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Shaping the Future

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Shaping the Future

Sea Grant,

Science, and Society:

The Role of Marine Education

Executive Summary

This report briefly explores the status of marine science education in the United States today and sets forth the unique capability of the national Sea Grant education network to address the science education dilemma. It also outlines goals and a plan of action developed to effectively use the multidisciplinary, hands-on exploration of marine and aquatic environments as a springboard for attacking specific elements of the broader science education problem.

Never before have scientific and global environmental issues influenced the actions of governments and individuals as they do today. Too few citizens, however, have an understanding of scientific principles and developing technologies—an understanding essential to help them make responsible decisions that affect their immediate environment and that influence governmental policies having global implications. The need also exists to ensure the United States' technological vigor through the attraction and retention of students, including women and minorities,

into the sciences. The National Sea Grant College Program has the leadership, innovation, expertise, and infrastructure to effect pivotal programs to combat scientific illiteracy, to encourage minority participation in the sciences, and to expand the pool of educated, scientifically trained individuals from which future leaders in research, government, business, and industry can be drawn.

Sea Grant has already established a model of excellence and effectiveness in its education and training of pre-college teachers. Through a commitment to focus the strengths of the Sea Grant network on common, identified goals in the arena of marine and aquatic science education, Sea Grant can accomplish the following by the year 2000:

- a broadened, general public understanding of the global interrelationships between the sea, the soil, and the atmosphere; and
- initiation and implementation of effective mechanisms to attract and retain students in the sciences.

Sea Grant—through its marine education programs—can and will help shape the future.

Vision Statement

The earth is a unique planet where a thin blanket of air, a thinner film of water, and a veneer of soil combine to support life. The daily needs of more than five billion people stress the limits of this naturally

regulated system. We are now faced with environmental issues that are global in scope (National Oceanic and Atmospheric Administration, 1991).

Never before have scientific and global environmental issues influenced the actions of governments and the concerns of individuals as they do today. Although scientific and environmental issues are covered almost daily by print and broadcast media, citizens are not aware of the extent and scope of such issues nor do they understand the impact of recent scientific discoveries and the technology needed to bring about positive social and economic change (Committee on Earth Science, 1988). To compound this situation, the United States has received poor marks on science education and training for the young people from whom our future scientists, engineers, and science educators will be drawn (National Science Foundation Survey Report, 1988).

The unique capabilities of the Sea Grant network represent a national resource for helping address this science education dilemma. Sea Grant has long used the sea to attract people of all ages to “hands-on” scientific exploration. Through the exploration of marine and aquatic environments, Sea Grant has also provided teachers—and thus their students—with the knowledge, “hands-on” techniques, and enthusiasm they need for scientific inquiry. Finally, Sea Grant has established the structure, with cooperating agencies, institutions, and industries, to bridge the gap between research and formal and informal education.

In the decade of the 90s, Sea Grant must commit to continue using oceans and inland seas as a means of creating a desire to understand the natural earth system and of teaching the fundamentals of science and the scientific process. Through this commitment, Sea Grant will help accomplish the following by the year 2000:

- 1) a broadened, general public understanding of the global interrelationships between the sea, the soil, and the atmosphere; and
- 2) mechanisms initiated and operating effectively to attract and retain students in the sciences.

Background

The greatest natural resource affecting the future of this Nation is our youth. There are more than 52 million young people between the ages of five and nineteen in the United States today. These young people account for 21 percent of our total population. If our Nation is to continue to prosper, it is imperative that these young people have the opportunity and motivation to develop into productive, responsible citizens.

Two landmark studies, *A Nation at Risk* (U.S. National Commission of Excellence, 1983) and *Educating Americans for the 21st Century* (U.S. National Science Board, 1983), indicated that America's public schools are not meeting the United States' need for informed students—students capable of meeting the scientific and technological challenges which will alter

their immediate environment, as well as the world. Varied factors have been cited as contributing to the lack of scientific understanding among this Nation's citizenry and to students' decreased interest in entering scientific fields of study:

- uninspiring and/or poorly educated teachers;
- irrelevant and unattractive subject material;
- lack of "hands-on" scientific experiences;
- the perception that science is difficult;
- the lack of respect, reward, and recognition for the teaching profession; and
- changing societal patterns.

