Advocacy and Credibility of Ecological Scientists in Resource Decisionmaking: A Regional Study

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In this article we report on a regional study in the Pacific Northwest concerning the attitudes of scientists, resource managers, representatives of interest groups, and members of the involved public regarding preferred roles for research and field ecologists in natural resource management. Specifically, we examine the question of whether scientists should act as policy advocates and, if so, in what way. We also examine the factors that are perceived to affect scientists' credibility in these roles.

Keywords: policy, advocacy, credibility, LTER (Long Term Ecological Research) Network

A series of articles in a special issue of *BioScience* in June 2001 reported on a symposium held at the Ecological Society of America's annual meeting in 1999; the symposium explored the relationships among science, values, and policy. In the introductory article, Edward J. Rykiel Jr. (2001) claimed that "contrary to prevailing opinion, the scientific community is fully engaged in politics" (p. 433). However, he asked whether that involvement comes at a "cost too dear" if those scientists who are "perceived to have a political agenda lose their credibility, and policymakers can therefore ignore any scientific information they provide" (p. 433). In a more recent issue of *BioScience,* Paul Ehrlich (2002) argues not only that scientists should be advocates, but that "the credibility of ecologists...has been enhanced as many of them have tried to diagnose environmental ills and suggest cures" (p. 33). Although there has been much debate among scientists and others regarding the impact of public advocacy by scientists, there has been little systematic study of preferences for, barriers to, and consequences of such advocacy. And, in most instances, the debate oversimplifies the term *advocacy,* thereby missing the wide range of possible activities and engagement of scientists in policy and management (Weber and Word 2001).

Although most theorists and the public have normative expectations that the inclusion of scientists and scientific information in some way could improve the quality of complex natural resource decisions, there is little empirical research that clearly verifies such benefits. Moreover, there is growing experiential evidence that tensions between the distinct institutional needs and cultural values of decisionmakers and scientists may preclude the effective use of science in such decisions (e.g., Collingridge and Reeve 1986, Brown and Harris 1992, Priest 1995, Meidinger and Antypas 1996, Weber and Word 2001). Social scientists have identified and discussed these interconnected issues, yet little or no empirical testing of theoretical propositions has been done (Peters et al. 1997) and almost no systematic data gathering has been pursued. This article reports on exploratory research that was conducted with ecological scientists and others involved in natural resource decisionmaking in the Pacific Northwest to identify preferred roles for scientists' involvement. In particular, we focus

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on expectations of different groups for the involvement of ecological scientists, including advocacy of preferred management practices and policies and perceived challenges to credibility with such involvement.

The technocracy–democracy quandary

The emergence of the United States as an advanced industrial society has led to an increasing array of social and political problems that are highly technical and increasingly scientific in nature. The management of natural resources has emerged in the second half of the 20th century as one of these problems. Managing natural resources involves analyzing complex biophysical, ecological, and social systems in which the collection and interpretation of substantial amounts of technical and scientific information are critical. Weighing and evaluating relevant scientific information is difficult and fraught with methodological problems. Moreover, some information that is needed for decisionmaking may be unavailable or incompatible with management decision timelines. In addition, historical allocation rules are being challenged by a growing population who demand access to commonly held resources, such as forests, beaches, waterways, wildlife habitat, and airsheds (Thornton 1991), leaving many citizens frustrated with policy decisions and implementation.

In tension with the increasing complexity of natural resource problems is the commitment of the US political system to public participation in decisionmaking (Ezrahi 1990). Public expectations for involvement in natural resource management have grown during the past 30 years, partly as a result of legal requirements imposed by Congress (Dunlap and Mertig 1990, Fischer 2000), including public hearings and comment periods mandated by the National Environmental Policy Act and other environmental laws. Yet communities and organizations are demanding more input into decision processes and practices of the natural resource agencies that affect their lives.

