

These multi-year investigations conducted year around at the Stone Laboratory highlighted annual and long-term variability in the plankton in relation to environmental factors, and demonstrated that long-term studies are needed to assess environmental trends in these large, dynamic systems. At the University of Michigan, currents and water masses were described from synoptic surveys of Lake Huron and Lake Michigan. Oceanographic techniques were employed, an achievement of some note in those days when data for thermal profiles were collected with bathythermographs on smoked-glass slides using students and other volunteers to make shipboard observations and collections, and navigation of small fishing tugs on their cross-lake transects was entirely by dead reckoning. Studies of Lake Huron were done jointly with the Ontario Department of Lands and Forests, an early example of institutional and international cooperation that Chandler promoted over the years.

He was concerned with the Great Lake scientific community and promoted its activities by supporting federal legislation to create the Sea Grant Program and successfully working for inclusion of the Great Lakes in the legislation. Another important accomplishment was providing platforms for Great Lakes research. Research vessels operated by the University of Michigan were available to scientists working in the region. Chandler's efforts enabled the operation of these ships as part of the University National Oceanographic Laboratory System (UNOLS). Michigan was the only non-oceanographic member of this consortium of 57 academic institutions. He also was President of the Great Lakes Foundation, an organization dedicated to promoting public understanding of the problems and facts of freshwater usage in the Great Lakes basin, and of the professional scientific research in these waters.

Chandler was concerned with good mentoring and encouraged an environment conducive to broad thinking for students, scientific staff, and associates. He encouraged innovation, but was never dogmatic in advising his fifteen doctoral students from Cornell University, Ohio State University, and the University of Michigan. The importance of innovation was stressed by insisting that graduate students utilize experimental techniques in their dissertation research. A broadly based scientific program in GLRD was promoted and encouraged by hiring not only limnologists and biologists, but also broadly trained scientists whose interests ranged from palynology and paleolimnology to radiochemistry and neutron activation analysis, as well as to taxonomy, geochemistry, physical limnology, and meteorology. A manned submersible, Star II, and an underwater laboratory were used in Lake Michigan to investigate the usefulness of such facilities in teaching and research. His legacy at Michigan would continue and the program would thrive under two reorganizations, first as the Great Lakes and Marine Waters Center and finally as the Center for Great Lakes and Aquatic Science (see Beeton and Schneider 1998, *J. Great Lakes Res.* 24(3):495-517).

David Chandler was known for his good humor, dedication, integrity and innovation. He was thoughtful, kind,

knowledgeable and articulate, but soft-spoken and very modest about his accomplishments. He was regarded with great respect by his many colleagues, associates, friends, and students, and will be remembered fondly by those who knew him. A daughter, Candace Loechl (Mrs. George); a granddaughter, Jessica Loechl; and a son, Robert, survive him. Pearl, his wife of 61 years passed away in 1995. A memorial service is being planned for spring 2002 in Ann Arbor, Michigan.

GETTING STARTED IN EDUCATION OUTREACH

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Scientists become involved in K-12 science education outreach for a variety of reasons: (1) scientists see a need to provide scientific expertise in their children's classrooms; (2) outreach is fun; (3) scientists want to contribute to science education reform within the U.S.; and (4) universities require faculty to provide service to the community. In recent years, another compelling reason has emerged for scientist involvement in quality education and public outreach (EPO) programs. Margaret Leinen recently quoted a Program Officer in the Division of Environmental Biology as saying, "NSF has many outstanding science proposals. It is beginning to be the case that the difference between an excellent proposal and an excellent proposal that will be funded is the quality of the response to Criterion 2 - the broader impacts of the research." (AGU Fall Meeting 2001). In other words, it is sometimes not enough to propose excellent science; it is necessary to add a strong education outreach component to research proposals. At this point, you may be asking yourself, "How do I develop a quality outreach program, when I am trained as a scientist and not as an outreach specialist, and I don't have the time anyway?" The goal of this article is to outline steps for developing a quality education outreach program, including finding partners who will be an asset to your project.

WHAT YOU NEED TO KNOW TO GET STARTED.

