Understanding and engaging values in policy relevant science

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"If you want advice on how to save the planet, don't walk into an ecology department." – Hugh Possingham. March 2009. Fenner Conference on Environment.

Introduction: Inside the little science box

When engaging in the practice of science, we invest much of our time in technical and academic details. If we expand the field of view and examine the underlying values that drive us, asking what impact our research has on a larger scale, we can discover a world of rich interconnections between science, society, and their function in the natural world. Identifying these interconnections can reinvigorate and perhaps redefine our relationship with science itself and bring about new ideas to fuel greater innovation.

In general, society ultimately expects some benefits from scientific research. However, due to its often slow and exploratory nature, scientific research does not always yield results that are immediately beneficial to society. For individual scientists, finding ways of making scientific results available to society can be even more difficult. Here we present some guideposts for how scientists may navigate and connect with the broader world and we outline potential roles scientists may pursue to help their work make an impact on society and policy.

Defining values

To identify the possible roles of scientists in society, we must first understand how values and policy are defined, and then investigate the interactions between values, policy, and science. Values characterize one's principles and standards. Personal or group values can come from religious beliefs, parents, teachers, or other influential people. For instance, the value of obtaining a college education can depend on whether one's parents attended college (Hossler and Stage, 1992; Goyette, 2008). Values differ from opinions in that values are much more resistant to change via reasoned arguments or information. Although values are never completely immune to change, the timescale for modifying or replacing a value is typically much longer, or triggered by a bigger event in one's life, than for an opinion.

The role of values in policy

Because each person or group has an inherent set of values determining the ranking of the importance of issues in society, values naturally play a strong role in the creation of policy. Societal values help set goals to be accomplished, while enacted policy is a specific way of attaining those goals. The values of many political actors (the voter base, lobbying groups, affiliated party values, and individual politicians) must be reconciled for policy to be enacted or for problems to be solved (Ebbins, 2003). Therefore, the values of those in power largely determine the political agenda and actions taken. For example, the Group of 8 (G8) decided in 2005 against taking action toward mitigating climate change, even though there were several lines of evidence indicating that climate change is a major world issue (Walther et al., 2005). It is difficult to know what prompted their inaction, but we may surmise that the G8 world leaders placed a higher value on other issues.

Values both determine which problems receive focus and what solution is best. For example, imagine that it comes to the attention of the public, or decision-makers, that the extent of woodlands licensed for logging has declined by 25% from its 1980 value, suggesting that management of these resources may need to be re-evaluated. A multitude of solutions can be proposed ranging from tighter regulations on the amount of lumber harvested, to mandating more replanting to compensate for the trees logged. When evaluating the performance or possible outcomes of various options, a person who values 'green' solutions will likely place a higher weight on a performance metric such as change in CO_2 released to atmosphere or net change in planted acreage. On the other hand, someone who values the financial success of logging companies (or the limitation of the government's ability to regulate the economy) might place a higher weight on 'net gain/loss in logging revenues' as a performance metric.

The role of values in science

It is important to understand how values influence policy; it is also important to examine how values come into play in the practice of science. Science does not exist in isolation, but is influenced by society in many ways. At a very practical level, society funds science and can therefore specify the research it wants in return. Scientists who try to bring first-class basic science to important applied problems often provide critical input to policy-making because their research is fundamental and relevant at the same time.

There is another, even more subtle, influence: all scientists are immersed in culture and values. In this way science itself is a product of our values and those of our society, often to a larger degree than we like to believe. Even the pursuit of science and reliance on rational arguments are values held by individual scientists (Polanyi, 1946). Although the scientific method is often portrayed as being objective, scientists working on the same problem and with the same methods sometimes forcefully disagree. As anyone who has read a debate in scientific journals knows, there is nothing wrong with disagreement; rather it is often this testing of arguments that exposes strengths and weaknesses and moves science forward.