These circumstances have produced a widescale dilemma for resource managers. How is it possible to increase public involvement in decisions, thereby enhancing the democratic quality of those decisions, when management of natural resources is so scientifically and technically complex? Wouldn't such decisionmaking therefore require a more significant involvement of experts? Some observers fear that the increasing need for scientific and technical expertise will erode public willingness or capacity to understand the relevant issues and to participate in making choices about how resources will be allocated (Kuklinski et al. 1982, Pierce et al. 1992). On the other hand, some are concerned that the public's growing distrust of the scientific, technical, and management communities will hinder the ability to manage natural systems. As Earman (1996) argues, "Many people hold views that run counter to scientific belief, and often, due to their lack of scientific knowledge, or [to] the belief that many environmental atrocities have been the direct result of science, they tend to not trust scientists, who they believe have damaged their world" (p. 18). The resulting "democracy and technocracy quandary" has put scientists in the middle of social and political debates in which scientific and technical information is increasingly relied upon to provide "objective and unbiased" information that can be used to better craft acceptable political solutions (Pierce and Lovrich 1986, Pierce et al. 1992).

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Traditionally, many scientists have been reluctant to become involved in policy decisionmaking, to act as advocates for specific management alternatives (Shrader-Frechette and McCoy 1993), and sometimes even to explain scientific results to the nonscientific public. Scientists offer many reasons for this reluctance, including the amount of time public education or advocacy can take away from their professional responsibilities; their lack of skill in the nonscientific arena; and their concern that their credibility as scientists will be challenged by colleagues, politicians, and representatives of interest groups. Recently, however, some prominent scientists have suggested that they and their colleagues need to take a more direct role in policy decisions and in learning how to communicate science to the public (e.g., Lubchenco 1998), and research funding organizations are exhibiting increased expectations for greater involvement by scientists in policy-relevant efforts (e.g., Lane 1997). Moreover, some scientists and scientist groups are taking very public stands on contested environmental policy questions (e.g., Oregonian 2000).

Research setting

This research was conducted in the context of a specific Long Term Ecological Research (LTER) program. The LTER program is a multisite research effort that has been supported by the National Science Foundation (NSF) since 1980 (Franklin et al. 1990, Hobbie 2003). Not only are LTER scientists expanding basic ecological knowledge that is changing the way scientists and lay people view the natural world (Luoma 1999), they are also increasingly expected to participate with nonscientists in efforts to develop and even implement natural resource policies.

The LTER program offers the opportunity to explore changes in the social contract between scientists and the public on multiple levels. First, research scientists working at LTER sites are conducting a variety of basic research projects that are funded by NSF at least in part because they meet the criteria of "social relevance." Second, scientists at LTER sites represent a wide range of research organizations, including colleges and universities, private research laboratories, and federal and state agencies. At the same time, LTER participants also represent a wide range of investigative and policy experience, from early-career scientists, managers, and public participants to "old hands" who have lived through shifts in natural resource policy, public attention, and public values (Steel and Lovrich 1997). Finally, some LTER scientists, particularly in the Pacific Northwest, are actively working with natural resource managers and the public in resource decisions and providing input to policymakers at local, state, and national levels.

The H. J. Andrews (HJA) Experimental Forest LTER site, which has had significant funding from NSF over the past 20 years, has a history of 50 years of ecological research. The Andrews Forest is located in Blue River, Oregon, in the McKenzie River watershed east of Eugene in the Oregon Cascades. Scientists from a variety of disciplines conduct research on natural and managed forest ecosystems at the Andrews Forest LTER site and nearby watersheds of western Oregon. The data and theories generated by these scientists are applicable to forest and natural resource management, particularly in the western United States. HJA scientists have conducted long-term experiments, measurement programs, short-term studies, and modeling analyses of such ecosystem components as climate, hydrology, disturbance regimes, vegetation succession, biological diversity, carbon and nutrient dynamics, and forest–stream interactions. The current and central research question guiding HJA scientists is, "How do land use, natural disturbances, and climate change affect the three key ecosystem properties of carbon dynamics, biodiversity, and hydrology?" (Swanson et al. 1996). The research questions and the interdisciplinary scientists at the HJA site are typical of the LTER program, which promotes basic ecological research over multiple temporal and spatial scales.

