natural aspects of the ocean environment. The diversity of possible ocean experiences accommodates a variety of learning styles, paces, interests, and physical abilities.



Whalewatching
Source: Fred Benko, Condor Cruises

Why are outdoor ocean experiences so powerful?

The ocean provides a superb opportunity for an individual to discover his/her connections to the natural environment. Outdoor ocean experiences, in contrast to those in a classroom, library, or other indoor learning environment, are powerful because they bring people into direct contact with the natural environment, encounters that may profoundly transform an

Artesian slough tour
Source: Don Edwards Complex NWR

Birding by kayak
Source: Anitza Valles

Beach walk
Source: Ed Cassano

individual. They also provide a milieu that can accommodate a host of diverse audiences from different age groups, socioeconomic strata, ethnicities, and cultures. The wide variety of outdoor locations and potential activities allows a multi-sensory intimacy with the ocean—the chance to see hear, smell, taste, and touch it.

Outdoor experiences are engaging for many reasons. They have the power to pull the participant into the natural world. They allow people to directly grasp the reality of the ocean. The potential inherent in an ocean outdoor experience can greatly facilitate the task of teaching people about the science of the ocean, the problems, and the role of the individual in solving the problems. Outdoor experiences give the participant the chance to become a better observer of the natural world with enhanced curiosity and the desire to explore natural phenomena. It provides the public with opportunities to know, confirm, and understand what is necessary to become ocean literate.

Experiences in which one directly interacts with the natural world can engage one emotionally, and the learning that results often imprints itself more deeply in our being. These experiences have the power to stimulate a desire to become more involved in understanding and caring for the ocean environment.

Birding
Source: Friends of Colorado Lagoon

Outdoor ocean experiences can lead people to become stewards of the ocean and its natural resources and develop into life-long students of marine natural history and ecology.

Outdoor experiences can be classified along a continuum from unstructured to structured. In some cases an outdoor experience that is initially unstructured may develop into one that is structured, or vice versa. An example is the casual beach stroller who is attracted by an instructional kiosk at a public beach. The message on the kiosk may capture the individual's attention and enhance the viewer's experience by prompting the viewer to look at the beach features in a new way, by explaining something about the beach that the viewer did not already know, or by explaining it in a way that the viewer can now understand.

Self-Guided Tours

If general public ocean literacy is to be achieved, one of the routes will definitely be through outdoor experiences. Being out in nature can be a hands-on learning experience whether the participant is engaged in an activity or not. Simply being in close proximity to the ocean can help a person gain a greater understanding of his/her surroundings; however, a little guidance can help this process tremendously. To that end, the outdoor experiences group believes that structured self-guided walks in which the participant has access to audio devices and/or printed guides will help the walker understand the many and varied connections they have to the ocean, whether in and around where they live, on the ocean, along its beaches or cliffs, within its wetlands, or at its tidepools—in fact, anywhere among or in its ecosystems.

Self-guided tours will allow participants to proceed at their own pace and according to their own interest level, while providing a non-intrusive form of interpretation to an experience participants might choose to have anyway. These tours not only allow participants to immerse themselves in the environment, but also enhance that interaction with a form of self-regulating guidance. This can help maintain the personal nature of the outdoor experience while, at the same time, allowing for a more intuitive grasp of some of the ocean literacy concepts that we seek to disseminate.

In general these self-guided tours will depend on their location and who creates some form of an interpretive guide. Ideally, the guides would be generic enough to be applicable to tours of tidepools, wetlands, beaches, coastal trails, etc. In their simplest form, guides would be provided that could be downloaded from the organization's Website or available at the tour head starting point in a pre-printed form. Printable tour guides provide a mechanism for displaying details to support a visitor inquiry. Images and figures to illustrate the questions as well as the answers to the specific questions can be provided. The newer electronic techniques of podcasting and vodcasting using an Ipod® or other digital audio players will need to be explored, designed and evaluated on the ability to deliver the various messages needed for these tours. Since not all walkers will have the necessary electronic equipment, the need for printed guides will not disappear with the availability of podcasts.

The intent of these tours is to give participants the opportunity to discover their environment without a facilitated person-to-person interaction. They may ask a listener or reader questions and encourage a participant to think and answer before moving on to later sections of the tour. They should also be expandable to include further information on individual topics of interest or information relevant to a spe-

cific location (e.g., a particular open area, pier, or beach). The series could include stops at strategic locations such as a point on a watershed or the participant's own home, so as to build strong links between the ocean and each individual's personal actions.

The group envisioned a variety of tours that the public could access. The table below illustrates examples of several categories with key concepts that might be addressed. The text of the concepts is in Appendix 1.

Tour Examples

At each step the walker either takes action or answers a question. Some examples to illustrate explanations that tie into the concepts are included.

Self-guided Beach Walk

Objectives:

1. To draw a beach walker to the ocean's edge to marvel, think about, and come to understand that the beach has amazing diversity, is an important ecosystem, and a dynamic interface between the ocean and land, and
2. To motivate stewardship of the coastal-marine ecosystem.

Walk design:

For a generic southern California beach. Beach walk tours should be designed for any beach, not just a particular one, an approach that would expand its potential use to more locations and users. It would be possible to adapt the general guide to the features of a specific beach. Self-guided beach tours already exist. These typically follow a predetermined path, with supporting interpretive material on-site. While some make references to ocean literacy concepts, the emphasis is more often on conservation.

Preparation and safety considerations:

Individuals utilizing this tour should be prepared to get wet from the knees down. They will be spending time in the wash zone of the waves along the beach. Care should be taken not to enter the zone where the waves are breaking. Beach goers should be aware of any high surf warnings and rip currents. Safety first!

I. The Beach Walk:

A. Start your tour at the edge of the beach as you face the ocean. What is the weather like? (concepts 3b, 3e; 6a) Is it clear? Cloudy? Foggy? Has it rained? What direction is the wind blowing from-(the ocean, toward the ocean, or up and down the coast?

Table 1: A Variety of Self-Guided Tours

Tour	*Concepts Addressed*
Home/neighborhood	3a,b,c,d; 4a; 5a,c,e; 6a,b,c,d,e,f,g
Open or natural area with connection to watershed or drainage system	1f,g; 2b,c; 4a; 5a,c,j; 6d,e,g
Beach walk	1a,d,e,g; 2a,b,c; 3a,b,e; 5d,f,g,i; 6b,c,d,e,f,g; 7a
Estuary (could divide into freshwater marsh, saltwater marsh, and river mouth)	1e,g, 2a,b,; 5b,g,i,j; 6c,f,g
Harbor/marina	1g; 2a,b; 5g,i,j; 6b,c,e,f,g
On-the-water (recreational boating, kayaking, whalewatching, fishing, etc.)	5a,c,f; 6e,f,g
Aerial	1a,c,g; 2a,b,c; 5f,g,i; 6b,c,d,e,g; 7a

Getting wet.
Source: Olympia NMS

1. Is this typical for this area? For this season?
2. How often does it snow at the beach? How often does the temperature rise above 37.8º C (100º F)?
   a. Why do you think this is?