Science education literature is replete with research that concludes that science teaching and learning need to be improved nationally (National Oceanic and Atmospheric Administration, 1991; U.S. Department of Education, 1991; U.S. Stratton Commission, 1969; Williams, 1990). Enrollment in high school science classes has declined. Science teachers are in short supply; and in many elementary classrooms little, if any, science is taught. A recent comparison of science achievement in seventeen countries placed the United States eighth at the fifth grade level, fourteenth at the ninth grade level, and from ninth to thirteenth in high school biology, chemistry, and physics classes (National Science Foundation Survey Report, 1988).

Whatever the reason, "what's been missing in science education is the AAAH!, the excitement of doing science with your hands and your eyes," (Roger Hogen as quoted by John Farrington, 1990). The

“aaah” has always been an element of the Sea Grant marine education equation. Whether formal or informal, Sea Grant educational efforts have provided the impetus for individuals from kindergarten student to graduate student to experience the excitement and reality of scientific study in a way that whets the appetite for more. The students, teachers, and citizens who experience Sea Grant programs encounter biology, chemistry, geology, physics, mathematics, and other disciplines as tools with which to explore, understand, and describe their world rather than as volumes of facts and formulas to memorize.

Further, there is no longer the perception that the marine environment begins at the shore, but rather that the understanding that what happens on land is critical to coastal marine environments (Chase, 1990). Watersheds, rivers, estuaries, and the continental shelf are now viewed and studied as a continuum. Trends in marine education are toward a more holistic approach to related ecosystems. Goodwin (1976) stated that marine education must be an integral part of this Nation’s educational process in order to have a concerned and informed public.

These facts support the need for continuing and expanding marine science education through Sea Grant’s marine education and training programs. The National Sea Grant College Program sponsors multidisciplinary programs in marine education and marine advisory services. Through its network of 29 programs and more than 300 participating academic

institutions, Sea Grant has been actively involved in developing teacher education and training programs; curriculum development, implementation, and dissemination; as well as formal and informal marine science programs for youth and adults. The Sea Grant system has also worked to make the public better informed concerning the responsible use and protection of marine and aquatic environments and their resources. These Sea Grant programs combine marine research, advisory services, and coastal resources education. Regionalized Sea Grant educational materials also provide “hands-on” activities that are relevant to students and complement many of the concepts presented in texts. This record is impressive.

Furthering scientific literacy through informal educational efforts, Sea Grant has successfully:

- educated and trained cadres of volunteers who use the marine and aquatic environment to introduce children and adults to global issues, helping them understand the interrelationships among the sea, the soil, and the atmosphere (Walker, 1991; and Meeker, 1987);
- educated and trained citizens to maintain needed environmental monitoring and data collection programs (Lee, 1988; Jaworski, 1989); and
- offered marine educational youth programs through 4-H and other sponsored camps, clubs, and special interest initiatives.

In the area of formal education, Sea Grant has:

- had a prominent role for the past two decades in the development of precollege—kindergarten through twelfth grade—marine and aquatic science curricula throughout this country. Many of these multidisciplinary, “hands-on” approaches to teaching science were developed to be infused into existing science/social studies curricula;
- implemented these materials through graduate and undergraduate teacher workshops and shortcourses. These courses have served as a mechanism for teaching marine and aquatic related concepts and activities to teachers who were not ordinarily accustomed to teaching these topics. Sea Grant workshops and shortcourses have taken teachers into the marine environment where they were able to acquire firsthand knowledge that is multiplied throughout their professional careers in their students’ learning experience;
- fostered the tradition of scientific training through which graduate students conduct elements of a respected scientist’s Sea Grant-supported research under that scientist’s guidance and direction;
- provided undergraduate and graduate students opportunity for conducting research through formal fellowship programs and other support;

- established the Sea Grant Federal Fellows Program/Dean John A. Knauss Marine Policy Fellowship through which graduate students work in Washington, D.C., for one year with host agencies and legislative offices. During that year, Sea Grant Fellows experience firsthand the governmental processes related to marine and environmental law and policy.

Goals

Sea Grant is well-equipped to accomplish the following specific goals representing a long-range educational plan:

- 1) To contribute to the development of a more scientifically literate citizenry who possess the skills and knowledge to bring about desirable change;
- 2) To improve the environmental ethic of our populace;
- 3) To better educate and train precollege teachers;
- 4) To promote improvement in the reward and recognition of the teaching profession;
- 5) To formulate and effect strategies to improve student performance in the sciences and to strengthen the pool of students attracted to and retained in graduate and undergraduate studies in science and engineering;
- 6) To increase the participation of women and minorities in science and engineering;

- 7) To develop, improve, and disseminate relevant curricula and to provide educators with information concerning effective marine and aquatic educational materials which use both traditional and new communications technologies;
- 8) To participate in the development and implementation of evaluation methodology for formal and informal educational programs; and
- 9) To encourage cooperation with other groups to further marine science education.

