CHAPTER 19
SCIENTIFIC KNOWLEDGE AND PARTICIPATION IN THE GOVERNANCE OF FISHERIES IN THE NORTH SEA

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Abstract

The participatory mode of fisheries governance is based on effective communications that are able to bring together the viewpoints of many stakeholders so that management decisions can be generated. This chapter offers a discussion of the relationship between stakeholder participation as it is taking place on a European scale and the generation of formal scientific knowledge for the management of fish stocks under the Common Fisheries Policy (CFP). It examines the demersal stocks in the North Sea in particular. Stakeholder participation has been an important factor leading to demands for changes on the ways in which formal scientific advice is generated and communicated. The impacts on scientific deliberations of three such demands are examined: a) a demand that advice shift from the fish stock to the fishery as its basic unit of reference; b) a demand that advice not be open to different interpretation by the various stakeholders; and c) a demand that the results of existing technical fisheries management measures be examined when preparing advice. The chapter concludes that a flatter decision making hierarchy could make possible both a richer knowledge base and greater public support for management decisions.

19.1 Introduction

The participatory mode in fisheries governance begins with a shared understanding of what is going on in the sea. Sharing such an understanding implies an approach to developing the scientific basis of management decisions that has itself, in some sense, been participatory. This idea should raise some eyebrows. Our common sense understanding of science, for good reasons, does not include the idea of 'participation'. Science is supposed to yield objective knowledge, not participatory compromises. The role of science in fisheries management is precisely to provide objective information about the situation that then can be used to make participatory decisions about responses to the situation. Participation, after all, is a polite word for politics, and science is supposed to be shielded from politics.

Jasanoff (2002) is one of a growing number of voices expressing an alternative approach to science and policy. While the West has spent the past 30 years developing institutions that are supposed to protect policy-relevant science from politics, she argues, this vision has never been achieved. Within every policy arena where science is relevant it has been continually re-entangled in politics. However, the world is changing and this entanglement is taking on different kinds of meanings. In the past, when totalitarianism and nuclear weapons were the defining images of science and technology, the danger

T. S. Gray (ed.), Participation in Fisheries Governance, 319–341.

was a "monolithic alliance of science and technology with the state" (Jasanoff 2002:367). Now, however,

> …it is the turn of civil societies to insist that the production of policy relevant knowledge should be made available for public scrutiny and input. To politicise science in *this* way – that is, by making it publicly transparent and accountable – is not the same as allowing science to be captured by the special interests of state and industry. Public accountability, carefully institutionalised, can only promote the interests of democracy. (Jasanoff 2002:368)

A clear case can be made for the application of Jasanoff's reasoning to fisheries. The early post-war years were indeed often characterised by an overly close cooperation between the fishing industry and the agencies responsible for the assessment and monitoring of fish stocks (McEvoy 1986), so a 'monolithic alliance' justifying itself with biased science was a real danger. It is hardly a danger today. Fishers face regulatory agencies staffed by scientists who have strongly embraced the precautionary principle (Wilson *et al* 2002) and any openings for fishers' participation in the scientific aspects of management could only conceivably exist within a civil society context in which marine conservationists would also have standing. Checks and balances would be in place that would allow Jasanoff's (2002) public transparency and accountability to make a positive contribution to the accuracy and legitimacy of the science being used by management decisions. Hence, we do not see a problem stemming from the basic idea of civil society participation in fisheries science.

The question is how such participation should be achieved. We believe that one important key lies in understanding the relationship between the physical (and social) scale of what is being managed and institutions doing the management. There are numerous examples of a knowledge base for fisheries management being produced through cooperation between scientists and fishers on **small** scales that are perceived by most stakeholders as useful and legitimate (Wilson 1999). However, collaborative programmes dealing with **large-scale** fisheries have been much more focused on involving fishers in particular roles, often as data gatherers or reviewers of completed science, without achieving participation in a broad sense (Bernstein and Iuddicello 2000). In fact, in our assessment, social scientists do not know very much about how to 'carefully institutionalise' large-scale institutions to allow participation in science to 'promote the interests of democracy'.

We examine aspects of the production of scientific knowledge for fisheries under the EU Common Fisheries Policy (CFP) in general and in relation to North Sea cod in particular. As the data presented in this paper will demonstrate, the issue is not in any important sense a problem of unresponsive bureaucrats or a lack of political will. It is a problem of institutional coordination; it is about the possibilities and constraints in how institutions make and communicate decisions. In our close observation of examples of these processes we actually found a good deal of **accountability** traceable to the concerns of the fishing industry, as well as extensive and honest attempts by many fisheries scientists to be **transparent** about how scientific decisions are arrived at. Yet this accountability and transparency has in no way led to a knowledge base for fisheries management perceived by stakeholders as useful and legitimate. Indeed, the scientific

structures of the CFP are so reviled that some groups of fishers openly and actively resist providing it with any data at all.

Our intent is to provide a systematic analysis of some of the impacts that the current forms of participation have on the science structures of the CFP. This is not meant to be a 'big picture' analysis of policy making in the CFP. We recognise that there are many other factors influencing policy beyond the kinds of participation with which we are concerned. In fact, we cannot assess its relative importance as a driver of policy decisions, but we do know that it exists and that lessons can therefore be drawn from it about how to improve governance institutions. The participation that is happening now is a long way from the ideal of participation. It takes place mainly through the intervention of politicians, lobbying by European and national organisations representing the fishing industry (and conservationists), and at times through active political resistance. This participation is strongly influenced by rivalry between and among fisheries and member states. Nevertheless, it is a form of participation that generates forms of accountability, demands transparency, and has real impacts, both positive and negative, on the way science is done. Indeed, what is happening with fisheries science in the CFP is, we believe, quite representative of stakeholder participation as it is actually carried out on large scales. Our hope is that an empirical analysis of the impacts of current large-scale, participatory practices, however flawed, on the generation of scientific advice will be a greater contribution to improving those practices than if we were to write an essay on how it might be done.

19.2 Theory and methods

We believe that thirty years of both case studies and comparative research has established that participatory approaches do increase the legitimacy of and cooperation with environmental policy. The interesting research question is now how to make such approaches work well at larger rather than local scales. To begin such an investigation there are many theoretical traditions to choose from. Within anthropology and sociology most of these approaches are based on the examination of small-scale processes and do not provide tools to examine scale. This weakness is not shared by political science and empirical work in that discipline has indeed made important contributions to our understanding of both scale and participatory institutions (Ostrom 1990). They have achieved this, however, by using game theory or other approaches based on an atomistic theory of motivation grounded in instrumental rationality. This works very well as long as it is applied to institutional contexts where the 'game' metaphor is a good fit with the way people actually approach situations.

