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PERSPECTIVES

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Perspective: communicating our science to influence public policy

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Abstract. We ask 3 questions that bear on the ability of aquatic scientists to influence public perceptions and public policy related to important environmental issues: 1) Why should scientists become better communicators? 2) What can we do to promote effective communication? 3) How can scientific societies help scientists meet this communication challenge? Shareholders in the environment include watershed groups, environmental interest groups, water-quality agencies, the general public, and the scientific community. These shareholders often are not professional scientists, but they influence the formation of natural resource policies. Individual aquatic scientists should be able to explain their science to other shareholders in a way that disabuses misconceptions of scientific principles, fosters informed dialogue concerning actions that affect aquatic ecosystems, and prevents poor decisions that can result from inaccurate information or short-sightedness. Scientific societies can effectively communicate the concerns of individual scientists by: 1) articulating the links between basic research and ecological principles to applied science, thereby building the foundation of science needed to support informed decision-making; 2) translating and disseminating results of scientific research to nonscientists to minimize inaccuracies, thereby fostering scientific literacy; and 3) taking proactive positions that promote infusion of sound science into policy debates on pressing environmental issues, especially those that bear on freshwater ecosystems.

Key words: communicating science, freshwater ecosystems, environmental policy, applied science.

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How often have scientists attempted to inform managers, policy makers, or the general public on an environmental issue, only to be ineffective because the scientist's position was deemed to be incomprehensi-

ble, economically infeasible, or socially unacceptable? How many scientific publications are read by nonscientists or used to support a management decision that influences the ecological condition of aquatic resources? As committed professionals, we scientists want to make positive contributions to decisions about protecting or managing environmental resources and hope that our contributions leave a legacy of environmental protection and conservation. A key to achieving this goal lies in effectively *communicating* our science to nontechnical audiences who, knowingly or unknowingly, have an interest in the health and sustainability of our shared natural resources. In addition, scientists must listen to and understand the arguments of the general public.

Members of many scientific societies (e.g., North American Benthological Society [NABS], American Society for Limnology and Oceanography [ASLO], Ecological Society of America [ESA]) possess a wealth of expertise and knowledge related to freshwater ecosystems. Aquatic scientists understand how to characterize the structure and function of the ecosystems they study, how aquatic ecosystem health is modified by human alteration of key biogeochemical and ecological processes, and the important services provided to society by healthy ecosystems (Davies and Jackson 2006). Our challenge lies in communicating this knowledge in a way that galvanizes the public and policy makers at a time when the threats to freshwater systems and the need for scientifically informed public policies to protect these waters are growing (Jackson et al. 2001, Baron et al. 2002, Dudgeon et al. 2006). In this paper, we ask 3 questions that bear on the ability of scientific societies and their members to influence public perceptions and public policy effectively. First, why should scientists become better communicators? Second, what can we do to promote effective communication? Third, how can scientific societies help scientists meet this communication challenge? In exploring answers to these questions, we hope to promote broader involvement by individual scientists and our scientific societies in more actively speaking out to educate the public and inform policy makers of the scientific concerns many of us have about the long-term health and sustainability of our aquatic natural resources.

Question 1: Why Should Scientists Become Better Communicators?

Effective communication can change policy

Decisions that negatively affect the quality of aquatic systems are made daily throughout the world, and many of these decisions are made on the basis of little or no ecological information (Barbour et al. 2004). Convincing policy makers that the scientific data are compelling enough to demand action really *is* difficult, particularly when the issues are complex, and scientific uncertainties must be balanced against potentially large economic consequences. Poff et al. (2005) argued that collaboration with nongovernmental organizations (NGOs) is beneficial for conveying the scientific basis of many issues, particularly freshwater arguments and advocacy. They pointed out that collaboration between NGOs and scientists has been crucial to breaching political barriers that hinder application of robust science to key conservation and management actions.

Support for science-based policy can be further undermined when we resort to reporting our data only as technical reports and academic papers. This is our training and our comfort zone; however, we believe that it is imperative for scientists to make the effort to publish in a more general forum if we wish to effectively inform policy or resource management. Such communication tends to facilitate or encourage broad public support for scientifically informed policy. Resource management requires an understanding that the individuals and organizations in this largely nontechnical audience are a diverse audience and are *shareholders* in the environment. These individuals include members of watershed groups, environmental-interest groups, water-quality agencies, and the general public. All of these shareholders have the potential to influence the way aquatic resources are used and protected, and it is critical that they have access to correct, complete, and understandable scientific information to frame discussions about policy or management decisions.