Explanation: The weather along the coast of California is affected by the coastal ocean. Our region is influenced by the California Current, which is an example of an eastern boundary current. The presence and temperature of the coastal ocean moderates our local coastal temperatures. In the summer it is cooler near the ocean than inland, and in the winter, it is warmer.

If you are at the beach in the evening, you may notice a strong wind blowing from the ocean to the land. These afternoon sea breezes illustrate the effects of solar radiation on land. The land heats up during the day as a result of heating from the sun. Air above the land is also heated, and warm air rises. Cooler air above the ocean rushes in to replace warm air rising above land—this is the cause of our onshore afternoon sea breezes.

B. Facing the ocean, start your walk across the sand to the ocean, picking up a handful of sand as you start your walk.

1. Where does the sand come from? Where is the nearest river or creek that flows to the ocean? Need help? Ask a lifeguard if one is present.
2. Describe the sand.
   a. Do you see different objects in the handful you picked up?
   b. Are the sand grains mostly the same size? Same color?
   c. Are there shell fragments or fragments of other objects in addition to sand grains?
3. As you walk to the waters edge, stop several times to examine the sand.
   a. Do the grains of sand change in size? In color?

Explanation: In general, sand comes from the weathering of continental granitic, and sedimentary rocks (the most common sources), weathering of oceanic volcanic rocks (basalts), and skeletal remains and shells of organisms (carbonates). The sand on our beaches is made of local rocks and soils. These rocks and soils weather (break down), primarily as a result of the chemical and physical action of water. (Adapted from: Waves, Wetlands, and Watersheds,

A handful of sand.
Source: Ed Cassano

Section 4.1 page 29, published by the California Coastal Commission.)

A great deal can be learned from looking closely at sand. By carefully examining the composition, size, rounding, and sorting of sand we can infer how far it has traveled, from where, and what type of rocks it came from. Scientists classify sand according to two characteristics, grain size and texture. (Source: Ibid. page 39)

The more rounded a sand grain, the farther it has traveled. Sand is material between 2 mm and 0.06 mm. Silt is finer than sand but still feels gritty. It forms a sticky ball when wet. Gravel is material larger than 2 mm. (Source: Ibid. page 40)

C. Having reached the edge of the ocean on your walk, feel the water (concepts 3b, 3e)

1. What is the temperature?

    a. Is it warmer or cooler than the air?

Explanation: The waters of California are cooled by the California Current for most of the year. (Note: The make up and seasonality of the currents in the Southern California Bight are extremely complex. Understanding that the temperature of the water along the west coast of the U.S. in general and the California coast in particular, is cool due to a southward flowing current would be a significant accomplishment.)

D. Look out at the water (concepts 1a, 1h)

1. What is the appearance of the water?

    a. What color is it?

    b. Is the surface calm or choppy?

    c. What direction is the wind blowing from?

    d. Are there waves breaking on the beach?

    e. Do you see wildlife, oil rigs, fishing boats, sail boats, surfers, swimmers, piers, other beach walkers?

    f. Is there debris in the water?

Conservation message: The ocean is the dominant physical form on Planet Earth. It covers 71 percent of the planet. The Pacific Ocean is 18 times the size of the U.S, has over fi of the world's waters, etc. (Other facts can be added to round out the explanation.)

The ocean is being greatly impacted by over fishing, point and nonpoint pollution flowing from the watersheds, invasion of non-native species, global climate change, coastal development, and many other assaults. Total effects are difficult to predict. Coastal management in which the ocean and land are managed as one integrated system, and ecosystem-based manageement, in which human beings and natural resources are managed in balance, is crucial to protecting our coastal and ocean resources.

2. Watch the waves as they come in (concept 2b)

    a. Trace the pattern of the direction that the waves come up the beach, and the direction that they retreat—are they different?

    b. Look closely—does any sand move with the waves?

    c. In what direction is the sand being transported?

3. Is the beach where the waves come in steep or flat? (concept 2c)

    a. Are the waves large or small?

    b. What season of the year is it?

Explanation: During summer months, sand builds up on our beaches, usually making them broad and flat. During winter months, heavy wave action and winter storms reduce their size and create steep, narrower

beaches. Strong erosion of coastal cliffs also occurs at this time. Rain events, river flow, and river bank erosion increase during the winter months. Debris, both natural and man-made, flows into the ocean from coastal rivers and streams.

Damming of our rivers, building coastal armoring, and development along our beaches, coasts, and watersheds have modified the natural progression of our beaches. Many communities fight beach and cliff erosion by artificial means. Combating beach erosion is a major coastal California expense.

4. Look back from the water. What does the upper beach look like? Look for activities on your beach that may indicate human intervention in maintaining a sandy beach. (concepts 2c; 6d, 6e, 6f)
    a. Is it broad or narrow? Are there dunes? Are there plants?
    b. What are some reasons why the beach might look the way it does?
    c. What human activities might alter the way a beach naturally looks? (grooming, sand replenishment, development)
    d. What man-made structures do you see? (buildings, piers, storm drains, sewer outflows, coastal armoring, harbor structures, etc.)
        1) How far are they from the water?
        2) Could they be affected by any natural hazards?
    e. What does the land beyond the beach look like?
        1) Are there cliffs or palisades? Ridges, terraces, or palisades?
        2) Is there a road between the cliffs and the beach? Will it cause beach runoff?
5. Look at the water again (concepts 5a, 5d, 5f). Do you see any animals above, on, or in the water?
    a. Are there birds, marine mammals, domestic pets?
    b. Are they resting, or feeding?
    c. Try to identify them. Are they permanent residents of this area? Or are they migrants?
    d. If they are migrants, what do you think brought them here? How might they be using this environment?
6. Scoop up some water (concepts 5a, 5b)
    a. Do you see any organisms?
    b. What about microorganisms? You can't see them but they are there!
7. Look closely at the sand near the water's edge (key concepts 5f, 5g, 5i)
    a. Is there evidence of animals living in the sand?
        1) Do you see any burrows? What do they look like? What kinds of animals might live in them? (sand crabs, clams, worms?)
    b. Dig down to see if you can uncover any organisms
    c. Try the same thing further up on the beach away from the water.
        1) Why are there no organisms here?
8. Walk the beach and look for other objects on it (concepts 6c, 6e, 6g)
    a. What kinds of natural objects do you see?

Trashed beach.
Source: Ed Cassano

(seaweed, shells, driftwood?)

b. What kinds of man-made objects?

1) If you see trash, what kinds? (fishing line, nets, cigarette butts, plastic containers, other?)

2) Could any of these be harmful to organisms on the beach? In the water? To humans?

c) What could be done to keep these objects off the beach?