This very strength, however, makes it less useful for understanding how to improve participatory processes in other institutional contexts where assuming that the process is a game is tantamount to assuming that the process will, at least to some degree, fail. To the extent that people interact as tactical opponents in a process they weaken those aspects of the outcomes that are the central aim of participation: legitimacy and cooperation. We cannot ignore the fact that people do interact as tactical opponents, but we will achieve little progress in improving participatory governance within large-scale institutions if we assume, either as a simplification or through an empirically uninformed understanding of society, that it is the only way that people interact.

It is these considerations that point us toward Habermas (1984, 1987) whose *Theory of Communicative Action* uses a dual theory of motivation in which actors are oriented both to instrumentally rational goals and towards achieving a mutual understanding based on what he calls 'communicative rationality' – the rationality that allows people to make sense of what they are saying to one another. This is a unique and important contribution, even if a somewhat incomplete one. The coordination of social action requires the existence of mutual understandings. Habermas's investigation of the underlying logic of communicative rationality, which he presents in tandem with a theory of social systems, provides a starting point for analysing the relationship between communications and scale. For fisheries management, this has been developed further (Wilson and McCay 1998; Wilson and Jentoft 1999; Wilson 2003) in the direction of examining how the rationalities of both instrumental competition and communication to achieve coordinated actions, coexist within social conflicts and help shape institutions. While there is no space for a full description, the main points of the theory relevant to the present paper are that:

- Institutions are shaped by both overt and tacit bargaining between groups in pursuit of diverse and/or conflicting goals;
- Institutions need communicative mechanisms to coordinate social action;
- Such mechanisms have strengths and weaknesses that are scale-dependent;
- The mechanisms that work well on small scales allow institutions to have greater sensitivity to social values and factual truth;
- The mechanisms that are effective at coordinating behaviour over large scales greatly restrict the content of communications and are much less sensitive to social values and factual truth;
- Communicative mechanisms play critical roles in the generation of the social power needed for success in the first point above. This leads to systematic distortions in communications;
- Institutions are expressed, reproduced and marginally changed by micro-level behaviours and can be analysed through the observation of the norms guiding such behaviours

Science is an institution that relies heavily on what Habermas calls rational communications. This communicative mechanism allows institutions to be sensitive to factual truth, about nature for example, but is poorly equipped for coordinating behaviour across large scales (Wilson 2003). Rational communications meet two conditions: there is no manipulation involved in the communication; and everything communicated is open to any question, from any participant, about its validity (White 1988). This model should not be thought of as an attempt to describe empirical conditions. It is a norm in the sense described below. People use it as a yardstick to evaluate the kind of communicative situation they find themselves in. While no one expects the conditions to be fully met, they have to be met to some degree if a convincing shared reality is to be produced (Habermas and Nielsen 1990). Science, as Merton (1968) pointed out, makes very heavy use of norms that seek to maintain rational communications because institutional sensitivity to the truth requires, more than any other communicative facility, an openness to the raising and evaluation of any claim without *a priori* constraints.

The terms ‘institution’ and ‘norm’ need a bit of fleshing out here. Following Scott (1995), we see institutions as patterned social interactions with regulative, cognitive and normative dimensions. This is not the more common ‘rules of the game’ approach. The emphasis is on shared meanings that define behaviours and cognitions as fitting or not fitting particular normative patterns. Hence, where other scholars may choose to analyse institutions by examining the written rules that emerge from formal bargaining, we feel that it is necessary to delve further into the link between institutions and actual behaviour.

In recent decades the term ‘norm’, for good reason, has gone out of fashion in sociology, because earlier uses implied values so widely-shared that they were seen as structural components of society. This idea had few empirical referents in a conflict-ridden world. Norms, as we use the term, are not structural but phenomenological. They do not define appropriate behaviour *a priori*, rather they are created through processes of deciding on, rationalising and accounting for behaviour (Heritage 1984). It is these processes that link shared meanings to behaviour. Norms are not empirical phenomena, they are cognitive phenomena, they are counterfactual ideals through which observed behaviours (including acts of speaking) are understood. This observing, rationalising and judging, however, reproduces institutions and has tremendous influence on subsequent behaviour.

This idea of norms as an analytic link between micro-level behaviour and institutions defines the method we take in this paper. Our central research question is with the kinds of influences exerted on scientific processes by other participants in the implementation of the CFP. In this chapter, we focus on the influences on these deliberations that are traceable to the needs of the fishing industry, sometimes directly, but usually channelled through the European Commission. We conceptualise and term these links as forms of ‘accountability’. The main reason for using this basically positive term for what also might be called ‘political pressure’ is because we believe that participation, even when hampered by large scales, is helpful and necessary. Stakeholders such as fishers, managers and scientists have a right in democratic societies to hold each other accountable. The tools they currently have for doing so, however, are blunt and crude and have the possibility of hindering, as well as helping, processes of creating pictures of nature that are both accurate and shared. The point of this paper is to describe the effects of these forms of participation on the work of scientists in hopes of finding ways to improve these tools.

19.2.1 THE SPECIFIC RESEARCH CONTEXT

Research activities were carried out under the auspices of the International Council for the Exploration of the Sea (ICES) Working Group on Fisheries Systems. We observed in detail two scientific deliberations within the ICES system: the September 2003 meeting of Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak; and the October 2003 meeting of the Advisory Committee on Fishery Management (ACFM). We also observed two meetings of the Scientific, Technical and Economic Committee for Fisheries (STECF). We carried out 23 formal and numerous informal interviews with fisheries scientists. Publicly available documents such as ICES and STECF reports and the Memorandum of Understanding between ICES and the Directorate General for Fisheries (commonly called DG Fisheries or DG XIV) were also analysed. Notes from observations, informal interviews, and original documents were analysed using NUD*IST textual data analysis software.

Fisheries advice for Europe is given through the ICES system. ICES was founded[1] in the late nineteenth century to investigate both natural and man-made causes for fluctuations in fisheries stocks (Rozwadowski 2002). ICES is an inter-governmental organisation that coordinates and promotes marine research in the North Atlantic, including adjacent seas such as the Baltic and North Seas. With more than 1600 marine scientists from nineteen countries around the North Atlantic, scientists working through ICES gather information about the marine ecosystem. This information is used to fill gaps in existing knowledge; it is also developed into unbiased, non-political advice. ICES advice is used by the nineteen member countries to help manage the North Atlantic Ocean and adjacent seas.

ICES has three advisory committees that provide advice on marine ecosystem issues. The committee of interest to this chapter is the one which provides advice on fish and shellfish stocks, the ACFM. The ACFM is the official scientific body providing advice to the Commission of the European Union in the form of DG Fisheries. Outside of ICES, DG Fisheries has its own advisory committee, STECF, which often consists of many of the same members as ACFM working groups. Unless otherwise specified, when this chapter refers to scientific advice it means the advice from ACFM and/or STECF scientists to DG Fisheries.

