# OCEAN EDUCATION AND OUTREACH FOR FAME AND FORTUNE—A CASE STUDY

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**"THE OCEAN SUPPORTS A GREAT DIVERSITY OF LIFE AND ECOSYSTEMS."**

*"The ocean is largely unexplored." These two of the seven essential principles of Ocean Literacy (National Geographic Society 2005) are most appropriate when exploring the Northwestern Hawaiian Islands. Ocean scientists played an important role in the recent designation of the Northwestern Hawaiian Islands as the nation's Papahānaumokuākea Marine National Monument by exploring these unknown environments and describing and studying the great diversity of life found in the national monument.*

How do students become ocean scientists? A discussion group of ocean scientists at a workshop focused on graduate ocean education discovered that each scientist had a significant, long-term set of experiences exploring the outdoor environment as a child (Ocean Science Education Retreat 2005). Personally, I spent several weeks each summer as a child freely exploring the intertidal environments of the Hawaiian Islands. In fact these experiences, influences, and memories were reflected in my application to graduate school. Rather than leave it to chance, ocean scientists can play an active role in exposing young students to the wealth of opportunity that a career in ocean sciences offers, yet many scientists are not engaged in education and outreach (E&O) because they cannot see how their careers can benefit from this type of activity. Science and teaching are both all about learning, so involvement in high quality educational programs can positively impact research programs in a variety of ways. Contrary to popular belief, given certain circumstances, scientist engagement in E&O activities can be fulfilling, rewarding, and can increase a scientist's stature at his/her institution. The following case study of my own involvement in ocean education and outreach illustrates some of the potential challenges and rewards.

## BARRIERS FOR OCEAN SCIENTISTS' PARTICIPATION IN EDUCATION AND OUTREACH

In a recent survey of over 100 ocean scientists (COSEE-New England 2006), a lack of time, money, and staff were the three leading causes preventing researchers from engaging in E&O activities. Many were interested, but could not justify spending the time, could not find the funds, or did not have the support staff to carry out their ideas. In addition, half were unsure of the needs of formal and informal educators. To produce significant impacts through their E&O activities, scientists must invest an initial effort to align their resources with educator needs.

For busy, focused researchers, it often seems impossible to spend even a moment of their valuable time talking to non-scientists, educating a group of kids about the wonders of the ocean, or learning about educational systems; and they have received little or no training in these activities. It does not appear to be a good use of time to educate a few transient individuals, while publishing papers leaves a permanent record of accomplishment. Researchers that do get involved often do not receive any information on the impact of their efforts and have expressed the need for follow-up. Engaging students in ocean sciences is exciting, but longitudinal research studies demonstrate that student engagement, achievement, and pursuit of ocean science courses, degrees, and careers, are few and far between.

Nonetheless, there is a clearly established need for scientists to communicate their research more broadly. Dissemination of one's research is not only distributed through scientific journals, but often through public media, interviews, and common dinner table discussion. Finding an efficient and effective way to communicate one's science is a noble goal of any researcher and can often clarify the most important aspects of one's research.

In addition, with NSF's Criterion II-Broader Impacts (http://www.nsf.gov), as well as the increasing need for funding agencies to justify their expenditures to Congress and the public (Pew Commission on Ocean Policy 2003; U.S. Commission on Ocean Policy 2004), there is a need and desire for scientists to translate their scientific results so that a broader audience can appreciate the workings and findings of the scientific community. Participation in effective E&O activities can directly and indirectly lead to increases in basic and applied research funding.

## EDUCATION AND OUTREACH FOR FORTUNE–FUNDING OPPORTUNITIES

My introduction to science education and integrated research/education funding has been recent and significant. I am currently involved in three major funded programs, but as these end or

Marine Science Institute graduate student, Michele Kissinger, engages middle school students with hands-on activities that excite them about the ocean.

move on, a number of other opportunities have arisen that blur the source of funds and integrate the work proposed. First, the Watershed-Integrated Science Partnership (WISP, http://www.wisp.umb.edu) is an NSF-supported, GK-12 program focused on using the local Neponset River Watershed to contextualize middle school learning within the existing curriculum of three school districts neighboring the University of Massachusetts. The goal of the GK-12 program is to provide a rich, year-long, K-12 classroom experience for science graduate students. Two goals have been clarified: to increase the ability of future scientists to communicate their science to non-science audiences; and to increase the interest and ability of future scientists to be engaged in K-12 education as they enter and continue their scientific careers. This eight-year program will fund 59 graduate student-years at a rate of $30K per Fellow/year. Not only does this funding help attract good graduate students and support them through critical years of their graduate career, but it also can support the Principal Investigator (PI) and various staff members in the program or department.