9. Now that you are at the end of your walk, why do you think we should care about the beach and the ocean? (concept 6g). This section should be used to tie together and wrap up the key concepts and provide motivation for stewardship and information about becoming a steward.

10. Feedback loop

a. Take pictures and send them to a regional website or clearinghouse or publish them on the Internet

b. Unanswered questions? Send these to a website where local experts post answers.

II. Self-guided Home/Neighborhood Walk

Objective: to get people thinking about their place on the watershed and their potential impact on the ocean.

A. Start inside your home (concept 6b)

1. Explore contents of refrigerator, pantry, medicine cabinet, garage, cleaning supplies, etc., for components or ingredients that originated in the ocean

2. Investigate home's energy sources for evidence of ocean or watershed origin (e.g. petroleum, natural gas, electricity)

B. Walk outside

1. Where do you live? (concept 6d)

a. How far are you from the ocean?

b. How far from a creek or channel?

c. How far from a storm drain or outfall?

2. What is your climate? (concepts 3a,b,d; 6f)

a. What is the weather like right now?

3. What kinds of natural hazards are you susceptible to? (concepts 3c,d; 6f)

a. Which of these may involve the ocean?

4. What kinds of wildlife do you see? (concepts 5e; 6e)

a. Birds, mammals, amphibians, insects?

b. Which of these are connected to the ocean in some way?

5. What kinds of domestic pets do you see? (concepts 5e; 6e)

a. Do they have a connection to the ocean?

C. Walk around your house or building (concepts 4a; 6e,g)

1. Where does the rain fall?

    a. Describe the surfaces (are they permeable or impermeable?)

2. Where does the water go?

    a. Onto a hard surface or into the ground?

3. Do any of these pathways lead to (end up in) the ocean?

4. What contaminants might be carried with the water? (oil, pesticides, fertiliz ers, cleansers, litter, trash)

D. Walk into your yard or the nearest open area (a park, or vacant lot) (concepts 5a, c)

1. Pick up a cup full of soil

    a. Approximately how many bacteria do you think are in the cup of soil? **Amazing fact:** The same volume of seawater contains over 250 million bacteria

2. What types of small organisms do you see in the soil? **Amazing fact:** The same types of organisms are present in seawater (but different species)

E. Why should you care? (concept 6g). This section should be used to tie together and wrap up the key concepts and provide motivation for stewardship and information about becoming a steward.

F. Feedback loop

1. Take pictures and send these to a regional website or clearinghouse, or post them on the Internet.

2. Ask questions

    a. Send these to a website where local experts provide answers

III. On-the-Water Outdoor Experience

Objective: to motivate people to think about their on-the-water activities, their potential impact on the ocean, and their on-the-water safety. (SCUBA not included).

A. Start inside your home (concept 6e, 6f)

1. Planning for your trip on the water includes:

Note to designers of guides for California beach walks:

Two references that provide pertinent information about why the California beach walker should care about the beach are:

1. California Beach Closure Report 2002 issued July 2003 by the State Water Resources Control Board, California Environmental Protection Agency. This report addresses causes of beach closures and sources of beach pollution. (http://www.swrcb.ca.gov/beach/report/2002/beachclosure2002.pdf)

2. California's Ocean Economy: Report to the Resources Agency, State of California. Prepared by the National Ocean Economics Program (July 2005). This report contains information about the economic value of California's ocean resources. There is extensive coverage of the value of California's beaches to the state's economy. In the year 2000 more than 12 million people visited Califronia beaches and, on average, each person made slightly more than 12 trips per year. Helping even a fraction of beach goers to understand the ocean could substantially increase the number of beach stewards. (http://www.respources.ca.gov/press_documents/CA_Ocean_Econ_Report.pdf)

a. Checking tide tables

b. Checking weather (NOAA marine forecast)

c. Determining what clothing to take (depends on weather)

d. Determine what gear to take (depends on specific activities) Planning to minimize your trip impact

e. Can you walk or car pool to your activity?

f. Do you have appropriate containers for waste you will generate?

g. If you are going fishing, do you have tools for releasing fish you will not keep?

B. Your vessel (concept 6e)

1. Is the propulsion system designed to minimize pollution?

2. Is your vessel being maintained so as to minimize pollution?

3. Do you have tools to minimize pollution (oil sponges, etc?)

C. Your vessel operation (concepts 5a, 5c, 5f,6e)

1. Do you consider sensitive habitats with respect to how you operate? Kelp beds, seagrass beds, rocky reefs (potential anchor damage), estuaries (high wake related to erosion)

2. Do you recognize and understand marine life you may encounter and their behaviors?

a. Marine mammal Identification and behavior

b. Seabird ID and behavior

c. Fish ID and behavior

d. Invertebrate ID and behavior

3. Are you aware of regulations and laws protecting ocean wildlife and the impacts you might have? Do you have a copy of NOAA's *Ocean Etiquette*?

a. Marine mammal injury or harassment

b. Seabird injury or harassment

c. Adhere to fishing regulations, taking only what you need and releasing unneeded or unwanted catch using techniques that avoid or minimize injury to the animal.

4. Do you recognize & understand issues concerning not-native marine life?

a. Plants such as *Caulerpa* spp.

b. Animals; Invertebrates and/or fishes

D. Why should you care? (6g). This section should be used to tie together and wrap up the key concepts and provide motivation for stewardship and information about becoming a steward.

E. Feedback loop

1. Take pictures and send these to a regional website or clearinghouse, or post them on the Internet.

2. Ask questions a. Send these to a website where local experts provide answers

Naturalist-led Shore-based or On-the-water Program

Seal Beach National Wildlife Refuge volunteers conduct bus, car, and walking tours of the 1,000-acre refuge. On walking tours they satff five stations along the trail: birding, wetland ecology, endangered species, floar and fauna, and conservation. The refuge is home to endangered California Clapper Rails, Belding's Savannah Sparrows, and, seasonally, California Least Terns.

Whether on-the-water or shore-based, naturalist-led

Source: NOAA's NMSP

outdoor experiences such as this Gulf of the Farallones NMS beach walk pictured above are ideal venues for helping the audience to understand selected key concepts.

Delivering the Message: Examples

Key Concept

The fundamental knowledge about the ocean that scientists think the public needs to understand to be considered "ocean literate" (documented in the workbook *Public Ocean Literacy: What Residents of Southern California Should Know*).

Interpretive Question: The question posed by the naturalist to engage the group at an opportunistic moment in an on-the water activity or when first arriving at a stop on a shore-based activity such as a beach walk.

Naturalist's Background Knowledge: Content knowledge needed relative to the concept so as to best facilitate the learning of participants.

Stop Location or Opportunistic Moment: A selected "site" that would best illustrate the concept(s) to be addressed. This may be predetermined in the case of a walk and at certain points on-the-water.

Props: Tangible objects to facilitate connection to intangible or abstract concepts. These can be part of the naturalist's equipment.

Stewardship Message: Contribution participants can make expressed in positive terms, i.e. "Do", not "Don't".

