

Marine Education in the Sea Grant Program

by

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INTRODUCTION

The oceans of the world remain one of the great mysteries to many of us. While the oceans cover a huge expanse of the surface of our planet, the population of the United States is relatively uninformed about the physics, chemistry, geology and biology of these vast water bodies. Many people who live only a short distance from the oceans have never seen them and the majority of the population living in the interior of the country has never ventured to the ocean shore. Teaching about the seas is not in the mainstream of the American educational system and as a result the state of ocean literacy is relatively poor in the United States. This paper describes efforts by Sea Grant to improve ocean literacy in the United States.

There are a wide variety of marine science educational programs available to students ranging from K to 12, undergraduate, graduate, post-doctoral and adult programs offered by many different groups. These programs range from small summer camps for K-12 students to large undergraduate programs that draw students from throughout the country. The marine science education enterprise in the United States is comprised mostly of small programs that create a loose network of educational opportunities. There are a few widely coordinated programs such as those offered by the Sea Grant network. The primary purpose of this paper is to provide an overview of the marine education programs offered by the Sea Grant network.

California Sea Grant is one of thirty Sea Grant programs that collectively form the Sea Grant network. There is approximately one Sea Grant program in every Great Lakes and coastal state in the United States. Funded in part by the federal government through

the National Oceanic and Atmospheric Administration (NOAA) and partly by local sources in each state, Sea Grant addresses national research and outreach needs through the state programs. Each of the Sea Grant programs concentrates on the nearshore environment and as such California Sea Grant focuses on the California coast. One important concept behind Sea Grant is that results from research supported by Sea Grant are made available to the public at large through coordinated outreach activities via field agents and public resource materials such as pamphlets, guides, websites, educational displays, exhibits and programs. Among the many tools that Sea Grant uses to bring information to the public is marine education.

Marine Education in the United States. In brief, there are a handful of nation-wide marine education programs in the United States. Below follows a brief description of these programs.

One of the newest nation-wide marine education networks is the Center for Ocean Science Education Excellence (COSEE) supported by the National Science Foundation (NSF) and NOAA. The purpose of this network is to bring skilled marine scientists from universities into the K-12 classroom to teach marine science. There are a ten COSEE centers in the US, with two of them in California. California Sea Grant has been closely affiliated with COSEE-California.

Smaller marine education programs are the Sea Semester and Semester at Sea programs that provide the opportunity for undergraduates to spend a semester on a sailing ship cruising and learning about the oceans. These programs provide a hands-on experience for undergraduates to learn the science of oceanography. In addition to these two on the water educational programs, there are several dozen universities that offer

undergraduate programs in marine sciences in the United States that utilize a variety of educational methods including summer field stations.

Summer programs and camps collectively form a marine education network that employs a variety of techniques ranging from residential camps to classroom settings to one-day camps. The emphasis is on marine science education for K-12 students living along the coast or traveling to the coastal environment for the summer. These camps tend to have a high emphasis on programs that include water sports such as kayaking, field classrooms and in-water observations via snorkeling and scuba diving.

Perhaps the marine education programs that reach the largest segment of the U.S. population are the free-choice learning opportunities that are easily accessible at public aquaria and zoos. Collectively free choice learning provides the biggest opportunity to teach a large segment of the general public about marine science. For example more than 4.3 million people visit an aquarium each year in California¹. Because these are considered “free choice” learning experiences, they are dependent on people making a conscience decision to spend their free time with ocean-related educational materials.

Sea Grant and Marine Education. The Sea Grant programs are involved at some level in all of the national efforts mentioned above. Many of the 30 Sea Grant programs employ one or more educational specialists with skills in marine education. Over the course of more than three decades of experience in producing high quality educational materials, Sea Grant programs have developed a large collection of items that work well to teach marine science.

