The ecology–policy interface

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G. Evelyn Hutchinson famously summarized the natural world as "the ecological play in the evolutionary theater". Unlike its Elizabethan namesake, this original "globe theater" opened without a Shakespeare; there were players and a stage, but no director or manager. Were this still the case, the work of ecologists would be just to study the play – in other words, to do ecology. However, as humanity has assumed the position of director and manager, the globe theater, earth, has become somewhat more like the Globe Theatre in London. The new director is no Shakespeare, and so the work of ecologists has expanded from understanding the play to providing notes for its direction – from doing ecology to guiding policy.

What role, if any, should ecologists have in policy making? For that matter, what should be the role of policy makers in ecology? In this forum, we have asked for both theory and empirical results. A new mission statement for ecologists might run something like this: "to provide the most useful scientific information possible for making the legislative and administration decisions that affect society and nature, by meshing their interests with those of policy makers".

Unfortunately, there are devils lurking in the details. In particular, two dimensions of ecologists' new role have provoked increasing debate. One of these is distance, and therefore objectivity. A time-honored model for the interaction between scientists and policy makers has been for scientists to maintain a "healthy distance" (Bush 1945). Scientific funding and salaries are often provided by institutions that do not make environmental policy, such as universities and the National Science Foundation. This frees scientists from political pressure to study particular topics or to produce results that support particular policies. The downside is that the results may not be very useful for policy, given that policy-making questions are often addressed only tangentially by any given research project, especially one not specifically directed towards them.

The alternative resembles endosymbiosis, with government agencies such as the USDA Forest Service employing and housing their own scientists. This arrangement seems more likely to ensure that the resulting research addresses specific policy needs, but less likely to ensure intellectual freedom. Some political scientists argue that when scientists take on a role that affects policy outcomes, their independence ought to be limited, because democracy requires such trade-offs between freedom and political responsibility (Price 1965). Some natural scientists view the bargain as Faustian, and caution colleagues that symbiotic relationships tend to switch between mutualism and parasitism as resource availability changes (Wagner 2001).

An intermediate scenario is the "ecology/policy middleman", in which a third party organization accepts commissions from policy agencies to tap scientists from academia to participate on panels, review current research, and provide synthetic reports that characterize the current state of scientific knowledge on a topic of the agency's choosing. The scientists gain exposure, plus expenses and perhaps publications, which go to the credit of the universities that pay their salaries. A hallowed example of this type of scientific retail in the US is the National Academy of Sciences' National Research Council (NRC). Would an "Ecological Research Council" draw ecologists and policy makers together by just (and only just) the right amount?

Consensual models seek to make the issue of distance irrelevant by creating issue-based institutions to which everyone belongs. For instance, the National Council for Science and the Environment includes stakeholders in discussions of research agendas and brings scientific information about the environment to the public and policy makers (Anonymous 2000, 2002). The real test of such models may come when such consensual bodies are given the power not just to advise on policy, but also to decide it.

The second controversial dimension of the role ecologists play in policy is activism (Kaiser 2000). The debate has commonly been framed as analysis ("here is what the data say may happen if society does this") versus advocacy ("here is what society should do"). One side argues that by staying neutral, scientists preserve their credibility, which is really the only special advantage they have over non-scientists in influencing policy. The counterargument holds that, by stepping out as advocates, scientists will gain much more in the exposure of their work than they will lose in credibility (although they may first want to wait until they are already famous, or else seek safety in numbers). Adherents of the "one head, two hats" strategy claim that one can finesse the dilemma by providing analysis as a professional scientist and advocating policy as a private citizen (Kaiser 2000; Wagner 2001).

Steel *et al.* (2001) point out that the potential range of activism by ecologists does not begin with analysis nor end with advocacy. Scientists might be seen as even more credible if they simply provided the results without discussion, instead of interpreting what their data say. Similarly, they may be seen as even more effective at putting science into policy if they could just go ahead and make the regulations themselves. However, their survey of scientists, resource managers, environmentalists, and the public suggested that none of these groups wanted scientists to be so

timid as to refrain from interpreting their results, nor so empowered as to decide policy (Steel *et al.* 2001).

Personal values add yet another wrinkle (Rykiel 2001). The values that scientists inevitably bring to their work are likely to be shaped by their professional role (Bell 1985). To the extent that scientists work for governmental agencies or other policy organizations, they may allow their organizational commitments to constrain and direct their behavior. Advocacy is necessarily value-laden, because a scientist's opinion as to what society should do clearly depends on what outcomes he or she holds dear.