Key Concept 1g

The ocean is connected to the land's drainage system including waterways by the watersheds that carry the drainage's outflow to the ocean.

(Encourage participant involvement at the beginning of the walk by asking what watershed he/she lives in. Be prepared to define and illustrate a watershed).

Interpretive Question: Would you drink this water? If no, why not?

Naturalist's Background Knowledge: What a watershed is, where the waterway began, its length, what part of the landscape it has passed through, what was its initial water quality, what happens during storms, role of stream, runoff phenomena, upstream land use, urban impacts, agricultural impacts, industrial impacts, dead zones, how water quality changes on its way to the ocean, how is a creek important to ocean? (Example: sand provision)

Stop Location: Mouth of creek, stream, or river that drains in the ocean or coastal bluff overlooking the river mouth

Props: Bottle of water, map of watershed (if available, historic and present), temporal published water quality information

Stewardship Message: Relate what partnerships of governmental agencies, non-governmental organizations, and volunteer groups are doing. Encourage reflection on personal commitment to reducing amount of solid waste we generate and whether per-

sonal practices/choices might impact the watershed and quality of water flowing into the ocean. Encourage participation in local coastal cleanups and groups involved in watershed ecosystems protection. Share sources of information about how to find such activities.

Key Concept 2b

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

Interpretive Question: Would you want to build a house here?

Naturalist's Background Knowledge: geology of California coast (comparison to East Coast), weathering in coastal environment, history of the area and problems of erosion along California's coast, human impacts on natural processes, efforts to mitigate erosion and costs.

Stop Location: A site that illustrates coastal erosion. (These sites are often highly visible during on-the-water activities)

Props: Bags of different sand samples, visuals of mudslides, landslides, etc.

Stewardship Message: Practice "leave no trace" ethics while walking in coastal bluff areas.

A Commercial Networked Partnership Focused on Ocean Literacy

There are a multitude of commercial enterprises that provide venues for the general public to experience the outdoor ocean world. In addition to cruise ships and commercial vessels carrying passengers from Point A to Point B, there are whalewatch and birding trips, kayak rental facilities, sport fishing operations, harbor and sunset cruises, dive and surf shops, wind-sailing rentals, boat rental facilities, natural history vessels, etc. While many commercial operations already provide opportunities for the public to have outdoor experiences, very few deliver ocean literacy messages to their customers. By partnering with commercial enterprises we can work together to change that.

Objectives:

1. To develop a networked partnership of commercial ocean enterprises with organizations and agencies that provide public outdoor experiences
2. To provide an Ocean Literate Commercial Network Program (OCLNP) which the commercial enterprise owners endorse, support, and participate in.

Two steps are necessary to achieve the objectives. These are to:

1. Identify commercial enterprises that provide the public with direct outdoor experiences,
2. Work with these enterprises to develop storylines that will increase the public's awareness and understanding of their ocean surroundings.

The program would incorporate applicable key concepts. It would include: a training program for boat operators and/or other staff of commercial enterprises, a take-home activity document, two videos, and various stand-lone passive items or artifacts such as a map or signage with light interactives. Each participating commercial enterprise would be evaluated to determine what type of program provides the best fit.

Training tailored for the specific needs and abilities of the various commercial enterprises would focus on face-to-face interaction. The key concepts of

ocean literacy would be illustrated with interesting and fun facts appropriate to the outdoor experience provided. Examples of ways to raise customer awareness and understanding of the outdoor experience would be supplied. Feedback from trainees would be encouraged. The anticipated end result? Boat operators and crew would become more active and comfortable in drawing attention to the natural world by sharing about ocean literacy information.

Media appropriate to the specific needs of the commercial enterprise would be supplied. Take home activity books would be similar to the one described in the example below. They would be colorful, interactive, and educational. Videos would provide an inspiring narrative with exiting ocean-related visual imagery. Fixed graphics would display key facts and fun facts for passive interpretation.

Proposed Program Example: Catalina Express

Background

Catalina Express provides west coast passenger boat transport service and is a major promoter of tourism to Catalina Island off the coast of Southern California. In its 22-year history, the company has carried more than 15 million passengers to and from the Island. Today the company annually moves more than one million passengers from Point A to Point B. These ocean-going trips present an opportunity to provide ocean literate messages to a captive audience.

Training

The training for Catalina Express boat operators and crew will include talking about key concepts and fun facts. Some examples: announcing when the vessel is over the deepest part of the channel, differences in summer and winter water temperatures, that gray whales migrate on both sides of the island, make reference to the take home activity book, etc. Ideally boat operators will point out whales and other wildlife to passengers, or even slow down the boat when wildlife is spotted to talk about ocean etiquette.

Activity Book

A companion take home document, the ocean literacy activity book, will be created that will be available on the boat. The document will be similar to NOAA's activity books and colorful and imagination-rich with activities for adults and children and suggestions for outdoor opportunities on Catalina Island. For example, the passenger might snorkel to visit a kelp forest, or take a walk to investigate beach sand. The document will include information about what the passenger can do to become an ocean steward. These would directly relate to areas of concern about the ocean linking back to key concepts.

Videos

Two 15 minute looping videos will be produced;

> Pre-island Video 1: Shown on the trip over to the island, this video might have a storyline that includes key concepts 5a, b, c, d, e and g (phytoplankton, traveling near shore to over basin to over kelp forest, California spiny lobster and sheephead, and the whale fall story) The video will prepare people for their experience on Catalina Island, encourage questions, and provide opportunities for exploration.
>
> Post-island Video 2: Shown on the trip back to the mainland, this storyline might include key concepts 6a, b, c, d, e, f, and g (reference California's Year 2005 economic report & impact of the ocean on California's economy, urban connections, development, and we are all connected to the ocean).

Props and artifacts

Items created for the boat might include a large graphic with colorful imagery that tells a story of going from Point A to Point B. The graphic would be in map form and large enough for the viewer to see where he/she is coming from and going to. The graphic could illustrate the urban interface and migration of gray whales, and ocean depths currents, and temperatures. If graphically feasible, key concepts could be part of the display. Operators and crew would be trained to talk about the points on the graphic

Staffing Outdoor Experiences

During discussion about the role of outdoor experiences in providing opportunities to achieve the goal of an ocean literate public, group members pointed to existing outdoor structured programs that are succeeding in giving the public ocean conservation messages that could be developed into ocean literacy storylines. These ocean-oriented programs, such as whalewatching, tidepool walks, beach walks, beach monitoring, coastal hiking and biking, etc, all had a common denominator—they were staffed either in part or totally by trained volunteers.

For example, the National Marine Sanctuaries have a volunteer program initiative called Team OCEAN (Ocean Conservation Education Action Network). The primary objectives of this volunteer program are: public education through one-on-one interpretation, promoting stewardship by instilling a sense of personal understanding, ownership, and responsibility for the sanctuary, and establishment of a sanctuary presence on the water that emphasizes proper use of marine resources now and for future generations. Illustrated are programs at some of the west coast sanctuaries.

