Background

Covering 71 percent of the Earth’s surface, containing 97% of the planet’s water, and providing 99% of its habitat, the ocean affects us and we also affect it. Oceanic resources provide food; raw materials for industry; energy for our homes and vehicles; new medicines to improve health; and important recreational opportunities. Historically, the ocean has buffered the United States from overseas conflicts and foreign intervention, thereby significantly enhancing our national defense.

The interactions between the ocean and the atmosphere control our daily weather and regulate world climate. El Niños, hurricanes, and coastal storms are having an increasing impact on growing coastal populations and infrastructure. In the United States alone, coastal hazards have resulted in nearly $50 billion in damages over the past decade. Such numbers will continue to rise as half the world's people now crowd onto the two percent of the Earth’s surface that forms the coastal zone and the migration continues.

To be healthy and productive, coastal oceans and the industries that depend on them need to be sustainable. The oceans provide many individuals with their livelihood. One out of six jobs in the United States is marine-related and one-third of our Gross National Product is produced in coastal areas, where most major cities are located. Travel and tourism is the largest and fastest growing segment of the U.S. service industry and 180 million people visit our shores each year. It is apparent in coastal areas worldwide that human activities are modifying coastal zone ecological systems substantially and seriously affecting their sustainability. Near-shore waters receive wastewater from domestic, industrial and agricultural runoff that has had a significant, negative impact on coastal ocean health. Many fisheries have collapsed and formerly economically valuable species are now considered endangered. Contaminated sediments have led to restrictions on dredging of major U.S. ports, through which 95% of our foreign trade must pass.

As these examples clearly demonstrate, the oceans are central to the natural processes of the planet, play an important role in our economy, and are rich with connections to our daily lives. The myriad of issues related to the coastal
environment and global climate change show no sign of waning in the future and in fact, will probably become more difficult to manage as global populations increase and as people continue to move into coastal areas. Policies to address these issues will be established either by default or through thoughtful planning and implementation. However, for the latter to happen a scientifically literate populace is necessary.

Recent surveys by the National Science Foundation (NSF), show that while the majority (>73%) of the U.S. public holds a positive attitude toward science and technology, that same group was only able to correctly answer 58% of the questions asked about basic scientific concepts (NSB, 2000). Furthermore, only 26% of those surveyed actually understand the nature of scientific inquiry. While these figures are an improvement when compared to previous survey results, the fact remains that the United States needs to continue its efforts in having a well-informed citizenry on matters of science and technology. Without informed citizens, we are guaranteed that policies will be established without sound science.

**How can ocean scientists help?**

Ocean scientists can help in alleviating this dilemma by leveraging the excitement and wonder that water elicits in the general public and the inherently multidisciplinary and often interdisciplinary nature of ocean research. The oceans provide an exciting context in which to teach the fundamental concepts of biology, chemistry, the physical sciences, and mathematics in accordance with the *National Science Education Standards* (NRC, 1996) and *Benchmarks for Science Literacy* (AAAS, 1993). Many individuals and institutions in the United States already are actively engaged in employing ocean sciences in the broader context of improving science education for all Americans; however those efforts are not well coordinated on a national scale.

**What is CORE’s Role?**

CORE was established to represent the entire ocean sciences community at the national level and to promote marine research and education on multiple fronts—with policy makers and agency representatives in Washington, D.C., as well as with the educational community and the general public. To that end, one of CORE’s goals has been to establish links and partnerships among member institutions and other entities that have missions in either science and technology or science education that are complementary to its own. An integral part of this goal is the development of a partnership between the ocean sciences research community and K-12 educators to enhance teaching and learning in science and to excite young people about careers in the sciences. To date, CORE has used its network of institutions and links to other professional associations to implement the
National Ocean Sciences Bowl (NOSB). These partnerships have enabled the NOSB’s success and it is now time for the CORE community to build on this success in order to move forward supporting other K-12 educational efforts.

This paper presents the CORE Education Committee’s recommendations for initiating significant and needed changes during this period of national transition and renewed focus on U.S. ocean policy. The question we are asking ourselves as a community of marine research scientists is how can we contribute most effectively to the education of the nation’s children, the leaders and decision-makers of tomorrow?

**Existing and Emerging Education Programs in the Geosciences**

Currently, there are many exciting opportunities to advance science education in the United States. The *National Science Education Standards (NSES)* and *Benchmarks for Science Literacy* have renewed the focus on the role of science in this nation’s classrooms and beyond. As a result of this attention, the geosciences community, through the NSF and other sources, has supported a variety of new initiatives to create efficient mechanisms for bringing the excitement of scientific inquiry into the classroom through a variety of media.