First, if you are new to education outreach, you must realize that you are stepping into a realm unto itself. You need to get educated about EPO before embarking on your project planning. Armed with the necessary knowledge about EPO, you will avoid reinventing the wheel, thus saving time, and also appearing naive to reviewers. There are EPO professionals, who are more than willing to give you guidance on your EPO plans. Ideas for learning about EPO include:

- Attend an EPO workshop (we will be offering one at the 2002 ASLO Summer Meeting <http://www.aslo.org/victoria2002/>).
- Contact an EPO organization, such as a NASA broker (i.e. Space Science Institute <http://www.space-science.org/>).
- Talk to colleagues engaged in outreach.

Alternatively, you could go to an education session at a society meeting, or call your University Outreach Council or Communities Relations group to find out who is involved in outreach. Doing so will let you come up to speed on the needs of the education community, and will give you needed education expertise and existing venues for project dissemination and sustainability.

Second, there are numerous options for your involvement in K-12 science education outreach. There are four broad areas of education outreach - students, teachers, curriculum, and systemic change. Chase's article (ASLO Bulletin 8(1) 1999) describes many ways for scientists to interact with students and teachers, and Romero's guide (2001) is also an excellent source of ideas. You need to determine which role suits you best. The intention of this article is to delve into the process of developing strong scientist/educator partnerships, thus garnering a more positive response from reviewers to your EPO plans.

Regardless of how you decide to get involved with education outreach, you will need to understand the needs of teachers, students, and school systems. Do your homework before embarking on your outreach program and include your partners in your planning process. This cannot be understated! As a first step, talk to some teachers and visit their classrooms. If you are a parent, your children's teachers are an excellent entry point. If you don't have children, contact your university's outreach office or visit your local informal science education venue (i.e., aquarium, science museum) and inquire about their outreach programs. Getting your feet wet with some real experience in working with children and teachers will help to understand what you are getting into.

WORKING WITH TEACHERS.

First and foremost, recognize and honor the fact that teachers know best how to teach in the classroom. The teachers are the classroom managers ["Listening to the teachers talk about the variety of kids they see in the class, emotional disturbances, tough inner city kids, multilingual, that is also something that at the college level you don't deal with. The teachers in K-12 are doing much more than teaching information." (Scientist, CIRES teacher workshop 1998)], and they are the trained experts in pedagogy. For instance, they know that young students think concretely, while older students think more abstractly, and that students have different learning styles. When first working with teachers, you will quickly learn that they too have their own jargon. Become well-versed in such common phrases as *inquiry-based*, *National Science Education Standards*, *hand-on*, etc. (see Sullivan's article in ASLO Bulletin 6(3) 1997 for a nice discussion of this). Again, an EPO workshop will help you come up to speed on the primary and secondary education culture.

Second, realize that the world of primary and secondary education is different than that of academia. While scientists thrive in a competitive environment, educators generally do not because the school environment tends to be more collaborative than the university setting. Acknowledge teachers' expertise in education, and do not be condescending

or use scientific jargon when you work with them. What teachers most often desire is your knowledge of science content and especially of the scientific process. The process of doing science is familiar to us, but few teachers have had the experience of actually doing science. As illustrated by one of our teacher participants, "I loved the research project, it was nice to get into science research and be able to work so closely with the scientists. I obtained an immense amount of knowledge interacting and listening to both the scientists and the other teachers...The experience will greatly enhance my skills as a classroom teacher." [Earthworks 2000 participant]. Modeling how science is done and transferring this ability to teachers can be one of the most effective avenues for science education reform in the modern day classroom.

Third, be a team member. Listen carefully to the teacher's needs and assess how you can best fulfill those needs. For example, an institute at the University of Colorado benefited by asking for teacher input, as they decided how to best develop an outreach program. The institute assembled a panel of high school math and physics teachers and asked the educators how the scientists could help them. All four teachers resoundingly stated that they have a very limited window of time for any extra classroom demonstrations. If the researchers do not tailor their outreach to fit within their curricular boundaries, then they are not interested in having scientists visit their classrooms. The audience also learned that the curriculum for the entire school year is set in stone starting from day one of the new school year. The general take-home point is that any EPO program must be initiated well in advance so that teachers can mold the activities into their curriculum, and the programs must take into account the teacher's standards, content, and curriculum requirements.

THE IMPORTANCE OF EVALUATION.

