

Developing and Implementing an Effective Public Outreach Program

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Because of the important role science plays in peoples' lives and the significant (and increasing) impact of humans on the environment, there is a great and growing need to improve links between scientists and society [e.g., *Lubchenko*, 1998]. Some funding agencies recognize this need and have shaped their priorities accordingly. For example, the U.S. National Science Foundation (NSF) requires grant applicants to address the broader impacts of proposed work, including "promoting teaching, training, and learning" [NSF, 2007]. NASA, the U.S. National Oceanic and Atmospheric Administration (NOAA), and other agencies also encourage and fund education and public outreach activities [e.g., *Franks et al.*, 2006; NASA, 2009].

In addition to increasing a researcher's likelihood of receiving funding, building an effective public outreach component of a research project also can greatly magnify the influence of one's research and enhance teaching efforts by connecting a researcher with new audiences and partners. Hence, public outreach can be an important and beneficial part of an early-career scientist's program. Yet Ph.D. students and postdocs rarely receive any formal training on how to develop and implement an effective public outreach program.

To address this need, a working group on outreach was formed at the December 2005 Dissertations Initiative for the Advancement of Limnology and Oceanography (DIALOG) VII Symposium for recent Ph.D. graduates across the aquatic sciences (<http://www.aslo.org/phd/dialogposter.pdf>). This article synthesizes several issues, discussed by the working group, that an early-career scientist should consider to develop effective outreach programs. The article also provides Web sites of formal and informal educational programs and institutions as well as some resources for scientists interested in developing effective outreach programs (see sidebar and the electronic supplement to this *Eos* issue (http://www.agu.org/eos_elec/)).

Finding Time for Outreach

Because early-career scientists are likely to be busy with teaching and research commitments, it is incumbent upon them to develop outreach programs that use their time and input efficiently. It is important for scientists to evaluate the sustainability of their commitment in the context of other responsibilities, and to account for time and financial requirements of outreach activities in any proposal they write. It is also important for them to think carefully about the

extent to which they will directly implement the program versus how much they will rely on others. Partnering and the delegation of work can lead to a more effective outreach program, save time and energy, and allow for focusing on one's strengths.

One way to make involvement with outreach programs more efficient is through the effective use of existing resources. To this end, early-career scientists who also are professors will want to find out whether their department, school, or college has education and public outreach professionals who have community contacts and are skilled at establishing relationships with target groups that might be appropriate partners. It also may be possible to leverage other, existing grants that have education and public outreach as their central purpose (e.g., NSF

Some Resources for Developing an Outreach Program

The Bridge Ocean Sciences Education Teacher Resource Center offers a growing collection of online marine education resources (<http://www.vims.edu/bridge/>).

Centers for Ocean Sciences Education Excellence is a network of regional centers that promotes the development of effective partnerships between research scientists and educators, disseminates effective ocean sciences programs and best practices, and promotes ocean education as a charismatic and interdisciplinary vehicle for creating a more scientifically literate workforce and citizenry (<http://www.cosee.net/>, http://www.coseeca.net/files/coseeca/epo_guide.pdf).

National Marine Educators Association and its regional chapters bring together educators, scientists, museums, aquariums, businesses, and governments interested in the study and enjoyment of marine and aquatic systems worldwide (<http://www.marine-ed.org/>).

NOAA's Coastal Services Center provides free training for coastal resource management professionals, including courses on project design and evaluation and on conducting needs assessments (<http://www.csc.noaa.gov>).

NOAA's Sea Grant research, outreach, and education programs promote better understanding, conservation, and use of America's coastal resources. Partnering with Sea Grant extension agents, communicators, and educators is an effective way to transfer one's research and expertise to local communities, educators, and other user groups (http://www.seagrants.noaa.gov/roe/edu_resources.html).

NSF's Faculty Early Career Development (CAREER) Program is a foundation-wide activity that offers prestigious awards in support of early-career development activities of teacherscholars who effectively integrate research and education within the context of the mission of their organization (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5262).

The **Online Survey Design Guide** is a collection of tools and information useful in formulating and executing surveys (http://lap.umd.edu/survey_design/index.html).

Project WET is a nonprofit organization dedicated to reaching children, parents, teachers, and community members around the world with water education (<http://www.projectwet.org/>).

Resources for Involving Scientists in Education, established in 1989 by the U.S. National Academy of Sciences/U.S. National Research Council, conducts workshops and publishes materials to help scientists and engineers play effective roles in improving science education, from kindergarten through high school (<http://www.nas.edu/rise/>).