Source: NOAA's NMSP

As part of the Channel Islands National Marine Sanctuary's program, volunteers accompany the public on boat trips to the islands aboard commercial boats that participate in a partnership with the NMS. In addition to the ship captain serving as a knowledgeable guide, the volunteers intermingle with passengers, answering questions and pointing out interesting sightings. The volunteers also serve as naturalists aboard whalewatch boats.

Source: NOAA's NMSP

Volunteers for the Gulf of the Farallones NMS SEALS program provide interpretation for the public and conduct research on harbor seals. They are provided with extensive field experience and classroom training as part of the program.

The group was also cognizant of many primarily volunteer-based nonprofit organizations that actively support marine education efforts. Such efforts are usually:

1. Tied to the specific mission or interest of the

organization. For example, local chapters of the Audubon Society teach the public about bird life during their field trips. Similarly Sierra Club hiking outings focus on topography, elevation, life zones, trail erosion, and so forth, or

2. Involves the organization's membership in outdoor experiences more directly related to the ocean. The extent to which these activities include specific educational goals and objectives, interpretation strategies, and instructional devices varies greatly.

Recommendations

1. Model Outdoor Experience Products

Recognizing the existence of organizations already involved in engaging the public in outdoor experiences, some of which include ocean literacy storylines and others that, while they convey conservation messages, these messages are not planned to achieve ocean literacy as a desired and important outcome, the outdoor experiences group made these recommendations.

Recommendation: The group felt that one practical "product" would be the staging of one or more regional workshops to create models to assist organizations and agencies in incorporating ocean literacy key concepts into their outdoor activities agenda. Prior to the workshops, a task force would need to be developed to identify entities that could be used as exemplary models for both public programs and volunteer training. For example, since the October workshop, the Catalina Conservancy has incorporated the key concepts into the support and reference materials for both the conservancy's naturalist training program and Master Interpretive Plan. The Gulf of the Farallones National Marine Sanctuary has a volunteer Beach Watch program and also one called SEALS (Sanctuary Education Awareness and Long Term Stewardship). The Seattle Aquarium in conjunction with several other sponsors including King County Department of Natural Resources and Parks has a beach naturalist program. CINMS has its Naturalist Corps volunteers. And there are others.

2. Volunteer Naturalist Training

The outdoor experiences group believes that volunteers trained in the delivery of ocean literacy storylines offer one of the best means for achieving the challenging goal of an ocean literate public through outdoor experiences-teaching, helping the public interpret and understand the ocean, and enhancing their appreciation of it so that they develop an ocean stewardship ethic that they will share with others.

Recommendations:

A. Identify and bring together representatives of organizations that have existing structured programs incorporating ocean literacy for training volunteer naturalists and monitors. Organizations should also be included that do not so as to encourage the inclusion of ocean literacy concepts into their activities.

B. Develop an outline and suggested content for a training manual and materials publication that emphasize the key concepts and are adaptable to a variety of outdoor experiences. The anticipated result? A statewide corps of trained volunteer naturalists who deliver consistent and accurate ocean literacy messages at places of public interface.

C. Structure a model training program for volunteer naturalists and monitors staffing outdoor activities that incorporates what the scientists in the CORE workshop thought an ocean literate person should know. The training program should be based on

the curriculum, lesson plans and pedagogic techniques of those organizations and agencies that have been recognized as having exemplary programs. Key stewardship activities that could give added value to these programs should be incorporated into the final program. The manual should address essential content, materials, and effective interpretive techniques to illustrate the concepts. The topics of data monitoring activities and other activities that contribute to responsible stewardship of our ocean should also be included. . Such a training manual would promote consistency of message and quality of delivery.

D. Develop a "how to" guide for creating a naturalist training program to serve as a practical model that summarizes the steps and initiatives that the organizations with exemplary models took to develop their outdoor educational activities and to recruit and train the staff and/or volunteer team members to implement the activities.

3. Commercial Networked Partnership

The value of an outdoor experiences commercial network is described above and a program example for Catalina Express described.

Recommendation: The outdoor experiences group should analyze the partnership of CINMS with boat operators and build on it to develop a guide for agencies and organizations to partner with the boating industry segment that provides outdoor experiences. The Aquarium of the Pacific should develop a model program using Catalina Express as the test site.

4. California Coastal Guides and Ocean Literacy

The *California Coastal Access Guide*, published by the California Coastal Commission (now in its fifth and last edition), includes information on all of California's coastal scenic and recreational facilities. In addition there are articles about the coast's geology, climate, erosion, wetlands, etc. This guide is being replaced with regional guides that combine the guide with the no-longer published Coastal Resources Guide. The first of these regional guides, *Experience the California Coast: A Guide to Beaches and Parks in Northern California* was published in November 2005. In addition to information about beaches, parks, access to the coast, etc, the guide contains environmental messages and introduces the coast's major environments, including beaches, rocky shoreline, and the redwood forest, and highlights the plants, animals, and birds that can be seen in each. A second guide focusing on California's central coast is in preparation.

The *California Coastal Trail Hiker's Guides* are works in progress. They are part of a coastwalk project supported by the California Coastal Conservancy. Maps of the California Coastal Trial (CCT) are being created and information gathered to provide hikers and other coastal visitors with a useful resource that will help in planning an outing. Underway since 2002, it is an ambitious project that involves volunteers up and down the California coast in walking the trail and recording its alignment with a GPS unit, taking photos and noting the amenities that are found along it. The information gathered will be incorporated into maps of the trail by Coastwalk staff, and these maps, photos, and the accompanying information will then be displayed on a web site with links to aerial photos of the coastline. The entire 1200 mile coastal trail extends from Oregon to Baja California.

Recommendation: The Outdoor Experiences group should investigate the feasibility of inclusions of ocean literacy messages in the guides.

5. Underserved Coastal Areas

Recommendation: Identify more populated areas along the coast that are not served by at least one program already contributing to the task of cultivating an ocean literate public through outdoor activities. By identifying such "gaps," advocates of ocean literacy will know where new programs were needed or where existing programs might expand into.

Outdoor Experiences Group

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The Web:
The Ducks and Bolts of Online Learning

The next big killer application on the internet is going to be education. Education over the internet is going to be so big it's going to make e-mail usage look like rounding error.

– John Chambers, CEO, Cisco Systems

Introduction

The web is a very flexible modality for providing storylines and messages that will help the public become ocean literate. It:

1. allows multiple layers of learning that can be updated regularly and tailored to meet the needs of diverse audiences and interests;
2. can offer elements for individuals, students, families, and teachers, that are multi-generational, and delivered in multiple languages;
3. can augment and enhance other modalities such as onsite or outdoor experiences through supplemental content on exhibits, online press kits, and other opportunities when space or time is an issue in communicating information; and
4. most importantly, it is an environmentally friendly way to disseminate information that can reach millions of people.