What is an ecologist to do? Are there potential models for cooperation that have been overlooked? Does advocacy compromise credibility? Is there an optimal policy role for ecologists, or should they learn about the implications of different roles, and then expand those roles in the hope that, as biodiversity may help maintain ecosystem function, a diversity of ecologists will lead to better functioning policy? If the ecology–policy interface is so complex on the local and regional levels, how can ecologists hope to work with policy makers to help make global decisions, in this ecological theater where we are all players.

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Ecologists can and must play a major role in the development of public policy. Society depends on ecologists for relevant information about particular habitats and species, populations, and communities within those habitats. Scientific information is particularly important because it is collected in a systematic manner. Other members of society, such as farmers or fishermen, may have detailed knowledge about particular places or species, but resource users are not likely to follow the scientific method as they gather information. As a result, their largely anecdotal information may be limited in scope and predictive power.

Ecologists must be able to provide information to the public in a way that it can be used. It is not enough to write a sentence or two at the end of an academic paper, suggesting that the key findings have potential to influence public policy. First, papers in academic journals are unlikely to reach an audience capable of influencing public policy. Second, if the information does reach the right people, the key findings may be presented in a way that is not comprehensible to them. Ecologists who believe their work may be useful in the development of public policy have a responsibility to provide the information in a form that can be understood by the lay reader.

There are numerous ways to disseminate information to the public. We can develop press releases for local newspapers and radio stations, or write articles for popular journals, using simplified language and pictures to describe key concepts. Docents at state and national parks, museums, zoos, aquariums, and botanical gardens can also be a source of ecological information for the public, and really adventurous ecologists can team up with film and television studios to create educational videos about ecology.

A greater commitment to public service may be required for the development of complex environmental policies. Ecologists might be invited to serve as advisors to committees and commissions that make policy recommendations. As advisors, ecologists generally serve for the duration of the development of a particular policy, providing intermittent consultation for months or years. In this role, the ecologist may be an integral part of the development process. At least one ecologist, and perhaps several, must attend committee or commission meetings, in order to field questions and identify the type of information required. Assembling this information may involve the review and synthesis of published materials on the subject. Based on this background research, the ecologists may develop criteria that will help the committee or commission to meet its policy goals. Ecologists may also be asked to come up with various alternatives for policy groups to consider, and/or to help develop monitoring programs to elucidate the consequences of particular policies.

Ecological principles alone are not sufficient to develop policies that will be acceptable to the general public. Economic and social factors must also be taken into account, to gain the support of affected citizens. After decision makers have integrated economic and social considerations, advisors may be required to evaluate proposed policies from an ecological perspective.

Another option is to include ecologists as an interest group rather than as objective advisors in the development of public policy. In this role, ecologists can empha-

size the value of ecological systems. People depend on healthy ecosystems for fundamental "goods", such as food and medicine, and essential "services", such as climate regulation, nutrient recycling, the detoxification of pollutants, and the control of diseases and pest outbreaks. We all depend on natural systems, not only for our survival, but also for inspiration. This value has been expressed throughout human history in literature, painting, music, dance, and other arts. The complexity and diversity of life on earth has inspired generations of students to pursue the science of ecology. However, as the realm of human influence grows ever larger, opportunities to study natural systems become more and more scarce.

When it comes to public policy, people inevitably hold different views. Ecologists can describe the general principles that govern ecosystem dynamics. Consumers can draw attention to the importance of sustaining natural resources while maintaining access to them. Environmental activists can emphasize the need to protect various habitats and species for their intrinsic value. In spite of the differences in these perspectives, we all share the common goal of sustaining biodiversity for future generations. As citizens who study the patterns and processes in nature, it is our responsibility to participate in the development of policies that affect the consumption and protection of life on earth.

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Alpert and Keller have dissected the ecology–policy dilemma into two components: distance and advocacy. While I agree that both are important, my concerns relate mostly to the latter. I have reservations about the long-term consequences of blurring the distinction between ecology as a scientific discipline and ecology as environmentalism.

I recently had a dental appointment, and the hygienist was new. In an attempt to relax me, she asked what I did. When I told her that I was an ecologist, she said that I must be pleased that voters had approved our city's open-space proposal. This caught me completely off guard, and around a mouthful of dental instruments, I responded "Um, ah, well, yes, of course". I don't propose that my dental hygienist represents a random sample of public opinion, but her idea of what an ecologist is reinforced my fears about what will happen to our claim to be scientists if we endorse the ecologist-as-environmental-advocate model. We may have, as Westoby (1997) suggested, already lost the battle for the title "ecologist".