Second, the Center for Ocean Sciences Education Excellence-New England (COSEE-New England) is a five-year, NSF-supported project that aims to partner ocean scientists with educators to communicate cutting-edge ocean research and improve authentic science in the classroom. This partnership between the New England Aquarium, the University of Massachusetts, and the Woods Hole Oceanographic Institution has sponsored workshops for scientists, workshops for teachers, and—most importantly—workshops and support for interactions between researchers and formal and informal educators. This project has allowed me to meet a wide-range of researchers, many of whom are outside my traditional research area. Discussions about science education lead to discussions of science, and respect in one realm (science education) generally leads to respect as a researcher. While not yet directly leading to a research collaboration, these diverse discussions among a wide variety of ocean researchers has enriched my view of ocean science. This project has supported a doctoral student and opened many doors in terms of research discussions.

Finally, the Boston Sciences Partnership, an NSF Math Science Program, supports the University of Massachusetts, Boston Public Schools, and the Northeastern University to improve science teaching in all 6-12 grades in the Boston Public Schools. Among several major initiatives, eleven Contextualized Content Courses (Biology, Chemistry, Physics, Engineering, and Earth Science) have been developed by teams of middle and high school teachers and University science faculty members. Excellent professional development for teachers and science faculty members has resulted in popular, content-rich courses for science teachers as well as improved teaching at the middle and high school, and undergraduate and graduate levels. This project supports seven graduate students and has involved twelve science faculty members as well as the Deans of the College of Science and Mathematics and the Graduate College of Education and the Provost.

In total, the educational projects ($18.5M) support many graduate students, faculty summer salaries, and in certain cases, a few months of technical support staff. The dramatic increase in my personal capacity (and that of the Department and the University) to offer broader impacts of my (or collaborators') research, and to develop effective education and outreach components of larger collaborative or center proposals has increased the chances that these proposals are funded. An example is the recent University of Massachusetts supported Center for Coastal Environmental Sensing Networks that integrates research based on coastal observations with the use of this real-time data in classrooms.

## EDUCATION AND OUTREACH FOR FAME—REWARDS FOR SERVICE

In recent years, I have been promoted from associate to full professor, been placed on several important committees, enjoyed a higher level of respect with the upper administration and academic community, and had a number of project opportunities that have resulted in part or in whole from my activities in education and outreach. In preparing my package for promotion from associate to full professor, I wrote about the changes in my teaching as a result of my educational activities, my presentations at national meetings on educational outreach, the funding that was brought in for these activities, and the impact that my colleagues and I were having in these projects. External reviews from individuals knowledgeable of my educational pursuits were included in my portfolio. A few excerpts from the review and promotion process are listed below:

- External Review: "…this highly successful collaboration [COSEE-NE] between sciences and education represents the best of interdisciplinary teaching, research, and service that Dr. Chen has fostered at the University."

- Department Chair: "I would like to stress that Dr. Chen's work in the area of "Science Education" cannot be pigeonholed into either "Research," "Teaching," or "Service," since this work integrates all three areas of his academic life."

- External Review: "Bob is a superb example of what a Professor should be: scholar, teacher, advisor, and mentor, engaged at all levels of education and outreach."

In addition to promotion, I was asked to present the integration of my research and education to the University of Massachusetts Board of Trustees in 2005; to co-chair the Academics Sub-Committee of the Chancellor's Strategic Plan in 2006-2007; and to serve on the University of Massachusetts Boston, Chancellor Search Committee in 2005 and the Dean of the College of Science and Mathematics Search Committee in 2006-2007. In 2005, I received the University of Massachusetts President's Public Service Award (one award per campus per year) in part for my educational activities. There was also the Dean's Outstanding Achievement Award for Overall Contributions in the Sciences and the Massachusetts Marine Educators Special Award in 2005.

In the professional societies, such as the American Society of Limnology and Oceanography and the American Geophysical Union, as well as at the National Science Foundation and the Consortium of Ocean Research and Education, my educational experiences have led to invitations to present as an "expert" in educational programs. This level of respect is higher than that of my status as "contributor" in research to those same organizations.

Overall, my work in E&O has helped me develop professionally both internally and externally: my capacity to develop and implement research and educational programs has increased, and I have received a greater respect from administrators and colleagues outside my established field of research expertise.

## JUSTIFYING THE TIME OR LACK THEREOF

Many scientists do not think they have the time to participate significantly in E&O. Their focus is on their cutting edge research; and because seeking funding is so competitive, any deviation from this focus is considered a distraction. By spending time on E&O activities, there is less time to spend on laboratory or field research. Results of this work are often not respected by peer scientists and so the time is considered "wasted."