That every scientist has values has two implications for policy relevant science. First, it is important to recognize that scientists may arrive at different positions just as politicians or citizens can argue for contrasting views. This plurality of scientific positions has to be resolved by hearing several voices and by having transparency in process, information, and decision-making. A practical consequence of this process is that scientific input to policy decisions is more likely to be done by committees and panels rather than by individual scientists. Second, it is important to understand that all scientists have values, including you (Polanyi, 1946; Kuhn, 1962). Being aware of one's own values and biases argues for more caution and humility in how we present science. Recognizing the constant feedback between society and science happening at both the institutional and personal level helps us to avoid being victims of the politicization of science (see 'Getting involved in policy' below), as well as to guard against letting our own values compromise our scientific practice.

Defining policy

Scientists must also understand policy and, more importantly, how policy, values, science, and society interact. Policy is a course of action; we identify four steps that are required for implementation in society: 1) agenda setting, 2) identification of alternatives, 3) enactment, and 4) preservation. Before a policy is even proposed, a decision-maker must set an agenda and identify an issue. After a decision-maker identifies an agenda, he or she (or more likely the legislative aides) will lay out proposed policy objectives and action plans. Eventually a few policies become enacted either through a legislative process or an executive order. To ensure that these policies are effective, they should be (but often are not) rigorously evaluated for the duration of the time they are in operation.

Getting involved in policy

Throughout the policy-making process, there is ample opportunity for scientists to get involved by bringing issues to light, proposing solutions, or evaluating the effectiveness of policies (Figure 1). In rare cases, scientists make a discovery that has huge implications for society (e.g. there is a hole in the ozone layer). Such discoveries often come unexpectedly and few scientists will make contributions of this type. More often, science provides critically gathered information and a set of methods that can be applied systematically to inform policy makers. In this way, we can develop knowledge about implications (e.g. increased UV radiation is hazardous to living organisms) and solutions (e.g. avoid releasing substances that break down stratospheric ozone) to better inform policy decisions. It is within such constructs of normal science (*sensu* Kuhn, 1962) that most scientists work, and where most of the science that informs policies is produced. It is within this science box that scientists are experts and where the credibility and usefulness of science resides (the black box in Fig. 1). The challenge is to understand how this box connects to the rest of the world, to identify how science can move out of the box.

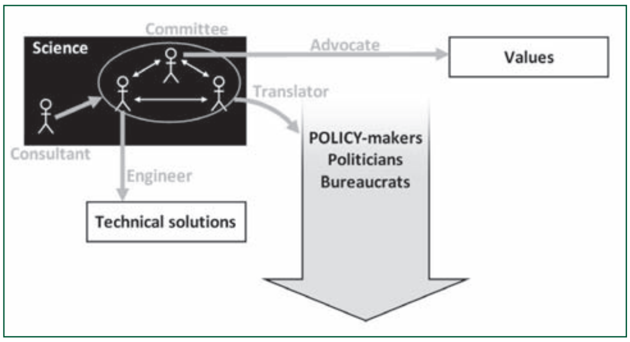

Figure 1. *Science input to policymaking (black box) is often done by committees of scientists that synthesize and translate science for policy makers. Consultants or experts may be called in when needed. Scientists can also act as advocates (Pielke, 2007) by championing a cause to influence values held by the public, or act as engineers by converting science findings for business or industry. Scientists may concurrently occupy any number of these important roles.*

Policy is constructed from social values about what is important. In many cases the values of different groups are in conflict and science is irrelevant (e.g. the legalization of gay marriage). In the murky area between science being crucial and science being irrelevant, science often gets used to sway a political argument and can be corrupted by politics (the politicization of science). This is where we need to be wary as scientists, and where an understanding of values and how they come into play in driving policymaking is most needed.