The Andrews Forest operation is unique among LTER sites, however, in that many scientists there have played a significant role in the shift toward ecosystem-based management of natural resources in the Pacific Northwest (Luoma 1999). This has been a result of relevant basic research and outreach efforts, including long-standing and continuing efforts to communicate research data and information on forest ecosystem processes to the general public, policymakers, and land managers in the Pacific Northwest and elsewhere. With regard to natural resource management and policy, HJA scientists have worked regularly with print and video journalists to distribute information to the public, both locally and nationally; conducted community forums with regional forest managers to discuss relevant research results; held numerous field tours of the research forest; and served in a variety of advisory and public roles. HJA scientists have provided information on such volatile and important policy issues as old-growth forest management, northern spotted owl protection, and watershed effects of forestry practices (Swanson et al. 1996). They were instrumental in supplying much of the science behind former President Clinton's 1993 Forest Plan for managing the federal forests of the Pacific Northwest (FEMAT 1993).

The results reported in this article refer only to those scientists, managers, and members of the public who are involved in research and management of Pacific Northwest forests, where there is a history of scientist involvement in forest policy. Although we cannot generalize to a larger population, there is increasing experiential and anecdotal evidence that the role of scientists in policy decisionmaking is changing in many ways (e.g., Fischer 2000). We believe that this study elucidates some of the concerns held by scientists and nonscientists about the role of scientific expertise in public decisions.

Research methods

We collected information from four different groups in the Pacific Northwest: (1) scientists at universities and federal agencies, (2) managers of state and federal natural resource programs, (3) members of public interest groups and organizations (e.g., environmental groups and industry associations), and (4) the attentive public. The terms *scientist* and *ecological scientist* are applied broadly in this article to include those who actively do ecological research, those who work as scientific advisors to managers, and those managers whose responsibilities are to interpret science in management contexts and who have appropriate scientific qualifications. Not all of the research scientists at the HJA site describe themselves as ecologists, although all are involved in understanding ecosystem processes described by Swanson and colleagues (1996) in the site's mission statement. We define "attentive public" as those individuals who have either participated in a public hearing by providing a comment on proposed natural resource or environmental plans or who, in some other way, identify themselves as aware of and involved in natural resource decisions. Studies have found distinct differences between the attentive and the inattentive public in the amount of knowledge they have of scientific methods and use of science in policymaking and in their attitudes about science in general (e.g., Steel et al. 2001). And, because of their participation in management planning, the attentive public is more likely than the inattentive public to be interested in and concerned about issues related to natural resource management (Weber and Word 2001).

We began by conducting 50 face-to-face interviews with representatives of the groups to identify their issues, concerns, and expectations for science and scientists in managing natural resources. We used information from the interviews to develop a set of survey questions, which were mailed to a sample of the four groups. Response rates for the survey samples were 82 percent for scientists, 77 percent for resource managers, 60 percent for members of interest groups, and 76 percent for members of the attentive public, which resulted in 639 usable surveys (see Steel et al. 2001 for details about the survey). One of the key questions explored in the interviews and surveys was whether preferences for scientist advocacy were changing, and, if so, how these preferences were manifested among the different groups. The survey findings are discussed in detail after we review the findings from the interviews.