One of the major concerns traditional educators have with Internet-based learning is that it will replace the important face-to-face element of the learning process. However, that need not be the case if a "blended learning" approach is applied. This collaborative learning combines aspects of face-to-face and online instruction that helps enhance the learner's experience and overall retention of facts and concepts. Blended learning with a web-based learning element takes into consideration the learner's time and individual learning style. It provides a consistent, familiar environment that helps learners make the important connections between what they learn and what they experience.

Recent studies have identified that blended learning with a web-based element increases knowledge retention by 25%, improves the scope of learning by 5 times, decreases cost of delivery by 1/3, reduces time of effort by 50-60%, and enhances audience reach with its scale, speed, and specialization. (*Sources: Horton W. (2000) Designing Web Based Training and Bersin and Associates.*)

Web-Based Learning (e-Learning)

Goal: to deliver the right information to the right people, and to make it accessible, convenient, and delivered at the key moment.

The learning must also appeal to a diverse range of learning styles including those who like to read and see, those who like to listen and speak, and those who like to do something interactively. In addition to the "Ocean Literacy Journey" tool, we recommend supplemental interactive e-Learning that will be focused on delivering expanded information to staff and volunteers of aquariums, museums, etc. to help them focus on ocean literacy key points with their visitors. Short 20-30 minutes courses will be designed to take learners through a linear path that includes essential information from the seven key concepts. On completion of a linear path, learners will receive a certificate of completion that identifies them as an "Official Ocean Literacy Advocate." Learners can return to the course at any time for

refresher review. We would also use this forum to include elements from the other team's reports that can be made available online. This e-Learning can also be made available to the general public. Schools can use it as a supplemental teaching tool, especially prior to a field trip experience.

The challenge for e-Learning is to appeal to these varied learning styles by engaging learners in an interactive, personal experience that holds their attention without overwhelming them with information. Our ocean literacy web-based learning site must be more than a place for people seeking additional information on an exhibit or ocean-related topic. The Website needs to be an entertaining, exciting, and intelligent experience that satisfies both children and adults.

Because the goal of the ocean literacy initiative is to educate the public on ocean key concepts, we must assume they are not already actively seeking this information. Therefore, the Website must attract their attention, entice them to learn more about the subject, excite them enough to recommend it to friends, and provide ongoing enrichment that keeps them coming back for more. The web modality should be more than an informational site because it must compete with a multitude of other sites for the learner's attention. By combining multimedia aspects such as animation and video and allowing the visitor to interact and make choices in an innovative, enjoyable environment, the Website will market itself through word of mouth.

Non-profit organizations and governmental agencies are beginning to realize the cost and time benefits of providing this blended "e-Learning" approach to their volunteers, staff, and audiences. The learning is available to them 24 hours a day around the globe. Learners can access the training at their convenience in their home environment. Organizations can capitalize immediately on volunteer/staff initial enthusiasm as these learners do not have to wait for a scheduled training class. This allows learners and the training staff to improve productivity and use their time more efficiently.

Blended e-Learning is also learner-directed, accommodating multiple learning styles and allowing learners more control over their learning process. They can go through the online learning linearly the first time, then return to the course content to refresh and to double-check their understanding. Organizations have also found that by requiring volunteers to take some online training and then supplementing it with focused classroom sessions, they effectively "screen" for committed volunteers. If a volunteer does not complete the online learning, he or she might not be the "right fit" for the organization, thus helping to reduce the time and costs of training and providing materials to someone who leaves in the first few months of service.

As part of the ocean literacy web modality, the web group created a structure for a website that uses an interactive story to educate visitors on the seven key concepts of ocean literacy. In addition to the story, it provides learners direct, easy access to additional information about these concepts. Our group believes that this is where we can blend the learning from the other modalities.

The Ocean and You Learning Center: Our Website, an Example of e-Learning

The main links will include the following topics: weather, seismics, oxygen, ocean currents, diversity, the unknown, and the ocean and you. Each of these topics serves as chapters in the story. On each page of the site, there will be context-sensitive information relating to that page that includes a "***You are Here***"

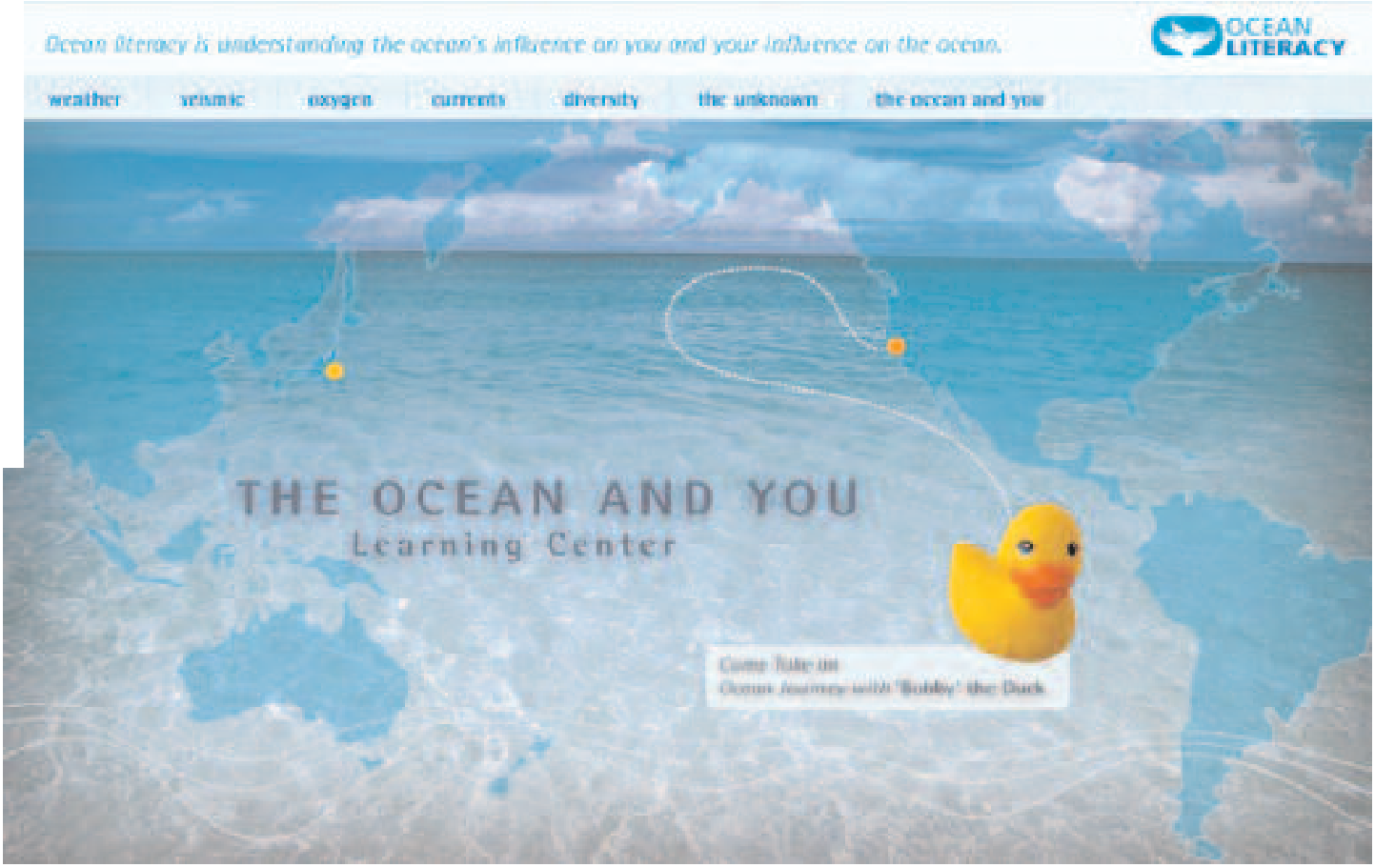
map to help learners become familiar with the geography of the ocean's locations, "***Dive Deeper***" symbols for more information on a topic, and ***"Resources***" with links to other sites, activities the learner can conduct at home, and upcoming events. All narrative will provide an option for captioning.