Scientists who wish to impact policy must confront the realities of political decision-making. Regardless of the science, politicians are most likely to support policies that are popular with their constituents and legislative allies. Thus, to successfully impact policy decisions, scientists need to help politicians generate strategies that minimize uncertainty and maximize political acceptance. Providing scientifically sound data to politicians does not always translate into swift or even desirable action. Rather, before a policy moves from conception to implementation, it often traverses through a difficult landscape filled with numerous opposition groups and challenges. In the face of political inaction, scientists must be willing and able to withstand these tribulations and retain their scientific integrity without succumbing to using fear mongering and exaggerations to push their policy proposals.

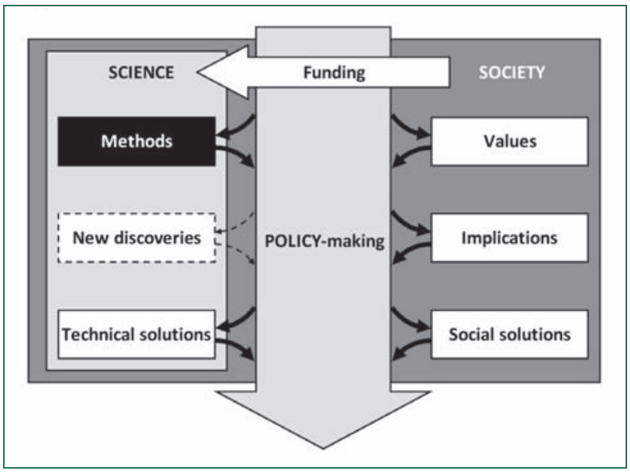

Figure 2. *Policymaking takes place at the interface between science and society, and often results in new laws or regulations. The motivation behind a policy is often driven by values that the public holds, and it is often designed because action (or inaction) can have negative implications for humans, society, or the environment. To succeed, policies need to incorporate existing or even produce new knowledge, which provides a role for science (the black box). In a few rare cases, science also stumbles upon discoveries of great importance that require a policy to be made (the dashed box). Solutions can come from both the science side (new technologies) and the society side (change of attitudes or behavior). A major reason society funds science is to attain policy relevant knowledge, and societies can influence science. A more subtle influence on science arises because scientists are part of society and therefore are immersed in values and culture.*

Characterizing political uncertainty

The values of political actors come strongly into play in decision-making and the creation and management of policy. This requires us to discuss the role of values (and especially conflicting values) when intersecting with uncertainty, the cost-benefit ratio of a particular issue, and how these three factors contribute to the role that science can play in policy (Figure 2).

Uncertainty can manifest in several parts of the political process: there can be uncertainty about what our goals should be, ways to reach those goals, and evaluating options both before and after action is taken. Uncertainty about goals is often confusion or conflict between values since values set the goals that public policy aims to achieve. Knowing the 'will of the people' (or at least of the decision-makers) is therefore critical for defining the problem. Polls and focus groups reduce this kind of uncertainty by providing decision-makers with information about the values of their constituents. The parliamentary process of agenda setting, bill writing and debating also serves to set goals. Uncertainty about the ways to reach stated goals is ignorance about options (see below).

Characterizing scientific uncertainty

When it comes to choosing and evaluating options there are two types of uncertainty to consider, epistemic and aleatory. Epistemic uncertainty is due to limited information (ignorance) and is a property of the analyst(s). This type of uncertainty can often be reduced, or at least characterized, by scientific work. For instance, when considering various policy options, scientists may create models to test the results of the multiple policy options (Sainsbury et al., 2000). One such model was developed to investigate how rising sea temperatures (a probable result of climate change) will affect the biomass of krill available to predators (Wiedenmann et al., 2008). The results of this model can be used to predict how this change of biomass will influence both krill predators and the krill fishery. The reduction in uncertainty surrounding the change in krill biomass allows policymakers to make more informed decisions about fishing. Aleatory uncertainty is due to inherent randomness in the system. This is a property of the system, is always present and cannot be reduced by science. However, it can be characterized (e.g. Ruokolainen et al., 2009).