- The newest, and arguably most ambitious, of these programs directly related to the marine sciences is the Centers for Ocean Science Education Excellence (COSEE, http://www.ims.usm.edu/cosee/), an NSF-sponsored initiative. A workshop was held in May 2000 to recommend strategies for developing a nationally coordinated effort to improve and promote ocean sciences education within the broader context of science education reform in the United States. CORE endorses the recommendations of the 2000 workshop and looks forward to developing partnerships within the COSEE framework.

- The Digital Library for Earth System Education (DLESE, http://www.dlese.org/) is a wide-reaching NSF-funded initiative that developers envision serving the needs of the education community by providing protocols and a digital portal for all information related to Earth Systems, including the oceans.

- The BRIDGE: Ocean Sciences Education Teacher Resource Center (http://www.marine-ed.org/bridge/) is an established on-line clearinghouse providing educators with access to peer-reviewed, web-based ocean science data and information useful in teaching. The Bridge is sponsored by the National Marine
CORE views the programs listed above as exemplary because of their potential for expanding the role of ocean sciences in K-12 education nationwide.¹

**Overarching Challenge**

According to the U.S. Department of Education there are 50 state education departments, 16,000 districts, 2.8 million teachers, 47 million students and 115 million parents. In order to affect positive change in K-12 education, the ocean sciences community must unite in meaningful ways to be heard among the many voices of educational reform.

Not only is the audience vast, but there are also countless other science programs with similar goals. Therefore, the voices of marine sciences must be heard as a choir, rather than a variety of talented soloists. Within this “choir,” there are many roles to play for organizations with different strengths in the educational and research-related aspects of the ocean sciences. Therefore, the development or enhancement of partnerships between agencies, institutions and organizations with an interest in ocean sciences is essential to infusing ocean sciences throughout the K-12 educational system. To that end, CORE members believe they can play an effective role in the K-12 educational reform in science by

1. facilitating the development of incentives and rewards that enable individual researchers to become involved in the local K-12 community;
2. developing and expanding collaborations among scientists and educators;
3. facilitating the involvement of researchers and research institutions in the development and review of research-linked educational resources that are correlated to science education standards; and
4. encouraging members to become familiar with existing science education standards and to support the adoption of standards-based curriculum in their local communities.

**CORE’s Recommendations**

¹ There are many other groups coordinating exemplary educational activities and programs that focus on marine science. There is inadequate space here to list all of these programs, some of which operate on a local or regional level, while others are available to a national audience. For more information on these programs, visit The BRIDGE web site (http://www.marine-ed.org/bridge/).
**Issue #1:** Promoting within academia the value of collaborations among marine scientists and K-12 educators.

Too often the scientific culture discourages involvement in educational endeavors other than the training of future researchers at the graduate level. This culture is reinforced by a merit system in higher education that does not reward educational efforts outside the university system. Programs such as NSF’s Faculty Early Career Development (CAREER; www.nsf.gov/home/crssprgm/career/start.htm) and Graduate Teaching Fellows in K-12 Education (GK-12; www.nsf.gov/home/crssprgm/gk12/start.htm) help mitigate prevailing attitudes by providing support to researchers interested in working in K-12 and undergraduate education. However, the current culture of indifference in academia has not been eliminated by such programs because they, and others like them, are limited in size and do not to make a national impact on the ocean sciences community. Expansion of existing programs, or development of similar ones, in addition to support by administrators and senior faculty, will help encourage the involvement of young marine researchers in their local precollege communities.

**Recommendation:** CORE institutions will develop incentives and rewards that enable individual researchers to become involved in the local K-12 community.

**Issue #2:** Expanding the role of the ocean sciences research community in pre-service education and in-service professional development of teachers.

CORE advocates a strong program of education and training for both pre-service and in-service teachers based on scientific as well as pedagogical methodologies. The importance of education and training cannot be overstated when one looks at the following statistics taken from a 1997 report, *Out of Field Teaching and Educational Equality* (NCES, 1996):

56% of U.S. students in grades 7-12 enrolled in a physical science classes are taught by a teachers who do not have a major or minor in any of the following; physics, chemistry, geology, or earth sciences.

39% of U.S. students are enrolled in a life science or biology course that is taught by a teacher who does not possess even a minor in biology or life sciences.