The concept of a journey can be expanded with new chapters on other topics, allowing the site to offer ongoing education. Those who have already participated in the journey can return to use the site's resources at any time. The journey is designed to be a clever, innovative, and interactive experience for all ages. Video can include interviews with scientists and even celebrities. Animations can be used to illustrate processes and complex subjects. Other elements such as chat rooms, blogs, teaching guides, online interviews, simulations, guided analysis and research, and virtual labs and museums can be added as layers. For those on limited budgets who cannot afford the programming involved to create the entire story, the individual chapters can be created to stand alone on an information Website to illustrate the individual concepts.

The storyline

The goal—to connect people with the ocean and show them what can happen to an object innocently left behind and the impact it can have.

Our story begins with a movie that shows a little girl



"Ocean and You Learning Center" homepage. *Source: Aquarium of the Pacific*

playing with a rubber duck on the shore. Her mother calls her and she leaves the duck behind. The duck remains there as the sun sets and everyone leaves the beach, then a sea gull picks it up thinking it might be food. Fooled, the gull then drops the duck into the ocean. The elements include families, sea gulls looking for food, children laughing, and surf sounds.

Next visitors are invited to "Come take an ocean journey with 'Bobby' the Duck, who was left on the beach at Santa Monica and then dropped in the ocean. He ends his journey on the coast of Japan. Your challenge is to find out how Bobby gets to Japan. Your journey will take you through a series of decision points at key situations. In some chapters, a correct answer will take Bobby closer to his destination. To begin your journey with Bobby, please click on his image.

Chapter 1: Weather

Illustrates the concept that the ocean determines our weather. Viewers will be asked to decide what happens when they choose between two ocean events—El Niño and La Niña. Elements will include an animated map of the two phenomena with accompanying narrative explaining each element and its effects. The viewer will then be asked "Which event will take Bobby closer to his goal?" Each choice will show a movie and how it affects the weather and people. The correct answer in all chapters will show Bobby moving on a map toward his goal.

Chapter 2: Seismics

Illustrates the concept that the ocean and life in the ocean shapes the Earth. Learners will be asked to determine what happens when two different seismic events occur—a normal earthquake and a slip-strike earthquake. Elements will include examples of the types of earthquakes and how they affect the ocean and people. It will incorporate a video of a tsunami, thus relating to current events.

Chapter 3: Oxygen

Illustrates the concept that the ocean makes Earth habitable. This chapter will not include choices as learners are shown what animals help us breathe. Elements will include animation of how marine organisms provide oxygen and narrative that explains the phenomenon.

"Chapter 1: Weather" concept page
Source: Aquarium of the Pacific

Chapter 4: Diversity

Illustrates the concept that the ocean supports a great diversity of life and ecosystems. Learners will be asked to determine what happens when different animals encounter Bobby. Elements will include a video showing ocean diversity and will focus on three animals: a sea turtle, a humpback whale, and a giant sea bass. A map of each animal's migration and home range will be included. The choices will explain the animal, its habitat, and our relationship to it. The whale will be the correct choice.

Chapter 5: Currents

illustrates that there is one interconnected world ocean with many characteristics. Learners will be asked to determine what happens when they choose between two different ocean currents. Elements will include a movie of the world ocean and its major currents. Learners will be asked to choose which current will help the duck reach its goal. Movies of currents, how they interact with other currents, and the elements they encounter will be included. Explanations will include how throughout history currents have allowed us to explore the planet, but also have spread pollution.

Chapter 6: The Unknown

Illustrates that the ocean is largely unexplored. Learners will be invited to find out what happens when Bobby descends deep into the ocean. Elements will include video of life in the deep ocean, statistics on how little of the ocean has been explored, and the importance of funding for research. Learners will not be given a choice here. They will see a movie of Bobby being pulled from the sea floor by the robotic arm of a research vessel and taken in. In doing so, they will view and hear interviews of researchers and videos of researchers at work.

Chapter 7: The Ocean and You

Takes place on the shores of Japan as the research vessel pulls up to the dock and a crew member gives the duck to his daughter. This chapter will discuss how humans are interconnected to the ocean. Elements will include a montage video on our connections to the ocean including medicines, food, recreation, and coastal communities. It will contain messages on our responsibility for the ocean and recap through Bobby's journey how our actions can have effects around the world. It will conclude with ways that learners can help and become stewards of the ocean.

Podcasting and Vodcasting

Podcasting is a method of delivering audio content over the Internet for listening on mobile devices that can receive digital audio files and personal computers. Podcasts allow users to listen to audio files when they want, where they want, and in the mix that they choose—song, speech, or a mix of sounds. In contrast, traditional broadcasting only provides one source at one time, and at the time set by the broadcaster. The ability to "aggregate" audio from multiple sources is part of the appeal of podcasting. Users can subscribe to services supplied by a podcaster such as an aquarium, museum, nature center, etc., download audio content from the organization's web to their personal computer, and from there to a portable digital audio player if desired.

Vodcasting is "video-on-demand". Almost identical to podcasting, it adds video to the audio broadcast. A more recent phenomenon than podcasting, it has now available on selected cell phones and other devices equipped to display video.

Both podcasting and vodcasting give 'podcasters' the opportunity to reach a large online audience, and many informal learning centers are incorporating this means of communication into their web offerings. NASA uses its "Science@NASA" podcast to provide science news stories. By February 2005, it had become the #1 most popular podcast among users of a podcasting news service. Two of the Santa Barbara Museum of Natural History's offerings focus on the Ty Warner Ocean Center and the museum has plans to incorporate ocean literacy concepts into its programs. The San Francisco Bay Joint Venture (SFBJV) is a partnership of public and private agencies, conservation groups, development interests, and others. The goal of the partnership is to protect, restore, increase, and enhance all types of wetlands, riparian habitat, and associated uplands throughout the San Francisco Bay region. The SFBJV has just launched a series of podcasts focusing on the area's wetlands. The Aquarium of the Pacific's has chosen key concept 1, “The Earth has one world ocean with many basins, seas, bays…”, for its first ocean literacy podcast, titled "Should Planet Earth Be Called Planet Ocean?"