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Values and uncertainty

The degree to which values are shared on an issue can determine how much uncertainty is 'allowed' before making a decision. When uncertainty is present, values become more important for decision-making and legislative action. Even when there is vast uncertainty surrounding an issue, values can tell us that something should be done. A good example of this is fishing in the Pacific Ocean. There are many uncertainties and many conflicting stakeholders, but a fundamental common value is shared: it is undesirable to have low fish populations. Thus, there continues to be a call to determine the best course of action and vigorous debate about the meaning of 'low'.

When a decision must be made but uncertainty about the outcomes of various policy options is high, values become important. Different value sets lead to different weightings for costs of action and performance metrics. Even if we are unsure about outcomes, discussion based on the inherent values of each stakeholder often allows us to choose a course of action consonant with the values that are shared by the majority of the public or the majority of the decision-makers.

The degree to which values are shared by policy makers determines the role they will play in a situation of high uncertainty. When values are shared, even if there is high uncertainty surrounding the possible outcomes, it is easier to make a decision. If people are in agreement at the core of an issue, deciding a course of action can be easy. The situation of shared values and low uncertainty is ideal; we know our options, agree on how to evaluate whether those options will work, and thus easily make a decision. Very high uncertainty can still make it difficult to make a decision, but it is not nearly as complicated as when values are not shared. For example, if a group in a room is told that a tornado is coming, there is always high uncertainty about exactly where a tornado will hit ground, but it is still a relatively easy decision to go to the basement until the storm has passed, because there is the shared value of saving themselves and a low cost associated with the decision (see below) (Pielke, 2007).

On the other hand, if values are largely unshared with high uncertainty, public discussion can lead to compromises between opposing groups or to political stalemates (Springer, 2006). That is, when decisions cannot be constrained by science (high uncertainty), the decision-making process must move to the discussion of options based on the inherent values of each political actor to come to a conclusion. In this situation there are cases where power can shift the debate. With unshared values and high uncertainty, science is often politicized or used to justify a position based on values (value-based science). For example, despite evidence that global climate change is indeed occurring (Walther et al., 2005; IPCC, 2007), Senator James M. Inhofe has used model uncertainty to claim that global warming does not occur (Inhofe speech, October 25, 2006).

The evolution versus creationism debate shares many features with the global warming debate: papers that express disagreement with some aspect of evolutionary theory as currently understood are often trumpeted as evidence that evolution is a 'dying' theory and acknowledgments of uncertainties are taken as evidence of weakness in the theory. These sorts of allegations serve as a mask to obscure the true nature of the debate, which is about the differing values of evolutionary biologists and religious fundamentalists (Mangel, 2001).

Values and the cost of a decision

When considering alternative solutions there are financial, environmental, and social costs to consider. How much money will a given solution cost? How much environmental degradation will it cause? How many lives are at stake? Thus, values are deeply involved even when determining the cost of a particular action. What may cost a lot to one group (environmental degradation) may not cost as much or be outweighed by other costs or priorities to another group (a business that cannot afford to clean up their production process). Costs can also change over time as societal values change. For example, public opinion on costs of the US involvement of WWII changed dramatically from 1941 to 1945 due to wartime events (Cantril, 1967).

The cost of a situation changes the balance between values, uncertainty, and the creation of policy. Where shared values may make it easy to make a decision even with high uncertainty, a high cost involved with a particular decision (or lack of decision) may then reduce the amount of acceptable uncertainty or the instances where science can be an effective tool at reducing uncertainty (Figure 3). Conversely if the situation or decision has low costs, decision-making is much easier (especially if there are also shared values and low uncertainty).

