
are about.

This does not mean that even more information should swamp small firms. Rather, the problem is that the information is not filtering down to those to whom SMEs, in particular, turn for business advice: namely, lawyers and accountants. More effective use of government funding schemes could be made if lawyers, accountants and other business services understand government and its objectives better.

BIZLINK and other such schemes

are an attempt to make government information more accessible. The problem is, however, one of cultural resistance to and lack of understanding by many accountants and other business service providers of government objectives and schemes.

An effort must be made by both the public and private sector to reach and educate the vast number of accountants and other business providers so that when firms turn to them for advice they will impart

proper knowledge and understanding of what government schemes are available and what they require of applicants. Firms and their business advisers must also consider whether federal or state schemes are the most appropriate and how to mix and match between them to get the maximum advantage for their innovation efforts.

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SCIENTISTS' PARTICIPATION IN ENVIRONMENTAL POLICY

As environmental science becomes increasingly politicised one would expect scientists to be playing an important role in initiating public debate and shaping environmental policy. However, when Susan Wilson and Ian Barnes surveyed senior environmental scientists they found that many are reluctant to enter the public spotlight.

The role that scientists should play in public policy debates is a particularly pressing issue for environmental scientists. Matters of resource use, biodiversity conservation, air and water pollution, or the management of hazardous substances are among the most contentious and intractable of contemporary public policy problems (Walker 1992). Environmental scientists can be involved in policy development in quite important ways, both in identifying the issues in the first place and then providing the information upon which debate and policy formation are based. In their activities as researchers, advisers and public communicators, environmental scientists can play key roles in getting environmental issues onto the public agenda, mobilising public concern and influencing policy outcomes.

In some cases the contribution of environmental scientists has been

decisive in shaping policy. For example, CSIRO scientists mobilised public awareness and significant government action on the greenhouse effect in the mid-1980s; scientists also played a key role in the Wesley Vale controversy in Tasmania in the late 1980s. In most cases, however, the role of environmental scientists is less dramatic and decisive, yet none the less important in the on-going task of conserving natural resources and biota and minimising the damaging effects of agriculture, mining, and urban and industrial development on the natural environment.

Despite the importance of environmental science in various areas of political debate and policy development, environmental scientists, like most other scientists, do not appear to have a clear ethos or ethic of political involvement. Notwithstanding the rapid commercialisation of scientific research, by and large scientists still seem to adhere to the concept of the

autonomy and political neutrality of science. The kind of "trans-science" activities of scientific advisers or activists is still demarcated from mainstream science (Jasanoff 1987).

It is unclear, however, as to the role that environmental scientists, as scientists, should play in policy development: whether they should be "policy technicians" that provide objective data for policy-makers but otherwise remain politically neutral; whether, on the basis of their expert understanding of environmental problems, they should play a determining role in policy formulation; or whether, as especially informed citizens, they should play an active role in political debates concerning environmental issues (Tong 1986).

The development of an appropriate ethos of political involvement is an important goal and will depend to a considerable extent on the attitudes and perceptions of scientists themselves with respect to the politics of

Table 1. Level at which questionnaire respondents are employed in their institution.

Position	(%)
Professor	13
Associate Professor	16
Senior Lecturer	24
Lecturer	21
Associate Lecturer	3
Reader	11
Research Centre Director	4
Project Director	3
Research Fellow	5

environmental issues. This paper reports on a recent survey that attempted to investigate the perceptions of public issues and the level of political involvement of an Australia-wide sample of environmental scientists. The survey involved the mailing of a questionnaire to a sample of 108 environmental scientists employed as researchers in Australian universities. The survey sought to gauge the input of scientists to the formulation of environmental policy by both direct means (such as making submissions to parliament, participating in government advisory committees and political party membership) and indirect means (such as involvement in conservation organisations and contribution to the media debate). Issues relating to such involvement were also investigated.

The Survey

The selection of the sample of senior scientists was based upon their research and teaching interests, as listed in the current *Australian Directory of Academics*. A broad, inclusive definition of "environmental science" covering a wide range of environmental/biological specialties was used. The sample was selected from names listed under a total of 23 major subject headings in the Directory. These included aquatic ecology, aquatic toxicology, applied biology, biological control, environmental studies, sustainable agriculture, marine science and botany.

A total of 70 responses was received, representing a 65% return rate. This level of response suggests a

Table 2. Percentage of respondents replying "yes" or "no" to the stated questions.

