

Stakeholder perspectives on fisheries science and modelling

Focus group discussions in Spain, Greece, UK, Denmark and Ireland

Focus group report, EFIMAS WP5

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Executive summary

To facilitate the development of better fisheries management regimes, the European Commission, in cooperation with 30 national research institutes, launched EFIMAS (Operational Evaluation Tools for Fisheries Management Options - www.EFIMAS.org), a large research project to develop a set of new tools that can simulate and evaluate both the biological, social and economical consequences of a range of fishery management options and objectives. This is a report of the work of a group of social scientists who were charged by EFIMAS with two main objectives. The first was to talk about modelling to the people who would use such models and report what they told us to the model developers to help guide their efforts. The second objective was to try to learn what we could about how models can and are being used to facilitate decision making in fisheries and elsewhere. The focus group interviews reported on here were performed in Spain, Greece, Ireland, UK and Denmark. Five stakeholder groups were targeted: the commercial fish harvesting sector; the onshore fish processing sector; women in fisheries; marine conservation groups; and local-level government fisheries managers. A total of 22 focus groups were carried out.

Models can be both cost- and time-efficient tools for decision making, and they hold a number of potentials for participation in the scientific and political processes behind management. However, most focus group participants expressed considerable scepticism towards the advice that is the scientific basis for the EU fisheries policies. Many specifically expressed scepticism towards the models used for fish stock assessments.

A core issue framing most concerns and recommendations for models and their use in policy making was related to the features of models that make science inaccessible and intangible to outsiders. Models are complex and operate in languages or jargons that are intelligible to outsiders. They reduce the complexities and amount of data and variables and come up with seemingly exact outcomes that do not reflect the multiple uncertainties and possible sources of error behind. These features of modelling may hide uncertainties. In the minds of some respondents were concerns with underlying political intentions using models to 'sell' initiatives. Models were seen to have the potential to marginalize people from the debate about the scientific validity while taking responsibility from politicians and managers and pinning it on a computer. Particularly fisheries dependent stakeholders associated modelled knowledge with theoretical deskwork, as opposed to the experience-based knowledge of fishers in touch with what happens on the ground.

Three recommendations were put forward for meeting these challenges:

First, greater access to the overall modelling process will allow stakeholders and peers to judge the validity of the model themselves and engage in the debate about their usefulness and continued development. While lack of accessibility was argued to raise scepticism towards the outcomes of models, increased accessibility was expected to improve the legitimacy of the results among stakeholders and the wider public. More specific suggestions on how to ensure accessibility include not making the models more complex than necessary, being transparent about the research process, basic assumptions, variables etc., and mediating this in ways that are intelligible to outsiders and relate to everyday life.

Secondly, fishers' participation in the overall fisheries science process was argued to be crucial. Participation was advocated with respect to the formulation of research questions, data collection and validation of data, choosing variables and formulating basic assumptions. Furthermore, some argued that as modelled knowledge cannot embrace fishers' knowledge, it should not stand alone, but be supplemented with this and other kinds knowledge in the decision making process. Particularly according to participants in the fisheries dependent stakeholder groups, fishers'

involvement was claimed to improve accuracy, enhance stakeholders' confidence in the results, ensure a more democratic knowledge base and improve fishers' compliance with the management informed by the model. Participants in the environmentalists' and managers' groups also pointed to confidence and compliance as an important objective – however, they also stressed that fishers have interests in the outcomes, and that fishers' knowledge should not be equated with scientific knowledge.

Thirdly, participants across all stakeholder groups argued that the socio-economic aspects of fisheries management should be taken into consideration, either by letting models embrace socio-economic variables or by supplementing modelled knowledge with socio-economic knowledge.

Environmentalist participants were the least outspoken about this, but still argued that fishers' involvement is an integrated part of an ecosystem based approach to management and helps in achieving compliance.

Due to the high stakes in fisheries management, the high levels of experience-based knowledge among stakeholders and the failures of EU fisheries management, fisheries science stakeholders are perhaps more alert in their approach to science than in a number of other regulatory sciences. Many participants warned about the potentially deluding effects of models – however, for what concerns the participants themselves, these features rather seemed to raise suspicion about the scientific validity and political bias. What did seem pervasive among the focus group participants was the growing development within fisheries science of new approaches to open up black boxes – that is, approaches to involve fishers, make the research transparent and open up for dialogue on for example the data collection, basic assumptions, variables and outcomes of models.

Experience in other science-based policy arenas has shown that 'participatory modelling' can allow decision makers and other interested parties to help scientists to choose the most useful simplifications of reality. This will still mean that a level of trust between scientists and lay people will have to be built up because quantitative skill in particular is always going to keep some boxes black to some people. This can certainly be overcome, however, as the public is comfortable with a division of labour based on legitimate levels of knowledge and ignorance. What is not acceptable, as is strongly revealed in these responses, is when lay people are constructed as being ignorant of things they are not and when everyone's ignorance, in the form of uncertainty, is not given the prominence it requires for decision making.

Chapter 1:

Introduction to the EFIMAS Focus Groups

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1.1 The EFIMAS project

European fisheries are not doing well at the moment. Many important stocks have declined and so have the number of fishing boats and people employed within the fishing industry. At the same time, the management and regulation of European fisheries becomes more and more complicated every year. In response to this situation, managers such as the European Commission and national authorities are hoping to develop alternative regimes that take a broader, more long-term perspective and consider not only the biological consequences of managing a fish stock but also the social and economic impacts, for instance on the fishing industry.

To facilitate the development of better fisheries management regimes, the European Commission, in cooperation with 30 national research institutes, has launched EFIMAS (Operational Evaluation Tools for Fisheries Management Options - www.EFIMAS.org), a large research project to develop a set of new tools that can simulate and evaluate both the biological, social and economical consequences of a range of fishery management options and objectives.

In the same way that a pilot might fly in a simulator before flying for real, the EFIMAS project has been a contribution to the development of software tools and simulation models that can predict and compare the outcomes of different management regimes on European fish stocks. And instead of only looking at the impact of these virtual regimes on the fish stocks, the project has also looked at the social and economic outcomes in a broader, more holistic context. This is meant to provide managers with a better idea of the consequences of a given management intervention before opting for a particular management approach.

The aim of EFIMAS has been to develop and integrate a variety of modelling tools into a robust framework within which to simulate and evaluate a range of fishery management objectives and options. In particular the project has:

- uses models to run stochastic simulations incorporating data from selected EU fisheries;
- compared a range of management options generated with the current management of the test fisheries; and

- compared the performance of a range of management options under alternative management systems and objectives.

EFIMAS has aimed at providing more reliable scientific management advice to fishery managers, including robust management evaluation tool and framework driven by numerically defined harvesting rules.

The project has contributed to the development of an evaluation framework of existing and new interactive fishery advice and management models that identify the socio-economic, as well as the biological, consequences of given management decisions.

Finally, the project is a contribution to the restoration of the somewhat shaken trust of stakeholders by incorporating a wider range of variables to illuminate the decision-making process and make it more accessible to them.¹

1.2 Objectives of the EFIMAS focus groups

The objective of the focus groups were to collect and compile reactions and comments from stakeholders (fishing organizations/industry/catching sector, NGOs, managers etc), whereby the utility and applicability of the EFIMAS evaluation framework could be assessed. The plan was to carry out 5 focus groups in each of five different countries (Denmark, Spain, England, Ireland and Greece). The evaluation of the effectiveness of the EFIMAS framework to inform the decision making process was meant to prepare the ground for the effective implementation by optimal practices for the use of complex modelling procedures in the implementation of policy.

Many strands of public policy, both within and outside of environmental governance, rely on multi-dimensional models to inform policy decisions. The role of the focus groups was to identify appropriate approaches to the use of the evaluation framework, as well as to provide feedback from stakeholders about possible implications of technical design decisions for the effectiveness in real-world policy contexts. It was thus an objective of the focus groups to enable the EFIMAS framework developers to anticipate reactions to the eventual use of the evaluation framework and to ensure - where possible - that stakeholder concerns were reflected in the design of this.²

1.3 Methodology

In the following sections we will look briefly at the general methodology of focus groups and how that methodology was applied in EFIMAS. It should be emphasised that the sections beneath contain a general description of the actual application of the methodology as well as the supporting guidelines (Annex 1) and presentation (Annex 2) were continuously improved during the project as well as adapted to the specific and changing contexts of the focus groups.

¹ The text in this section is a modified version of the introductory text from the EFIMAS project website: www.EFIMAS.org.

² The text in this section is constructed on the basis of sections from the relevant work package description from the Technical Annex of the SAFMAMS contract with the Commission.

1.3.1 Focus groups in general

Focus groups are an accepted format for social research (see Merton *et al.* 1956; Krueger 1988; Morgan 1993). As Glitz *et al.* (2001) report:

The focus group is a qualitative research technique, originally developed by social scientists, to gather data on the opinions, perceptions, knowledge and concerns of small groups of individuals about a particular topic. The technique involves questioning and listening within the small group setting, to allow participants to describe their experiences in their own words. These words constitute the qualitative data which, when organised and analysed, can help in planning, decision-making, programme evaluation and model development.

Thus, their purpose is to improve the knowledge of the research team about a particular subject, and to improve their understanding of the perspectives of focus group participants.

A second important aspect of focus groups is that they feature interaction between participants. Thus they produce group data, as well as individual perspectives. The importance of the interactive aspect of the focus group methodology is emphasised by Morgan (1996), who perceives interaction as a source of data as being one of three key characteristics of focus groups. The others being data collection and the key role of the researcher in precipitating discussion.

A strong lead was taken within the EFIMAS focus groups from focus group research conducted by Steven Yearley, reported in his article, 'Computer models and the public's understanding of science: A case-study analysis' (2001). This was due to commonalities between the purpose of the EFIMAS focus groups – to gain feedback from stakeholders regarding the EFIMAS modelling framework – and those of Yearley's own groups – which was to examine stakeholder views of a computer model for air quality in use in Sheffield in the UK. Yearley's (2001: 851) description of the focus group methodology is as follows:

The research was conducted using group interviews akin to focus groups, a well-established research methodology which has been applied and developed within social and market research for more than 30 years... As is well known, the aim of the focus group is to allow the participants to develop and display their own understandings and definitions centred around core themes introduced by the facilitator. The facilitator may ask questions to encourage group discussion, but in general his/her input is secondary to that of the invited participants. Analyses of the subject under discussion are formed by the individuals in the group and through their interaction with each other. The discussion is recorded, and transcripts form the basic material for analysis.

A further common aspect of these two studies, is that they each seek to address underlying issues relating to public perceptions of science and computer modelling – what Yearley (2001: 845) describes as PUS or public understanding of science.

1.3.2 Focus group participants

According to Burrows and Kendall (1997), focus group participants are selected on the basis of applicability, rather than representation. For example, Richardson and Rabiee (2001), maintain that focus group participants should be selected on the basis that they would have something to say on the topic, have similar socio-characteristics and would be comfortable talking to the interviewer and each other (Richardson and Rabiee, 2001).

Thus, the decision was taken to draw participants for the EFIMAS focus groups from interested parties, who, in many cases, work closely with each other, and were from the five identified stakeholder sectors – the catching sector, onshore fisheries sector, women in fisheries, fisheries managers and environmentalists. The aim was to have 5-9 participants in each focus group, with each group being from a different sector of fisheries.