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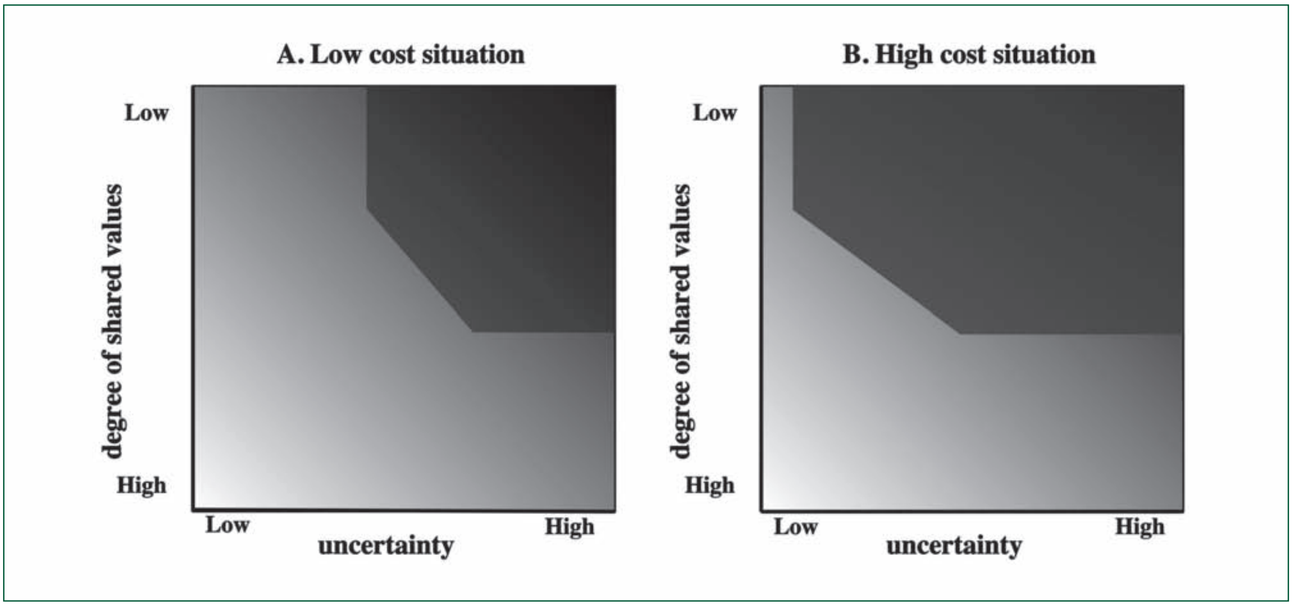

Figure 3. *The color within the plots indicate ease of decisionmaking where dark gray indicates extreme difficulty if not impossibility and white indicates ease. The ideal circumstances for making a decision are those that have shared values and low uncertainty, in both cost scenarios (lower left corners). For the low cost situation, as 25 uncertainty increases and/or the degree of shared values decreases, it becomes more difficult to make a decision. Once a threshold is reached, decisionmaking becomes near impossible (dark gray section). If the cost is high there is a similar pattern, however the near impossible section increases along the uncertainty axes because decision makers are less willing to deal with uncertainty when the cost is so high; i.e. a wrong decision at a high cost will be more detrimental than a wrong decision at a low cost.*

If values are unshared and a situation has a high cost of inaction, there may be more pressure to make a decision. Then extensive debate can occur, or diplomatic efforts used to bridge values and make compromises so that a decision can be made. Often the status quo is preserved and the values or opinions of those in power dominate the debate. The continued presence of US troops in Iraq is an example of such an issue: although initially there was high public support for the occupation, over the last few years public opinion has become more and more polarized. The point was reached where there was substantive disagreement between large sections of the populace about whether or not to stay in Iraq, but attempts to craft compromise policy failed. In this case public debate was largely ineffective at changing the status quo.