However, another way to look at this is: What is the job of a scientist? The scientific community has different expectations for hard money faculty members compared to soft money researchers, similarly for government scientists. When a faculty member describes her or his job, s/he might include teaching, communicating one's science to the public, changing policy, or being an expert resource. With different definitions, activities in education and outreach can fulfill many of these goals and expectations of any or all these positions. While I have

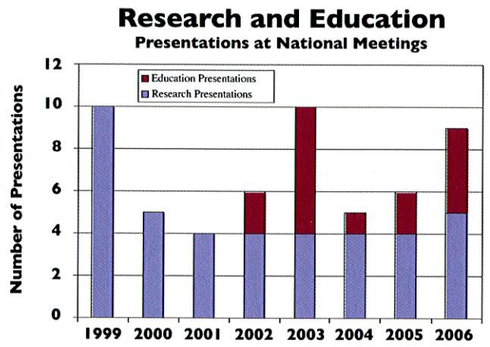


Figure 1. Number of presentations at national meetings since my significant work in education and outreach initiated in 2001.

recently spent less "time" on my narrowly focused research area, I have broadened the scope of my work to include collaborative, interdisciplinary, multidisciplinary, and more complex projects that include partnerships, mutual respect, learning new fields, and facilitating interactions. These skills and characteristics have allowed me to grow as a scientist, a professor, and a researcher.

Interestingly enough, my research has improved due to my work in education and outreach. A large part of establishing educational partnerships is based on defining and stating clear goals, planning a strategy to accomplish those goals, and evaluating the results and impacts of a particular research project. In part, my research has begun to focus on problems of more societal importance, and my students and I have become more careful and strategic in the process of science. My students have also benefited in becoming more well-rounded scientists. Entering the competitive job market, they are better communicators, more focused researchers, better time managers, and have gotten true experiences in both the research and education worlds. With a look at two (or more) career alternatives, they can better reflect on an appropriate pathway for them.

Of course, every scientist is "busy" and overcommitted, multitasking many projects, interactions, and experiments. The integration of research and education can be synergetic, however. By using one's data to develop classroom lessons and utilizing K-12 teachers and students in one's research, the lines between education and outreach begin to blur. Figure 1 shows presentations that could be defined as "education" or "research," but many of these presentations should not be defined with either term. They are science talks with a diverse audience that fall on the continuum from developing methods to carrying out experiments to disseminating results to using science to impact society. The number of annual presentations suggests an increase in the productivity and a broadening of the interests in my extended research group.





## IMPACTS

The demands on a scientist's time often force researchers into a more focused research program. For some, however, different skills can be enhanced to broaden one's research capacity and to develop effective E&O activities that impact students, teachers, and society. Within the peer-reviewed world of science, there are emerging opportunities to gain respect and reward for efforts in E&O, especially if these efforts are strategic, efficient, and effective. Evaluation (often external) of these efforts and collaboration with experts in science education are critical to the success of this work. Below are a few examples of high impact results of educational activities that have been rewarded at the University of Massachusetts Boston and beyond:

- A watershed mural was created from 1100 tiles, each painted by a middle school student to show a single organism that lives in their local Neponset Watershed. Together, the organisms depict the whole watershed ecosystem that crosses 14 towns and communities (Figure 2). The 10 x 13 foot mural is on display at the New England Aquarium.

- The Environmental Science Content Institute is a summer graduate course that uses the Neponset Watershed as a context to learn middle school science content. Presentations by university faculty and local experts "cover" greater than three quarters of the Massachusetts State Science Frameworks. Up to 30 participants learn both in the classroom as well as outdoors, from Hilltop to Seafloor, with field trips to the Blue Hills Observatory (the oldest weather station in the country), the Pine Tree Brook (next to Milton High School), the Neponset salt marsh (largest surviving salt marsh in the greater Boston area), and Lovell's Island rocky intertidal (Boston Harbor Islands National Park Area). This course has run successfully for the last five years.

- Ocean Science Literacy Essential Principles and Fundamental Concepts (National Geographic Society 2005) have been developed, adopted, and published by the national Centers for Ocean Sciences Education Excellence network, NOAA, National Geographic Society and the College of Exploration, and are being implemented regionally and nationally in a large variety of venues and programs.

- Eleven "Contextualized Content Courses" have been developed by university faculty in partnership with middle and high school teachers (http://www.bostonscience.net). These courses have been taken by the majority of Boston Public Schools science teachers (>200 participants so far), improving the quality of teaching in this large urban school district.

Figure 2. Some of the middle school students who designed the Neponset Watershed mural. The green tiles in the center outline the Neponset Watershed. The mural is currently on display at the New England Aquarium. Dr. Chen stands in the center of the second row.

SUMMARY

While many barriers are perceived that prevent ocean scientists from participating significantly in education and outreach activities, some of these barriers are being lowered by demands from federal funding agencies and a slowly changing academic culture. NSF's Criterion 2-Broader Impacts is a strong example of the commitment of funding agencies to show impact of the research that they support. Large collaborative projects require effective and strategic educational plans. Some universities acknowledge, recognize, and reward well-documented and high impact efforts in schools and communities (University of Georgia 2006). In fact, some scientists can use their diverse skills to find fame (recognition, respect, and reward) and fortune (funding) by participating in and leading high quality education and outreach programs.

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PHOTO CREDIT

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