Numerous examples illustrate the effective impetus of clear communication of science on policy decisions on issues with immense social impact. Perhaps the most well-known example is Rachel Carson's *Silent Spring*, published in 1962, which articulated the effects of pesticides on humans and on the environment in a way that galvanized the public and led to strict regulation of certain pesticides in agricultural and residential settings. Scientific studies demonstrating that tobacco smoke causes lung cancer (Hill 1965) eventually led to stringent limitations on smoking in public areas and facilities in the USA in the 1990s. Recently, reports in the popular media of accumulating scientific evidence that human activities are causing global climate change have led to broad public concern about climate change. An April 2007 report (Intergovernmental Panel on Climate Change [IPCC] 2007) summarizes the last 6 y of scientific studies and clearly identifies the adverse changes resulting from global

warming. Al Gore's *Inconvenient Truth* (Gore 2006, 2007) is a prime example of effective communication of scientific data that has caused a shift in public perception.

Scientists have a social obligation

We believe that scientists have an obligation to communicate their work to society. Public funding of research carries with it society's reasonable expectation that the research will generate scientific understanding of how natural ecosystems function and of the ecosystem consequences stemming from a range of human activities (e.g., Lubchenko 1998, Palmer et al. 2004). Thus, we as aquatic scientists should explain our research questions and results in ways that clarify or eliminate misconceptions regarding scientific principles, stimulate shareholders to become involved, foster informed dialogue concerning the actions that affect aquatic ecosystems, and prevent poor decisions that result from inaccurate or incomplete scientific information. The role of scientists has changed in this regard. In the postmodern world, scientists cannot be external, detached experts who provide objective solutions; rather, we must become active participants in a process wherein our role is to provide factual information to support informed decision-making (Ludwig 2001, Rogers 2006). Scientists have specialized knowledge, and as participants in the process of democratic self governance, we have some civic obligation to share that information. New partnerships between scientists and shareholders are essential if water managers are to resolve conflicts between the needs of human use and ecological health (Poff et al. 2003, Postel and Richter 2003).

Scientists must build public trust in their motives

Scientists should recognize that it is not uncommon for the public to harbor a basic skepticism and misunderstanding of our work, which sometimes is perceived as motivated solely by self-interest (curiosity, pursuit of funding, economic gain) or as conducted with some value-driven policy preference in mind. Therefore, we must take care to communicate our science in a policy-neutral way, i.e., to describe empirically the way things *are*, not the way we think they *ought* to be (Lackey 2007). Society must have confidence in the broad benefits of science if we expect continued support for public funding for salaries and research activities of scientists at current or enhanced levels. Another key element of building public trust involves sharing the excitement and sense of discovery of science with young people to inculcate a deeper understanding of the value of science's contribution to helping resolve complex social–environmental issues. Such *outreach* also can inspire and motivate young people to become scientists themselves and perhaps to become more involved as informed adults willing to engage actively in the pressing issues of aquatic science and conservation. Communicating the results of our science to shareholders, be they elementary school students, members of a watershed council, or elected members of government, is one of the responsibilities and rewards of being a scientist.

The broad and clear message scientists must communicate to shareholders is that conservation and restoration of self-sustaining aquatic ecosystems that reliably provide a range of ecosystem services to human society over time are fundamental bases to the quality of life and to economic prosperity (Millennium Ecosystem Assessment 2005). One of NABS's Environmental Stewardship Award winners said, "When scientists fail to make a strong case for decisions based on science, the long-term costs often outweigh the short-term economic arguments for *not* using scientific insights" (Karr 2006). Increasingly, a healthy environment is seen as critical to a healthy economy. For example, in the midwestern USA, which currently is experiencing a serious economic downturn, financial investment in environmental restoration has been estimated to be highly cost-effective, and it can influence job creation and home values (Austin et al. 2007).

Question 2: What Can We Do to Promote Effective Communication?

Scientists must work collaboratively

An understanding of complex environmental problems requires an interdisciplinary approach, and scientists have learned to exchange information, lessons learned, and basic principles among researchers in other, sometimes very different, disciplines (Cullen et al. 1999). Now, interdisciplinary teams of scientists must learn to work with the public and with resource managers in the context of a shared vision of some future ecological condition (Rogers 2006). The success of such broadly integrated efforts to generate the scientific understanding that can help solve complex environmental problems will require a commitment by scientists to effective communication. Links with NGOs can provide a stronger voice than that of any single entity when trying to convey a scientific foundation for management decisions (Poff et al. 2007).