1.3.3 Focus group structure

The purpose of focus groups is to give participants space and opportunity to speak about and discuss issues on their own terms and using their own language. Thus, contributions on the part of the research team should preferably be kept to a minimum, with topics introduced but not strongly structured or guided. For the purposes of the EFIMAS focus groups, it was necessary to have some intervention during the focus group process in order to introduce scientific information regarding the EFIMAS modelling framework. Thus, where possible, each focus group was conducted using a team of three researchers, who played different roles – focus group leader, second leader and scientist. The respective roles of these three team members are described in Box 1.1. In practice several of the focus groups were, however, carried out without a second leader.

Box 1.1 – Focus group researcher roles

Focus group leader

Gives the introduction, asks the questions, and steers the proceedings.

Second leader

Makes sure the recorder is working, takes enough notes so that the recording can be easily transcribed; and, most importantly, watches out for interesting threads in the discussions that should be followed up on and then asks the appropriate questions. This is necessary because the leader will be focused on the guidelines and may or may not catch an interesting comment.

The scientist

Presents the EFIMAS model in Section Five below; answers any technical questions that come up in subsequent discussions; asks the questions in the final part 6.

The focus groups commenced by introducing the EFIMAS project and the concept of focus groups. Participants were assured of their confidentiality in this process and their permission was requested to record the sessions. A common set of guidelines - although slightly adapted to each country and stakeholder group - was used to conduct each focus group, structured into six key issues, which the participants were gently prompted to discuss. These were: 1) perceptions of science; 2) perceptions of fisheries science; 3) perceptions of fisheries management and the use of science therein; 4) computer models; 5) the EFIMAS modelling framework; and, 6) scientists' questions. Annex 1 features the full standard focus group guidelines. The focus groups began, consequently, with fairly broad questions to explore what the respondents' initial understandings of science were and then along the way the focus narrowed in on reactions to scientific models and the EFIMAS evaluation framework.

Sections 4 and 5 involved the presentation of a series of PowerPoint slides, by a scientist involved in computer modelling, detailing, in the case of '4) computer models', a fairly basic description of what the research team mean by scientific or computer models. This was followed by a short discussion in each case of what participants understand by the term 'model'. Following on from this, in the case of '5) the EFIMAS model', slides provided an explanation of the structure of the EFIMAS framework, the difference between this approach and more traditional stock assessment modelling, and examples of bio-economic applications of the framework. Again, a discussion of the EFIMAS approach and its possible applications followed these slides. For reference, the standard PowerPoint slides are included in Annex 2.

1.3.4 Reporting

All focus groups were recorded and transcribed. Based on the transcripts, the information was predominantly by the focus group leader analysed and compiled into a report on the findings for each of the five countries. These reports constitute chapter 2-6. With a particular focus on modelling, a synthesis on the main findings was then worked up. The synthesis can be found in chapter 7.

1.4 Key findings

Before we go on to the case reports, we sketch out briefly the headlines of the synthesis. As the objective of the focus group discussions are to inform the development of the FLR modelling framework, we here focus on stakeholder perceptions on modelling.

Models can be both cost- and time-efficient tools for decision making, and they hold a number of potentials for participation in the scientific and political processes behind management. However, they also add new difficulties to the relation between science and the public. Difficulties that must be taken into account if models are not to be an obstacle for stakeholder involvement and for the public legitimacy of the management informed by them. While most focus group participants expressed considerable scepticism towards the advice laying the scientific basis for the EU fisheries policies, and while many specifically expressed scepticism towards the models used for fish stock assessments, the study also shows some urgency in dealing with these challenges in an EU fisheries management context.

A core issue framing most concerns and recommendations for models and their use in policy making was related to the features of models that black box the research process – that is, make them inaccessible and intangible – to outsiders. Models were among other things said to be complex and to operate in languages or jargons that are intelligible to outsiders. On the other hand they were claimed to reduce the complexities and amount of data and variables and come up with seemingly exact outcomes that do not reflect the multiple uncertainties and possible sources of error behind.

These features of modelling were again claimed to make models useful tools for manipulation in policy making, for example by hiding uncertainties and underlying political intentions in order to 'sell' an initiative, by marginalizing people from the debate about the scientific validity, and by removing responsibility from politicians and managers to the computer.

Finally, particularly fisheries dependent stakeholders associated modelled knowledge with theoretical deskwork, as opposed to the experience-based knowledge of fishers in touch with what happens on the ground. Hence, it was argued, models exclude the latter kind of knowledge from the research process.

Three recommendations were put forward for meeting these challenges: First, the accessibility of the modelling process, e.g. the data collection process, variables and basic assumptions, was claimed to be important. Access to this process, it was argued, will allow stakeholders and peers to judge the validity of the model themselves and engage in the debate about their usefulness and continued development. While lack of accessibility was argued to raise scepticism towards the outcomes of models, increased accessibility was expected to improve the legitimacy of the results among stakeholders and the wider public. More specific suggestions on how to ensure accessibility include not making the models more complex than necessary, being transparent about the research process, basic assumptions, variables etc., and mediating this in ways that are intelligible to outsiders and relates to everyday life.

Secondly, fishers' participation in the process was argued to be crucial. Participation was advocated with respect to the formulation of research questions, data collection, validation of data, choosing variables and formulating basic assumptions. Furthermore, some argued that as modelled knowledge cannot embrace fishers' knowledge, it should not stand alone, but be supplemented with this and other kinds knowledge in the decision making process. Particularly according to participants in the fisheries dependent stakeholder groups, fishers' involvement was claimed to improve accuracy, enhance stakeholders' confidence in the results, ensure a more democratic knowledge base and improve fishers' compliance with the management informed by the model. Participants in the environmentalists' and managers' groups also pointed to confidence and compliance as an important objective – however, they also stressed that fishers having interests in the outcomes, and that fishers' knowledge should not be equated with scientific knowledge.

Thirdly, participants across all stakeholder groups argued that the socio-economic aspects of fisheries management should be taken into consideration, either by letting models embrace socio-economic variables or by supplementing modelled knowledge with socio-economic knowledge. Environmentalist participants were least outspoken on this, but among other things argued that fishers' involvement is an integrated part of an ecosystem based approach to management and also helps compliance.

Due to the high stakes in fisheries management, the high levels of experience-based knowledge among stakeholders and the failures of EU fisheries management, fisheries science stakeholders are perhaps more alert in their approach to science than in a number of other regulatory sciences. Many participants warned about the potentially deluding effects of models – however, for what concerns the participants themselves, these features rather seemed to raise suspicion about the scientific validity and political bias. What *did* seem pervasive among the focus group participants was the growing development within fisheries science of new approaches to open up black boxes – that is, approaches to involve fishers, make the research transparent and open up for dialogue on for example the data collection, basic assumptions, variables and outcomes of models.

For a more extensive version of the key findings see chapter 7 – in the following chapters 2-6 we go through the country cases one by one.

Chapter 2: Report from the Northeast English Focus Groups

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2.1 Introduction and methodological considerations

A series of five focus groups were held in York during August 2006 to obtain feedback from fisheries stakeholders in northeast England on the EFIMAS modelling framework. This was the pilot run for the following focus groups being held in four other countries across Europe. A focus group meeting was held for each of five key stakeholder sectors. These were the catching sector, onshore fisheries sector, women in fisheries, fisheries managers and environmentalists.

The report details the discussions that took place between participating stakeholders within the focus groups. In doing so, the transcribed text reflects corresponding responses to key questions posed that formed the focus groups structure. The findings also highlight some cross-cutting themes which emerged during the process as being significant across the range of participants. Thus this report outlines the results relating to key issues. These are: 1) perceptions of science; 2) perceptions of fisheries science; 3) perceptions of fisheries management and the use of science therein; 4) perceptions of modelling; 5) the EFIMAS modelling framework and its potential applications. Conclusions summarise the common themes that emerged from the focus group process. A brief description of lessons learned during the pilot process is included in Annex 3.

2.1.1 Focus group participants

More than a hundred potential participants were approached by both email and telephone. Interest in the project was significant. However, many of those interested were unable to attend. In particular, several catching sector participants withdrew at late notice due to an unexpected availability of salmon, *Salmo salar* L., in north-eastern waters. Overall 26 stakeholders attended a focus group. Table 2.1 details the breakdown of stakeholders in each group.

Table 2.1: Details of focus group participants

Stakeholder group	Number of participants
Environmental interests	7
Fish-catching sector	3
Fisheries managers	7

Onshore sector representatives	5
Women in fisheries	4
Total	26

2.1.2 Data management and analysis

All five of the focus groups were recorded using audio equipment – digital and mini disk recorders. Secondary notes were also taken in case of technical problems arising with the recordings. After each of the focus groups had been conducted all members of the research team discussed the strengths and weaknesses of each session and made adjustments to the following one. The transcripts of the focus group discussions form the data for analysis on which this report is based.

Following transcription, the data was coded using *Nvivo* software. This computer software enables data to be organised according to a set of nodes, which are derived from the data itself. This analytical process enables key themes to emerge and helps to highlight the similarities and differences between the different groups, thereby enabling conclusions to address all key issues inherent in the data.

2.2 Perceptions of science

<p>General Perceptions</p> <ul style="list-style-type: none"> • Science is an objective analytical process used to answer questions about and increase knowledge of a given subject. • Science as a discipline holds intrinsic credibility. <p>Key Problems</p> <ul style="list-style-type: none"> • In practice, science does not always live up to the ideal of objective analysis. It can be subjectively conducted and is often subjectively received. • Uncertainties in the data can undermine the accuracy of scientific conclusions.
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Focus group participants were asked about their perceptions of science in general. This topic brought out views from participants and discussion between them regarding the science process, the purpose of science, key characteristics of science, and factors affecting the quality of science.

It is worth noting that participants were less comfortable talking about science in general, as opposed to fisheries science. Thus, there was, in the cases of those participants without formal scientific training (approximately two thirds of participants), the sense that ‘science’, rather than ‘fisheries science’, is somewhat outside their, and the general public’s, direct experience. This is supported by the following argument made during the Environmental Interests focus group: “...people just perceive science as being beyond them a lot of the time, a lot of the general public. So it’s difficult, in a lot of cases people don’t try and understand. That communication doesn’t exist as

well from the perspective of the general public because sometimes I think they just perceive it as being too much to sort of get their head round” [UK 2006].

Further, the semi-structured nature of the research process meant that participants had some freedom to interpret questions themselves. As a result, when asked ‘what is science to you?’, the amount of time devoted to perceptions of science, as opposed to fisheries science, varied somewhat. Some groups – notably Managers and Environmental Interests and, to a lesser extent, the Onshore Sector – spent some time addressing this question, while others immediately launched into a discussion of key issues relating to fisheries science. For these stakeholders the question ‘what is science to you?’ was instinctively interpreted as being about ‘fisheries science’.

2.2.1 The science process

Science was conceptualised by some participants – in three of the groups: environmental interests, managers and the onshore sector – as being an ‘analytical’ process, method or approach. For example, “At any point in time where you have to perform any kind of analytical task, you are using, to some extent, a degree of science in whatever you do” [UK Environmental Interests 2006]. This is a fairly broad and open definition of science which suggests it has wide applications and can play a role in a variety of contexts.