Action Plan

The teacher is the key to reversing the serious lack of knowledge of science for the school-aged generation. These students represent our future citizenry and scientific professionals. The National Science Foundation (1978) pointed out:

What science education will be for any one child for any one year is most dependent on what that child's teacher believes, knows, and does—and doesn't believe, doesn't know, and doesn't do. For essentially all of the science learned in the school, the teacher is the enabler, the inspiration, and the constraint.

One of the concerns addressed in *Educating Americans for the 21st Century* (U.S. National Science

Board, 1983) was the necessity to improve the competency of science and mathematics teachers. "Top priority must be placed on retraining, obtaining, and retaining teachers of high quality in mathematics, science, and technology. . ." (p. vii). The report further states: "It is a Federal responsibility to assure that in the present crisis, appropriate retraining is available. Inservice and summer training programs should be established with Federal support" (p. viii).

There remains a gap in the precollege teacher's familiarity with the latest scientific research findings and investigative methods. In most colleges and universities, the science educators who are responsible for educating inservice teachers are often far removed professionally from the applied and fundamental research conducted by scientists. Teachers and scientists must work together to close that gap. They must find ways to teach science as it is practiced—with wonder and excitement—in order to attract and retain more students in scientific careers (Herring, 1991). The magnitude of major scientific breakthroughs, together with rapid developments in technology, underscores the critical need for such communication between the researcher and the teacher. We must remember that those involved in scientific research depend on educators to bring to them the scientists of the future. Sea Grant provides the mechanism for this cooperation. Undergirding Sea Grant educational efforts is a Congressional mandate to conduct marine research, technology transfer, and education and training. The

researchers, advisory service specialists, and educators working to fulfill the Sea Grant mission are resources for accomplishing stated educational goals through the following plan of action.

Sea Grant should:

- 1) educate and train preservice and inservice precollege teachers through a continuation of exemplary informal workshops and through undergraduate and graduate courses as developed, piloted, and refined within the Sea Grant network. Teaching teachers is a national priority;
 - 2) promote improvement in the reward and recognition for the teaching profession;
 - 3) capitalize on the romantic allure of the ocean and its inhabitants to increase scientific literacy, to retain students in scientific disciplines, and to attract young people to marine and aquatic science;
 - 4) increase activities to attract and retain minorities and women in the sciences;
 - 5) target assistantships and fellowships toward specific professional opportunities in areas of scientific research and technology transfer identified by the Sea Grant network as of high priority in meeting the scientific and technological needs of the Nation;
 - 6) present scientific concepts involved in marine and aquatic environments to broad public audiences through "hands-on" activities. This
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strategy will foster an expanded public awareness and understanding of marine and aquatic environments, of the effects of human interactions on those environments, and of the role of oceans and inland seas in the global environment;

- 7) draw on network expertise to augment efforts, through Sea Grant workshops and courses, to develop or improve and disseminate stimulating instructional materials that can be used for specific audiences in formal and informal educational settings;
- 8) provide leadership in evaluating and incorporating the use of specific new electronic communications technologies into formal and informal teaching strategies to meet Sea Grant's educational objectives. Satellite systems, for example, now exist that beam curricula directly into classrooms, and Sea Grant marine educators are developing programs for these systems;
- 9) link Sea Grant with agencies, industry, and other organizations which share common goals in marine science education.

Anticipated Benefits

As with most problems facing us today, there are no singular, simplistic solutions for marine and aquatic science education. Only carefully considered, multiple approaches will lead to incremental improvements for

the next decade and beyond. The educational component of the National Sea Grant College Program—coupled with agencies, industry, academic institutions, and the private sector—will continue to provide the leadership, innovation, expertise, and infrastructure for exemplary learning opportunities. Through focusing the strengths of the Sea Grant network on identified, common educational goals, Sea Grant will contribute to the enhancement of scientific literacy of the general populace and to the increased attraction and retention of students in the sciences. In accomplishing these goals Sea Grant will also broaden the awareness and understanding of marine and aquatic environments and the role of such environments in the global relationships of sea, soil, and atmosphere. Sea Grant—through its marine education programs—can and will help shape the future.

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