¹ 2007. Association of Zoos and Aquariums Member Directory. T. Lewthwaite, Editor. Published by Association of Zoos and Aquariums. Silver Spring, Maryland

The establishment of the COSEE centers five years ago enhanced the Sea Grant efforts by bringing those scientists who conduct the research directly into the classroom. One or more Sea Grant programs are affiliated with each of the ten COSEE centers in the United States. In some cases the COSEE center is co-located with a Sea Grant program.

Sea Grant is involved in undergraduate education by providing scholarships that bring undergraduate students into the laboratories to work on marine research projects. These hands-on experiences are often the tipping point of a young career to get the students enthused about marine science. In a similar fashion, Sea Grant serves as the link to steer undergraduate students to opportunities such as Sea Semester.

Perhaps the largest impact Sea Grant has as a national network is via graduate education. Because Sea Grant spends about one half of its funds supporting research, this creates numerous graduate student fellowships to support marine science students. Over the course of the thirty-five year history of Sea Grant, thousands of graduate students have been supported via Sea Grant sponsored research.

Finally, the national Sea Grant network plays an increasing role in free choice learning aimed at the entire population or so called “K through Gray.” With Sea Grant sponsored research providing the background material, items such as exhibits, displays, posters, signs, CDs, DVDs and printed documents make a large contribution to free choice learning of ocean information and issues. Increasingly Sea Grant sees the free choice educational opportunities as an excellent venue to enhance ocean literacy among the American public.

CALIFORNIA SEA GRANT AND GRADUATE MARINE EDUCATION

The California Sea Grant College Program participates at some level in all of the marine education activities mentioned above. Because each Sea Grant program in the United States has a somewhat different emphasis and approach, California Sea Grant likewise has differing levels of efforts in each form of marine education. The marine education programs at California Sea Grant that receive the largest amount of support are graduate and post-graduate education. Below is a description of the graduate and post-graduate programs, how they function and the success these programs have enjoyed over the past thirty years.

Graduate Education in the California Sea Grant Trainee Program. By far the largest and most successful program in marine education within California Sea Grant is the graduate student trainee program. Developed almost 30 years ago, this program is based on the premise that producing high quality future marine scientists is highly dependent on research experiences. As such, each investigator that receives support for a research project from California Sea Grant is offered the opportunity to have one graduate student “trainee” for the entire duration of their project. Trainees are graduate students enrolled in a graduate degree granting institution, normally the same institution where the Principal Investigator is located. The Principal Investigator is given the opportunity to receive a traineeship without incurring additional costs to their research project. In essence this provides a huge incentive for a researcher to support a graduate student on their California Sea Grant research project as there is no extra cost for the student stipend.

The educational benefits of the California Sea Grant trainee program are many fold. Graduate students spend a significant amount of their educational experience

learning research methods, being exposed to cutting edge research and benefiting from a mentoring experience. Many former California Sea Grant trainees have remarked that these have been career-shaping experiences for them. Over the years the California Sea Grant trainee program has made a substantial contribution to the current pool of marine scientists and policy makers in California and throughout the United States. Since the inception of the program in 1968 more than 900 graduate students have been supported by California Sea Grant traineeships. Table 1 is a list of the current location of some of the former California Sea Grant trainees.

CALFED Science Fellows Program. In 2000 California Sea Grant was approached by the CALFED Bay-Delta Program to work in a partnership to establish a pre-doctoral and post-doctoral fellowship program. Titled the CALFED Science Fellows Program, since 2003 six to eight fellows have been funded each year for a total of 30 Fellows. The overall purpose of the CALFED program is to promote a better understanding of the bays and deltas formed by the confluence of the Sacramento and San Joaquin Rivers at San Francisco Bay in central California. The environmental and economic challenges associated with the use of water resources in this area are extensive and the CALFED program seeks support via the Science Fellows Program to bring pre-doctoral and post-doctoral expertise to bear on these issues. Drawing from throughout the United States, the primary criteria of selection are high quality science, a focus on the bay-delta environment and relevance to issues faced by the CALFED program. This program has a mentoring relationship as an essential component. Students may not apply for a CALFED Science Fellowship unless they have both an academic and community mentor. The academic mentor is the person who guides the fellow through their doctoral