Effective communication tools

Developing a scientific consensus and publishing a white paper constitute one of the most effective

approaches to communicating science. Poff et al. (1997) articulated the view that a river's natural flow regime was integral to its ecological integrity. The paper basically communicated an emerging, global consensus that dynamic flows are important to river ecosystem structure and function. The concept of using the natural flow regime (environmental flow) as a baseline for evaluating the success of stream and river restoration is now widely established as a framework for evaluating success in restoration and management planning (Postel and Richter 2003, Annear et al. 2004), is promoted vigorously by nongovernmental organizations (e.g., Nature Conservancy Sustainable Waters Initiative; http://www.nature.org/initiatives/freshwater/), and influences funding priorities. Of course, recognition that managed rivers require environmental flows to support broad ecological function is not the same as implementation of practices that ensure environmental flows, which requires a societal decision based on more than information alone. For example, a 1994 agreement by the Council of Australian Government (http://www.coag.gov.au/meetings/250294/index.htm#water) recognized the environment as a legitimate user of water. However, 14 y later, agreement has not been reached on how to release water to achieve positive outcomes and how to assess those outcomes. Moreover, and partly as a consequence of these issues, the political will to implement environmental flows in Australia is lacking. The challenge of setting environmental flow standards globally is now a pressing issue (Arthington et al. 2006).

Scientific papers provide the foundation of water law (or guidelines for water resource protection) in several countries, i.e., US Clean Water Act (Senate Public Works Committee 1972, Barbour et al. 2000), UK Water Framework Directive (Harper et al. 2000), Austria (Chovanec et al. 2000) and Australia Water Law (Bunn and Davies 2000) and assessment and management (Norris et al. 2001, 2007). The scientific papers containing the arguments for science-based water law are not easily accessed or understood by the general public and decision makers. However, this obstacle can be overcome by committed scientists. For example, in 2003, the US Environmental Protection Agency (EPA) and the US Army Corps of Engineers did 2 things to challenge the Clean Water Act: 1) they sought public comments on whether waters that are considered to be isolated, intrastate, or nonnavigable, should be excluded from the act; and 2) they instructed their field staff not to enforce the law to protect these waters or to seek guidance from headquarters on a case-by-case basis (Meyer et al. 2007). This challenge stimulated a number of leading scientists from different disciplines to prepare a treatise for shareholders on the scientific imperative for defending small streams and wetlands (Meyer et al. 2007). The authors articulated first principles of ecology in nontechnical language so that individuals and organizations could be armed with the scientific foundation they needed to make environmentally sound management decisions. In a similar effort to reach a broad audience, Poff et al. (2002) prepared a report directed to the general public and lawmakers on the effects of climate change on inland freshwater and estuarine ecosystems. A report containing scientific information on Australia's largest river system (Murray–Darling River Basin; Norris et al. 2001) influenced a joint governmental committee to allocate $500 M Australian for environmental rehabilitation and reclaimed 500 ML of water from irrigation for the environment.

One effective strategy for communicating scientific results to shareholders is to use the popular media. For example, science reporter Elizabeth Weise worked with scientists to convey an important message when she discussed the prediction that the combined pressures of population growth, fishing, habitat alteration, and pollution might lead to extinction of 90% of the ocean's edible species by 2048 (Weise 2006). In another case, results of a synthesis on global depletion of freshwater fisheries (Allan et al. 2006) were reported on National Public Radio (NPR), which brought the attention of the general public to overfishing.

Learning how to work with news media is a critical piece of communicating our science. Most universities have media specialists who are eager to learn about interesting new findings, and who are looking for opportunities to publicize our work. Leadership and communication training is central to the Aldo Leopold Leadership Program (www.leopoldleadership.org), to which individual scientists may apply, and media training is provided to Smith Conservation Fellows (www.conbio.org/SmithFellows) under the auspices of the Society for Conservation Biology. NABS and other professional societies could facilitate our collective learning by sponsoring media training at its meetings and inviting media coverage of its sessions.

Overcoming barriers to effective communication

Many scientists find effective communication of science challenging. Some lack training in public speaking or in nontechnical writing. Others worry that simplifying the science for public consumption might lead to inadvertent inaccuracies or misrepresentations in the message. A few scientists see no reason to communicate with nonscientists and make