Underlying models

The traditional understanding of the role of scientists in decision processes is an outgrowth of the philosophy of positivism and attitudes about the nature of science (e.g., Dewey 1927, Fischer 2000). It suggests that, where science is relevant to policy processes, the role of scientists is to facilitate management decisions by providing objective scientific information to managers and policymakers, who in turn have the primary responsibility to debate management options, interpret scientific information, and make decisions. Laboratory or experimental scientists themselves are not to be directly involved in management or to make decisions. They are also not to be advocates of particular management options or to expect that their management preferences have any special weight or merit in the decision process. In this model, science has special authority in resource management decisions; however, scientists lose their credibility as scientists if they cross the line between science and policy or management. Instead, they are expected to remain essentially separate from decisionmaking, serving only to provide data, findings, and expertise as needed and called for (List 2000). Of course, this description of the traditional role does not describe any individual career. It is posited as an "ideal type," a way to describe the essential characteristics of a social phenomenon (Weber 1946), thereby making comparisons among complex phenomena possible.

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During our interviews we did find that a scientific culture based at least in part on the traditional understanding of science, with its own esoteric requirements, processes, standards, and rewards, was apparent to members of all four populations, particularly HJA scientists and managers. This culture differed in certain respects from the culture of management and public environmental decisionmaking. While research scientists may interact with managers and others on a regular basis, there is a certain tension brought on by this cultural distinction. For example, because of the nature of scientific processes and interactions, scientists told us that they are often cautious in formulating their scientific findings about ecosystems. They may not make decisive statements about the practical implications of their research, preferring instead to hedge their predictions and opinions, to recommend additional evidence if it exists and additional confirmation if possible, and to conduct more research if all else fails. Managers, on the other hand, reported that relatively brief decision time frames and legal, bureaucratic, and political demands pressure them into a decision before all scientific evidence is in or specific scientific theories are confirmed. For their part, members of interest groups and of the attentive public generally reported that both research scientists and managers are slow to make decisions about implementing even obvious solutions.

At the same time, we also heard challenges to the traditional model of science and scientists, not so much on the authority of scientific information as on the proper roles for research scientists in natural resource management. According to this emerging model, research scientists should become more integrated into management and policy processes, coming out of their labs and in from their field studies to directly engage in public decisions within resource agencies and in other venues, such as courts and public hearings. There is a need for more science in these processes and decisions, our respondents told us, but this can be brought about only if research scientists themselves become more actively involved. We also heard from a few respondents that scientists should not hesitate to make judgments that favor certain management alternatives or options, if the preponderance of evidence and their own experience and reflection move them in certain practical management directions. They, after all, are in the best position to interpret the scientific data and findings, and thus are in a special position to advocate for specific management policies and alternatives.

Potential sources of this emerging model are various. One key factor is the increasing complexity of resource problems, described in a classic planning and policy essay as "wicked problems" (Rittel and Webber 1973). Wicked problems, characterized as having "multiple definitions as to their nature," are the object of several and conflicting criteria for defining solutions, have "solutions" that become "problems" for others, and "have no obvious stopping rules that define when enough has been accomplished" (Freeman 2000). This complexity is made more intricate by statutory requirements in federal and state laws, which have tended to democratize and localize resource decision input, if not decisionmaking. There is also the coincident perception that more science is needed to solve these problems. Moreover, public expectations about the role of scientists may be changing, particularly with what appears to be an increasing public skepticism about the ability of bureaucracies to make sound environmental decisions that use the best scientific knowledge available. This emerging integrative role calls for personal involvement by individual research and frontline scientists in bureaucratic and public decisionmaking, providing expertise and even promoting specific strategies that they believe are supported by the available scientific knowledge.

Preferred roles for research scientists

Using the information revealed in our interviews, we identified a list of five potential roles for scientists. These ideal types do not describe the behavior of any single scientist;

instead, they reflect a complex relationship among individual and cultural expectations of science, attitudes about resource management, and decisionmaking styles. Through our interviews, observations, and previous surveys of scientists and natural resource managers, we have found that these descriptions accurately describe distinct preferences for the role of research scientists in natural resource policy (Steel et al. 2001).