or post-doctoral education. The community mentor is the person often associated with CALFED that is interested in analyzing, generating, interpreting and or expanding data, central to the fellow's project. Typically, these mentors are agency scientists, restoration program managers, and technical staff in environmental organizations or stakeholder associations. The CALFED Science Fellows Program has become recognized as the hallmark of an excellent partnership that provides a consistent source of support for graduate and post-graduate marine science education and excellent new information and insight regarding the bay-delta system. Because CALFED Science Fellows are recognized for their substantial contributions in new knowledge about the bay-delta system, many are successful at launching new marine science careers at the conclusion of the fellowship (see web listing at <http://www.csgc.ucsd.edu/RESEARCH/PPCALFED.html>).

FELLOWSHIP PROGRAMS AT CALIFORNIA SEA GRANT

California Sea Grant participates in a wide variety of fellowship programs that are primarily aimed at students just completing their graduate education in marine sciences. The two most prominent fellowship programs at California Sea Grant are the John A. Knauss Marine Policy Fellowship program and the California Sea Grant State Fellows program. The latter is modeled after the former and as such they share many similar attributes. The rationale for both fellowship programs is that graduate education in marine science or a related field can be substantially enhanced through an experience working in federal or state government. This gives students with skills in marine

sciences an opportunity to learn how federal or state policies are created and put into action.

The John A. Knauss Marine Policy Fellowship: The John A. Knauss Marine Policy Fellowships provide an opportunity for recent graduates to spend a year in Washington DC learning about how the federal government addresses marine issues. The program is nation-wide and recruits prospective fellows from all 30 Sea Grant programs. Each Sea Grant program may nominate up to six candidates each year for consideration as a Knauss Fellow. After an intense selection process, upwards of 45 recent graduates are admitted as finalists to the program. Normally a little more than one half of all applicants are accepted as finalists. Finalists travel to Washington DC in November or December to conduct a series of interviews and select a host location for the coming year. Ten finalists spend a year working as staff in the US Congress while the remaining finalists spend a year working in federal agencies in the Washington DC area. The John A. Knauss Marine Policy Fellowships are offered only to those students who have recently completed an MS, Ph.D. or JD with an emphasis on marine sciences. The fellowship program is described in detail at: <http://www.seagrants.noaa.gov/knauss/>. Included on this web site is information on the experiences of previous John A. Knauss Marine Policy Fellows, a list of former fellows and details on the application process.

California Sea Grant State Fellowship Program: The successes of the John A. Knauss Marine Policy Fellowship program prompted California Sea Grant to develop a parallel program offering a similar experience in California. Using much of the same guiding philosophy as with the Knauss Fellows Program, California Sea Grant created the California Sea Grant State Fellows Program in 1988. The concept is that many

excellent educational experiences are available to recent graduates within California, in particular in state government. Similar to the John A. Knauss Marine Policy Fellowship Program, the California Sea Grant State Fellows Program is open only to those students who have recently completed an MS, Ph.D. or JD with an emphasis on marine sciences. Over the course of the twenty years, 41 students have participated in the California Sea Grant State Fellows Program. Details of this program may be found at:

<http://www.csgc.ucsd.edu/EDUCATION/StateFellow.html> including stories from past California Sea Grant State Fellows regarding their experiences during their fellowship.

Additional Fellowship Programs at California Sea Grant: Students who are currently pursuing an advanced degree in marine sciences may also apply through California Sea Grant for two other nation-wide fellowship programs. One program is the Fisheries Graduate Fellowship. In this case NOAA's National Sea Grant Office and NOAA Fisheries established a Graduate Fellowship Program in population dynamics and marine resource economics. The fellowship is for Ph.D. students who are interested in either of these two disciplines. The other is the Sea Grant Industry Fellowship Program that provides support for graduate students who are pursuing research and development projects in topics of interest to a particular industry/company. In a true partnership, the student, the faculty advisor, the Sea Grant program, and the industry representative work together on a project from beginning to end. This latter fellowship has strong ties to the extension portion of each Sea Grant program and will be discussed in more detail in the paper by Dr. Paul Olin, also from California Sea Grant.