In light of such statistics, the importance of providing strong scientific educational opportunities to both new and practicing teachers is apparent. Additionally, CORE believes, and studies confirm, that there is a need for ocean science researchers to
work in concert with education professionals in developing professional development programs for teachers. The recent *Third International Mathematics & Science Study – Repeat (TIMSS-R) Benchmark* study in the state of Michigan reports:

“The upward trends on the state assessment program and national assessment results have been consistent for the past 15 years...Much of the credit goes to a tradition of collaboration between higher education institutions and local districts.” (NEGP, 2001)

This “tradition of collaboration” is due in part to the NSF’s Local Systemic Change program, which was adopted by the consortium of Michigan schools who participated in the *TIMSS-R Benchmark* study. While the intent of this paper is not to define or advocate the use of specific programs or curricula, it is important to highlight those programs and curricula that demonstrate effective collaborations among researchers and educators.

CORE recommends expansion of successful K-12 teacher professional development programs in the oceans sciences. However, lack of sustained funding remains a serious concern that must be addressed. While, the multi- and interdisciplinary nature of ocean sciences is a benefit in terms of the integrated approach to learning, it is a detriment with respect to funding because these programs do not easily fit within a single traditional scientific discipline (e.g., physics). As a result, teacher enhancement programs in ocean sciences tend to be overlooked and receive insufficient long-term support. Major sources of funding (at the national, state or district level) are often tied to the better established, single-discipline sciences.

**Recommendation:** CORE supports the expansion of collaborations among scientists and educators at both the individual and institutional level by building on existing, successful programs. CORE will work to obtain adequate and sustained funding for such programs.

**Issue #3:** *Providing high quality, peer-reviewed, educational resources on marine science topics through a variety of media.*

(The educational resources are defined as digital and paper-based documents for the purposes of this paper.)

Considerable K-12 educational materials are currently available. However, there is no single location or entity that lists available materials and programs in multiple media formats. Existing portals, such as the BRIDGE, meet many of these needs in an electronic format, but will require additional and sustained funding for
expansion to meet the needs of teachers on both sides of the ‘digital divide.’ In addition, this clearinghouse of marine science educational resources will benefit from greater visibility within the broad field of science education by linking to larger clearinghouse efforts, such as DLESE.

**Recommendation:**
In order to address issue #3, CORE recommends that:

- funding be maintained for at least five years for the continued operation and expansion of the BRIDGE;

- protocols developed for the BRIDGE and DLESE for the review and ranking of materials, curricula and programs be used as the foundation for any future peer review of all marine science educational resources;

- the clearinghouse of peer-reviewed marine science educational materials be available in paper form as well, for those teachers who do not have access to the internet.

**Issue #4:** Endorsing the National Research Council’s National Science Education Standards (NSES) and American Association for the Advancement of Science’s (AAAS) Benchmarks for Science Literacy as the framework for improving science literacy in this country.

CORE would prefer to see the ocean sciences formally incorporated into the existing science education standards and benchmarks. However, we recognize that the NSES—particularly those for earth and space sciences—and the Benchmarks generally allow for the teaching of ocean sciences. A more pertinent and pressing problem is generating greater awareness and understanding among educators regarding the relevance and flexibility of ocean sciences for meeting the science education standards because of their multidisciplinary nature. A marine science course can integrate issues related to science, technology, and society and address all of the standards. Many science educators see integrated science courses as a viable alternative for helping students have a more meaningful learning experience and enabling them to reach higher levels of scientific literacy by the end of their K-12 education (Horton, 1981; Hurd, 1997; McComas and Wang, 1998).

**Recommendation:** CORE will distribute to its members copies of the *NSES* and the *Benchmarks*. CORE will also encourage use of the *NSES* and the *Benchmarks* in members’ local efforts to strengthen and enhance standards-based curricula by incorporating the use of ocean sciences.
Final Thoughts

Other programs and organizations, such as the Sea Grant College Program, National Marine Educators Association, and the National Science Teachers Association have extensive networks of educators. CORE intends to work more closely and systematically with these organizations to implement the above recommendations.

Increasing science literacy in this nation is a monumental, but essential task. In developing this paper, the CORE Education Committee decided deliberately to focus on specific needs in K-12 education in the United States, that CORE institutions can address positively. We recognize that scientific researchers are only one constituency and we must formally coordinate our activities with ongoing efforts to increase the awareness of the oceans and to improve scientific literacy among the citizenry of this nation.

References