Other groups did not refer to the ‘analytical process of science’ as such in response to the question ‘what is science?’ However, there was reference made to analysis during all the five focus groups. For example, Managers referred variously to risk analysis, cost-benefit analysis, population analysis and probability analysis; the Women in Fisheries group referred to statistical analysis; and the Catching Sector made reference to mixed species analysis and logical framework analysis. One participant in the Environmental Interests focus group, who did have a science background, described his perception of the science process in detail:

It’s a way of tackling problems that strictly speaking should follow a fairly well-defined process, and in that well-defined process you should be able to set questions and objectively test those. And if you can set those questions as proper testable hypotheses, and then you set either a recording scheme or an experimental scheme – a field or laboratory experimental scheme – to get the right sort of data...objectively. And if you can test those hypotheses you can then answer certain questions. And, in theory, those questions – we won’t know everything – will lead to other questions. So, it’s a cyclical process – get your ideas, formulate your hypotheses, test them in some way, answer them by getting information, leading to formulating other questions. [UK Environmental Interests 2006]

2.2.2 The purpose of science

This description also highlights the participant’s perception of the purpose of science – “a way of tackling problems” and testing hypotheses – and some characteristics of the analytical science process – objective, dynamic and cyclical. In contrast, a participant in the same focus group with no direct scientific experience described his perception of science as:

From a layperson’s point of view I regard science as a means by which we can understand the world in which we live, by the way in which we organise the means to do it, I suppose. It differentiates between the spiritual and the metaphysical.

The comments made in the focus groups on each of these aspects of science – purpose and character – will now be addressed.

There were differing perceptions of the purpose of science expressed. A commonly shared conceptualisation relates to science as being the pursuit of knowledge or understanding: “If you want to understand something, you don’t necessarily have to investigate it but somebody else has. So, science is pretty much in that investigation, using principles of science – biological, chemical, physical, whatever” [UK Onshore Sector 2006]. This statement also reflects on the importance of science and its necessity. And, again, the concept of “investigation” reflects back on the idea of science as a process. Further, it was emphasised in the managers’ group that knowledge is insufficient. It should instead be “the best available knowledge” [UK Managers 2006]. This is an important distinction as it reflects the view that it is not possible to know everything. In this sense, then, science is also regarded as limited in scope.

However, this perception of the purpose of science was also perceived by some as encompassing the use of knowledge. This becomes more important as we begin to think about participants’ perceptions of the use of science in fisheries management (discussed below). For example, a participant in the Environmental Interests focus group described science as, “...an approach to getting information and using information”. The following statement made during the managers’ group brings together the ideas of science being an analytical process, that gathers knowledge and adds a use dimension to its purpose – decision-making: “Science is a term which describes a process whereby...the knowledge of systems are systematically analysed, and that knowledge of that particular subject are then established; and you can then use that knowledge in the context of decision-making...”

And, indeed, such knowledge or information is broadly conceived. The same environmental interests participant who referred to the purpose of science as obtaining and using information, went on to maintain that, “...it doesn’t really matter whether it’s social science or whether it’s natural sciences, political sciences, or economic sciences, it’s still an approach to getting information.”

2.2.3 Characteristics of science

Other characteristics of science, in addition to this multi-faceted understanding of the term and of the reach of science, were also raised by participants. Characteristics that both endorsed the value of science and expressed caution thereof are described. One of these has already been touched upon – ‘objectivity’. This was particularly discussed within the environmental focus group, where, for example, it was maintained that science is “...a method of looking at things analytically, objectively, rather than subjectively”, of objectively testing questions and of gathering data objectively. It was maintained that this objectivity is important to ensure that findings can stand up to scrutiny [UK Environmental Interests 2006].

However, the inherent objectivity of science was not seen as entirely acceptable by all participants in this group. One asked: “Have scientists themselves proved that? Suggesting that scientists somehow have some claims to objective truth?” [UK Environmental Interests 2006]. The response from another participant (one with scientific qualifications) was that “Pure science should be objective”, but that

its use is not necessarily so [UK Environmental Interests 2006]. For the most part, other groups did not discuss the importance of objectivity regarding science itself, however, in a similar vein, in the managers' group there was an interchange regarding 'factual knowledge', with the implication that "observable facts" are the basis of science:

M1¹: I think that science is basically factual observed knowledge but I recognise that a lot of information which is basic, which you can perhaps called social science at the moment is not necessarily factually based, it's based on, well, it's based on group assessments or statistical manipulations of information into a computer rather than objective-based numbers.

M2: It's largely for scientists not to give an opinion unless he has facts on which to base that opinion... A scientist will give advice where there is a requirement to give advice and the facts are insufficient and he will base that advice on as many facts about that subject as are available – hence the precautionary approach. [UK Managers 2006]

In addition, the Managers' group also highlighted the concept of objectivity in relation to modelling, which will be discussed later.

A second characteristic, emphasised by participants, was the inherent uncertainties of science and its outputs as depicting the real world. According to one fisheries manager, "It's the best available information. Which means it's not the whole picture of the world; there's an enormous amount of uncertainty in it; it will change over time." Thus, science is perceived to be dealing with dynamic, rather than static, subjects, our knowledge of which is inevitably limited. One environmental participant also expressed the view that science itself is not a static concept, but instead is societally determined and linked with context: "I think it also reflects where we all are. A hundred years ago there was a different perception and in another hundred years science will have developed and be on a different philosophy, a different paradigm – I'm not entirely sure which one" [UK Environmental Interests 2006]. Similarly, for one fisheries manager, our perceptions of what constitutes good quality in science are also not static: "And the problem is that man being what he is that man is forever seeking to further analyse scientific results just to check that it works, to see that it's correct. So what is good science today may not be good science tomorrow" [UK Managers 2006].

2.2.4 The quality of science

The question of what can be described as 'good' science and 'bad' science was put to participants during the focus groups. For some, this question raised issues of how robust and objective science is. This is summed up by a fisheries manager: "...generally, your definition is, science is the best available information we can get about a given subject and almost all the science we have is good science." This was endorsed by the following comment, stressing data-dependent nature of science, also made during the Managers' focus group: "The other thought about good science and bad science is that science is only as good as the information that is fed in to deliver your, a result" [UK Managers 2006]. This was reinforced by the following comment made during the environmental interests group: "There are a lot of examples of bad science – that is where someone has gone to do an experiment – and we've all done this – done an experiment on something but the statistics, or

¹ M1 and M2 refer to two participants in the Fisheries Managers Focus Group

your date doesn't bear up to scrutiny, that's bad science" [UK Environmental Interests 2006]. The theme of data-dependence recurred throughout the different topics covered during the focus groups.

However, the issues of 'good versus bad' science also solicited a certain amount of discomfort with the idea that good and bad science can be easily defined. Instead, many participants emphasised that such judgements about science are inherently subjective and will often be determined by the audience of science and scientific findings. For example, in the managers' group: "...this is about subjectivity of whether we think it's good or bad. Science should be basic information. Different people will have a view of it, of whether it's acceptable or not. And if it's not acceptable it's bad, and if it is acceptable it might be good." In this interpretation, science is perceived as good if its findings are what we want to hear. In addition comments were made with the environmental interests group about general disillusionment with science resulting from communicative gaps and a failure to democratise the science process, particularly with regard to setting objectives.

Other key aspects relating to the quality of science that were identified by participants included a sense that science is expensive and should therefore be conducted with care: "It's important to be robust in science – when you say good science that would mean robust science. If we were doing a trial we would make sure it would be robust before we do it. So we'd take enough samples, for instance, or we'd use the right methodology, that's how it works. So before you engage you need to make sure...that it's going to stand up at the end of it. If you only half do it you're wasting time and money" [UK Onshore Sector 2006]. Equally, a lack of investment can undermine science: "I sometimes think that scientists have suffered from being inadequately resourced so the results they've actually received through the research that they've done have been inadequate to the task they've been asked to perform" [UK Environmental Interests 2006]. This was followed up by the concern that such science is, nevertheless, used: "Those results have been used politically to the detriment of other people" [UK Environmental Interests 2006].

Alongside concerns about the quality of science, the view that science is seen to have intrinsic credibility was also expressed – "science, creating data, is seen as legitimate" was how one participant in the women in fisheries group expressed this [UK Women in Fisheries 2006]. However, while this indicates that science as a discipline is well regarded, it also implies an inherent danger that scientific findings can be taken at face value by the general public. As one member of the onshore sector group put it: "If you're looking to get some credibility, science is a valuable tool there" [UK Onshore Sector 2006].

2.2.5 Conclusion

This discussion of perceptions of science held by participants in the focus groups has indicated that there was a relatively sophisticated understanding of the process of science, the potential usefulness of science and its inherent value. However, there was a strong indication that science is not regarded as infallible. Given the connection of all the participants with fisheries, these perceptions must be coloured to some degree by their experience and knowledge of the use of science in fisheries and its management. The two subsequent sections address these issues in turn.

2.3 Perceptions of fisheries science

General Perceptions

- Fisheries science is primarily understood as meaning traditional fish stock assessments.
- The credibility of findings in fisheries science is partly dependent on the credibility of the institution or individual responsible for carrying out research.
- Non-stock assessment science in fisheries is more likely to be perceived as being 'good'.

Key Problems

- Fish stock assessments are perceived as having flaws in both scope and methodology which undermine the credibility of fisheries science and there are institutional obstacles to effective fisheries science.
- There is inherent uncertainty within the marine environment and general awareness of this creates scepticism among all sectors regarding fisheries science and the level of certainty that can be attributed to findings.
- The marine environment is dynamic and yet fisheries science is not flexible enough to respond to change quickly.

Recommendations

- Fisheries science needs to be broader than just fish stock assessments.
- Fisheries-Science Partnerships can improve both the quality of fisheries science and relationships between the fishing industry and scientists.

Discussions of fisheries science during the focus groups covered many of the same issues and concepts as the consideration of science in general. However, participants expressed more certainty about their views relating to fisheries science, than they had in the preceding discussion, and furnished their comments with many examples to illustrate their views. The implication of this is that fisheries science very much affects and impacts upon the lives of all the sectors consulted within the focus group process. This is backed up by the following statement from a participant in the onshore sector focus group: "...for such a small industry – 10-12,000 catchers, 20,000 employed in processing – I can't think of another industry (certainly in the UK let alone around the world) that is so heavily surveyed, and so heavily talked to by scientists, social scientists etc. etc." [UK Onshore Sector 2006] Key issues in this section include traditional conceptualisations of fisheries science and their methods and scope, broader conceptualisations of fisheries science, concerns regarding fisheries science and recommendations for how fisheries science can be improved.

2.3.1 Traditional conceptualisations of fisheries science

Within discussions in all five groups there was a strong focus on the traditional conception of fisheries science as fish stock assessment. For example, one fisheries manager [UK 2006] maintained: "Fisheries science does encompass actual assessments of fish stocks directly...as well as using fishermen's information and catch returns." This has been the main form that fisheries science has taken within the context of the North Sea to date, and it has been employed to determine total allowable catches (TACs) on all key species since the introduction of the Common Fisheries Policy in 1983. The incipient debates regarding the positive and negative aspects of fish stock assessments revealed the essentially contested nature of the validity of fisheries science, and of fish stock

assessments in particular, from the perspective of participants, based on their experiences. The problems associated with fisheries science by some participants is illustrated by the following comment made by a member of the catching sector focus group: “In a nutshell the science should be accurate and be delivering use to the industry, which the science in the North Sea is clearly not” [UK Catching Sector 2006]. Discussions of fisheries science also highlighted recommendations for improvements to fisheries science proposed by participants.