What is it about ecologists venturing into the advocacy game that worries me most? In a nutshell, it is losing what Alpert and Keller referred to as "the only special advantage [we as ecologists] have over non-scientists in influencing policy". What is it that distinguishes us from members of environmental activist organizations, whose mission is to save or preserve some aspect of the earth? Our goal is to generate knowledge about the natural world, whether it furthers environmental protection or not. As scientists, we have the responsibility to be objective (or at least evenhanded) in generating and reporting knowledge, to be willing to subject every idea to critical testing, regardless of our feelings about it, and to express the underlying uncertainties associated with our findings. This is what distinguishes science from other ways of understanding the natural world, and it is all that makes us different from others who try to do the same.

Is it important that we preserve our distinction as scientists? I think it is crucial that we be seen as different from environmental activists. If we are not scrupulous in defending our scientific standing, we may lose our ability to contribute to decisions and policy that will influence the future of the biosphere. I fear advocacy by ecologists will endanger our standing on lists of invitees to future deliberations about environmental policy. For instance, we do not want a situation in which organizers of a panel that already contains a member of the Sierra Club might assume that inviting a member of the Ecological Society of America (ESA) is unnecessary. Compromising our scientific standing in the eyes of policy makers and the public may very well make us redundant with other pro-environment voices.

Will it be possible for us to finesse the "one-head-two-hats" strategy? Again, I know of no theory or data to guide a response to this question, but an anecdote captures my concerns. The best financial advice I have ever received was never to accept financial advice from anyone who has a vested interest in one of the potential solutions. If you ask a realtor what you should invest in, the answer will probably be real estate. The critical issue is that, even if real estate is indeed the best investment, you can never be sure that you received unbiased advice. Certified financial planners (CFPs) recognized the potential for damage to their profession from individuals providing biased advice, so all CFPs are now required to sign a code of ethics. If you employ a CFP, this code guarantees (in principal) that the advice you receive is unbiased. The ESA's code of ethics (www.esa.org/ecologist/codeofethics.htm) is ambiguous about such a conflict of interest for ecologists.

The "one-head-two-hats" scenario does not have to be identical to the CFP example to damage our profession's credibility. Merely expressing interest publicly in the role of "environmentalist" calls our objectivity into question. Although financial assets that create a potential conflict of interest for a CFP can be demonstrated with data, attitudes are less easy to pin down.

When the ESA invited The Nature Conservancy to co-host an annual meeting, what questions did that pairing raise in the minds of policy makers and the public? When ecologists become spokespersons for environmental issues, how does that affect their scientific credibility and that of the entire field? The perception that stock analysts pro-

vided biased advice to further their own financial agendas or those of their employers during the tech boom of the 1990s has sullied the reputations and credibility of all stock analysts. What makes us think, if we allow our environmental biases to confuse our audiences about our scientific ethics, that we are going to be immune to the same discrediting process?

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I could not agree more that ecologists must participate in the "evolutionary theater", but in what role? More specifically, what roles exist for federal scientists?

In the seminal report *Science – The Endless Frontier,* Bush (1945) described the relevance of investigator-initiated research using a metaphor of science feeding a "reservoir" of knowledge, in which benefits flow downstream to society over the long term. The implication, of course, was that science should keep a "healthy distance" from policy. However, this model has been questioned because it lacks political accountability and relevance to real-world problems (Byerly and Pielke 1997; Pouyat 1999). After all, many scientists use taxpayers' money to conduct their research, and simply relying on downstream flows of knowledge may not be enough to keep up with the demands of today's fast-paced world. Moreover, cultural and procedural barriers block the flow of information between the science and policy communities (Pouyat 1999). Byerly and Pielke (1997) suggested that the denial of accountability in basic research circles actually encourages an "elitist isolation" from the rest of society – a behavior that, in my opinion, results in a trickle rather than a flow of knowledge.

While most academic scientists engage in investigator-initiated research that trickles down, most federal scientists engage in mission-initiated research closely tied to societal needs. Alpert and Keller argue that federal scientists are in an "endosymbiotic" relationship with their host agency, which closely binds their research to policy, but which will inevitably hamper their intellectual freedom. Indeed, in the scientific community there is a perceived gap between mission- and investigator-initiated research. Unfortunately, this view results in the dichotomy alluded to by Alpert and Keller, which points to an inevitable trade-off between intellectual freedoms and political accountability.