The role science can play: A balance between uncertainty, cost, and the degree of shared values

We have discussed the role that values play in the creation of policy and how the degree of shared versus unshared values interacts with the uncertainty and cost of a situation. Taken together these factors determine the role that science can play. If values are shared and there is an ample time horizon, science can play a helpful role in reducing uncertainty, especially when costs are high. When values are unshared, the political landscape is filled with the discussion of reconciling values; science often becomes a political tool to advance the policies of one side or the other.

Science is important for reducing uncertainty

A scientific problem can be thought of as a jumble of jigsaw puzzle pieces. The scientist must attempt to assemble the image without necessarily knowing what the image is supposed to be, or whether the pieces even belong together. Indeed, often characterizing the problem is more important than finding the solution (Mangel, 1982). Further research into a topic can clarify or distort the working image, just as scientific research can discover new ideas or reveal new problems. Just as using an incorrect piece in a jigsaw puzzle results in a distorted image, inaccurate predictions and models lead to all kinds of problems in science. But continued research tends to reduce uncertainty, bringing the image into further clarity.

Accepting scientific results as an impartial part of the political process requires a variety of actions. First, since uncertainty can never be eliminated, but only reduced, we need to be honest about the assumptions and methods utilized in our studies. Simplifications and approximations are necessary approaches that should be clearly communicated to policy makers and the general public. Second, researchers must be upfront about the evolving nature of scientific information and condition non-scientists to accept that scientific theories are constantly updated with the collection of new data. Third, by being truthful about their values, methods, and uncertainty, scientists can more convincingly play the role of unbiased advisors to the policy process. Advice given by scientists should be purposefully transparent to mitigate the possibility of results being interpreted as agenda-based rather than question-based. If the public perceives scientists to be stealth advocates (*sensu* Pielke, 2007) that hide behind scientific arguments to promote an agenda, they may distrust conclusions drawn from scientific data and misinterpret the accompanying uncertainties. The public needs to trust science before science can be meaningfully utilized.

Educating the wider community regarding policy issues can lead to policy if there exists either some level of value consensus or some malleability of opinions among the public. However, when such conditions are not in place, even an extraordinary reduction in uncertainty is not always sufficient to change public policy. A large divide in values between scientific results and the accepted opinions of society will ensure rejection or drastically delayed acceptance of those results. For example, the concept of escalating human-caused climate change has gained public support due to public education efforts by prominent politicians and media figures. Increasing the public's awareness of the issue helped cause a values shift and rendered people more amenable to scientific conclusions.

In contrast, a continually divisive area is evolution, which is accepted by the vast majority of scientists and rejected by a large portion of the US public (Pew, 2009). Little flexibility exists in this matter, and the values remain resistant to change despite scientific consensus. In this case public acceptance occurs on a timescale at least an order of magnitude greater than that of the scientific community. A less heated example of public rejection of scientific conclusions is the reaction to the reclassification of Pluto from a planet to a dwarf planet: the New Mexico legislature passed a resolution that declares that within its borders, Pluto is a planet regardless of the decisions of astronomers (Gutierrez, 2007).

These cases illustrate that more than just scientific results are needed for public edification. Efforts must be made to present the information in relevant terms, or in relation to an existing problem. Increasing public awareness and shifting societal values are just as crucial as the presentation of the data, since a new understanding can promote greater acceptance of scientific conclusions. While this may happen quickly if spurred by a dramatic event such as Hurricane Katrina or Al Gore's movie *An Inconvenient Truth*, public opinion often takes many years or even generations to change. Even so, scientists must be persistent in continuing to produce and disseminate studies that advance our knowledge of pertinent issues so that we can be ready with an answer whenever the public is willing to listen.

Science can expand policy options

When uncertainty about an outcome is high, science has the potential to expand policy options regardless of the degree of consensus in values. The level of consensus shapes the political process and determines how the scientific information is used (or abused) and which option is ultimately chosen. Basic science can first provide an increased understanding of a particular issue. With a broader knowledge of the issue at hand, a larger array of policy options can be formulated, and science can be used to evaluate (1) the potential outcomes of the various policy options, (2) the outcome probabilities, and (3) possible consequences of choosing one policy option over another.