A key concern regarding the validity of fish stock assessments related to the process by which they are conducted. Two central issues here are, first, the methods and, second, the scope of fisheries science. Concerns regarding methods included problems related to the adequacy of sampling techniques. These were raised mainly by those who work within fisheries and have practical experience, or at least second-hand knowledge, of the mechanics of deploying fishing gear at sea. The inadequacy of the scope of fisheries science was raised by a much wider range of focus group participants and included such issues as the need to widen fisheries science beyond fish stock assessments and the knowledge or information associated with those. A recommendation to emerge from discussions of each of these aspects – methods and scope – was the need for a greater involvement of the fishing industry in fisheries science.

The perception among participants was that the traditional, and entrenched, approach to fish stock assessment has involved two key data-gathering methodologies – sampling using research vessels and the collation of landings data – each of which feed into a process of stock projection using stock assessment models. This process has been the exclusive task of fisheries scientists, rather than any other actors in the fisheries field. There was a strong belief from several participants that there is intrinsic unreliability within the stock assessment process. For example, a member of the catching sector stated:

...the gear research vessels are using...is incapable of catching fish. Because of that it cannot produce a meaningful time series through the years which it's spread. We knew the gear was not right two or three years ago, and were assured by scientists that nothing had changed, it was the same gear that it always has been. Then we discovered, or we got an admission from the scientists that it had in fact changed in 1992 and that is when the assessments started diving. The problem with the gear is that they have a configuration which is decided in Brussels. And they're not allowed to change it. [UK Catching Sector 2006]

Since that time, members of the industry have been invited onboard research vessels by CEFAS to observe sampling practices and to have the opportunity to offer advice. According to some focus group participants, the outcome of that process was that re-rigging the gear in line with the fishermen's advice enabled the research vessel to catch far more fish. A member of the women in fisheries focus group [UK 2006] described this: “Once they towed properly, with the gear properly rigged, at the right speed – or near as the right speed as the CEFAS Endeavour could do – the boat caught fish. But they couldn't use that data because it wasn't in the ICES guidelines. The gear wasn't rigged to ICES specification. And this is what builds up the distrust and the lack of confidence on the part of the catching sector.” As such, the rules for rigging research sampling vessels remain the same. As a member of the women in fisheries focus group pointed out, “within the fishing community, it's a widespread feeling”, that “the trawls that they're doing, they're not setting the gear up right, they're not doing the right speed, they're not fishing the right places for it to actually mean anything” [UK

Women in Fisheries 2006]. Another member of the same group attributed this situation to institutional constraints: "...I think the problem lies with the doctrine that ICES are putting out, how they're telling you to go and do your surveying and sampling. So the model if you like is wrong there and it's had a knock-on effect down the line" [UK Women in Fisheries 2006].

The catching sector group also highlighted the example of *Nephrops* TV surveys in the Irish Sea which they see as having ignored the role that tides play in the availability of *Nephrops*: "When the tides were factored into the equation it was actually 2 or 3 times the spawning stock biomass actually coming through the standard assessment process" [UK Catching Sector 2006]. Further, another member of the catching sector highlighted other factors that he believed scientists to have ignored:

...we've found their practices disconcerting. Now there was a degree of defence on that...question of time series: they've fished every week in November in this particular spot for the last thirty years using this gear and this gear configuration. And the fact that they were doing that was a defence. We started raising issues: three years ago the state of the tides, which has a lot to do with catching, was entirely different than it is this time, have you taken that into account? No. Have you taken into account sea temperatures, weather conditions? No. Do you realise that the fish is shoaling differently, there's different ways of catching it now? And whether they were aware of that or not they would disregard it because they felt that to adopt new fishing techniques which demonstrate a high perhaps sustainable sustained catch per unit effort was inappropriate to the way in which their modelling of the science had been set up forty years previously. [UK Catching Sector 2006]

A member of the women in fisheries focus group also reflected this scepticism, stressing that:

The problem that we've got is that for many, many years we've considered the science to be unreliable. Through on board observers on survey vessels we've proven the method of collecting data is unreliable. But unfortunately because of the constraints of ICES we're unable to change anything. So consequently that side of the science is extremely unreliable and of no benefit whatsoever to the industry. [UK Women in Fisheries 2006]

The overall lack of credibility afforded to the stock assessments by industry is characterised by the following comment by a member of the Onshore Sector: "I think...there is clear evidence that the scientific methodology used for stock assessments is greatly flawed. And therefore people are basing assumptions, and therefore the economic impact of that assumption – job losses or whatever it may be – on something that is not proven" [UK Onshore Sector]. As this quote illustrates, the science and its associated problems, is seen as having a significant and potentially detrimental influence on the fleet and on onshore sectors of the fishing industry.

One participant from the onshore sector indicated that although the findings of fisheries science carry with them inherent uncertainty, the science produced by institutions such as ICES and Fisheries Research Services (FRS) in Scotland is the most credible option:

...you've got a system which has evolved over the last sixty years and the methodology seems to be pretty sound, there are some variables that are not accounted for, and yes we do give them a lower risk rating. But overall, there is a risk going with this information, because they can't catch every fish, they can't measure every fish. They're taking a sample, and they're extrapolating from that sample with what knowledge they know of the rest of the stock, and that may or may not be right. [UK Onshore Sector 2006]

This view was backed up by fisheries managers who agreed that publicly-funded or independent scientists are more likely to produce reliable and robust science than would scientists employed by a particular party – whether that be industry, environmental organisations or any other interest group – and who have a vested interest in the findings.

The scope of fish stock assessments was also called into question during the focus groups. In particular, members of the catching sector and women in fisheries focus groups raised the question of the failure to address causes of stock mortality other than fishing. The following statement made by a participant in the catching sector group sums up this perspective:

You know, the extent to which they can fully take into effect another form of fish mortality such as warming the seas, other sources mortality such as seal predation and pollution, and mixed species analysis...We in the fishing industry, at least, are not fully convinced that stock assessment is...sufficiently scientific and rigorous for us to necessarily bear the short-term pain, which seems to be ever-enduring as the years roll by as a consequence of those results. [UK Catching Sector 2006]

Similar concerns were expressed by a participant in the women in fisheries focus group who provided anecdotal evidence of apparent changes in species composition in the North Sea resulting from climate change – for example, squid becoming a year round, instead of a summer, fishery; and an incidence of a fisherman catching a swordfish off the Northumberland coast. This participant also emphasised the importance of considering the effects of other marine activities, including aggregate dredging, oil and gas, pipelines and windfarms and maintained that:

...science can be too biased towards just one effect on fish stock mortality. Everything seems focused, all the publicity you hear about – this business with supermarkets wanting to buy sustainable fish etc. etc. – everything comes down to one thing: fishermen doing the damage. And this is what we need to move away from. Science seems to now have tunnel vision, that it is only the fishermen affecting fish stocks. And the plain and simple fact is now there are not enough fishermen left in the North Sea to have an effect on fish stocks. [UK Women in Fisheries 2006]

2.3.2 Broader conceptualisations of fisheries science

Following on from these concerns about the narrow scope of traditional fisheries science, other practices, approaches and disciplines that come under the broader heading of fisheries science, were also discussed by participants. For example, a participant in the Environmental Interests focus group argued that:

It's more than just the biological side of it. It's also the technical side of fishing, boat design, net design. So it goes well beyond the immediate assumption that it's just fish; it's got to be fish, technology, oceanography, anything where there's...even, you could say, develop it into the landside of processing the fish to ensure best quality products. So, everything, not just the small, little bit of it. [UK Environmental Interests 2006]

While another participant in the same group took a similar view:

If you chop off science in its most narrow of terms – that is the strict biological aspects that relate to the resource that you're using: stock size, reproduction rates, growth rates – I think if you look at that, then you say 'that is not enough.' You would say...fisheries science (is) actually all the other things – technology, the legal side of the scientific approach...social, economics and all those – then...fisheries science in the true sense of the word has to build all those other things (in). Even at the strict natural science level, people would often get hung up on fisheries science being at the

community level – population, movement of population and communities or species. Of course now we know that fisheries science is much wider than that – fisheries science goes through the genetic aspects all the way through to the ecosystem aspects. So the problem is where you say what our perception of fisheries science is. Fisheries science in the true sense of the word should actually mean what we can call a toolbox – we have a whole set of tools at our disposal and we use all of them. [UK Environmental Interests 2006]

Further, more examples of ‘good’ fisheries science were raised relating to non-stock assessment style scientific research and application. For example, one fisheries manager [UK Managers 2006] described the case of the southwest mackerel box as having “been seen to work” to protect a key nursery area and as having “contributed to strengthening fish stocks”.

This sense that fisheries science is inadequate to the task of producing valid estimates of fish mortality and stock status, underpinned by concerns regarding its methods and scope, inevitably undermines the credibility afforded to the outputs of this process. This, in turn, impacts upon the credibility of management decisions associated with fisheries science findings, an issue we return to in the subsequent section of this report.

2.3.3 Concerns regarding fisheries science

A key outcome of these discussions about the methods and scope of fisheries science was the general sense that there is scepticism and uncertainty relating to fisheries science among participants from all sectors. For example, a member of the onshore sector group [UK 2006] stated: “It’s very difficult to take seriously sometimes as well, because you’re always wondering what has generated this particular piece of science. Soon you become very sceptical.”

Such scepticism can also be related to the question of uncertainty raised during the ‘what is science?’ part of the focus groups and was expressed particularly by industry participants who question the validity of scientists’ conclusions about the state of key commercial fish stocks in waters they fish. For example, a member of the onshore sector group compared fisheries science with agricultural science with regard to uncertainty:

You can’t pin it down. Soil samples are simple. You take a sample from a field, it doesn’t move. The sea is so dynamic and the variables are uncontrollable and probably poorly understood as well. So if you have variables say in iron samples which you do, then it undermines what you’re trying to do. Therefore, the science itself, the biological stock assessment, whatever, it’s very difficult to have the certainty that maybe the managers are looking for or the fishermen are looking for or whatever. So you have to accept that this has to be taken with a pinch of salt. [UK Onshore Sector 2006]

Participants from other sectors also identified uncertainty in science as being important. For example, a fisheries manager maintained that:

...I think the problem with the marine environment is that it is just so dynamic. And can you achieve accurate science? Probably not. It is a very, very difficult environment to work in. There’s so many factors, environmental factors, biological factors which are impossible to account for. [UK Managers 2006]

Additionally human factors are considered to contribute to uncertainty. Just as with perceptions of science in general, data-dependence was regarded by participants as a key issue within fisheries

science. For some, a heavy dependence on fishermen to provide data leaves science open to a high degree of uncertainty and one fisheries manager pointed out that:

...marine scientists in particular are dependent on data which they collect, which is either given voluntarily or statutorily from the stakeholders, from the fishermen. Other areas of science, I would imagine, the scientist is responsible for the integrity of his experiments of his data collection. With fisheries science, the scientists as I understand it use the information which they gather from the fishermen and there must surely be perhaps a question mark over the validity of that data. Particularly if the fishermen realise that data is going to impact either good or bad on their opportunity of earning a livelihood. I think that that's possibly where fisheries science differs slightly from other forms of pure science. [UK Managers 2006]

A further concern regarding fisheries science was expressed by a participant in the women in fisheries focus group who emphasised the need to integrate scientific research better: "There doesn't seem to be joined up science. There may be a whole lot of projects going on but nobody's bringing the whole lot together..." [UK Women in Fisheries 2006]. However, awareness was also expressed by participants that there are problems with the inclusion of other forms of data and knowledge. Presently, fisheries science is dominated by the single-stock stock assessment, as embodied by the International Council for the Exploration of the Seas (ICES) as an institution. Awareness of how problematic this is caused one member of the women in fisheries group to comment: "...if we take a broader view within science it hopefully would make more sense. But how we would then transmit that through ICES and back into...you know...that's difficult" [UK Women in Fisheries 2006]. This sense of inflexibility is also reflected by the following comment from a member of the managers group who expressed the view that fisheries science is slow to respond to external changes: "There are occasionally some problems, institutional problems, about the way the science is organised, which get in the way. For example, I'm not sure that fisheries science has picked up environmental change early enough, and that may have affected some of the advice that we use" [UK Managers 2006].