Professional Societies With Explicit Outreach Goals

- American Geophysical Union (<http://www.agu.org/outreach/>)
- American Society of Limnology and Oceanography (<http://www.aslo.org/outreach.html>)
- Ecological Society of America (<http://www.esa.org/seeds/outreach/>)

Graduate Stem Fellows in K-12 Education (GK-12) grants); it may be possible to join these programs directly or build on existing relationships between such programs and the community. One also can enlist students to help with public outreach efforts. Gaining experience communicating science to nonscientific audiences can help students develop skills and contacts that will be useful later in their careers, especially if they are planning to work at the interface between science and society. If one's institution does not have an outreach professional on staff, it may be worth considering hiring one separately or partnering with other faculty to hire one. Though it can be expensive to support outreach professionals, they can greatly enhance the effectiveness of public outreach efforts—and potentially grant-writing success—of a research group or institution.

Determining Need, Target Audience, and Outreach Goals

For an outreach program to be effective, it should address an important need. The relative importance of the needs of a community can be assessed by formal means (e.g., a survey or series of workshops) or by other, less formal input (e.g., from community leaders, teachers, or others). Some examples of important, community-based needs include increased science literacy related to environmental issues (i.e., education to increase knowledge) and increased understanding of an applied problem that science can help solve (i.e., education leading to behavior change in society). Also useful is consulting funding-agency Web sites for information on their current areas of interest regarding agency needs and target audiences.

An effective outreach program, in addition to addressing an important need, also should identify and target a particular audience. Potential target audiences include policy makers, resource managers, teachers, students, citizens, and particular professional or recreational groups. The target audience will vary depending on need, so determining the specific need will help identify the correct target audience, thereby allowing for the development of the best outreach method.

Also, determining need will allow scientists, or the public outreach professionals with whom they are collaborating, to identify key members of the community to consult with at the onset of a project regarding appropriate outreach methods and approach. Identifying key partners can be a particularly daunting task for an early-career scientist. Some possible approaches might include a Web search of recent public hearings related to the research topic of interest, consulting with colleagues, and contacting the alumni office of one's institution for leads. Another possibility is to attract key partners by offering a well-publicized and generally accessible public lecture on one's research topic, to which community leaders

are invited. Consultation with key members of the community also may help scientists to refine their concept of community need.

It is also important to identify helpful partners who might be more familiar with the target audience. These existing groups, which often have important contacts and have established trust within a target community, may be more effective at delivering the outreach message for a research project than the researcher herself or himself. Allowing partners to tailor the message to their needs also increases their sense of ownership of the message and the likelihood that partners and the target community will adopt real change in the long term [Krasny, 2005].

In addition to determining the need and audience for an outreach program, identifying some specific measurable outcomes and products also is important. Being specific and explicit about one's goals early on will focus efforts and will also allow for evaluating success and impact (and potentially making midstream adjustments). A few examples of specific and concrete goals to consider (by no means an exhaustive list) include increased test scores for students, a change in attitudes and behavior of community members, the creation of a Web site that is regularly consulted by a target audience, and an observable change in the use or quality of a shared resource (e.g., water or air quality).

The identification of need, target audience, and desired outcomes will help with the design of an effective outreach method. Some examples of outreach activities include public lectures, field trips for students or adults, community-based participatory research, community or professional workshops, the development of an educational brochure or citizen's guide, partnering with K-12 teachers, and service on a board or committee of a local volunteer organization. Examples of the authors' outreach activities can be found in the electronic supplement to this *Eos* issue (http://www.agu.org/eos_elec/).

Resources

Soliciting advice from a mentor who has attempted something similar to one's outreach effort may save a lot of time and prevent false starts. Also, there may be other faculty with whom to collaborate, potentially sharing the workload and magnifying one's impact. Community organizations also may be effective partners, particularly if they have worked with one's institution in the past. In seeking to partner with individuals or organizations outside the academic research environment, it is useful to listen to their needs and expectations from the beginning and to approach them as collaborators who bring a valuable and complementary skill set.

In this vein, each partner should approach the collaboration with specific goals for participation. For example, scientists

might expect to amplify the impact of their research or enhance their sampling capacity (e.g., through coordination with community volunteers), whereas outreach professionals might expect to gain access to state-of-the-art information and expertise that can be incorporated into their public outreach efforts. Clarifying these goals at the outset will help define the nature of the partnership and avoid potential misunderstandings as the project develops.

Developing a Mechanism for Feedback

The effective evaluation of outreach activity relies on clearly stated and quantifiable goals (outcomes). The evaluation of a project should not happen only at the end of the project; rather, it also should occur during the project so that midcourse corrections are possible. Evaluation methods might include "before, during, and after" surveys of the outreach target audience (see information about the Online Survey Design Guide in the sidebar) or indices of understanding (e.g., student test scores) and metrics of behavior change. For example, in trying to raise awareness of best management practices for farmers within a watershed, it might be useful to evaluate changes in agrochemical consumption due to one's program (note that this will require collecting data on use before and after implementing one's program).