19.3 Some examples of the influence of stakeholder participation on fisheries science deliberations

Our examination of the relationship between fisheries scientists within both ICES and DG Fisheries' own STECF has uncovered a number of ways in which changes are being demanded of scientists. These changes are rooted in a desire for forms of scientific advice that facilitate managers' relationship with industry and other stakeholders. This tightened accountability can be directly traced to pressures stemming from the participation of the fishing industry, and to a lesser extent, conservation NGOs. While a substantial number of changes are being demanded, for the sake of space and thoroughness we discuss just three of them. The first two are channelled through DG Fisheries, while the third is experienced by the scientists as coming more directly from the fishing industry. These changes are:

1. A demand that advice shift from the fish stock to the fishery as its basic unit of reference;
2. A demand that advice not be open to different interpretation by the various stakeholders;
3. A demand that the results of existing technical fisheries management measures be examined when preparing advice.

We examine each of these kinds of changes in turn, asking what impact they are having on how advice is formulated and communicated.

[1] Though ICES officially designates its start as 1902, scientists were working in the decades prior to this to get the organisation up and running.

19.3.1 SHIFTING FROM THE FISH STOCK TO THE FISHERY AS THE UNIT OF REFERENCE FOR ADVICE

The institutional reality of fisheries management is driving ICES towards giving advice based on fisheries, many of which affect several fish stocks, rather than on the fish stocks themselves. Historically, ACFM scientists provided advice on fish and shellfish in the form of a single stock of a single species. Such advice is founded on well-established theory and practice in fisheries management based on the principle of density-dependent population regulation (Rosenberg *et al* 1993).

DG Fisheries, in response to the needs of the industry, are making the case for this shift from the stock to the fishery. As the STECF has said:

> Q1. ICES advice is explicitly single species though on occasions a comment is included that management should take the restrictions on another stock into account. Whilst it is helpful to have the issue stated, the failure to provide suitable advice is a problem. In the particular instance of recovery plans there [are] often extensive interactions between the catches of different species in the fishery. There is a need for fishery-based options, which provide matched restrictions to **mixed fisheries** at a range of rates of exploitation.[2] (STECF 2001:9)

From the industry and Commission perspective, single species advice ignores the basic reality that it is fisheries, that is, complexes of fishing ports, fishing boats, and fishing gears, that managers actually manage. The term 'mixed fisheries' in the quote above is the critical one because the problems that the fishing industry is holding the managers accountable for, arise where a 'fishery' is fishing for more than one 'fish stock'. For example, boats that fish for nephrops also catch cod as bycatch. If, as current ICES advice would have it, there was a complete ban on the capture of cod, these nephrops boats would be unable to fish for the nephrops that they would otherwise be allowed to catch. The 2002 report of the Working Group on the North Sea and Skagerrak explains the issue as follows:

> Q2. Current advice provided by ICES is mainly given in the form of fishing mortality limits and associated catch options, which are derived separately for individual fish stocks. This form of advice has two major disadvantages. **First, it takes little account of biological interactions**. Second, the stocks being analysed are often caught together in mixed-species fisheries, so the catches of species harvested by a given fleet are not independent of each other. This process is traditionally referred to as technical interactions. If, as currently, TAC [Total Allowable Catch] are set independently for each stock, fishing for one species may lead to discards and/or misreporting of another species, for which the TAC has already been reached… **The Commission has** on several occasions **acknowledged the need** to deal with technical interactions in ICES advice. This year, a request has been made to ICES to compile age-structured catch and effort data by fleet as appropriate, and to initiate multi-fleet multispecies short-term forecasts based on these data. (ICES 2003c)

[2] Bold emphasis has been added to quotations by the authors.

The bolded wording asserts that dealing with mixed fisheries is both a scientific issue and an ICES initiative. By beginning with a reference to biological interactions, they are constructing the managerial imperative to address mixed fisheries as a scientific requirement, and this has indeed been a concern of fisheries scientists since the 1970s, one that has been frustrated by the substantial data demands of multispecies modelling (Peterson 1993). Describing the addressing of technical interactions in mixed fisheries as an ICES initiative, which the Commission rather passively 'acknowledges', in the context of a response to the Commission's managerial requirements, has the effect of repairing the 'science boundary'. This is a well known concept in the sociology of science (Gieryn 1983), which points to the ongoing contest of deciding what is and is not 'science' and, often, who is and is not a 'scientist'. It emerged as a key theme in this research, particularly in the form of distinguishing between science and management.

In 2003, ICES initiated a Study Group for the Development of Fishery Based Forecasts to try to define fisheries and establish a framework for pulling together the necessary data. They chose to base their definition of fisheries on a combination of target species, gear, geographical area and season (ICES 2003b), hence combining the biological question of species with technical and geographical variables.

The move toward mixed fisheries influences the ways that scientific advice is produced in a number of ways:

- It requires that biological advice be fitted to a social unit rather than a biological one;
- It intensifies a norm of consistency in descriptions of scientific outcomes;
- It blurs even further the distinction between 'science' and 'management'.

We discuss each of these influences in turn.

19.3.1.1 *Fitting Biological Advice to a Social Unit*

A fish stock is a natural phenomenon while a fishery is a social one. The move from basing scientific advice on a natural concept to a social concept is a profound one. Social scientists have long understood that the difference between references to things in the natural world and the social world is a critical aspect of human communication (Festinger *et al* 1950). A reference to something in the natural world involves material substance that makes verification of the reference possible, at least in principle. The social world, as we define it here, is a communicative system made up of shared meanings that can only be interpreted and never directly verified. Whether or not one agrees intellectually with this definition of the boundary between the two worlds, as an empirical reality this distinction between assertions with and without a material reference is built into the most basic coordination mechanisms of many social institutions (Habermas 1987), including ones that are important for fisheries management (Wilson 2003).

Many scholars would question our assertion that we can meaningfully distinguish between a 'social unit' like 'fishery' and a 'natural unit' like 'fish stock' (Freudenburg *et al* 1995; Latour 1987). Their concerns are well-grounded and require a short aside. Their argument is based on a) the fact that institutions can only respond to ideas (social

constructions) about nature rather than nature itself; and b) in our 'post-modern condition' it is practically impossible to verify the degree to which these ideas reflect nature. We argue here that a fishery is a complex that includes economic, social, biological and technical ideas that are linked together through negotiated shared meanings, and hence is social. Then we argue that a fish stock is a construct based on physical proximity and genetics and that shared meanings do not play an ontological role in the constitution of the stock. Hence the stock is natural. They would then rightly respond 'but the fish stock as it actually matters is really a linkage of a set of definitions of species, people in landing areas sorting fish, research vessel hauls, computer data bases and so on, it is just as socially constructed as the fishery.' And they would be right. From some theoretical perspectives this is a very useful insight. In the communicative systems theory we are using here, however, the ontological distinction is important because there is a difference in what is meant by 'being correct' in respect to communicative assertions about material things, and in respect to communicative assertions about shared meanings. In common language, we call this the difference between 'facts' and 'opinions' (Festinger *et al* 1950). The size of a fish stock is a (likely unknowable) fact; the boundaries of a fishery will always be an opinion, even if codified in law. This difference matters crucially to institutions because certain institutional communicative mechanisms, particularly those effective on large scales, depend on this distinction in the way they coordinate action. This leads to a constant pressure from large-scale social systems to reify social relations – to reconstruct social phenomena as natural phenomena amenable to technical control (Habermas 1987). An example of this is the legal codification of the boundaries of a fishery in an attempt to make it into a 'fact' in respect to regulation. The reification of social relations is often strongly resisted because it can violate nuances and meanings that are important to people. This accounts, for instance, for much of the current resistance on local scales to 'globalisation'. These systemic changes in shared meanings are an important part of how communicative systems theory understands institutions.