2.3.4 Recommendations for improving fisheries science

Despite such scepticism and concerns, a recommendation made by many of the participants for addressing the issue of uncertainty was to narrow the gap between fishermen and scientists by increasing the participation and involvement of the fishing industry in fisheries science. Strong emphasis was placed on the validity of a partnership approach to fisheries science and the benefits that this would accrue to the credibility of findings. For example, a participant in the environmental interests focus group suggested that "the idea of involving everybody that's likely to be affected by the decision" constitutes an "ecological approach" to fisheries science. This participant [UK Environmental Interests 2006] went on to explain that:

Part of the difficulties that perhaps have arisen in the past is that science has been very narrowly focused in many ways...Because of the narrowness of the focus, it didn't appreciate the consequences or the implications... (T)he ecological approach is where you actually take account of all the possible consequences for all the stakeholders, and ensure that the process in which you are making decisions, their interests are being included. In what, in social parlance these days is called 'partnership working'.

Equally, a participant in the women in fisheries group proposed a similar solution, having cited an example where monkfish quotas in the south-west of England were increased as a result of fishermen inviting scientific observers on to their vessels:

The direction we'd like to see it going is through more fisheries-science partnerships projects which are still done in conjunction with organisations like CEFAS etc. And more onboard observers on actual fishing vessels. We think that method of collecting data is more reliable. The fishermen themselves have more confidence in the data because, you know, it's what they're doing day in day out anyway. We think that if these projects could be built on year on year and got some really good time series data built up then that would give a completely different picture from what the scientists say now.
[UK Women in Fisheries 2006]

And catching sector participants gave several examples of fisheries-science partnerships which they perceive as working best when they are industry-driven – “fishermen have been able to identify where they require and benefit from a greater understanding of the fishery or fishing method, bycatch and issues of that sort, and have worked in collaboration with scientists and fisheries administrators to move projects forward” [UK Catching Sector 2006]. These examples included fishermen participating in the flatfish survey in the North Sea, the former North Sea Commission Fisheries-Science Partnership, the fishermen’s North Sea Stocks Survey and invitations to fishermen to observe scientific sampling. The feeling held by the catching sector participants was that this process works well on specific issues within a designated scale. However, concerns were expressed regarding how you can scale up that kind of positive collaboration to the European level.

This view was endorsed by a participant in the environmental interests group who stated, “Where there seem to be good examples is where you have a local or regional sense of ownership” [UK Environmental Interests 2006]. Further, fisheries managers also mentioned examples of good collaboration between fishermen and scientists – on lobster v-notching to protect berried females, and collaboration on monitoring of a fishery in the Wash. Likewise, onshore sector participants supported a collaborative approach, citing the example of Northern Irish fisheries which, since the introduction of registration of buyers and sellers, have had to work with scientists to improve the accuracy of stock assessments which fishermen claimed underestimated the potential yield of the stock because, prior to the new registration requirements, there were high levels of black fish landed which would not have been included in the landings data that scientists used.

Further, it was suggested that this partnership approach should work both ways, with more fisheries scientists needing to spend time on commercial fishing vessels. The reasoning behind this could be explained by the view that no one group has all the answers or access to all knowledge. A member of the women in fisheries group stated, “I think when it comes to a subject like this, to trust just one point of view – whether scientists, fishermen or environmentalists – it would be a mistake really. It’s quite clear from the past that if you do that it’s not going to work” [UK Women in Fisheries 2006].

A very tangible example of this partnership approach which recognises expertise on both sides of the traditional science-industry divide, working in practice was described by the onshore sector group [UK 2006]. Finding themselves at loggerheads with supermarkets regarding a proposal, led by Asda in response to a Greenpeace campaign, to withdraw skates and rays from their fresh fish counters, the

fishing industry moved quickly to acquire scientific evidence to support the case that such a policy is unfounded:

O1²: ...earlier this year Greenpeace decided to stage a protest at Asda HQ in Leeds. As a kneejerk reaction to that, Asda decided to remove skate and rays from their portfolio of fresh fish. Because I have members in my association who are specialists in these species, I spoke to Seafish and a working group was put together with fishermen, scientists and processors. We tried to get the NGOs involved as well but they wouldn't come and play. It was amazing the wealth of knowledge that came out of that meeting that was there available to talk about sustainability and stock preservation that nobody had bothered to capture or even really thought about. As a result of that we have a clear plan which people will be taking cognisance of. You know, next time CEFAS are talking to somebody there is that information there they can tap into. We were pleased with the outcome of that.

O2: People participating in it were fighting for their livelihoods. And the scientific aspect came from ourselves, our organisation, and a few other people. But essentially, this information came from fishermen and from processors. It was generated by these people. What the scientists did is took their information and their knowledge and presented it in a scientific manner that basically allowed the processors and fishermen to say 'Hold on a minute. You're saying that our stocks aren't sustainable and we have data here that suggests otherwise. And what you're saying is reckless. And what you're saying is actually doing us out of a living, putting our families out of a living and socially that is reckless. So you're saying we're unsustainable – actually what you're doing is even more dangerous.' And that's kind of how it turned out in the end. Supermarkets now have scientifically robust information, which allows them to rebut what Greenpeace has come out and said.

The outcome of this was that all supermarkets, apart from Asda have reversed this policy. The emphasis overall regarding this suggestion for partnership between industry and scientists was that each have something to learn and that closer cooperation can facilitate the development of trust between the two. As one women in fisheries participant pointed out: "...from a few cases, a lot of fishermen have a better relationship with scientists as a result and vice versa. You really do see that building a trust" [UK Women in Fisheries 2006].

2.3.5 Conclusion

Thus, the main themes to emerge from discussions of fisheries science within focus groups related to, on the one hand, the validity of fish stock assessments, and, on the other, the potential offered by a broader interpretation of fisheries science, one conducted in partnership with resource users. In addition, there was a strong sense conveyed that the members of the fish catching, onshore and women in fisheries focus groups feel that there are institutional obstacles to effective fisheries science. This is an important issue that will be addressed further in the next section, relating to the use of science in fisheries management.

² O1 and O2 refer to two participants in the Onshore Sector Focus Group

2.4 The use of science in fisheries management

General Perceptions

- Fisheries management is underpinned by fisheries science at both policy and practical levels. ‘Good’ science would facilitate ‘good’ management.
- Fisheries management tries to find a balance between competing objectives.
- Policy development, decision-making and enforcement are all key roles of fisheries managers.

Key Problems

- Compromise can mean poor fisheries management, which does not achieve its stated objectives.
- Unobtainable objectives are counter-productive.
- The status of European fisheries as a common resource complicates and can undermine management.
- The emergent role of scientists as advisors on management policy, rather than as providers of objective knowledge, is perceived as a source of concern. Scientists should be independent from the politics and policy process.
- Science can be misused and this undermines its legitimacy and relationship between different actors in fisheries.
- Fisheries science does not always have the capacity or capability to support the role of fisheries managers who have the responsibility to find policy solutions that balance a wide range of factors in human and marine environments.
- Science, and the limits of science, are often communicated poorly, especially to the fishing industry.

Recommendations

- Scientific information needs to be more accessible.
- Fisheries managers need to bring in knowledge from other disciplines, such as economics, sociology and ecology, to support management decisions.
- Fisheries-Science Partnerships can improve both quality of fisheries science and relationships between the fishing industry and scientists.

The focus groups addressed perceptions of fisheries management, specifically with reference to the use of science. Fisheries science was broadly perceived as unpinning fisheries management and, while this was perceived to be positive in principle, it was felt by participants that this was not always the case in practice. Key issues here relate to how scientific findings are treated politically and how they are used and often reinterpreted once they are in the public domain. Discussions also referred to the roles that scientists play in fisheries management. Thus, this section first briefly considers focus group participants’ perceptions of fisheries management and then addresses a more detailed discussion of the use of science in the management process.

2.4.1 Perceptions of fisheries management

With regard to perceptions of fisheries management, the fisheries managers’ focus group highlighted what they perceived to be the key issues. In fact, it was this group that was most keen to discuss fisheries management per se. The general sense was that fisheries management, for this group, is concerned with balancing objectives, making policy decisions on that basis and enforcing regulations to implement policies. The critical balance in management objectives is largely between

environmental or stock-oriented goals and economic and social aspects. This was summarised by one fisheries manager who stated that:

For me, in our position as inshore managers, it's about trying to strike the right balance between, in terms of fisheries, ensuring stock sustainability, balancing that with ensuring the fishermen getting the right economic level out of the job. And that's it really. It's about striking a balance. Being able to manage the fishing effort and the fishery as such that it stays healthy, it provides a good living for the fishermen involved. Ideally, this is an absolutely ideal scenario – it gives them a reasonable economic return but the fishery continues to expand and develop. It's a very simplistic view and a naïve view maybe to some extent, but that's the ultimate goal. [UK Managers 2006]

However, in practice, the fish catching sector can actually find the ultimate outcome of that balancing process to be non-sensical. Compromise, for them, can mean poor fisheries management. For example, one member of the fish catching sector cited the example of the cod recovery plan which, while aiming to reduce the targeted fishery on cod has in fact incentivised the use of small mesh sizes which have a higher discard rate – under the terms of the cod recovery plan vessels targeting whitefish using a 120mm mesh net have a lower number of permitted days fishing pre month than do vessels fishing on other species with 70-99mm mesh.

The picture that emerged during this discussion is that fisheries managers are coming under an increasing amount of pressure as environmental legislation mounts up on the one side and pressures to execute good governance within their fisheries accrue on the other. According to the managers group, the need to pursue environmental objectives, as opposed to fishery ones, is becoming a larger part of their role as fisheries managers. This is posing problems as one fisheries manager described:

The problem we've got as well nowadays, particularly in the last decade or so, it's not just about fisheries management, it's not just about fish stocks, it's about environmental management. And that's really creating some real problems. And there's links there to good and bad science. In some aspects we're being driven by environmental legislation, backed up by not particularly good science, and being forced to make decisions under an environmental legislative route, which is proving incredibly difficult. [UK Managers 2006]

While another fisheries manager explained the importance of attempting to consult all relevant parties and to try to find a consensus position:

But it's not just the environmental side, it's also the people side. There are a lot more people coming into any decision you take nowadays than there were for me twenty years ago. There's a lot more pressure from small groups of people who have a particular interest or aim in mind. And those have all got to be taken into account in any decision you come to. So the manager is actually making a decision about what's going to happen, or what needs to happen. [UK Managers 2006]

This development was regarded as potentially damaging by a member of the women in fisheries focus group, whose perception was that 'stakeholder' forums on fisheries issues can be weighted against the fishing industry, who only have a minority position within such bodies. And yet, the managers focus group perceive that they are under pressure to take all views into account to ensure transparency.