CALIFORNIA SEA GRANT AND UNDERGRADUATE MARINE EDUCATION

Although the preponderance of resources that California Sea Grant devotes to marine education goes toward graduate programs, there is one undergraduate fellowship available. California Sea Grant supports the John D. Isaacs Marine Undergraduate Fellowship. Originally conceived as a four-year \$12,000 fellowship to one high school senior entering college, this fellowship is now a multi-student summer program for undergraduates.

John D. Isaacs Marine Undergraduate Research Assistant Program.

Recognizing that what drives students most into a career in marine sciences and expands their knowledge of the marine environment is hands-on experiences, this program was revised in 2005 to provide summer research assistantships for up to six undergraduate students. The approach is that researchers whose projects are supported by California Sea Grant may apply for a fellowship to support one undergraduate student to work on their project during the summer. Offering up to \$2500 for each undergraduate student, the researcher may request California Sea Grant support for the student during the summer. Only researchers who receive California Sea Grant research funds may apply for an Isaacs Undergraduate Research Assistantship.

K-12 MARINE EDUCATION PROGRAMS AT CALIFORNIA SEA GRANT

There are a variety of mechanisms that California Sea Grant has used to support K-12 marine education. About half of these focus on summer programs and the other half on school-year programs. Collectively California Sea Grant has reached thousands of youths to help raise the level of ocean literacy.

Summer Camps. In the past few years California Sea Grant has made a commitment of \$40,000-50,000 per year to Camp SEA Lab located in the Monterey Bay region of California. This program, now in its sixth summer of operation, employs a mixture of residential and single day camp experiences for K-12 children. With a special emphasis on disadvantaged youth from schools that do not normally have access to ocean education programs, Camp SEA Lab utilizes activities that range from classroom exercises to ocean field trips. Classroom exercises tend to draw on existing curriculum developed elsewhere and brought as teaching modules to Camp SEA Lab. Field trips are tailored to the age of the youth and range from a visit to the beach to a five-day ocean voyage from San Francisco to Santa Cruz. During the field trips students are taught a range of ocean related subjects such as navigation, physical oceanography, meteorology, coastal marine ecology, and historical and cultural traditions of the sea. The support from California Sea Grant does not cover the entire cost of operating a program such as Camp SEA Lab that includes hundreds of students each summer. Rather the Sea Grant funds are added to a larger pool to provide overall support for the program. Dr. Rick Starr, one of the California Sea Grant Field Advisors, is deeply involved in this program and sits on the Board of Directors for Camp SEA Lab. More information on Camp SEA Lab may be found at <http://www.campsealab.org/>

California Sea Grant makes smaller contributions to other K-12 summer ocean education programs in California. Typically in the range of \$3000-\$5000 per summer, a variety of summer programs has been supported. An example of these is the Summer Girls Camps taught at the University of Southern California's Wrigley Institute of Environmental Studies on Catalina Island. The contribution from California Sea Grant

provides scholarship funds that are used to bring disadvantaged high school girls to the camp so that they may experience the ocean for the first time.

In aggregate, the summer programs supported by funds from California Sea Grant have supported programs that expose hundreds of youths over the course of many years to the oceans. The primary intention of these summer programs is to make youth aware of the marine environment, that protection of coastal resources requires a considerable effort, the types of organisms found living at the edge of the sea, and to increase the interest level of the students so that some of them may choose to study marine sciences as they enter college.