While there are certainly many scientific complexities around defining a fish stock – including genetic variation, migration, spawning behaviour – these are the kinds of questions that fisheries scientists are trained to resolve. Fisheries, on the other hand, are social units with porous boundaries that individual fishers can cross. In fact, fishers can unconsciously or deliberately blur the boundary between various fisheries. Fisheries compete with one another among ports and nations, and have lobbyists and politicians that speak for them.

This shift changes the way that the fish themselves are understood, as classifications are driven by social rather than biological concerns, which become more important in the discussion. During the ACFM meeting, scientists reported that fishers had communicated concerns to them about scientists examining catch composition and making judgements about which species were targeted and which ones were bycatch, an economic distinction having little to do with fish biology. Nevertheless, if scientific advice is to attach to fisheries, then the fisheries must be defined as precisely as possible. The required precision, of course, stems from the fact that managers must apply often costly and contested regulations to fisheries. If it is not completely clear who or what is in that fishery, then regulations cannot be implemented.

ICES is in the process of trying to develop models for mixed fisheries that would allow managers to predict the complex outcomes for many fleets fishing for several fish

stocks. We observed some of this process at the 2003 meeting of the ICES Working Group on the North Sea and Skaggerak (WGNSSK) where the scientists were concerned with building such a model focused on the North Sea cod, including other fish stocks caught by fleets that caught cod both as a target species and as bycatch. They defined the fishing fleets based on gear and mesh size and included the fleets for which they had the necessary data for a total (during this meeting anyway) of 83 fleets. The definitions of fleets used were a controversial point among the scientists. Getting useful and comparable data for all these fleets was perhaps the greatest challenge and they were glad to have the data they had, even though it was only for one year. Collating the data for the eventual use of this or similar models for management advice was going to require the attention of several ICES working groups. More aggregate data – total landings by fleets and countries – was available than data that reported the age composition of the catch. Age composition is an important aspect of stock assessment models so whether or not to include the simpler, age-aggregated data was a point of discussion. It was clear to the scientists that these data problems precluded any use of the model in decision-making, and they were concerned that this would be misinterpreted. The model's results were very sensitive to decisions about how the fishing fleet were defined and combined, which suggested that the model should be set up to aggregate fleets together as little as possible. This, however, meant that the model would be even more demanding of good data. Another problem was how to handle the question of relative stability – the principle in the CFP that the relative shares of fisheries enjoyed by countries does not change through management decisions.

In the Autumn 2003, ACFM scientists were confronted with having to figure out how to generate fisheries-based advice based on this new unit (fisheries, rather than fish stocks) in the face of the extremely serious situation with cod in the North Sea. The seriousness showed itself both in terms of the low numbers of fish – the biological reality of the stock – and economic implications for the people making their living in the related fisheries. Their data about the condition of the stock led to an unquestioned consensus that fishing on cod needed to be reduced to zero. As one scientist put it at ACFM: "are we giving stock or fisheries advice, are we bound because we give fisheries advice to ignore that this stock is near commercial extinction" (from observers' notes). But what did this mean for fisheries on other healthy stocks that could not avoid catching a few cod? They could not simply say 'a few cod would be alright' a few cod from many other fisheries would be many cod. They were loath, however, to put fishers fishing mainly on healthy stocks out of work.

The scientific decision they were being asked to make was unavoidably also a political one as soon as the focus was shifted to fisheries. An exchange at ACFM:

> Q3. **Session leader:** The problem is the linkage of stock and fisheries advice, and that is a problem. We should not say 'closure of all fisheries' but 'a zero catch of cod' then we raise the question of closing the fisheries. But we **have to keep the fisheries and the stock separate things**…[further discussion]. **Scientist One**: We don't want to take away the strong message [about the cod, but] we are giving unclear advice that says you can have fishing and not, we cannot escape criticism. **Session Leader** this is moving in the right direction, we must anticipate that criticism with some text. (From observer notes at the ACFM meeting in October 2003)

The advice they felt most comfortable giving was advice about cod fish, not about fisheries. In this case, the scientists were unable, in the end, to shift the scientific advice from the natural unit to the social one. The official outcome read as follows:

> Q4. It is not currently possible to provide analytical forecasts for input into mixed fishery evaluation models. The main obstacle is that ICES does not have access to discard data for most fisheries. Development of such capability furthermore requires better catch monitoring, fishery analyses, and management decisions. The lack of such mixed fishery forecasts necessitates the development of complementary processes that do not require analytical short-term forecasts. ICES has in this report taken a first step towards the formulation of advice in a mixed fisheries context…ICES acknowledges that defining relevant allocation scenarios places difficult demands on managers and that mixed fishery advice in particular will require interactive communication between scientists and managers. EC DG Fish has indicated to ICES some scenarios that would be of interest for managers. However, mainly because discard data for most fleets are not available, ICES is unable to provide the required scenarios at this time. (ICES 2003a:5-6)

The main problem cited was the technical question of inadequate data. But constraints stemming from the organisation of management and better interactions between scientists and managers, interactions which presumably help clarify the science-management boundary in relation to particular scenarios, are clearly important to ACFM.

19.3.1.2 *Fairness in Fisheries Management: Consistency and Scientific Advice*

Required to give advice for multiple fisheries, scientists are very concerned about consistency within advice for stocks and fairness among sectors. The source of this concern is the participation of the industry. It is not a new thing. Scientists have always been concerned about consistency in terms of making consistent use of the best information and methodologies. They have also been concerned about treating different fisheries consistently long before the fisheries-based advice became an issue. Nevertheless, the turn to fisheries-based advice intensifies this desire for consistency.