Additionally, while the need for "clear and coherent" objectives within fisheries management was pointed out by a member of the onshore focus group, another member of the same group pointed out the problems of achieving that in a mixed fishery. He stated that, with "a multi-species fishery in

the North Sea with (approximately) sixty nine prosecuted species...and twenty odd nations targeting those, how do you find consensus to manage all of that?" [UK Onshore Sector 2006]. Related to this in some ways, was the view expressed by two members of the women in fisheries focus group that management has to be flexible, given the complexity of managing multiple species and for the industry to succeed in making a living from the sea. The capacity to trade and swap quota for different species was highlighted by this group as a key fisheries management tool.

The discussion of concrete objectives was only mentioned by a few participants. However, they took the view that science plays a role in determining "clear and coherent" objectives. The current debate revolves around the concept of maximum sustainable yield, or MSY, as a long-term management objective – the long-term element of fisheries management was also identified as being important by participants in the environmental interests group. Again, though, scepticism was expressed if such a goal can be applied effectively in a mixed fishery context: "And what is maximum sustainable yield? It's really something that can only go on an individual stock basis" [UK Onshore Sector 2006]. A further factor raised in this discussion by members of the onshore sector was that our knowledge of the marine environment is too limited to implement such an approach effectively:

The thing about MSY as well is that we're at a point now where pretty much the whole food group in the North Sea has been altered, so what do we take as our baseline? Do you take what it is now? Do you take what it was a hundred years ago? What stock assessments are we looking at?...We know a lot more now but we're still at the very beginning stages of understanding.

Other factors are perceived as complicating management. The lack of ownership in the marine environment was mentioned, for example, by a member of the onshore sector:

You've the common resource problem as well, that's not common anywhere else – it's a uniqueness for the fishing industry. And the fish could be in Norway tomorrow, the day after it's in Denmark, the day after it's in France. Who owns the fish? Nobody owns it. [UK Onshore Sector 2006]

Fisheries managers also raised this issue, perceiving the common management of fish stocks at the European level as being a key obstacle to effective fisheries management. They perceive this primarily as a political problem, as the following exchange illustrates:

M1³: It seems to me that the distinguishing characteristic of the fisheries that we manage, apart from shellfish, is that they're managed within an EU framework...and that is the biggest single obstacle to effective management. I think this is because ministers are criticised collectively if they don't deliver environmental objectives, but they're criticised individually if they don't deliver a deal for their fishermen, so the accountability is different. If they come back from a management discussion with measures that disadvantage UK fishermen, or Irish fishermen, or whoever, then they will be personally held responsible. If they just make a bad decision and don't conserve stocks, the Council failed in its job again, but no minister is really held responsible for not delivering or delivering a sustainable system.

M2: The whole common fisheries management, the political side of it, presents huge difficulties and huge challenges, but equally, the way I see it, for most of these species there needs to be common management because the fish species are moving around various member states, and simply to shut

³ M1 and M2 refer to two participants in the Fisheries Managers Focus Group

shop and have UK independent management I don't think is going to work. So the common idea is right I think, but there's just so many political challenges, and the structures are incredibly difficult to get around and cut through.

Further, the differences in regulations for the UK fleet as opposed to foreign vessels, according to managers, undermines their relationship with fishermen. A fisheries manager mentioned the example of a multiple trawl order which only restricts UK vessels which fishermen regard as being unfair.

The issue of enforcement was another key aspect of fisheries management raised by participants. One fisheries manager raised the problem of the mismatch between regulations and the capacity to enforce those regulations in the real world:

There is a tendency I think with those who write the management laws to forget that what they are in effect writing is a law, a regulation – you might as well write something that can be enforced and should be enforced. If we get a regulation that's poorly drafted you can't enforce it so you have ineffectual management, I don't think when laws are sometimes written it's always fully anticipated what problems might occur. [UK Fisheries Manager 2006]

Such regulations do not take account of resource limitations in fisheries management – “...we don't have the resources which allow us to enforce management rules 24 hours a day, 7 days a week, 365 days a year on every fishing boat at sea or landing in port” [UK Fisheries Managers 2006]. Instead, enforcement has to be targeted. This is in sharp contrast to an example, described by a member of the women in fisheries focus group, of Canadian regulation enforcement which now features very close monitoring of all vessels electronically. Although this was imposed on fishermen and was apparently not well-received, it has shown to improve the transparency of the management and enforcement process. This has had knock-on effects for the science: “Because everything is transparent now, the scientists are actually working with them, and they have video logs of everything that's being caught” [UK Women in Fisheries 2006]. A fisheries manager, however, proposed an alternative approach to the limited management resources problem – freedom:

For me, my view of management has changed over the years. My view of management twenty years ago would be to control everything and to exercise that control because I didn't want things to get out of hand. I think my view of management now is much more...to provide freedom for people with the information that we've got available, to allow things to happen. But ensuring that we can take steps to close doors if necessary when the situation looks as if it's moving in the wrong direction. [UK Managers 2006]

In some ways, this is backed up by the view that, as with policy development, stakeholder involvement in drafting regulations and deciding on appropriate enforcement measures is vital:

...if you're going to have successful management you've got to have compliance. You can't force compliance on people; well, you can, but history's told us that forced compliance doesn't always work. What you've got to do is get the other side on board and hope that you achieve success with management through consultation and through talking together with the stakeholders, which at the moment seems to be the favoured way forward. Unfortunately, there are certain fisheries where in order to be successful in management perhaps you've got to be unpleasant first, in order to get your participants, your stakeholders, down to an acceptable level and then it can rebuild. [UK Managers 2006]

2.4.2 The use of science in fisheries management

Moving on to the role that science plays in fisheries management, an ‘ideal’ view of fisheries management, which includes fisheries science, was put forward by one fisheries manager and this strikes a chord with regard to the complexity of achieving successful and effective management:

But the ideal scenario is obviously having good science, good knowledge of the stock you’re managing, have good management, statutory management procedures in place, and effective targeted enforcement to ensure compliance. And, ideally a high level of compliance within the industry in relation to that element or to that management element, ultimately a good result at the end of the day for the fishery. [UK Managers 2006]

However, there are problems with the use of science in fisheries management. A member of the women in fisheries group pointed out that science is not designed to be a policy tool: I think a lot of fisheries science...(is) traditionally very uni-directional, very inwardly focused, so it’s difficult trying to transform it into policy. It’s not really a policy tool, investigating the answers often shows what isn’t the answer” [UK Women in Fisheries 2006]. Thus, how policy-makers respond to the science is important and influential. A fisheries manager mentioned the precautionary principle which is a policy tool which cautions managers not to allow fisheries activities in given areas if scientific evidence is not available to support any contention that the activity will not have a detrimental impact on key objectives such as stock sustainability. According to him, this has a tendency to “cause some confounding of decisions...: because you’re scared something might happen...you stop everything happening” [UK Managers 2006].

Having outlined the perceptions of focus group participants regarding fisheries management, it is necessary to consider what role they perceive science as playing in the management process. Significantly, any of the themes that were raised during the ‘what is science?’ and ‘what is fisheries science?’ discussions recur here – in particular the role of objectives and the inadequacies of science. However, new issues also arose, with one focus falling more on human actions and reactions in terms of applications of science and reception to it. Discussions highlight the importance of context and human influence in determining the successful use of science in fisheries management.

Before discussing these more theoretical issues, it is worth focusing on the variety of practical uses that participants perceived science as having in the fisheries management process. Management as decision-making was a common conception, with science playing a role in that process. As one fisheries manager pointed out: “I think from a management perspective it’s about trying to establish a baseline position and by then you can make a decision; take a fisheries management decision forward for the benefit of stocks, and hopefully future sustainability, in the very briefest, basic of senses” [UK Managers 2006]. Thus, as with the earlier discussion of ‘what is science?’, the role of fisheries science is to provide baseline knowledge and it is upon this knowledge that management decisions can be based. Another fisheries manager endorsed this perspective, stating that: “Science is a term which describes a process whereby systems are, the knowledge of systems are systematically analysed, and that knowledge of that particular subject are then established; and you can then use that knowledge in the context of decision-making – in our case fisheries management and the establishment of fisheries laws to protect conservation, also setting the quotas” [UK Managers 2006].

The provision of scientific information to support management can take time. A fisheries manager described the following example relating to bass trawling where the process by which a decision was made was dependent upon a lengthy scientific process:

...we wanted to make sure that they would go in without interfering significantly with the runs of salmon and sea trout, so we undertook a period of three years of testing with a couple of nets to assess what the catches were in a given net coverage in a given period of time at given stations. And the evidence from that gave us an indication of the bycatch of salmon and sea trout. And I think that was science; and we certainly made a decision based on that which was to allow a limited number of nets to operate on that...coast. I think that's...my opinion of reasonable science. [UK Managers 2006]

In addition, as well as playing a high level role in providing information to the initial decision-making process of fisheries management, science also plays a practical role in day-to-day fisheries management. In particular, scientific monitoring of impacts of management measures on target fish stocks, other fish species, non-fish species and habitats is becoming increasingly important, as one fisheries manager pointed out: "We go on with...monitoring, which I think is also science, to enable us to say whether this is continually sustainable or whether we need to make some changes" [UK Manager 2006]. Again, he gave the example of monitoring levels of salmon and sea trout as bycatch in coastal trawling fisheries and stated that if it was at a high level then management measures may have to be revised. Thus, continuous fisheries science processes can support the management process and helps management to focus on and ultimately move towards its objectives. Fisheries science is thus also a tool for adaptive management of fisheries.

This contrasts significantly with the perception of a member of the catching sector focus group who took the view that fisheries management is not adaptive, but is instead concentrated on inflexible and unachievable goals. He stated that:

Our science is inputted into a regime where, first of all, we're pursuing in my view the unattainable which is that everything's being focused upon the progressive rate of recovery of the cod stock and, despite the fact that in order to do that, boats which aren't targeting cod, or even necessarily catching cod to a certain extent, are limited to 14 days a month, not viable...But, despite that, the unobtainable objective remains there which is a certain level of biomass, a certain rate of improvement in the biomass. And then we have, coupled in with that, we have measures which actually allow more days for boats which are using smaller mesh nets, we have years of very ineffective enforcement, we're still plagued by policies which use discards as a means of equating to both compliance with mesh sizes and quotas. It's there rather than bad science; it's the role science has in the overall management structure which is the issue here. [UK Catching Sector 2006]

A participant in the environmental interests focus group raised the possibility that science can act as a positive force in the quest for achieving agreement in fisheries management. His view was that people feel that fisheries management as a concept has negative connotations which creates problems for fisheries management: "...I'm wondering...if you could have some sort of common agreement of (an) acceptable, reasonable, scientific way of predicting things and trying to manage them better that everyone is happy with, then it may be an opportunity to resolve some of those problems" [UK Environmental Interests 2006]. The theory here, therefore, is that common agreement on science could facilitate common agreement on management. This could answer some of the problems with compliance discussed above.

However, one member of the catching sector indicated that it is important to avoid scientific institutions being compromised by taking a role in the management decision-making process. While he took the view that “clearly, fisheries science has an input and a legitimate role to play in the (fisheries management) process...I think our concern is that as part and parcel of the greening of the political climate that increasing undue reference, undue court, is given to the input from science in the totality. It’s got to the point where scientists – ICES certainly – are playing up to the role.” He cited the relatively new trend of ICES issuing press releases as evidence of this. Where previously scientists have provided the “raw material’ for discussion between fisheries ministers, now there is “...a much greater reliance directly on the recommendations of the scientists. And very often just one, the most eye-catching – we’ve a range of recommendations coming from scientists because it’s rare that there’s only one solution that they come up with, there’s a whole matrix, but it’s always the top line that is picked out and publicised. And often by themselves now” [UK Catching Sector 2006].