National Ocean Sciences Bowl. Whereas the summer ocean camps tend to meet the needs of many students with a broad scale approach, ten years ago a nation-wide program was devised to address high-achieving high school students interested in marine sciences. The National Ocean Sciences Bowl (NOSB) was developed along a quiz bowl format with teams of six high school students that compete against teams from other high schools. First rounds of competition are held on a regional basis with the regional winners moving to a national round and an eventual national winner determined. Ocean science researchers develop the questions used in the NOSB. The level of competition among the high school teams is intense. Many researchers conducting cutting-edge research cannot answer the questions in the national finals with the same skill as these high school competitors.

Over the years Sea Grant programs have played a major role in the NOSB. In many states, including California, more than one regional competition is held. In those cases the local Sea Grant programs tend to provide financial support. In other states

where a single NOSB regional competition is held, the local Sea Grant program often steps in and organizes and runs the event. Sea Grant also supports the nation-wide NOSB finals. Many of the highly skilled quiz bowl moderators and science judges come from Sea Grant staff. More information about the NOSB program can be found at <http://www.nosb.org/> including videos of the 2007 national finals competition.

Centers for Ocean Science Education Excellence (COSEE). Five years ago a joint initiative sponsored by the National Science Foundation (NSF) and National Oceanic and Atmospheric Administration (NOAA) was created to develop regional COSEE programs. The primary purpose of COSEE is to promote ocean literacy among K-12 youth by enhancing the quality and amount of materials available for classroom use. The COSEE Centers achieve this objective by bringing the talents of marine scientists to bear on creating K-12 educational materials. The COSEE network's mission is to "spark and nurture collaboration among scientists and educators to advance ocean discovery and make known the vital role of the ocean in our lives." The mission statement goes to state that "Through its work, COSEE strives to provide opportunities for citizens of all ages to have a scientifically grounded understanding and appreciation of the ocean." More information on the COSEE concept and network can be found at <http://www.cosee.net/>. The COSEE mission fits very well with the Sea Grant education mission and as a result many of the COSEE Centers are highly affiliated with Sea Grant.

There are two COSEE Centers in California, COSEE-California and COSEE-West. The former has been affiliated with California Sea Grant for more than five years. A major accomplishment of this affiliation is the inclusion of an education component in many of the research projects supported by California Sea Grant. Prior to the

establishment of COSEE-California it was unusual to find an educational component in a proposal for research support to California Sea Grant. Since COSEE-California came into existence, most of the research proposals submitted to California Sea Grant now include an educational component.

FREE CHOICE LEARNING

A well-established educational activity has taken on a new name in the United States lately. Now called free choice learning, this consists of the election by peoples of all ages to spend some of their discretionary time and income to learn about issues that interest them. In the case of the oceans, interest levels by US citizens remain high although ocean literacy in general is low. This provides an outstanding opportunity for organizations to develop materials for free choice learning. Since its inception, Sea Grant has developed materials for this explicit purpose. These materials come in the form of brochures, booklets, books, videos, CDs, DVDs, displays, calendars, posters, signs, web pages and other items. Each of these has an objective to teach interested individuals more about the oceans and Great Lakes. All Sea Grant programs try to reach a broad audience through such efforts. In many cases the final result is achieved via a partnership. For example, signs warning ocean swimmers of the dangers of rip currents and how to safely escape such a current are designed and produced by Sea Grant and installed by local lifeguards. A book on marine mammals is written by an expert on marine mammals and then edited, illustrated, printed and marketed by Sea Grant. A video is researched and prepared by a Sea Grant program and then aired by a local

television station. Sea Grant sponsored research projects often serve as the source material for a display at a local aquarium.

The advantage of free choice learning is that a very broad swath of the population can be reached. Ocean education materials developed by Sea Grant are often circulated or used many times reaching an ever-expanding array of people. The number of people reached via these materials vastly exceeds all of the other educational programs combined. One may find a sample of the publications available from California Sea Grant for free choice learning at

<http://www.csgc.ucsd.edu/PUBLICATIONS/SgPubIndx.html>.