As the following quote indicates, DG Fisheries is held accountable by the industry for fairness among member states and fishing sectors:

> Q5. When ICES advises a closure for cod, haddock, and whiting and not for plaice, sole, and nephrops, there is a perception in the whitefish sector that the flatfish sector is not taking up its share of the conservation burden. **We need equitable and credible mixed-fishery advice**. The advice given for one may be in conflict with advice for other stocks, limiting the credibility of the advice. (An ICES official quoting a concern expressed by the Commission)

DG Fisheries wants ICES' scientific advice to be equitable and credible. Credibility is a clear enough idea from a scientific perspective, science is about credibly explaining how you know what you say you know. But equity? Equity is about distributive justice,

it enters fisheries management through the desire of various user groups to be treated fairly (Loomis and Ditton 1993). How can scientific advice be equitable? The closest a scientist can come to 'equitable advice' is to be as consistent as possible in the ways they analyse and describe the various fish stocks (and now fisheries). Yet consistency of outcomes and descriptions of those outcomes is not a scientific value. In fact, good science tends to uncover differences. ICES' response to the particular DG Fisheries concern quoted above illustrates this:

> Q6. The situations were not similar as the fisheries in these areas were not identical, they take place on different grounds, cod is more in the north of the North Sea while plaice and sole are generally more southerly. ICES attempts to point to critical links between fisheries and provide good current advice, but the situation may change from year to year [*nevertheless*]…ICES has started to move toward fleet-based advice. (The same ICES official describing the ICES response)

To raise an argument such as 'we have to do it this way for sole because we did it this way for sprat' is to draw on other norms than scientific ones. Furthermore, as it is accountability from the industry that is driving this need for consistency, it is in the public face of the advice that the consistency is most imperative, leaving open the possibility that publicly offered explanations of conditions of fish stocks will be simplified to the point where differences are no longer apparent (see the comment of Scientist One below in quote Q8).

This norm of consistency has a strong influence on scientists' deliberations. During the ACFM discussion of cod in October 2003, the scientists' desire to be consistent about advice for cod influenced their interactions many times. In our first example, they were discussing how to deal with the ways that underreporting of catch (from both discards at sea and unrecorded landings) influenced stock assessment outcomes. Some amount of cod was removed from the stock by the fishery over-and-above the removals that the scientists had information about. This difference was serious enough so that it was one of two prominent reasons (the other being that the extremely small size of the cod stock itself introduced uncertainties beyond any scientist's experience) that the WGNSSK, the working group that does the cod assessment, had declined to make forecasts about the future of the stock based on their assessment. This decision led to a number of discussions at ACFM including the following:

> Q7. **Scientist One**: I had real concern about landings in 2001 about 2002 I don't know, I feel that 2003 will be weak again. In 2001 there was a change in F of 50 per cent, there were reports by social scientists that misreporting was going on. [In a recent meeting with fishers] we were raked over the coals by the industry by suggesting it was a problem. If we are going to reject this we will reject every assessment as the basis of a forecast, this is no less inconsistent, but for this stock in particular it will not change the advice so customers may say 'you must have a forecast' but for advice we don't need the forecast [cod was so low that no prediction was necessary about the impacts of fishing in the coming year as it was clear to them that no amount of fishing could be considered] . **Scientist Two:** if we are going to do a forecast I would rather it not be us. We can't correct for a bias in landings for an analytical forecast, let those who want massaged figures

> to do the massaging...**Scientist Three**: we need a decision**, the biggest argument for getting a forecast is consistency**, where does the burden of consistency fall, in sub groups [i.e. on judgements about individual stocks] in plenary [where the general advice is formulated]? **Scientist Four:** the art is for the sub-group to begin consistency by being internally consistent, but we need to be consistent about how we deal with language about underreporting. (From observer notes at the ACFM meeting in October 2003)

In spite of the fact that they already agreed that scientific advice for the cod stock had to be zero catch, and that the cod stock was in such a condition that singling it out for special treatment, by not offering a forecast, was justified scientifically, they were still very concerned that they describe the cod in a manner consistent with other stocks. This concern was driven, in this case directly, by the response of the industry to the issue of underreporting. The conclusion was to be careful that underreporting was dealt with the same way for each species within the language of the official advice.

Another exchange took place a while later. It illuminates the strength of the desire to be consistent:

> Q8. **Scientist One**: Don't write anything, leave it, it is too complicated, just say they [biological reference points for cod] have been updated. **Scientist Two**: We agreed that we could not do forecasts, so if we change reference points based on the same assumption, here we say we can revise a reference point in the medium term when we said we could not for haddock. **Scientist Three**: Is this repeating the medium term exercise? **Scientist Two**: We should be consistent. **Scientist Three**: Yes, but what is the Fpa based on. **Scientist Four:** The algorithm was run again at the same age range. **Scientist Three**: So it is technically the same. **Scientist Five**: A couple of well crafted sentences about changing age ranges and rescaling the reference points to make it clear what we have done in the introductory pages, otherwise I agree with Scientist One. **Scientist Two**: I am just saying for cod we concluded one thing and for haddock another because of the selectivity pattern. **Scientist Four**: The concern is starting stock sizes and that does not matter in the long term, in haddock it is the exploitation pattern and that matters in the medium term. **Scientist Two**: I don't want to complicate things, but if you then go to sole and only look at Floss the revised reference point for sole was only 0.56. **Scientist Three**: It was updated in different ways and was supposed to reproduce what was done, but it doesn't?? [Scientist Two is outnumbered and gives up with body language clearly suggesting dissatisfaction with the outcome.] (From observer notes at the ACFM meeting in October 2003)

During this exchange, no scientist questioned the idea that the assumptions underlying the identification of reference points for cod and haddock should be the same, even though there were important differences in the condition and available information about the stocks, as evidenced by Scientists Four and Five's comments. Scientist Two, however, was emotionally committed to the idea of consistency and pushing for it to an extent that the other scientists all thought would make the advice unnecessarily complex.

19.3.1.3 *Mixed Fisheries-based Advice and the Line between Science and Management*

The boundary between science and management is seen by scientists as a critical one.

Indeed, it is the basis of how scientists understand their role in fisheries management: scientists describe what is true about nature and then managers decide what to do about it (Wilson and Degnbol 2002). In practice this is a very hard line to maintain. All stakeholders at least nominally support this clear line between science and management. As a DG Fisheries official told us in an interview: "advice should tell managers **what** to do, not **how** to do it." Moving toward fisheries-based advice, and toward advice dealing with mixed fisheries in particular further obscures this already porous boundary.