While the descriptions reflect preference for scientist involvement ranging from minimal to dominant roles, they also distinguish between science as an activity separate from other, nonscientific activities and science as an activity integrated with management and other activities. The five potential roles that research scientists in natural resource decisionmaking might play are

- *reporting* scientific results that others use in making decisions onnatural resource management issues,
- reporting and then *interpreting* scientific results for others who are involved in natural resource management decisions,
- working closely with managers and others in *integrating* scientific results into management decisions,
- actively *advocating* for specific and preferred natural resource management decisions, and
- *making decisions* about natural resource management and policy.

The first role limits research scientists to reporting results and letting others make resource decisions. This reflects the traditional, separatist model for scientists. The next two roles form what is emerging as an integrative role for research scientists. The second role, interpreting scientific results so that others can use them in policy- or decisionmaking, is often expressed as an agency's use of scientists in consultation positions or as a scientist's promise to granting organizations that the results will be translated for nonscientific users. In this case, the final interpretation of science would rest with the agency or with another user. The third role, a more involved one for research scientists, is to work closely with managers and others to integrate scientific results directly into resource policies and decisions. Implementation of adaptive management experiments in Pacific Northwest forests often reflects this type of scientific integration in resource decisionmaking, in which scientists sit on formally recognized committees that are responsible for adaptive management areas. The fourth potential role is for research scientists to actively advocate for specific resource policies or management decisions that they prefer or that they believe stem from scientific findings and research. A final role, reflecting the increasingly technical and complicated decisions facing natural resource managers, is the technocratic ideal of having scientists make resource decisions themselves.

This list of potential roles for scientists in natural resource decisionmaking does not amount to a precise continuum, because the roles are not necessarily mutually exclusive. It is unlikely, however, that anyone who reports favoring a minimal or separatist role for scientists would also prefer the technocratic role. On the mailed survey, we asked respondents to report their level of agreement or disagreement with each of the potential roles. Table 1 presents mean scores for the responses for the four groups surveyed in the study.

Even though *F*-test results reported in table 1 indicate that differences between the four Pacific Northwest groups concerning the five potential roles for scientists are statistically significant, all groups except the scientists found the integrative role most preferable. Although scientists on average preferred the interpretative role most, they were very supportive of the integrative role as well. In general, most respondents were least supportive of scientists making decisions themselves. However, interest group representatives and the attentive public were not enamored of a minimalist role in which scientists just report scientific results; they were more likely than the other two groups of respondents to support an advocacy role for scientists. In general, managers, scientists, interest groups, and members of the attentive public have similar preferences for the role of HJA research scientists in natural resource decisionmaking: They would all like to see the research scientists involved in interpreting and helping to integrate the results of their science into policy decisions.

In an essay archived at the National Center for Ecological Analysis and Synthesis Web site, *www.nceas.ucsb.edu*, the role of scientists in decisionmaking, as Wagner describes it, mirrors the role that most of our respondents preferred (Wagner 1999). He refers to an obligation for ecologists to be involved in the public process by actively seeing to it that objective scientific evidence is known to all contending parties and to the public at large, through such means as the media; however, he indicates that ecologists should avoid advocacy of public policy options. Scientists can help lay out the value implications and consequences of policy alternatives, but they should keep their environmental value judgments to themselves.

Scientific credibility

Although many HJA scientists reported that appropriate roles for scientists might include more participative roles (i.e., interpreting and integrating scientific information into natural resource policy and decisionmaking), many also told us in interviews that they feared their credibility would suffer if they or other research scientists became more involved in natural resource decisionmaking. They pointed to examples of scientists who had, in their judgment, clearly lost their credibility within the scientific community because of their advocacy of management policies that were not adequately based on the best or latest science in their fields. Scientists perceive scientific credibility to be a basic requirement for privileging their interpretation of research data over less acceptable interpretations by other parties, such as nonscientists or scientists outside the most directly relevant scientific discipline; thus, scientific credibility is something that they embrace intellectually. During our initial interviews we investigated a large number of factors that might influence

Table 1. Mean scores showing preferred role for scientists in natural resource decisionmaking, and F-test results.