Mission-oriented research does not always result in a loss of intellectual freedom, nor does political controversy necessarily handcuff a federal scientist in his or her research. Government research projects are often broad in scope and allow investigator-initiated questions. Big government research projects also have unintended benefits, such as the development of research infrastructure and the training of graduate students (Weathers and Lovett 1998).

Moreover, while ecologists in academia may have the luxury of taking individual positions on issues, federal scientists typically conduct their research in a contentious political environment. This is not necessarily bad, since knowledge is most comprehensively developed not by individuals in isolation, but through a dialogue with others who have different points of view, particularly when those views emanate from a diversity of disciplines (Gibbons *et al.* 1994). This dialogue is particularly important, because environmental and natural resource problems are complex and interdisciplinary in nature. Federal scientists, who often work in multidisciplinary teams, therefore benefit from being challenged by differing points of view, in contrast to scientists working in the more isolated environment of academia.

Perhaps a more important trade-off that scientists experience is the time and energy devoted to either science or policy and other public services. Burke and Lauenroth (1997) recognized this, and presented a conceptual model showing the career trajectories of ecologists who divide their time between research and non-research activities. Ecologists who initially spend a large part of their time on research were highly productive and formed the model's upper boundary, while the lower boundary represented ecologists who contributed a great deal to service activities early in their careers, but did not achieve a high level of scientific productivity. Whether or not one agrees with this model, the trade-offs proposed are relevant to the question of how these should be dealt with in the scientific community.

For the same reason a "superorganism" has yet to evolve in the evolutionary theater, we should not expect there to be a "superscientist" who can be all things to society. As with all theatrical productions, the ecological play requires not only a director, but also a producer, stagehands, set designers, and so forth. The same is true for the ecological sciences; we need federal ecologists as much as we need the academic researchers, the "ecology–policy middlemen", and a diverse array of career paths to most effectively direct and manage nature's play. The key is to remember that the science of ecology is the study of relationships, in more ways than one.

(The views expressed do not in any way reflect the views of the USDA Forest Service.)

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In their research and teaching, ecologists find themselves probing issues of great importance to society at large, and to policy makers specifically. This hasn't always been the case, but in recent years, the growing documentation of the increasing human impact on ecological systems has placed ecologists in a key position to interpret the consequences of these changes. Furthermore, the development of policy instruments to address these large issues has required the scientific community to provide policy-relevant information. Often, this occurs almost in real time, as with the ozone protocol.

Our graduate training system ill prepares scientists to engage in science–policy dialogues. Neither does it prime students very well to engage in teaching, or even to operate efficiently in the many complex social environments they will encounter in their work. These skills are generally gained through on-the-job training, although programs such as the ESA's Aldo Leopold Leadership Program help in this regard.

The most important aspect of an academic ecologist's training is learning how to solve problems – how to gather and analyze data and to draw conclusions regarding their significance in relation to the questions posed by the analysis. Since individual creativity and competence is emphasized in these studies, they are usually done by individuals. The conclusions that can be drawn are therefore limited, and only in unusual cases are the results of singular value to the complex policy issues of the day. However, individual scientists do carefully evaluate data from other studies, in relation to their own conclusions.

It is this process of critical evaluation that provides the most direct way for ecologists to help the policy process. The National Research Council (NRC) has developed a highly regarded science assessment process, the results of which are valued because of their impartiality and their dependence on the critical analysis of peer-reviewed material. These assessment panels are established with great care, to make sure that they are made up of leading experts and that the panel is well balanced in terms of the relevant disciplines, and the results are rigorously evaluated by yet another set of experts. In most cases, the assessments are requested by various agencies, and thus by their very origins are the results aimed at helping to solve a particular policy question.

In recent years, the science assessment process has expanded greatly at the international level, and many of these assessments have directly addressed ecological issues. The most notable examples have been the Intergovernmental Panel on Climate Change, the Global Biodiversity Assessment, and the Millennium Ecosystem Assessment currently in progress. These initiatives have a number of features that give them high credibility: (1) they carefully evaluate peer-reviewed literature, (2) they usually provide some measure of the certainty of the conclusions they draw, (3) the participants are balanced in expertise, region, and gender, (4) the results of the assessment undergo rigorous review at many levels, and (5) the final document not only provides a technical analysis of the information, but also puts the findings into terms that are relevant (but not necessarily prescriptive) to policy. The policy community takes the information provided according to these guidelines very seriously.