From the President of the United States down to the local school district, accountability has become a common buzz word. Funding agencies and school districts now require robust evaluation of EPO projects. Evaluation should include both the outreach delivery (lecture material, labs, etc.), and the teacher or student progress and end-results. The purpose of the evaluation is to be sure that you are meeting your outreach goals and objectives. Evaluation in the initial stages of your project will allow you to adjust what you are doing "on the fly". For example, the CIRES Outreach Program offers an inquiry-based professional development workshop for secondary Earth science teachers, called Earthworks Assessment, which was an integral component of the workshop starting with the first day of the workshop and continuing with post-workshop interviews of participating teachers and scientists, showed us that we were not inquiry-based enough in our first year. We adjusted the format of the workshop significantly, and we now offer a highly successful EPO workshop.

Good evaluation includes a number of different techniques (i.e., pre- and post-tests, interviews, surveys, analysis of journal entries), and a professional evaluator can be an important team member of your outreach project. It is vital to include this

person in the planning stages of your proposal, as they will help you clarify your outreach goals and outcomes. The evaluation component of your project will need to be a budget item in the proposal, and it can be a significant fraction of the total budget (i.e., 7-30%). Individuals who can help develop evaluation plans for your project can be found within your university's Education or Social Science Departments. Some useful sources for evaluation can be found within NSF's *The User-Friendly Mixed Methods Guide to Evaluations* (and the Online Evaluation Resource Library).

NOW WHAT?

After reading this far, you may still feel as if you are not cut out to develop an outreach program. Don't be discouraged, but do be realistic. This endeavor, like any project, will take time to develop, and like everybody you are short on time. Creating a realistic project is a balance of resources (time and money), talent, and commitment. If this is your first project, start out small, seek out others who have developed a similar type of project, and ask them about the nuts and bolts of it, (i.e., time commitment, materials, teacher or student feedback, and so forth). Do remember, however, for all the effort you put into your outreach program, you will reap the rewards. In addition to having a lot of fun, some other ways scientists benefit from their involvement in education outreach are (Andrews et al., in prep.):

- Enhanced teaching abilities and communication skills.
- Broadened scientific knowledge.
- Personal satisfaction.
- Chance to effect education reform.

In addition, you will be acting for the greater good of our discipline. Aquatic sciences, being a multi-faceted discipline, are a natural platform for K-12 education because it integrates science, math, geography, and literacy. Incorporating aquatic science into a quality outreach program will increase the visibility of our discipline, which ultimately could generate more public support and encourage more students to choose careers in limnology and oceanography.

AN EXAMPLE: MY PERSONAL EXPERIENCE.

I began my outreach career by participating as a scientist mentor for Earthworks three years ago. I caught the bug, and I am now a half-time employee in the CIRES Outreach Program. In the past year, I have been involved with a half-dozen exciting water-related outreach activities that include: professional development of science teachers who serve disadvantaged populations; creating a district-wide wetlands curriculum for a new Environmental Education Center; supporting two elementary teachers in developing a field-based watershed curriculum; and helping prepare scientists to mentor teachers participating in Earthworks.

Involvement in education outreach has conferred many benefits to me, and I encourage other scientists to participate. Scientists have unique contributions to make to education, and professional societies are in a position to facilitate that contribution. The American Geophysical Union has recently issued a statement indicating its commitment to effective

science education for K-12 (http://agu.org/sci_soc/policy/earthspace_educ.html). I am hopeful that an active discourse on education outreach ideas, opportunities, and programs between ASLO scientists will help us make a vital contribution to aquatic science education.

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FROM THE EDITOR'S IN-BOX

NOMINATIONS SOUGHT FOR 2002 STOCKHOLM WATER PRIZE

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Nominations for the 2003 Stockholm Water Prize are now being accepted by the Stockholm Water Foundation until September 30, 2002. The international scientific and environmental communities, the business sector and the general public are invited to submit nominations for the prize, which includes a \$150,000 award and is presented annually for outstanding contributions to the conservation and sustainable use of the world's water resources.

The span of disciplines and activities from which a nominee may be chosen is very wide. Any field of research or practice is eligible. Nominated candidates may, for example, come from fields such as natural science, technology and engineering, economy, health and water, water management, integrated water basin management, coastal zone management, wetlands, aquatic ecology and water resources in any form.

The Stockholm Water Prize has been awarded annually since 1991 by the Stockholm Water Foundation to an institution, organization, individual or a company. The prize honors achievements in science, engineering, technology, education or public policy that increase knowledge of water and protect its usability for all life. Prize Laureates have represented many water-related activities (e.g., technology and engineering, directed research, economic research, water supply and development, education, etc.) and have come from