Question	Yes	No
Are you a member of a community group concerned with environmental protection?	50	50
Are you a member of any group of scientists concerned with social responsibility?	17	83
Are you a member of a political party?	1	99
Have you ever made a submission to a parliamentary or government inquiry on environmental policy issues?	54	46
Have you ever been a member of a government policy committee in Australia?	24	76
Do you provide scientific information to politically active environmental community groups in Australia?	54	46
Do you interact with the general media on issues of environmental policy or management (e.g. writing letters to newspapers, radio interviews, segments on the news etc.)?	64	36

high degree of interest in the subject of the survey. The responses were confidential and the scientists' anonymity was guaranteed. The respondents were largely well qualified scientists, 89% having a doctoral degree or higher and holding senior positions in their universities (Table 1), and the majority had at least 10 years post-doctoral experience. Most respondents drew their funding from external sources (87%) and collectively received a total of \$16.9 million dollars over the 5 years prior to the survey. Of particular interest was the fact that the vast majority (68%) of respondents relied on government agencies for 70% or more of their research funding.

Not all questions and responses have been provided in tabular form due to their complexity and the need for brevity.

Responses

Political and public involvement

A number of the survey questions focused specifically on the nature and level of political involvement of environmental scientists (Table 2). Only one of the respondents was a member of a political party and thus all active in the development of party policy. Although half of the respondents were members of various community groups concerned with environmental protection, only 12%

were members of the Australian Conservation Foundation, the most broadly based national environmentalist organisation. It was also of interest that only 17% of respondents were members of "social responsibility in science" organisations, 7% being members of United Scientists for Environmental Responsibility and Protection (USERP), a group active in the Wesley Vale controversy. Relatively few had been members of government policy committees, and only 4% had been members of more than three committees in their entire career. A greater number had made submissions to parliament, but again very few on a regular basis (the majority having done so less than three times in their whole career). Many scientists provided information to community groups. However, it is of interest that 16% of these acted exclusively in an anonymous capacity and a further 43% acted anonymously at times. More than half of the respondents were involved with the general media on issues of environmental policy, but only 17% on a frequent basis (i.e. more than five times per year).

Public science

Given the high visibility of complex environmental issues in recent years, it is perhaps not surprising that two-thirds of the respondents believed that environmental research was

becoming increasingly politicised. Against the background of the growing politicisation of environmental science, a number of questions focused on whether scientists were sufficiently well prepared for involvement in political debate and public communication on environmental issues. Questions were also included to explore some of the issues of science in the public sphere (Table 3).

The respondents generally acknowledged the limitations of their professional training in the area of science communication. There was a clear consensus acknowledging the need for training in public communication and a belief that their own scientific training had not provided them with the necessary skills to communicate and interact with the range of public groups concerned with environmental policy. Only a few felt that their training had prepared them to communicate with politicians, bureaucrats, the media or community groups. There was very strong support for the inclusion of training of young scientists in ethics, politics and the media.

With respect to communicating their research activities outside their own specialist communities, most respondents (71%) never published in popular science journals. It was very clear from the survey that publication of research anywhere other than in specialist publications was not a priority: the vast majority of respondents (81%) published 80% or more of their work exclusively in the specialist literature. This publication pattern is interesting given that most scientists felt that research findings were not very "available" to non-specialists. This belief was coupled with the opinion of most respondents that there was not enough input by scientists in the political process and that politicians and bureaucrats did not have a good understanding of science. It is not surprising given these beliefs that the respondents were unanimous in their opinion that scientists should be involved in environmental protection policy formulation.

When asked what would be the best means for involvement in policy formulation, the majority of respondents considered a role as providers of impartial expert advice to public groups as the most appropriate approach. The next most favoured

Table 3. Percentage of respondents replying "yes", "no" or "unsure" to the stated questions.

Question	Yes	No	Unsure
During your training as a scientist do you feel you were given the skills to communicate and interact with:			
Politicians	13	81	6
Bureaucrats	21	72	7
The media	15	79	6
Community groups	24	69	7
Do you think it is important for scientists to receive such training?	67	13	20
Do you think it is important for students to receive training in:			
Ethics	83	6	11
Politics	51	26	23
The media	60	20	20
Do you believe politicians and bureaucrats have a sufficient understanding of science?	3	88	9
Do you believe research findings are readily available in a form for non-specialists (i.e. the public, bureaucrats, politicians)?	17	73	10
Do you believe there is enough input by scientists into the political process?	6	76	18
Do you believe scientists should be involved in environmental protection policy formulation?	100	0	0

approach was as members of government policy committees. The least favoured approach was as policy-makers, followed by a role as members of politically active community groups. In general, the responses revealed a pattern of public involvement that was largely limited to apolitical advisory roles rather than active political participation (Table 4).