In recent international assessments, scenario building has been part of the process, and lets policy makers envision the consequences of different policy choices. Since these scenarios often extend for half a century, they cannot be simple extrapolations of current trends, because of the complexity and interactions of the drivers of change. They do, however, give policy makers a glimpse of possible futures, to help guide their current deliberations.

Policy makers are often captivated by what they can do today that will have a favorable outcome in a very short time. Nevertheless, ecologists can play an important role in shaping the thinking of policy makers by carefully constructing diverse scenarios that entail alternative options for the future. One thing is clear – the results of ecological studies are becoming ever more important in the policy realm, because of the increasing consequences of the alteration of biotic systems in relation to human welfare.

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Society increasingly expects all stakeholders, including publicly funded scientists, to contribute to its overall ability to respond to environmental challenges, an ability some have identified as society's "intellectual fitness" (eg Breen *et al.* 2002). They are asking different questions, including how we can better understand and meet each others' needs and values, and how to bridge cultural divides (Rogers 1997; Ludwig 2001). Here we consider the South African experience in working towards a consensual ecology–policy interface.

Society increasingly expects scientists, in exchange for public funding, to demonstrate their intellectual fitness to respond to environmental challenges. The demand for accountability is heightened in post-apartheid South Africa, a microcosm of the changing global society, where diverse cultures speak 11 official languages and the distance between the "haves" and "have-nots" amplifies the gulf between development and environmental protection.

South African national think tanks and "foresight" exercises set out future goals for science and technology. All major science funding agencies respond by assessing research proposals against these national needs. Review panels routinely ask how relevant the research is, whether there is strong evidence for effective cooperation with industry and/or government agencies, and whether researchers are actively involved in redressing social inequalities and in capacity building in previously disadvantaged sectors of the population. Scientists are increasingly sensitive to the trade-offs between intellectual freedom and social responsibility, and address these questions in their research programs. For instance, research on the rivers of Kruger National Park was directed towards three goals: (1) achieving a common understanding; (2) developing and implementing ways of managing rivers; and (3) enhancing individual and institutional capacity (Rogers and O'Keeffe in press; Biggs and Rogers in press).

On a national level, government water resources engineer Fred van Zyl presented the South African freshwater ecological community with an imperative a decade ago: "We all agree on the urgency for understanding and managing river ecosystems. If ecologists can't quantify environmental flows, we will unfortunately have to make the decisions ourselves so that society can move on." Ecologists, motivated by the challenges of post-apartheid renewal, rose to the challenge. They sat down with the Mandela government to devise new water legislation that sees ecosystem protection as the only "right" to water (all other users must compete for licenses). Together with managers, they evolved a philosophy to contribute on a "best available information" basis, and also developed tools for assessing environmental flow (King and Louw 1998) and adaptive management processes (Rogers *et al.* 2000b) with which to implement the flow recommendations.

This approach is starting to show success, and environmental flow requirements are being defined for our major rivers. A new interactive theater is emerging, in which dialogue has replaced segregation and suspicion, but we still have a long way to go. Here are some of the lessons we are learning:

- A full cast of players, including scientists, policy makers, agencies, managers, and societal stakeholders, is critical to success.
- Different players have different values, professional norms, and reward systems (Rogers and Biggs 1999; Rogers *et al.* 2000a). Helping others to achieve theirs will help you to achieve yours.
- Seek first to understand, and then to be understood. Listen and respond to the values and needs of others. Science is not paramount – partnerships are.
- Ecologists instinctively criticize any explanation. The challenge lies in achieving a constructive dialogue (Pickett *et al.* 1999) that turns differences of professional opinion into hypotheses that are testable in adaptive management programs.
- Decisions are never final, and must always be followed by other, more informed decisions. Don't pressure managers or policy makers to delay decisions because of a lack of data; instead, help them to make the best decision with the best available information.
- Ecologists should formulate their information as a contribution to current best practice. "The most difficult task was to get ecologists to provide the knowledge we needed [to determine flow requirements], rather than the information they had" (J King, pers comm). Ecologists "need to measure what we need to know, not what they know how to measure" (D Galat, pers comm).

Perhaps the most important lesson ecologists should learn is not to enter the new social theater as "experts" (Ludwig 2001), but as co-learners, interactive players seeking consensus on stage. For some ecologists, and for ecology as a science, this transition will certainly be difficult. We will judge success by a shift from research outputs that impress peers to outcomes that allow society to better respond to environmental challenges.

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