Scientist role	Scientists	Managers	Interest groups	Attentive public	F-test
Scientists should only *report* results and leave others to make management decisions	2.86	3.18	2.45	2.72	7.588***
Scientists should report results and then *interpret* for others involved in management decisions	4.18	3.92	3.99	3.86	3.696**
Scientists should work closely with managers and others to *integrate* scientific results into management decisions	4.09	4.30	4.20	4.28	1.867
Scientists should actively *advocate* for specific natural resource management decisions	2.20	2.19	3.21	2.95	28.847***
Scientists should *make decisions* about natural resource management	1.66	1.79	2.65	2.47	32.110***
	$n = 154$	$n = 167$	$n = 117$	$n = 190$	

Note: Survey question: We would like to know what you think should be the proper role of scientists in natural resource management decisions. Please indicate your level of agreement or disagreement with the following statements. Scale: 1, strongly disagree; 2, disagree; 3, neutral; 4, agree; 5, strongly agree. Significance level: *** $p < 0.001$; ** $p < 0.01$.

scientific credibility, including advocacy. We were interested in what actions or behaviors might affect a scientist's credibility as an expert whose knowledge and judgment were privileged in the decisionmaking process. In the survey, we asked respondents to tell us how important each of the factors is in contributing to their perception of a scientist's credibility. We were interested in how scientists judged each other's credibility, as well as how nonscientists assessed scientists' credibility. Table 2 provides mean scores among the four Pacific Northwest study groups for each credibility factor in descending order of importance, as perceived by the scientists surveyed.

Responses to most of the factors contributing to a scientist's credibility vary significantly between HJA scientists and the other three groups. Not surprisingly, the quality of methods used, data generated, and reputation in a specialization were rated by almost all scientists as highly important to a scientist's credibility. These three factors are the tools of the scientific method commonly accepted among scientists, and their high ranking reflects the scientists' attitudes about the foundations of proper science, especially in the traditional model described above. On the other hand, although many Pacific Northwest managers and representatives of interest groups valued disciplinary reputation in determining a scientist's credibility, significantly fewer valued the importance of data generated or the methods used by scientists. The traditional tools used by scientists for judging credibility in the scientific arena—conceptual models, quality of journals, and even data generated—were not strong factors for managers, interest groups, or members of the public in determining a scientist's credibility. This may not be surprising given the probability that members of these groups are generally not familiar with some of these factors and thus cannot readily use them in assessing a scientist's credibility or authority to speak in public contexts. They must rely, then, on other criteria.

For the nonscientific respondents, HJA scientists' credibility appears to be based on a scientist's disciplinary reputation, on the practical nature of the research conducted, and on experience and knowledge of place-specific sites. Thus, scientists' credibility, as assessed by nonscientific respondents, is their ability to deliver research results that managers and others can use. In addition, it is significant that the nonscientific respondents were more likely than the scientists to believe that the ability to communicate with other groups contributes to the credibility of the scientist. In particular, members of the public reported that effective communication through nontraditional channels is important to a scientist's credibility.

Traditional scientific culture, of course, includes some important forms of communication, such as peer review and publication of results in academic journals or professional meetings. Our respondents generally reported, as shown in table 3, that they find these strategies for disseminating scientific information important. However, response varied about what types of communication strategies they consider most important for disseminating scientific information. Not surprisingly, HJA scientists ranked academic journal publications the highest. Managers ranked communication of research results to the public through on-site trips and demonstrations the highest, as did the attentive public. An interesting result was that interest group representatives, like the scientists, ranked academic publications of highest importance in communicating science results.

With these results, a profile of communication preferences can be constructed for each group. Thus, HJA scientists prefer the traditional means of communicating science—within the scientific community and directly to natural resource agencies. They have less enthusiasm for various means by which they could communicate with the public, such as public hearings or forums.