When addressing issues and outcomes with high uncertainty in policy-making, it is essential for policy makers and the public to recognize the uncertainty inherent in the scientific process. Science does not expand policy options, the scientist does. The scientific method is inherently subjective--from the choice of research topic, to the methods employed, to the interpretation of data. Policymakers can decrease the degree of subjectivity by calling for multiple scientific studies, although often at the expense of increased uncertainty. Options are ultimately weighed and debated through politics and the political bargaining process with the goal of deciding upon a course of action.

A specific example of science expanding policy options is the recent resolution by several coastal states within the United States and other developed countries to develop climate change and sea level rise adaptation and mitigation plans. The purpose of drafting these plans is to implement policies to deal not only with recent and current effects of climate change, but also to preemptively account for and curtail future impacts. Although there is still debate as to the dynamics of global warming, there is general agreement (low uncertainty) that it is occurring. The great uncertainty surrounding the issue of climate change is future impacts and feedbacks within the system.

On November 14, 2008, California Governor Arnold Schwarzenegger issued an Executive Order for state agencies to plan for potential impacts of climate change and sea level rise. As a result, California is drafting a Climate Adaptation Plan (CAS) that "*will synthesize the most up-to-date information on expected climate change impacts to California for policy-makers and resource managers, provide strategies to promote resiliency to these impacts and develop implementation plans for short and long term actions*" (California Climate Adaptation Strategy, 2008, <http://www.climatechange.ca. gov/ adaptation/index.html>). Scientists have developed climate models to predict a range of future climate scenarios and potential impacts on state air quality (Mahmud et al., 2008), water and other resources (O'Hara and Georgakakos, 2008; Miller et al., 2008), agriculture, species diversity and behavior (Yates et al., 2008), and coastal infrastructure and ecosystems. The 'Overview of the California climate change scenarios project' (Cayan et al., 2008) includes a comprehensive analysis of the science underlying climate change models and studies, and the range of possible future scenarios predicted by the models. Cayan et al. (2008) stress the need for open communication between policymakers and scientists and the importance of these scientific studies for expanding policy options: "*While none of these [studies] are policy prescriptive, they are all policy relevant*" (pg. S5). Science is expanding the possible approaches for dealing with climate change consequences, and has the potential to expand policy options in a wide array of settings.

From translator to advocate: How to be an honest advocate

The role of an advocate (Pielke, 2007) is to influence values to obtain a particular policy outcome (Figure 4). While scientists may legitimately use prestige or respect to state an opinion to influence values and policy, it is dishonest for scientists to use the authority of science to advocate without a discussion of values and policy alternatives.

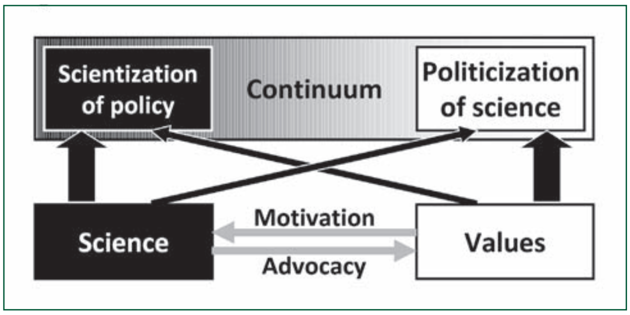

Figure 4. *Input to policies comes from both science (knowledge) and society (values). Scientization of policy (technocracy) can happen if science is clear and values do not weigh heavily, then bureaucrats can silently run policies with input from scientist (an example is monitoring of heavy metals in drinking water). The opposite happens if the public is strongly opinionated and the advice from science is either irrelevant or contaminated with high uncertainty. For example, there is strong public support for putting criminals in jails, but little scientific evidence that it helps. Additionally, science has little to say about whether gay couples should be allowed to marry (disagreement about values and science has few relevant facts). Science then becomes politicized, and science is either pushed over the sideline or disagreeing parties try to hijack science to inflate their credibility. From a scientist's perspective, the dynamics of these two situations are very different, and there is also a continuum between these two extremes.*

As scientists, we may become involved in advocacy either directly by becoming a part of the policy-making process, or indirectly when our work is used as a tool by advocates for advancing their cause. Because our involvement in the process has important ramifications, scientists will benefit by following the three criteria essential to being an honest advocate.