It is true that podcasting and vodcasting can provide links to learning about ocean literacy. Used before a visit to an informal learning center or on a self-guided beach tour, they can prepare the visitor, i.e., set the stage; expand the visitor's experience at the nature center, for example, on a self-directed tour; and they can provide follow-up experiences. However, a few words of caution.

The value of podcasting and vodcasting to a learning center is dependent not only the content and how it is presented, but also in the quality of the sound or video display. The public is accustomed to high quality TV and video productions as well as the polished voices of broadcasters. Extensive testing and control of quality is essential for '"homemade' programs. It should also be kept in mind that these delivery vehicles are adjuncts to the teaching tools already available, not replacements for them. There will always be a segment of the public that uses methods other than electronic devices to learn. MP3s should be provided on the learning center's website for those who do not have Ipods® or use iTunes® so that programs can be played on the individual's alternative MP3 player or personal computer.

Summary

The web can provide an effective tool with which to deliver ocean literacy messages to a large and widespread audience. In order to compete with all the other potential sites and engage an otherwise uninformed audience ,web-based messages must be innovative, interesting, and interactive, while at the same time effective in teaching complex processes and allowing those who want to know more to "delve deeper" for additional information.

Recommendations

1. Applications for e-Learning

In addition to the "Ocean Literacy Journey" tool, the web group recommends d supplemental interactive e-Learning focused on delivering expanded information to staff and volunteers of aquariums, museums, etc. to help them relate the ocean literacy key concepts ocean literacy to their visitors. Short 20-30 minutes courses should be designed to take learners through a linear path that includes essential information from the seven key concepts. On completion of a linear path, learners would receive a certificate of completion that identifies them as an "Official Ocean Literacy Advocate." Learners can return to the course at any time for refresher review.

Elements of the design for staff and volunteers e-learning should be adapted for the public and made available online. In addition, it should be modified so it can be used as a supplemental teaching tool, especially prior to a field trip experience.

Recommendation: The web group should be included in the development of model training programs for volunteers, monitors, and boat operators and crews so that e-Learning can be incorporated into the programs if applicable.

2. Need for "Inside" Communication

On-site experiences and many outdoor experiences involve direct interactions with the public. Outdoor experiences also often occur at public places. In contrast, the web is an interaction of the viewer with an organization or agency electronically that often occurs in the individual's home or workplace. The web group believes that it is important that e-learning be coordinated with the storylines and messages offered by other modalities so that content of all is consistent and meets the same high standards for quality.

Recommendation: The web group should have access to and be kept informed about how ocean literacy key concepts are portrayed to the public so that the content of storylines and messages developed by all groups is consistent.

3. Podcasting and Vodcasting

These newer methods for communicating with the public can be valuable tools for presenting and/or enhancing ocean literacy messages and storylines but they need to match as closely as possible the quality of video and broadcast productions to which the public is accustomed.

Recommendation: The web group should analyze and make recommendations to other groups about the use of podcasting and vodcasting as media for enhancing public ocean literacy and should be involved in the quality control of the productions.

Web Group

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Appendix 1:
Key Concepts (Adapted from COSEE-NMEA Concepts)

Key Concept 1

The Earth has one world or global ocean with many basins, seas, bays, lagoons, estuaries, and other features such as submarine canyons, seamounts, volcanoes, and marine ecosystems.

a. The ocean is the dominant physical feature on planet Earth covering about 71% of planet Earth.

b. An ocean basin's size, shape and features (such as islands, trenches, midocean ridges, and rift valleys) are shaped by a result of movement of Earth's lithospheric plates.

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.

d. Sea level is the average height of the ocean relative to the land with the differences caused by tides taken into account.

e. The world ocean has an average salinity of 3.5% and properties that make it unique from fresh water.

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

g. The ocean is connected to the land's drainage system including waterways by the watersheds that carry the drainage's outflow to the ocean. (See the Southern California Bight section for information about some California watersheds).

h. Although the ocean is large, it is finite and its resources are limited. *(Note: see also Key Concepts 6 and 7).*

Key Concept 2

The ocean and life in the ocean shape the Earth.

a. Sea level changes over time have exposed and flooded continental shelves, created and destroyed estuaries and inland seas, and shaped the coastline and the surface of coastal areas.

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

c. 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.

c. Condensation of water evaporated from the oceans provides the energy for hurricanes, cyclones, and typhoons.

d. Tectonic activity, sea level changes, waves, and tides influence the physical structure and landforms of the coast, as well as human-built environments.

e. Many of the sedimentary rocks now exposed on land were formed in the ocean. Ocean life laid down the vast volumes of siliceous and carbonates rocks that we see today as a result of sea level changes and tectonics.

Key Concept 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 sys-

tems.

b. The ocean absorbs much of the solar radiation reaching Earth, then redistributes it through surface circulation, regulating the temperature of the planet.

c. Condensation of water evaporated from the oceans provides the energy for hurricanes, cyclones, and typhoons.

d. Next to the seasons, the El Niño-Southern Oscillation is the most powerful force driving global weather.

e. The ocean acts as a global conveyor belt for heat, moderating our global climate.

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

g. Changes in the ocean's circulation have produced large, abrupt climate change during the last 50,000 years, with far reaching consequences for life on Earth.

Key Concept 4

The oceans make Earth habitable.

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

b. Most of the oxygen in the atmosphere originally came from the activities of photosynthetic organisms in the ocean-making the oceans the "lungs of the planet."

Key Concept 5

The ocean supports a great diversity of life and ecosystems (i.e. kelp forests, coral reefs and hydrothermal vent communities).

a. Most life in the ocean exists as microscopic organisms, however, ocean life ranges in size from the smallest virus to the largest animal believed to have lived on Earth, the blue whale.

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

c. Most major groups of organisms 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 great deal 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 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.

Key Concept 6

The ocean and humans are inextricably interconnected and every human is affected by the ocean.

a. The ocean supplies fresh water, moderates the climate, and influences the weather. (These are addressed in depth in Key Concept 3 and briefly in Key Concept 1).

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

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.

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

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.

Key Concept 7

The ocean is largely unexplored.

a. The ocean is the last, large unexplored place on Earth.

b. Understanding the ocean is more than a matter of curiosity-exploration, inquiry, and study are required to better understand ocean systems and processes.

c. The future sustainability of ocean resources depends on our understanding of those resources and their potential.

d. Enhanced and new technologies are expanding our ability to explore and understand the ocean and its resources.

e. Ocean exploration is interdisciplinary.