Table 2. Mean scores showing factors perceived to be important to individual scientist credibility, and F*-test results.*

Factor	Scientists	Managers	Interest groups	Attentive public	*F*-test
The quality of the methodology used in their scientific research	4.70	4.18	NA	NA	5.28**
The scientific data and information generated in their research	4.64	3.73	3.90	NA	39.31***
Their reputation in their field of research and specialization	4.35	4.00	4.03	3.89	7.60***
Quality of the scientific and professional journals in which they publish	3.94	3.11	NA	NA	6.44**
Their ability to make significant contributions to interdisciplinary research	3.95	3.99	NA	NA	0.87
Their experience and knowledge about the management of public lands	3.62	4.18	4.18	4.30	19.97***
The applied and practical character of their research and findings	3.41	3.40	3.97	3.88	26.52***
The length of time they have spent working in their area of research and specialization	3.35	3.53	3.70	3.77	6.44***
My personal familiarity and interaction with them	3.14	3.38	3.42	3.22	1.74
The quantity of their publications	2.96	2.25	NA	NA	5.28**
The scientist's ability to communicate effectively with...					
Resource managers	3.86	4.40	NA	NA	11.89***
Legislators and elected officials	3.19	3.66	3.52	3.97	14.59***
The general public	3.13	3.71	3.86	4.15	27.45***
Interest groups	3.00	3.74	3.78	3.86	20.00***
Media representatives (TV, radio, newspapers)	2.92	3.36	3.44	3.84	18.21***

Note: Survey question: We are interested in your opinion about the importance of the following as indicators of credibility of individual scientists who work on natural resource issues and ecological questions. Scale: 1, not important; 2, little importance; 3, moderately important; 4, important; 5, very important. Significance level: *** $p < 0.001$; ** $p < 0.01$.

Managers agree to some extent with scientists, but they emphasize direct communication to themselves and also to the public through on-site demonstrations. They are quite unenthusiastic, on the other hand, about scientists communicating directly with the public through the Internet or with the mass media, possibly because they see this as their own prerogative and prefer to filter science through bureaucratic layers of interpretation. They believe that managers should be the translators and transmitters of the relevant ecological information in most public contexts—not scientists, and perhaps not even other interested groups. Managers in the Pacific Northwest also believe that scientific matters are not the only factors relevant in policy decisions, something scientists may not completely understand or account for. This implies that scientists who ignore or do not work very closely with managers could incur disfavor if managers perceive them as going around the responsible agency or manager.

Representatives of interest groups in this region agree with scientists' strategies but add that testifying at public hearings is also quite important. The attentive public shares communication preferences with the other three Pacific Northwest groups but has its own profile. The public is generally more enthusiastic than any of the other groups about scientists communicating science in such venues as public planning bodies and the mass media, perhaps because these are the means whereby the public typically learns of the latest scientific findings.

These results suggest that, at a minimum, both scientists and nonscientists involved in natural resource management in the Pacific Northwest support a nontraditional model of integrated scientist involvement in resource decisionmaking. Although no group of respondents, least of all scientists and managers, prefers advocacy of policy choices by scientists, all strongly support HJA scientists becoming more involved in resource management. If research scientists wish to retain their credibility while they act in this new role, especially with managers, they will need to add the skill of communicating with nonscientific audiences to their repertoire of credibility-making skills.