The use of an interactive Web site (e.g., a survey or data submission Web site) is one way to evaluate the participation of the target community in an outreach activity. Simply counting the number of Web site visits is somewhat less useful, but it also can provide information about whether a Web site is effective. It also may be possible to interview or form focus groups with participants to obtain feedback on program effectiveness. Effective evaluation is critical for improving outreach programs and for reporting back to granting agencies in annual and final reports, especially if the education and public outreach activity was proposed as part of the work plan.

Developing an Exit Strategy/Sustainability Plan

Most research grants last only a few years, so it is important to think about a plan for sustainability or an exit strategy at the outset of the outreach program. If the program is meant to address a discrete problem, project goals should be clearly defined at the project's outset so that success can be effectively evaluated. If the program is meant to last beyond the period of one's grant, it is essential to develop a sense of ownership within the target audience, leading them to support and possibly fund the program. Establishing a self-sustaining outreach program requires that members of the target audience value the outreach effort and that at least a subset of the target audience feels capable of continuing to promulgate the outreach

message in the absence of continued participation by the primary researcher. One way to engender this ability and attendant confidence might be to train teachers and volunteers to train others.

In sum, effective outreach programs can take many forms, but some consistent characteristics of such programs include (1) a realistic expectation of time to be invested on the part of the primary researcher, (2) an effective and mutually respectful collaboration between scientists and outreach professionals, (3) a well-targeted audience and/or a well-defined problem, (4) reliance on the cumulative wisdom of mentors, in the academy as well as in the target community, (5) a mechanism for feedback and mid-stream adaptation, and (6) an effective exit strategy or sustainability plan.

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MEETINGS

Addressing Issues for Land Change Science

Workshop on Vulnerability and Resilience of Land Systems in Asia; Beijing, China, 15–17 June 2009

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There is a growing international community of scholars who work within the interdisciplinary field of land change science, a scientific domain that seeks to understand the dynamics of the land system as a coupled human-environment system. A coupled human-environment system is one in which the social and biophysical subsystems are intertwined so that the system's condition and responses to external forcing are based on the synergy of the two subsystems. Research on land system vulnerability, defined as a function of exposure and sensitivity to natural and anthropogenic perturbations, such as climate variability and sudden changes in macroeconomic conditions and the ability to cope with the impacts of those perturbations, is a fundamental component of land change science.

To address issues related to land system vulnerability, the Global Land Project (GLP; <http://www.glp-beijing.org.cn/index.php> and <http://www.glp.hokudai.ac.jp>) brought together an interdisciplinary group of researchers with backgrounds ranging from environmental to social sciences. Participants came from both developed and developing countries. The workshop sought

to (1) improve knowledge of the causal processes that affect a system's vulnerability and capacity to cope with different perturbations and (2) identify factors that hinder the integration of vulnerability assessment into policies and decision making.

Workshop participants identified three major issues that the land change science community should address. First, it was pointed out that a broad spectrum of scholars engaged in vulnerability assessment use different meanings for the same terminologies. This hinders exchange of information among global change scientists. Participants agreed that to facilitate transdisciplinary understanding of pertinent issues, the major concepts related to land system vulnerability need to be clarified using nomenclature that all can understand.

Second, the amount of damage to a land system and its ability to recover after a perturbation depend on the configuration of the coupled human-environment system. The effects of a perturbation are inextricably linked to the interactions of different actors in a given sociopolitical context. Reducing vulnerability and improving resilience may lead to conflicts between different actor groups at various levels of organization, workshop participants pointed out. For instance, inclusion

of trees in agricultural production systems reduces soil loss and sequesters more carbon dioxide than annuals, but the delay until the benefits begin to pay back the costs of tree establishment is a key consideration for most land managers. To avoid these conflicts, such trade-offs need to be addressed and corresponding institutions must be made available to support negotiations.

Finally, participants noted that to connect research and actions for reducing vulnerability, science-policy interaction must be an ongoing process beginning at the onset of vulnerability assessment and continuing throughout the scientific assessment and the eventual design of appropriate adaptation measures, such as changes in crop variety and crop calendar in drought-affected areas. Consultation with relevant stakeholders, including end users of adaptation measures, markedly increases the probability that a community will apply scientific research results. Participants agreed that it is important to identify the information most useful for policy and to convey the message in a concise manner using the relevant media.

The GLP plans to further contribute to an understanding of these issues through networking and collaboration with relevant global change researchers. The workshop was made possible with support from the Asia-Pacific Network for Global Change Research, the Chinese Academy of Sciences, the National Natural Science Foundation of China, and the Japan Science and Technology Agency.

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