First, conclusions must be based on the data, without data being selectively used to support a pre-determined conclusion. For example, Hilborn (2006) argues that there has been an increasing trend of faith-based fisheries science, in that marine scientists have accepted certain ideas (e.g. global fisheries are in crisis, or marine reserves are the only effective management tool) on faith, and then search for data to support these ideas. Hilborn (2006) contends that such 'science' is dishonest, and it not only damages the credibility of scientists in general, but also science as a process.

Second, whenever possible, multiple hypotheses should be explored to ensure that conclusions are not spurious. By exploring multiple hypotheses (Hilborn and Mangel, 1997) and determining the relative support for each hypothesis from the data, we decrease the risk of drawing false conclusions, and thus increase the likelihood of the adoption of more effective policies. For example, numerous studies attempted to explain the decline of Steller sea lion, *Eumetopias jubatus*, in western Alaska by exploring single hypotheses, leading to many explanations, including: predation by killer whales, a natural change in the prey community (i.e. a regime shift), or competition with fisheries for prey (Wolf and Mangel, 2009). These findings have very different policy implications for the recovery of the Steller sea lion population, as some suggest natural causes, while others suggest anthropogenic causes. Wolf and Mangel (2009) explored multiple hypotheses simultaneously using a mechanistic model, and found evidence for multiple causes (both anthropogenic and natural) with different impacts across different life stages. Thus, their results suggest that testing hypotheses in isolation may lead to spurious correlations, which in turn may lead to ineffective policies.

Third, when working on applied problems it is important to provide a suite of policy alternatives unless the values of the scientists are clearly stated. For example, in tropical forests there is frequent conflict between the preservation of endangered species and the rights of the indigenous people who hunt them. Some conservation biologists argue for the removal of people to create 'pristine' nature preserves (e.g. Terborgh, 1999), while some indigenous rights advocates argue for large autonomous indigenous reserves (Schwartzman and Zimmerman, 2005), but this dialogue is fundamentally influenced by the relative value placed upon indigenous rights versus vertebrate conservation. Despite these seemingly conflicting goals, both parties use science to make and frame their arguments. Conservationists propose policies that only aim to enable the persistence and recovery of endangered species, however allowing some degree of indigenous hunting may still allow that goal to be met. Conversely, indigenous rights advocates seek to ensure that the native way of life is not threatened by conservation. Autonomous reserves are one solution, but allowing unregulated harvest could result in local extinction of some endangered species. A policy that regulates hunting of these species may be in the best interest of both wildlife and indigenous people via persistence of long-term game resources (Levi et al., 2009). Thus, the scientist acting as an honest advocate should offer a suite of policy alternatives and discuss their implications for a particular problem.

Conclusion

As scientists it is important to remember that we are not isolated individuals removed from society, but that we are an integral part of our communities. We must also acknowledge the role that values play throughout our research, and be aware of the policy process and our role(s) within it. We must recognize that there is always some amount of uncertainty within our research that is irreducible and acknowledge the simplifications and assumptions we necessarily make in our models and research. Science has great potential to contribute to policy and politics by expanding policy options and reducing uncertainty, but it is critical that we are honest about our position. We must not let our bias motivate our science (unless we clearly state that this is so), but instead use our science to motivate a solution, or ideally a multitude of solutions. Our challenge to you is: Get outside of your little science box!

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