no effort to do so. They tend to only interact with environmental managers or publish in scientific journals that are not widely read by nonscientists. Agency scientists oftentimes are restricted in their communications on specific environmental issues because of impending litigation, politics, or a mandated authorization process that provides oversight on its scientists. However, even government scientists are able to engage in public outreach and education. This is a form of communication that they can do, and it is not restricted so long as it is policy-neutral. Many professors and other science educators are instrumental in reaching out to nonscientists, either through special curricula or community involvement. In addition, a few aquatic scientists who have established reputations in scientific research and conservation issues have become visibly involved with the nonscientific community. Examples of issues that have been addressed include: ecological effects of regulating rivers (Ward and Stanford 1979), alteration of flow regimes and the implications of water management (Poff et al. 1997, Pringle et al. 2000, Bunn and Arthington 2002), The Freshwater Imperative (Naiman et al. 1995), the jeopardy to the overall ecological health of the USA's rivers by continued land use (Allan 2004), the uncertain benefits of river restoration despite large financial expenditures (Bernhardt et al. 2005), the significant alteration of landscapes by mountaintop removal and valley fill (Stout and Wallace 2003), and the emerging science of dam removal and ecosystem recovery (Hart and Poff 2002, Stanley et al. 2002).

Question 3: How Can Scientific Societies Help Meet the Communication Challenge?: NABS as a Case Study

Societies facilitate communication

Many scientific societies actively facilitate communication among their members/leaders and lawmakers, resource managers, and the general public. For example, NABS organizational structure includes several committees that are charged with communicating outside of the society. The Public Information and Publicity Committee (PIPC) is a venue for educating the public about the need to balance ecosystem health and human activities. Much of this education is conducted through the society's web site. The Conservation and Environmental Issues Committee (CEIC) promotes interaction between NABS and freshwater conservation organizations and promotes protection and restoration decisions based on good science. The CEIC also provides resources, such as slide shows and a video library, that make scientific information available outside the society. The Science and Policy Committee (SPC) forges links between scientists and policy makers by providing scientific insights into prevention, protection, and ecological risks. These 3 committees enable NABS to advocate good science as a basis for informed decision-making.

An individual scientific society can serve as a collective voice for its members and advocate science as a basis for making informed decisions regarding resource use and management. In 2007, for example, NABS prepared a letter to the US EPA on the need to incorporate new scientific data on freshwater mussels to update NH_3 criteria for surface waters. This letter was a shared response with several other organizations concerned with freshwater quality, and several of them subsequently submitted similar appeals to the US EPA.

Societies can speak collectively

Scientific societies also can act collectively to communicate the need for a particular response from lawmakers or resource managers. For example, a recent rewriting of the Endangered Species Act by the US Congress threatened to weaken the scientific foundation of protection for species at risk. In a concerned and united effort, 17 scientific societies, including the Society for Conservation Biology in North America, Ecological Society of America, American Fisheries Society, Entomological Society of America, Society for Range Management, The Wildlife Society, and NABS, joined together to release a statement on the use (and misuse) of science in the Endangered Species Act (Trombulak et al. 2006). Scientific societies have taken several advocacy positions associated with the expertise of its members. For example, the Freshwater Imperative (Naiman et al. 1995) was a call to action from members of several scientific societies in a collaborative effort to convey the issue of clean water to the public and to US lawmakers. Its goal was to convince lawmakers of the critical need to protect freshwaters from further degradation, and one tangible outcome of this effort was the National Science Foundation (NSF)–EPA program in Water–Watersheds. The Council for Scientific Society Presidents, in which NABS participates, provides opportunities for communication among societies to strengthen their common goals related to communicating the science needed for sound decisions related to the use, protection, and management of natural resources.

The role of scientific societies

In our opinion, leaders within a particular scientific society have the responsibility to raise the awareness

of society members about the need and opportunity for individuals and the society to take positions on emerging environmental issues. The role of a professional society should be 3-fold: 1) The society must bridge the gap between results of basic research and the application of that science to build the foundation needed to support informed decision-making. 2) The society should be a forum for translating research findings into terms the nontechnical public can understand and should serve as a conduit through which these results are transmitted to nonscientists so that inaccuracies and misunderstandings of science are minimized and the public becomes more science-literate. 3) The society should take proactive positions that promote infusion of sound science into policy debates on pressing environmental issues, especially those that bear on freshwater ecosystems. Our science should provide a solid foundation from which nongovernmental organizations, citizen groups, and government agencies can advocate decisions based on objective (science-based) positions on specific issues. A society's position on current environmental concerns is justifiable on the basis of the intrinsic value and fragility of the living systems that the professional society members study. However, we also must recognize that we greatly strengthen our case when we are able to connect our position to ecosystem services that yield human benefits (Kareiva and Marvier 2007). Last, a position statement from a professional society would provide a scientific argument for quality of human life now and in the future and might help us avoid future costs of remediating impaired ecosystems. Collectively and as individual scientists, our path is clear—we must articulate our science for decision-making, or risk irrelevance to society in general.

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