The following exchange took place at the WGNSSK among a group of scientists working on the development of a fisheries-based model to aid managers in understanding interactions between different fisheries. The exchange illustrates two interesting things. The first is how the scientists, particularly on the level of a sub-group working on the nuts-and-bolts of figuring out how to meet the needs of managers have to feel their way into the details of a leading-edge question like mixed fisheries without having a very clear idea of what their work is going to be used for. Along with this is the real concern they feel that their work is going to be misinterpreted or misused by managers and other stakeholders who will be reading it. Particularly the suggestion by Scientist Six at the end of the exchange tells us something of the level of this concern:

> Q9. **Scientist One**: When we have completed this data base what shall we use it for**? Scientist Two**: Are we using this to produce alternative advice? **Scientist One**: Yes. **Scientist Two**: It will be used as an example. **Scientist Three**: ACFM wants to see this kind of thing. **Scientist Two**: It is illustrative, management will not be based on it this year. **Scientist Four**: We should use the 2004 data so people don't pick it up and use it as something real…**Scientist Five**: What I thought I would do is to use the data from last year's STECF meeting and do an exploratory analysis with data sets that are not proper enough for good results, we will use the analysis to explain what the model is doing and how it can be used…**Scientist Three**: Ideally it would be better to use the same data set. **Scientist Four**: But if it is just an example it won't matter. **Scientist Six**: Maybe you should use bad data so no one is tempted to use it for something inappropriate. (From observer notes at the WGNSSK meeting in September 2003)

In the plenary later on, this same model was evaluated as much in terms of its management implications as its technical characteristics:

> Q10. **Scientist One**: This is dangerous, let me give you an extreme example, a fleet is catching 100kg of cod and no other species. Another is catching 1000 kg of cod and 10,000 plaice. It is the first that will have to stop fishing! **Scientist Two**: No, that is why you have option P1 and P2[3], so that managers can make decisions like this. **Scientist Three**: We need to put in all the calculations, we can't put forward only one analysis. **Scientist Four**: You just suggested we put forward a scenario, while I thought this was just a sensitivity analysis. If you suggest options, one may be taken up, but this sensitivity analysis shows that this model is very sensitive to how it is set up. **Scientist Five**: But that is a political

[3] Ps refer to the fact that the model gives managers the option of reducing each fleet's catch equally or in proportion to the species composition of a fleet's catch, or in proportion to the portion of the catches of all fleets combined.

> decision…If we don't think we can explain this we should not put it forward. **Scientist Four**: After this discussion about Scientist One's point it sounds like we can't really explain this model **Scientist One**: Instead of naming the fleets give them a code or something so they can't use the data except for sensitivity. **Scientist Five** [visibly frustrated]: We step forward and as soon as it becomes a little political we say let's cover it up so you can't see it. (From observer notes at the WGNSSK meeting in September 2003)

Each of the scientists is coming at defining the line between science and management in respect to mixed fisheries in a different way. Scientist One wanted to make sure that nobody was going to be able to use the model to make decisions while there were possibilities of 'dangerous' inequities in results. He wanted to put the data in a code that obscured the identity of the fleets so that it could never be misused. This idea led to Scientist Five making strong objections. Scientist Two (explaining the approach taken by the sub-group, which included Scientist Five) wanted to give the managers options based on pre-programmed model parameters, so that 'managers can make decisions' within these predefined options. The options were likely intended to help the managers avoid, or at least deal with, the inevitable political wrangling between fleets as they competed to avoid having their portion of the mixed fishery cut back as little as possible.

The scientists at ACFM pick up this discussion of the mixed fisheries from the WGNSSK. They had put aside the model being developed at the WGNSSK both because it was not fully developed and tested and because there was insufficient data. They were still forced to deal with the underlying issue. What follows is an excerpt from their discussion:

> Q11. **Scientist One:** I think really we need to say there is not a science-based way of establishing what minimum [bycatch of cod] means and how it should be distributed among the fisheries. The managers have to deal with the ratio between the fisheries. [Extended discussion followed of the seriousness of the cod problem and the need for a zero catch.] **Scientist Two**: We could have an opening statement saying the catch should be 0 and all fisheries closed, then continue with this text [saying that bycatch should be minimised]. **Scientist Three**: I agree to a large extent, but it should be made conditional on the implementation of the cod recovery plan [a plan under consideration at that time by the Council of Ministers] as that would take account of the mixed fisheries. **Scientist One**: The evaluations of the recovery plan last year shows that that would take 8 years. **Scientist Three**: That may be acceptable to managers. **Scientist Four**: Yes, but to the stock. **Scientist Five:** This is, of course, a management decision, but you need to decide if you are giving stock advice or fisheries advice, this is the mixed fisheries issue. You stated in your evaluation of the recovery plan that you said it would work, so why say 0 here? **Scientist Three**: We are saying that we should give advice contingent on recovery plan. We need input from managers in priorities if we give fisheries-based advice. (From observer notes at the ACFM meeting in October 2003)

The scientists, without the possibility of a 'science-based way' or even a mathematical description of how bycatch could be distributed, continued to struggle with what their advice should be and what role it should play in the midst of a broad and confusing set

of possible management scenarios for cod. They felt the need for a dialogue with the managers, with input about priorities, but this contradicted the formal role they are supposed to play to provide 'objective advice'. The main outcome of the debate is the following text from the ACFM Report:

> Q12. ...for the mixed demersal fisheries catch options must be based on the expected catch in specific combinations of effort in the various fisheries. The distributions of effort across fisheries should be responsive to objectives set by managers, but also must result in catches that comply with the scientific advice presented above...An evaluation of how any combination of effort among fleets would affect depleted stocks would require that the catch data on which such estimates were based included discard information for all relevant fleets. Such data have been collected for many fisheries, but have not been made available to ICES. Therefore, ICES is not in a position to present scenarios of the effects of various combinations of fleet effort. However, if reliable data on all landings and discards by fleet were available, it would be possible to present forecasts based on major groupings of fleet/fisheries, and evaluate the impacts on cod and other rebuilding species of various distributions of effort among fleets. If management were to allow any demersal fisheries in 2004...some catch of cod would be inevitable, and therefore the fisheries would be inconsistent with the ICES advice. It is obvious that the larger the catch of cod the larger the risk that the stock will decline even further, and the greater the discrepancy from the ICES advice...However, the data...do not make it possible to calculate the true catches (and hence the impact on the stocks) by fleet or fishery. Therefore, there is no defensible basis for suggesting what fishing opportunities would still ensure no catch of cod and few discards of plaice and sole. (ICES 2003a:222)

The text reflects the discussions. The inability of ACFM to resolve their dilemma is placed squarely on the data problems. The lack of clarity about the use, misuse and meaning of the work is no longer directly evident, though its shadow can be seen in the careful use of language. This choice of emphasis re-establishes the boundary between science and management and portrays this line once again as a clear one. Once a model has been developed that allows a mathematical description of the distribution of by-catch, and adequate data collated to run the model on the actual fleets involved, the model itself will stand on, define, and will likely in some fashion, such as the P options described above, hide the porousness of that boundary.

19.3.2 DEMANDING THAT ADVICE NOT BE OPEN TO DIFFERENT INTERPRETATIONS

The second type of influence we would like to discuss also arises because scientists are being held accountable for providing advice in a form that facilitates managers' relationship with industry and other stakeholders. DG Fisheries expects ICES to provide (fisheries) advice on sustainability and yield, and to provide managers with a range of options and their consequences with respect to the advice. While a range of options is desired, DG Fisheries does not want this advice to be open to different interpretation by various stakeholders. 'Stakeholders' in this instance refers to the fishing industry and conservation NGOs, as well as national interests.