CONCLUSION

California Sea Grant has a rich variety of programs that support marine education. Ranging from the highly focused CALFED Science Fellows Program to broad free choice programs, the collective effort is to raise the level of ocean literacy of Californians. The ocean plays a vital role in the ecology, history and economy of California. The ocean affects all of the residents of the state in many ways. Having a more ocean literate population is a key component working to protect the California ocean environment and make the best use of ocean resources. Ocean literacy cannot be achieved by educating a single group of people or with a single message or a single approach. The task is never-ending and yet constantly rewarding and perhaps best

summed by the quote from Richard Wilbur “All that we do is touched with ocean, yet we remain on the shore of what we know.”²

² 1988. Richard Wilbur. *New and Collected Poems*. 393 pp. Harcourt Brace Jovanovich, San Diego

Table 1. California Sea Grant has supported hundreds of graduate students through the Sea Grant Trainee Program. This is an example of where some of the former trainees are now located.

David Aubrey, Director, Coastal Research Center, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts
Christine Blackburn, Program Manager, California Coastal Conservancy, Oakland, California
Louis Botsford, Professor, Department of Wildlife, Fish and Conservation Biology, University of California, Davis
Denise Breitbart, Research Scientist, Smithsonian Environmental Research Center, Edgewater, Maryland
Jim Carlberg, President, Kent SeaTech Corporation, San Diego, California
Jeffrey Crooks, Research Coordinator, Tijuana River National Estuarine Research Reserve, San Diego, California
Carolyn Culver, California Sea Grant Advisor, Ventura, California
Christopher Dewees, Emeritus Fisheries Specialist, University of California, Davis
John Dixon, Ecologist/Wetlands Coordinator, California Coastal Commission
Falk Feddersen, Research Scientist, Scripps Institution of Oceanography, University of California, San Diego
Peggy Fong, Associate Professor, Department of Ecology and Evolutionary Biology, University of California, Los Angeles
J. Scott Foott, Fish Health Biologist, U.S. Fish and Wildlife Service
Elizabeth Fuchs, Coastal Program Manager, California Coastal Commission, San Francisco, California
Phyllis Grifman, Associate Director, USC Sea Grant Program, University of Southern California
Judith Hansen, Manager, Research and Development, Plant Sciences, Inc.
Bruce Harger, President, Neushul Mariculture, Inc.
Christopher Harrold, Director, Research and Conservation, Monterey Bay Aquarium, Monterey, California
Thomas Herbers, Research Scientist, Scripps Institution of Oceanography, University of California, San Diego
Kevin Hill, Marine Biologist, California Department of Fish and Game
Anson Hines, Assistant Director, Smithsonian Environmental Research Center, Edgewater, Maryland
Dale Holliday, Director of Research, BAE SYSTEMS
Todd Hopkins, Program Manager, San Francisco Bay National Estuarine Research Reserve
Donald Kent, Executive Director, Hubbs-Sea World Research Institute, San Diego, California
Lisa Levin, Professor, Scripps Institution of Oceanography, University of California, San Diego
Milton Love, Professor, Marine Science Institute, University of California, Santa Barbara
Amber Mace, Science Advisor, California Ocean Protection Council and Executive Director of California Ocean Science Trust, Oakland, California

Michael Orbach, Professor, Duke University Marine Laboratory, Beaufort, North Carolina
Julie Packard, Executive Director, Monterey Bay Aquarium, Monterey, California
Miriam Polne-Fuller, Research Scientist, Marine Science Institute, University of California, Santa Barbara
Richard Reid, Director of Biochemical Research, Erik and Ese Banck Clinical Research Center
Laura Rogers-Bennett, Research Scientist, John Muir Institute, Bodega Bay Marine Lab, University of California, Davis
Jongheon Shin, Korea Ocean Research & Development Institute
Theresa Stevens, Project Manager, U.S. Army Corps of Engineers
Steven Thomas, Hydraulic Engineer, National Marine Fisheries Service
Richard Zimmer, Professor, Department of Ecology and Evolutionary Biology, University of California, Los Angeles