This view was in some ways endorsed by the view of a fisheries manager, with the support of others in the group, that while science supports management, decision-making is a political, rather than scientific process. He stated that:

The science is actually providing the facts to enable us to make a decision whether to go ahead or not. How far along you go along saying ‘Yes, you can go ahead’ then becomes a political decision in terms of what you think...because you make a judgement then...of just what level of activity might be sustainable there for a given period of time. [UK Managers 2006]

And the role of managers in this process is to balance the subjective or political interests of different groups and make a decision while still keeping scientific knowledge and advice in mind. As one manager pointed out: “As a manager my role is to take what science, what information, perhaps we can muster and use those to show what I believe the situation to be and to influence people in terms of the management of the fisheries” [UK Managers 2006]. In addition, then, science is used to convince people of the need for a given management decision or measure. Further, another stated that scientific facts must be balanced against other factors such as economic, political and environmental aspects, with decisions being based on all this, not just a single perspective. From this perspective, science is one factor among many.

One problem with this, identified within the fisheries management focus group, is that dealing with a wide range of interests means dealing with a range of motivations and a variety of levels of knowledge. In particular, they highlighted the difference between taking an objective perspective and an emotional one, as the following exchange reveals:

M1⁴: One of the problems with management that I see is when we are trying to deal with opinions or views. Certainly my experience of management is that most managers that I come across are from a scientific background and developed into fisheries management. And therefore there is a natural tendency for them to try and use science to actually combat arguments from the emotional route.

⁴ M1 and M2 refer to two participants in the Fisheries Managers Focus Group

M2: *But in actual fact, the proponents of the welfare issues are not coming from a scientific basis, they're coming from an emotional background. And to try and argue the logical route against the emotional way can lead to difficulty.*

Further, while science could be a tool of fisheries management, it can also be perceived as undermining management as a result of its inherent uncertainty. As one member of the catching sector focus group pointed out: "...one wonders whether there is enough certainty within stock assessment to actually regard it as a science, when there are so many uncertainties which aren't understood and which aren't properly modelled for, that one should have the degree of reliance which is now being placed upon fisheries advice, and the consequences of that advice, whether it is entirely appropriate" [UK Catching Sector 2006]. This would seem to illustrate a certain level of mistrust in official scientific institutions. This is further enforced by the following description of the current situation from another catching sector participant:

I can tell you that our fleet, despite the fact that a large number of the boats have been engaged in non-fishing activities – guardship, oil-related work and such – our cod catch at the moment for this year is 10% up on last year, our whiting catch is up 10% on last year (and that's up from very high levels last year), saithe 100%, sole 200%, plaice 100%, and just for a throwaway, sea bass is up 650% on last year. So the fishery is not in decline. It's on the up. And we're being threatened with more and more restrictive measures taken out by the EU in the coming months and it all boils down to the fact that the science is not picking up this improvement. [UK Catching Sector 2006]

This example pursues the view that science essentially has a restricting impact on fisheries management and on the freedom of fishermen. The detailed discussion of fisheries science in the preceding section illustrates that it has a significant influence and bearing on fisheries management and on fisheries and fishermen. One key statement by a fisheries manager speaks very much to this conceptualisation that fisheries science has a high impact: "To a working fisherman, science is something that grates on the fisherman, because it means restriction in one form (or another)" [UK Managers 2006]. Another fisheries manager states that: "The problem is that what...may in the eyes of the managers be described as good science, in the eyes of the fishing industry will not be described as good science because it is seen as too restrictive because you've set a limit on the number of nets that may be placed in a certain area [UK Managers 2006]. Thus, the use to which science is put can determine its acceptability and these fisheries managers conceive that fishermen's perceptions of fisheries science are coloured by the ways in which it impacts on their daily work, the way in which it is interpreted through management.

Following on from the theme discussed in preceding sections relating to participation of the fishing industry and stakeholders in science and the management process, was a point raised by all the focus groups – that there have long been problems with the way science used in fisheries management has been communicated. This has had the general effect of undermining the findings of fisheries science, management decisions and fisheries policy in practice, in particular in terms of its legitimacy and credibility in the eyes of resource users. One member of the environmental interests focus group, for example, described the following scenario regarding possible reasons for the disillusionment of the fishing industry with science:

...did they become disillusioned because they think science has got all the answers and it doesn't have all the answers? Or do they become disillusioned with it because of the ease with which people use

jargon – and I started doing it just now; the ease with which scientists are very happy talking to scientists, and, I guess, fishermen talking to fishermen? It's that interface – and we're not very good at bridging those, at moving across the different disciplines. We've each got our own language, we've each got our own terms, each got our own methods. So I'm just wondering why people get disillusioned with it. I think that the first one of those I said is that people think science has all the answers then they suddenly realise you haven't got all the answers and I guess they get disillusioned with it. I'm just wondering whether that's the scientists' fault.

This raises two possibilities, that failure on the scientists' part to develop a common language has alienated fishermen from scientists – another environmental interests group participant described this in a different way: “From where I am, science has not democratised itself...” [UK Environmental Interests 2006]. And, second, that this has had the effect of the fishing industry not being well enough informed about the limitations of science, each of which has created disillusionment with science as a discipline and with the role of science in the management process. This second perspective on this issue was also raised by another participant in the environmental interests group who stated that:

Part of the motivation to suspect the science is that we all seem to have an ability and a desperate need to control the world we live in and science seems to offer a better way of doing that. But that, in people's desperate need to believe in it they're not always aware of its shortcomings and have been very disappointed when those shortcomings have become very obvious, in that their science seems to have failed – the information that science is offering as it turned out didn't prove adequate enough. [UK Environmental Interests 2006]

This was endorsed by a member of the women in fisheries focus group:

What we expect sometimes with science is probably a lot more than it can provide. No-one likes to have grey, we want black and white. I think quite often fisheries scientists or scientists generally are forced to draw conclusions that managers want – like what will the quota be this year? They have a legitimate voice that fisheries scientists are even comfortable having sometimes. Perceptions – science, creating data is seen as legitimate. [UK Women in Fisheries 2006]

Another member of the women in fisheries focus group suggested that one solution to this situation would be improve the availability of scientific information to interested parties: “That would be useful if they know all the different sorts of information and where they can find it. If somebody actually brings that all together – what's available where” [UK Women in Fisheries 2006].

In some ways, then, fisheries science can be inadequate to support management systems in a way that is robust enough to be regarded by all as acceptable. According to a participant in the environmental interests focus group, this is particularly the case with regards to management demands for predictive science. He stated that:

There's also that need to predict into the future. Try and figure out what's happening to optimise sustainability. When people say to me, 'how do you figure out how many fish are going to be in the sea in a year, let alone twenty years, when there's so many different things happening in terms of climate, in terms of people needing different use of the resource – and when I say that I mean in terms of habitat extraction, in terms of holiday-makers and in terms of pollutants – that balance, can't predict what's going to happen. [UK Environmental Interests 2006]

While a member of the women in fisheries focus group stated, “Even if you've got good science it's very difficult to predict what's going to happen” [UK Women in Fisheries 2006].

Discussing the annual negotiations on TACs and quotas at the EU level, a fisheries manager pointed out that:

...a lot of the problems are where the scientists don't know – they can't answer the question they're being asked. One example of where that applies, which tends to be classified as bad science, is the annual quota decisions, which has been set up to require that scientists tell us exactly how many fish can be taken out of the sea next year. It's by no means clear that scientists know enough to be able to do that for a lot of stocks with a lot of confidence. But in the end, we want a single number we can agree on the 21st December. [UK Managers 2006]

In contrast a member of the women in fisheries focus group pointed out that a lot of the information we do have currently has no place in the management process and thus is effectively ignored: "Information is sometimes just not used because it takes time and effort to have systems that work in a way that synchronise, you know. It is complicated to integrate different kinds of information, very valuable information." This is felt by others to be a problem as well – it was generally agreed that economic, social political and environmental information is also relevant to fisheries management. One manager in particular emphasised the importance of taking economic factors into account:

There's a whole lot of economic factors. We are bound by government legislation to consider costs and benefits of the decisions we take. So we have to find some way of assessing costs and benefits in fisheries decisions we arrive at. We're bound by legislation to consider the impact on rural communities. We have to take that into account. We've got to look at obviously the habitats in terms of European directives. And we've got to look at the pressure groups in any particular area. Equally, as Mike said already, any change naturally generates a whole load of opposition to it, so you have to take all those considerations, whether they're real or not. Almost everything, actually, in a decision, that can affect that decision – from the people, the economics, the environmental background have to be taken into account at some stage, like the full environmental impact assessments of any decision that's taken nowadays. [UK Managers 2006]

However, not all participants agreed that this is the case. One member of the women in fisheries group took the view that fisheries management does not take socio-economic impacts into account:

I don't think economics is really considered at all to be honest. Looking at the knock-on effect with port infrastructures, I just don't think it's considered at all. Because, look from a ship repair point of view now in Grimsby, that sort of infrastructure now is virtually non-existent. The job losses, the socio-economic impact of what people do. Once they cut quotas, they've no idea of the domino effect it has, right through families, earnings and everything. [UK Women in Fisheries 2006]

The issue of insufficient scope of science to meet the needs of management applies to fisheries science specifically as well. A member of the managers focus group stated that science can be too limited to a stock focus and should sometimes look further afield: "Things more distant than local can have an impact which in some way should be taken into consideration. And we're only learning that as we go on, as we realise it's not just this local thing that's a problem, it's other distant things" [UK Managers 2006]. While another manager pointed out that: "There's oceanography, tidal cycles, salinity changes – the whole gamut, obviously, affects fisheries to one degree or another. So there's a huge number of different elements all relevant" [UK Managers 2006]. And a third mentioned the failure to address the cumulative effects of multiple developments in the same spatial area within the marine environment. Science, therefore, is perhaps currently insufficient to meet the needs of

managers who have the responsibility to find policy solutions that balance a wide range of factors in the human and marine environments.

Connected with this issue of communication is the additional point that different institutions and individuals use science in different ways, some of which are regarded as more legitimate than others. For example, a member of the environmental interests focus group stated that: "I think there are organisations who selectively misuse science, who selectively misuse the facts or the data. Now, one difficulty that...science comes up with some facts and then you get interpretation. It's a bit like having twenty economists in a room, twenty-one different views sort of thing. And, you have in fact a number of different interpretations" [UK Environmental Interests 2006]. Similarly, one member of the catching sector focus group questioned the legitimacy of the use environmental organisations put science to. He stated that:

It's a case of quasi-science – it's like an advert for toothpaste. You get someone who comes on and looks like a dentist in a dentist surgery, and the first thing that they say is 'I'm not a dentist but I can guarantee that this will be good for your kids.' And it sells with that message. And environmentalists are in the same trap – science has a credibility amongst the public, so it's an inappropriate use of science, and it's non-regular science. We see it from Greenpeace and the Marine Conservation Society – they've taken scientific data from ICES, misinterpreted it, put it out in the public arena buried in a very emotional media campaign, and getting reactions from the multiple retail outlets that we've had recently. But they're not accountable; it's not regular science that can be questioned.