Conclusions

In recent years, many commentators have called for reconsideration of how we involve science and scientists in resolving natural resource issues (e.g., Yankelovich 1991, Lee 1993, Fischer 2000). For example, in *Compass and Gyroscope,* Lee (1993) proposes a new form of planetary stewardship that he

Table 3: Mean scores of perceived importance of various communication strategies, and F*-test results.*

Strategy	Scientists	Managers	Interest groups	Attentive public	*F*-test
Publish research results in academic journals	4.36	3.91	3.94	3.88	8.60***
Present research results at professional meetings	4.16	3.74	3.78	NA	6.83***
Communicate research results directly to the public through organization/agency publications	3.68	3.93	3.68	3.92	3.80**
Communicate research results directly to the public through trips or on-site demos	3.61	4.25	3.87	3.99	11.39***
Communicate research results to the mass media (newspaper, television, radio, etc.)	3.43	2.40	3.11	3.24	28.09***
Communicate research results directly to the public through the Internet	3.41	3.01	3.05	3.25	4.66**
Testify at public planning hearings for natural resource agencies	3.32	3.07	3.61	3.74	13.57***

Note: Survey question: We are interested in how you report and communicate your research on natural resource and ecological issues with various audiences. How important do you consider these activities? Scale: 1, none; 2, limited; 3, somewhat; 4, important; 5, very important. Significance level: *** $p < 0.001$; ** $p < 0.01$.

calls "civic science," a blend of science and politics that uses adaptive management strategies to apply scientific information to environmental policy. As proposed, civic science requires that research scientists work closely with teams of collaborators in natural resource agencies to design and monitor ecosystem experiments and subsequently establish new management directions using results from the experiments as well as other information. In *Citizens, Experts, and the Environment,* Fischer (2000) describes "deliberative policy making" that elicits and integrates information from multiple sources, including scientists. As experts, scientists "would comment publicly to the technological, legal, and financial feasibility of a particular proposal" (p. 229). Scientists would provide information about what is known and what is not but also provide interpretation of the empirical consequences of alternative policy choices. These models for science are remarkably similar to the preferences expressed by our respondents for scientists to more actively integrate their particular expertise in natural resource management without taking on the policy choices themselves.

Given the data presented in this article on the advocacy roles and credibility of scientists, Pacific Northwest scientists and others in the nonscientist population would be likely to support Lee's efforts to promote a more activist, integrative role for research scientists in resource management and Fisher's proposals for a scientist role in deliberative environmental policymaking. For example, previous social research indicates that the Pacific Northwest public is generally supportive of basic adaptive management concepts (although considerable public hesitation remains, because early adaptive management experiments on federal lands are still unfolding and are not well understood; Shindler et al. 1996).

There will be risks involved for those research scientists who work closely with managers and the public to conduct ecological science and formulate new environmental policies, whether their work is done on the grand scale of civic science or whether it involves more modest forms of integrated scientist collaboration and participation in deliberative resource management. Not only will research scientists have to leave the comfort of their own labs and field locations and their traditional interactions with scientist colleagues, they will also have to learn to work more effectively with agency personnel and managers, public interest groups, and the public. In the case of adaptive management, for example, many factors pose problems for scientists, as Lee indicated, such as the possibility of experimental error and, consequently, failure in the public eye; the long time spans between beginning a management experiment and learning from the results; and the polarized nature of interest groups and of debates about resource management alternatives. However, even in more modest resource management or more typical public contexts, research scientists' work and behavior will inevitably come under closer public and interest group scrutiny than that carried out in the traditional scientific contexts. Consequently, the intellectually privileged and secure role of research scientists as generators of objective knowledge through basic research at sites like the Andrews Forest LTER site may be questioned, very likely by some of their own peers, who will be skeptical about the advisability of deeper scientist involvement in management and policy matters.

This study indicates that research scientists who do become more active in these matters will have to become more effective communicators with resource managers and nonscientist groups, so that scientific information can be integrated into decision processes and policy decisions in meaningful and scientifically respectable ways. At the same time, managers, representatives of interest groups, and the public will have to learn how to accept the uncertainties that come with scientific experimentation and modeling and to avoid posturing and distortions of the results of ecological science. They may also have to modify oversimplified or stereotyped views about what ecological science and scientists can and cannot tell us of ecosystems and their management.

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