DG Fisheries has been critical of the advice provided by ICES. This criticism was described in an interview with an ICES official, where it was commented that the DG Fisheries stated:

> Q13. Advice for a number of stocks leaves room for interpretation. Advice must be clear and understandable. (Interview with ICES official)

The same ICES official went on to explain that DG Fisheries felt, for example, that:

> Q14. ICES advice on cod included a short-term catch option table that was interpreted by industry to mean a moderate reduction in TAC would result in significant increase for biomass – such forecasts did not seem to fit the need for a cod moratorium (Interview with ICES official)

This interviewee agreed that ICES advice should not be open to interpretation. He further stated that they (ICES) remained interested in working together with DG Fisheries on this issue:

> Q15. Advice should be clear and [we] will continue to work on this along with the Commission observers at the ACFM meetings. (Interview with ICES official)

However, the ICES official did also defend the advice provided to the Commission:

> Q16. It was clearly stated that even if the indicated improvement could be realised, it was insufficient to rebuild the stock in a short time. (Interview with ICES official)

Much of DG Fisheries' desire for clear advice that is not open to interpretation revolves around data tables. According to some scientists, DG Fisheries seems to only read the tables and not all of the information presented to them. As one scientist noted in STECF, "We're in the difficult position again…people (managers) just look at the numbers and not the health warnings." In this case, 'health warnings' refers to the caveats in the explanatory text, which is an important part of the advice because it describes the limits of the knowledge. Such information, it is clear from the scientists' discussions, is not meant to be supplemental to tables, but to explain the full picture of the fishery. Scientists state that managers must read this text to get the full advice since the caveats given in the written text help describe some of the uncertainty and other issues important to take into consideration when making management decisions. There had been some discussion surrounding the idea of a separate ACFM report, or section of the report, written for laymen, such as the fishing industry. It was thought that this would be one means of mitigating part of **the** problem of differing interpretations by the various stakeholders. In the end, however, it was decided that having advice described in too many different ways could aggravate the problem rather than diminish it and this idea was shelved, according to one of our respondents who is an ICES official.

DG Fisheries demands that advice not be open to differing interpretations by various stakeholders. ICES agrees the advice should be clear and understandable. Yet, scientists have pointed out that the advice should be read in full by managers. Choosing not to do

so may increase the number of differing interpretations with each interpretation being made by stakeholders to support their own position. The following exchange reflects the level of the scientists' concerns:

> Q17. **Scientist One**: We should stop pretending we know how many fish are out there**. Scientist Two**: That is where we are going. The trend is there, the scale is wrong**. Scientist One:** The system will use it at the Council of Ministers. **Scientist Two**: That is why I want all these caveats. (From observer notes at the WGNSSK meeting in September 2003)

Hence, ICES' most important technique for addressing uncertainty is writing textual caveats around the tables of numbers they are asked to provide. Managers seek to be objective and fair in making their decisions and to have such decisions be transparent and resting on the 'best available science.' As pointed out by Porter (1995), the best data for being objective and fair in holding people accountable is quantified data. This need for quantification to achieve non-scientific as well as scientific goals raises important conundrums for ICES scientists. The scientists are beginning to directly address these issues, as is evident in the report from the Working Group on Fisheries Systems (2004), for example, which questions whether such advice provided by ICES really is transparent, accountable, and of high quality:

> Q18. Just picking a number to express a piece of qualitative information is often not adequate and estimates are based on expert judgement rather than strictly objective criteria. Examples are choices of models and sub-models, generalisations and at times personal weighting of time series for the tuning (which is a quantification of qualitative knowledge or impression). Such choices are necessary but given the interpretive flexibility in the data, a single quantity decreases the transparency and the accountability in science. Two scientists do not necessarily produce identical assessments with the same assessment tool because the best choices in running the model are not always obvious. (ICES 2004:20)

Thus, though quantitative information is perceived as being of higher quality, the scientists providing the information realise this is not necessarily the case:

> Q19. In the text of the ACFM report some caveats may be addressed that still are not taken into account in the calculations. When the advice is presented in a precise way, it may thus look like the problem is not a significant problem, as the precision of the knowledge is not affected. (ICES 2004:20)

In order to insure that the advice remains 'scientific', in the sense that any assertion that something is truth can be backed up with an explanation of how it is known to be true, the scientists must provide these caveats. They further insist that DG Fisheries must read the caveats to know that the caveats are as much a part of the full advice as the tables. This reliance on qualitative explanation, however, makes it that much more difficult to reach DG Fisheries' ideal of information that is not open to various interpretations.

19.3.3 CONSIDERATION OF TECHNICAL MEASURES

The third demand for change in the way scientific advice is provided that we will examine is that scientists evaluate the effects of technical measures used in fisheries management. Technical measures include not only gear restrictions such as mesh size on fishing nets, but also measures such as area closures. The fishing industry feels strongly that scientists need to consider these measures as they formulate their advice. As related in one interview:

> Q20. Fishers and others believe that environmental changes, pollution, and **management measures, closed areas** and other things are important. These need to be described in the advice in a way that indicates they have been considered. (Commission view quoted in an interview with ICES official)

This form of accountability from the fishing industry is both directly felt and not entirely welcome, as the following exchange indicates:

> Q21. **Session Leader**: I wonder if all these technical details may not be overkill on this assessment, we can calculate the potential benefits of technical changes, but never demonstrate them. We can now do this and say 50 per cent and it will mean X, but in the past we have never observed any changes because of these technical measures…**Scientist One**: If we do a forecast and don't take into consideration these technical measures it is going to cause trouble back home, at least for us. **Scientist Two**: and when we have to take this to the North Sea Commission [Fisheries Partnership] **Session Leader**: How straightforward is it? **Scientist Two**: It is easy to put in a forecast if we know what it is, they have the multipliers for the selection patterns and they could look at a range of values. They could do a table showing how much gain you would get for the uptake, but our scenarios fall with this. **Scientist Three**: This is fine for whiting or haddock, but the expert group has said not to do this with cod. **Session Leader**: So we can refer to this expert group we were all in. **Scientist One:** It should not be ignored…I would much prefer it be looked at. Apart from temperature it will be the first thing the fishers will pick up on. (From observer notes at the WGNSSK meeting in September 2003)

Why is there such interest by the industry in technical measures? The industry feels technical measures need to be considered because these are questions they feel very directly and about which they can draw on a good deal of their own knowledge. Putting the advice in terms of technical measures translates it into a form they can directly and immediately understand and which may give results directly observable through changes in catch. It will also tell them if there will be an economic effect in terms of outlay for new gear if there is a technical measure change. Technical measures are things that fishers can do on the local scale. They are measures that the fishers understand the reasons for and can see whether and how they are having an impact. Technical measures are also politically easier than other kinds of measures (Wilson 2000). For example, requiring everyone to use a net of a certain size is something that can be seen to be implemented fairly much more easily than dividing a fishing quota among a large number of boats.