Beliefs and experience of public activity

Some questions were included in the questionnaire in an attempt to gauge the perceptions of scientists of the repercussions of public activity (Table 5). The responses indicated an awareness of, though not always direct experience of, the hazards of political involvement. There was a significant level of caution about "speaking out" on environmental issues. More than half of the respondents felt that scientists jeopardise their careers by speaking out against government policy; only 17% felt that scientists would

not be jeopardising their careers and 29% were unsure. Approximately one-third of the respondents knew scientists who had been disadvantaged. Nonetheless 52% of the respondents claimed to have publicly criticised government policies on environmental protection; 69% believed that they had not been disadvantaged because of their views on environmental issues.

Conclusion

The responses to the questionnaire are both encouraging and a source of concern. They are encouraging as they indicate a clear recognition on the part of senior environmental researchers of the need for political involvement and for a greater emphasis on the preparation of scientists in such areas as politics, ethics and the media.

The responses are a source of concern because of the obvious constraints on involvement in political

Table 4. Ranking of the various approaches of scientists' involvement in environmental policy formulation (highest ranking represents the most appropriate approach, lowest ranking represents the least appropriate approach).

Involvement in the formulation of environment protection policy	Ranked highest by respondents (%)	Ranked lowest by respondents (%)
As policy-makers	14	52
As members of government policy committees	31	2
As members of politically active professional bodies that lobby politicians	11	11
As members of politically active community groups	3	24
As providers of impartial expert advice to public groups	41	11

Table 5. Percentage of respondents replying "yes", "no" or "unsure" to the stated questions.

Question	Yes	No	Unsure
Do you believe that scientists may jeopardise their career prospects or research funding success by speaking out on environmental issues?	54	17	29
Have you ever criticised publicly any government policy relating to environmental protection?	52	48	0
Have you ever been disadvantaged because of your views on environmental issues?	11	69	20
Do you know any scientists who have been disadvantaged because of their views on environmental issues?	36	49	15

activity and public communication. Clearly there is a concern about the consequences of "speaking out" in terms of career development, and this is coupled with a sense of not being equipped to be more actively involved in public communication. The reward structures and social organisation of science at the very least do not encourage the active involvement of scientists in political debate or public communication. Such activities are still seen as distractions from the "real business" of research and as an impediment to career advancement. Indeed, sociologist Brian Martin has argued that in some cases, the involvement of environmental scientists in politically unpopular causes has resulted in intellectual suppression (Martin 1981, 1992; Martin *et al.* 1985). These constraints on political activity and pub-

lic communication reflect the deeply institutionalised impediments to a robust public science that can improve the awareness and understanding of environmental issues on the part of citizens, the media, business and government.

Also a cause for concern is the obvious under-utilisation of environmental scientists in the policy development process. Some of the respondents were in receipt of very substantial research grants and had up to 35 years experience as research scientists yet had never had any input to policy development at a formal level. In addition, the vast majority of researchers only publish their research findings in the specialist literature and agree that they are not readily available for non-specialists. Again we are confronted with the lack of career incentive to publish

anywhere other than in professional journals.

With the exception of perhaps one or two, the respondents to this survey could hardly be classed as radical or activist scientists, and it can be inferred that their political activities are largely constrained by the pressures and priorities of research. Nonetheless there was a clear general support for the development of a more politically engaged ethos of environmental science and, in broad terms, for changes in science education that would produce scientists better able to communicate research findings in public debate. Certainly, there is a need for a culture of science that encourages and enables scientists to do this. There is also a need to go beyond the often tokenistic inclusion of humanities components in science courses by the development of forms of science training that make new scientists more critically aware of the contexts as well as the contents of science.

Acknowledgements

The authors would like to thank all those scientists who gave their time to complete the questionnaire. The financial support of a Richard Gabriel Environmental Research Fellowship is gratefully acknowledged. The libraries of Imperial College, University of London, were used throughout parts of this research and their availability was greatly appreciated.

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