What seems clearer on a local scale, however, can seem much murkier to those who are observing from higher scales. The impacts of technical measures in the aggregate are far

from clear:

> Q22. Technical measures are not supported by scientists but are popular with other stakeholders. The technical measures are so complicated and cannot really be understood, and the change in fishers' behaviour does not seem to be great and there seems to be little change in actual selectivity in the fish catch. (DG Fisheries representative)

and

> Q23. Predictions of the impact of measures are predicated on everything else being equal, and then fishers change their behaviour in response to the measures and they mention other reasons – they are long term, they have been known not to be effective, people cheat – that predicting measures is hard. Against this backdrop you will realise that the scientists are **reluctant to base advice on non-demonstrated effects of new management measures**. (ICES official)

Despite this lack of support for technical measures by scientists, the issue continues to be raised when scientists get together to discuss fisheries advice, such as in working groups (including WGNSSK) and the ACFM meetings.

DG Fisheries is beginning to de-emphasise technical measures despite industry concerns. Many assessment scientists and managers, in viewing the results of such measures across the broad perspective of EU fisheries, feel that technical measures do not really work as a management tool. As the DG Fisheries official commented above, "the change in fishers' behaviour does not seem to be great and there seems to be little change in actual selectivity in the fish catch." This could include gear-type technical changes, but also, area closures. One such example is the emergency measures instituted before the cod recovery plan was accepted. Some believe that industry supports technical measures simply because they have greater control and can 'tweak' the systems. For example, alterations can be made to fishing gear, which close gaps and decrease the mesh size. Though DG Fisheries is slowly de-emphasising technical measures, it is still an important issue for stakeholders and as such, one issue in which scientists are made accountable and pressure is applied on them to continue considering such measures.

19.4 Conclusion

Do these few examples of impacts on scientific deliberations from stakeholder participation tell us anything about how to 'carefully institutionalise' public accountability in science for policy decisions across large scales? This paper has considered just a few aspects of the impacts of certain types of participation, and then only on the formal scientific processes involved in describing the knowledge base for fisheries management. Some tentative lessons may be drawn, but a good deal of further research and reflection is required to understand these linkages.

The most telling point that has emerged in the interactions examined here is the degree

to which demands for accountability from stakeholders are pushing the fisheries scientists to continually redefine their work to consider more and more extra-biological questions. This is pressure that works in direct contradiction to nearly everyone's expressed desire to keep the science objective and 'scientific'. The pressures, however, are very real. Their most direct expression is the need to move toward fishery-based advice, especially in mixed-fishery situations. This need reflects the reality that fisheries management itself is a social activity, empowered by politicians and implemented through agencies and organisations that work both with and within these indistinct social-technical-biological complexes we call fisheries. The scientists try to respond with complex quantitative models with immense data requirements, requirements that they are not currently able to meet, along with calls for more intensive communications between themselves and the managers to help define exactly what the managers need for particular situations.

The scientists experience this accountability both directly and consciously, and much of their time is spent discussing how to respond in a responsible, i.e. 'scientific' way. They have to do this without having a good picture of how their work is going to be used, and they experience a real fear, based on experience, that their work will be misused. This leads to acute concern with the presentation of their work. They worry about consistency beyond what is scientifically required. They spend a great deal of time writing caveats in hopes that their results will not be misused or overdrawn. They worry about the appropriate level of complexity, considering what should be included or what should be left out in the interest of simplicity. Some of this leads to strong and emotional disagreements.

The scientists constantly seek to repair the tattered boundary between what is and is not science. This science boundary, as Jasanoff (2002) and many others have pointed out, is never as clear as people would like it to be. Even in the most esoteric laboratory, objectivity is never perfect and social considerations influence results (Collins and Pinch 1998). Within fisheries science the essential link between science and management and the constant demand for scientific answers to management questions makes a clear distinction between science and not-science impossible. Scientists go to great lengths to maintain this boundary intact. The power they derive from professional prestige and solidarity that allows them to carry out their professional roles and privileges depends on that boundary being strong. This can lead to distortions in communications when non-scientific decisions are hidden within results or information is suppressed for fear of misuse. Their major tool is the caveat writing where they seek to distinguish as precisely as possible between what they are willing to call 'science' and what they are not. Managers' power relies on bureaucratic rule making, which directly depends on clear decision rules that trigger legal actions. They want scientific advice to provide this clarity, often in the form of a number on a table that does or does not exceed some predetermined threshold, while simultaneously and somewhat paradoxically they want the advice to give them flexible options to attain their policy goals. Tables surrounded by extensive qualitative caveats do not provide such clarity, creating the temptation to distort the information by pointing to the table while ignoring the caveats. Indeed, if simultaneous clarity and flexibility is the goal, complex models giving point estimates surrounded by pages of caveats seem to be almost the opposite of what is required.

In principle, nearly everyone wants the science boundary to be clear so that management negotiations can be based on realistic information about what is happening with the fish.

It is this constant need for objective information and clear decision rules about both the natural and social aspects of the fishery that makes it so difficult in practice to separate the scientific analysis from the rest of the management system. Managers want to be able to point to some kind of objective support for all their decisions, even those which are more about allocating the impacts of management than directly about how many fish are to be killed. This leads more and more to demands for science to address social realities. Adding social science activities to the broad-scale scientific deliberations would likely not be of much help. The decisions to be made are about complex biological-technical-economic-political interfaces where different aspects of the problem are appropriately approached with different methods and kinds of measurement. Hence, any cross-disciplinary 'model' purporting to provide a clear answer would likely be so abstracted from on-the-ground realities as to be useless. What would better address the problem would be allowing the science to have a more concentrated focus on biological, and ecological phenomena by creating more participatory and open institutions to address management questions in a less bureaucratic way that is less demanding of precise findings to underlie every decision.

The way participation is presently structured through large-scale lobbying and political pressure, particularly as it is channelled into bureaucratic requirements through DG Fisheries, does little to relieve the demand on science to find answers to every question. A less hierarchical approach to management would allow more locally tailored decision-making less dependent on exact findings. This could be a cooperative effort to repair the science boundary by finding "serviceable truths" (Guston 2001) that allow management to move forward without seeking great precision. Approaches involving simple indicators of ecosystem health are one good example. Third party certifiers that negotiate sustainability goals with managers of individual fisheries are another. Serviceable truths would be a more helpful way to approach the repair of the science boundary than present practice, which sometimes calls forth purely defensive reactions among scientists (and fishers) trying to maintain professional prestige.

A shortening of the chain of accountability that currently must run all too often through Brussels would allow richer communications. More direct ties between fishers and scientists would avoid the formalisation that defines too precisely what scientists should do – formalisation that leads too often to both overwrought and data hungry models on the one hand and an excessive concern with presentation and the appearance of consistency on the other. A network of fishers, conservationists, managers and scientists working on multiple problems at multiple scale levels may offer more flexible fisheries governance as well as better science. Institutionalised in **this** way, public accountability and transparency in fisheries science deliberations could make possible both a richer knowledge base and greater public support for management decisions.

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