In contrast, he went on to argue, the industry have very little scientific credibility in the public domain, with journalists unwilling to listen to or reflect their point of view. This is backed up by the following statement from a participant in the women in fisheries focus group who was discussing the failure of the media to promote positive fisheries images and the failure of environmental interest groups to communicate examples of good practice when they find them. She stated that: "We've tried...but nobody's interested in listening to things like that because it's not bad news. All they want to listen to are the likes of WWF and Greenpeace and people like that, English Nature, going on about how bad the fish is and it's the big bad nasty fishermen that's doing it. That's all the media wants to hear" [UK Women in Fisheries 2006]. That there is internal awareness on the part of environmental interests that this can be a problem and science has been misused in some cases by environmental organisations is an important point. One participant in the environmental interests focus group stated:

...it's very difficult to get a piece of science without a preconception of where you might want to go with that. Perhaps you've got an organisation; thinking as an NGO, you've got a campaign. And you're kind of sure in your head that it can't all be good, that there must be a problem out there. I'm not saying...it comes back to communication again. You can take the data and you can...any organisation is going to want to run with the communication at an angle that is going to bring in more funding, that leads them down a campaign route or whatever really. It's very difficult to believe that a piece of science is going to be carried out without those preconceptions and that definite spin on the communication of it. [UK Environmental Interests 2006]

This situation poses a key problem for achieving that consensus view on science and management that the member of the environmental interests focus group spoke of. If different stakeholders connected with fisheries do not trust each other to use science in a way that all regard as legitimate then relationships between them are unlikely to go much beyond mutual toleration, at best.

However, it is worth noting that this kind of comment does illustrate that participants from different sectors are sensitive to the availability of opportunities to present scientific ideas as facts, and that this is distinct from the science process itself. Participants were very much aware that science can be misused in fisheries management and gave several examples of where they felt this had been the case.

2.4.3 Conclusion

The role that science plays in fisheries management was, broadly-speaking, perceived by participants as being to underpin or justify the management decisions. However, the general sense conveyed during discussion was that many participants took the view that traditional fisheries science is insufficient in and of itself to underpin the kind of management they would like to see. As such, science needs to be broader, taking in a range of disciplines and more participative, particularly involving fishermen. However, the science is not the only element in this relationship that is perceived as needing to change. The way that different actors use science in the management process and to influence that process was also heavily criticised. A key recommendation of participants to address these two issues was for ways to be found to better communicate science and the uses science is put to in fisheries management to a wide audience, which often has limited scientific knowledge or expertise.

2.5 Computer models

General Perceptions

- Participants were less familiar with computer models, than with fisheries science per se.
- Computer models were perceived to be the domain of scientists, but some examples of models used in fisheries, environmental management and in industry were raised.
- Modelling outputs should not be regarded as concrete predictions of the future. Instead models offer information about broad projections or trends.
- Models can be used variously for risk assessment in information-poor situations; for project management; for decision-making; for business planning; to trigger debates and discussions in fisheries.
- Models are limited by what we think we know.

Key Problems

- There is scepticism regarding the practical use of models in fisheries science and management.
- Modelling the marine environment, which is highly dynamic and often poorly understood, is likely to be characterised by high levels of uncertainty.
- Outputs of modelling are determined by the quality of data that goes into them and by the nature of the assumptions they are based upon. This has inherent dangers.
- Models are costly to develop in both time and money and often the same outcome can be achieved using alternative means.

Recommendations

- We need to be cautious about the degree to which we regard them as describing the real world and about their use of models in fisheries management.
- Collaboration with industry would help to validate model outputs and improve their credibility.
- Models must be communicated in such a way that makes clear their assumptions, the data and any sources of uncertainty which may have affected outputs.
- Models need to be adaptable to include new knowledge.

Discussions of computer models revealed the level of familiarity of participants with this kind of technology. In particular, it highlighted examples of computer models being used in the work context by some participants; key problems that participants perceived computer models has having; and some recommendations for how computer models can be made more effective and useful.

2.5.1 Examples of computer models

There was a sense within all the groups that computer models are not something that they use every day, or at all. However, each group had a slightly different take on what models do, are used for and how relevant they are to their own work. The catching sector focus group and the onshore sector discussed economic business models, quota management models and stock assessment models; managers focused on human resource distribution and environmental management; while, in the environmental interests and women in fisheries focus groups discussion tended to be quite disjointed, with those with scientific experience being more comfortable than others when talking about the concept of computer models. For example, one member of the environmental interests

focus group distinguished between conceptual descriptive models and numerical models that could be used for prediction. This was atypical for the sample as a whole.

In addition, there was also a certain amount of reluctance to discuss modelling in all the groups. Where, on the issues relating to science, fisheries science and fisheries management, views were forthcoming, on modelling discussions were slower to get going. This could be attributed in some cases to an inherent scepticism of modelling. The following statement by a fisheries manager illustrates this:

I think in the context of these focus groups, what I would hope you're looking for is to develop a model that will lead to an effective regime of effective management. And I don't feel that coming. Because what you're now going to do is talk about computer models and how effective are they in your work and how do you use them? There's an important answer, I know how to switch a computer on and I know how to do various things with it. If you're going into scientific modelling, I'll take a backseat.

However, practical uses of models began to be described by participants and the initial overarching scepticism receded somewhat. Participants raised various circumstances under which they thought models can play a useful role. Fisheries managers suggested that they can enable risk assessment and management in circumstances where concrete knowledge is low; that they have a capacity to enable knowledge-sharing; that they can provide a level of standardised objectivity to a subjective decision-making process; and that they have a role to play in project management. Members of the environmental interests group suggested variously that models act as decision-support tools or decision-taking tools. The catching sector participants suggested that models can be used to produce projections or predictions for the future and can form the basis of management discussions. Onshore interests raised the prospect that models can be used to measure performance and provide a basis for planning, for example with budgets. While women in fisheries participants, maintained that models can produce indications of trends in fisheries and can be used to trigger management debates and discussion.

A concrete example of a model being used by participants was that of the economic model, which is used by fishing industry representatives to examine the implications of advice and forecasts that come out of ICES for changes to fishing opportunities in terms of cod equivalence. In using this model they "...look at both ends of the process...assumptions that have been made, what data's used to input, we get a technician to run the model for us, and we talk about interpretation and results at the other end" [UK Catching Sector 2006].

A second example relates to the distribution of enforcement resources by fisheries managers. In this case, the model carried out a risk analysis in order to assess enforcement requirements for different areas and different fisheries. The risk analysis looks at the likelihood of blackfish in individual fisheries, based on quota level, value and supply, and ports are then ranked as high, medium or low risk and resources are allocated accordingly. He stated that, it would be positive to expand and find a way to validate this system:

...in an ideal world you would link up your risk based model with your surveillance/ inspection data and that would then produce a report, which would show just how effective you were being and

whether or not you are in fact working in line with your risk ratings. It will also of course tell you conversely, whether you've got your risk ratings correct. [UK Managers 2006]

Third, another fisheries manager gave the example of marine pollution models used by the coastguard agency when a significant pollution incident – such as an oil spill – occurs at sea. This model, which covers all UK waters provide an anticipated path of an oil spill on the basis of parameters such as time, the wind and sea state. He stated that: “...that to my mind is a classic example of where a computer model positively affects the work you do, because without that model you would be sending people hither, thither and everywhere, but that model enables you to accurately dispose of your resources such as they can take positive steps in dealing with that” [UK Managers 2006].

Fourth, managers described a model which can predict, on the basis of weight of fish inputs, amounts of saleable product and waste resulting from fish processing. There is also a similar model for *Nephrops* which shows weight loss because of the tail. As well as providing a useful tool for processors to be able to estimate outputs, this model can also flag up cases of unreported landings, where weights of inputs and outputs don't match.

2.5.2 Problems with computer models

Despite these examples, there was the sense expressed by participants that models have a limited application. When asked when stock assessment models are useful, a member of the onshore sector stated: “When determining quota allocations at the end of the year – that's about the only time” [UK Onshore Sector 2006]. The conclusion within that group was that such models can act as a “barometer” for fisheries managers, indicating trends, rather than an intrinsically accurate picture of the state of fish stocks. Another example was of discussions of profitability models within the fish catching sector – participants took the view that these would be too much work and would contravene the confidentiality of individual vessels. Further, following on from the discussion of different types of models, a fisheries manager stated that:

All these types of models are excellent – the pollution model, the river basin modelling – but when it comes to models in terms of fisheries science and fisheries biology, it's an absolutely different kettle of fish...When you start to work with natural parameters and dynamics, it's hugely problematic...The difference is the dynamics and being able to get accurate information on things like recruitment, natural influences, fishing mortality, natural stock mortality – all these things are hugely, hugely difficult to quantify. Whereas with things like oil pollution, you can get all your criteria, accurate criteria, reasonably quickly – you've got wind speed, tidal direction, tidal speed – and all those type of factors can all be put into the model and they're reasonably accurate. But when it comes to fisheries modelling it's hugely inaccurate. [UK Managers 2006]

This view was endorsed by that of a member of the onshore sector focus group who highlighted the dynamism of the marine environment as a key problem: “The second you put down the pen everything can change. But it's a valuable tool nonetheless” [UK Onshore Sector 2006].

One of the problems with computer models, as far as some participants were concerned, is that they are expensive to develop and implement, and they take a long time to develop, and yet it is possible to achieve the same outcomes without them. With regard to the resource distribution example cited by a fisheries manager, another fisheries manager indicated that he goes through exactly the same

process of consideration of priorities and of assessing the appropriate distribution of resources, but does this manually. Discussing which was better, he stated that: "...you could argue which one works better – you maybe couldn't split between the two: a very formal model where a lot of money's gone into developing that, does that work any better than what we're doing? We're actually basing it on our experience of the area" [UK Managers 2006]. Significantly, this may be a question of appropriate tools for different scales. The manager describing the model was part of a national management network, which perhaps had more inherent complexity in terms of staff and responsibilities than that of the second manager, who was working on a regional scale. Similarly, a member of the fish catching sector explained that they do use a 'decision-tree' style of logical framework analysis in their work, but that this does not constitute a formal model as such.

This issue of how long it takes to develop and fine tune a model to the point where it can have a useful application in fisheries management was raised by a member of the catching sector focus group. Giving the example of a model under development by the UK government to look at the impact of policies being introduced to manage deep sea fisheries, he explained that it has taken a lot of time and work to move from a rudimentary model to a more sophisticated tool and queried as to whether, even now, it's at the stage where it can produce anything "meaningful". Additionally, he referred to a sense that money had been earmarked for a particular part of the fleet and that the model was being used to justify that policy. This implies a high degree of distrust of the way in which models are used and can be misused.

A further concern about models was the issue that they are based on assumptions. The view expressed by a member of the onshore group, during a discussion of economic business models, was that we should be "cautious" when using computer models. He stated that:

Models can be dangerous. Because, you know, you take your budget and change one number, that changes another one, another one, another one, another one. And, if your first assumption is well off then the knock-on effect can be massive. So from that point of view you really need to be cautious about it. [UK Onshore Sector 2006]

A member of the women in fisheries group, giving the example of a fisheries management project in southwest England, which is using modelling as a management tool, also expressed concerns about assumptions and their interpretation. She stated that:

Of course the assumptions are a critical part. It comes back to that grey area – often people want answers so it's a real danger of models to take the answers as being gospel...Hopefully it picks apart something in a way that provides greater clarity. But try and see caution all around it, understand what those assumptions are. [UK Women in Fisheries]

In this sense, then, what we need to be cautious about is the certainty of the output of models with regard to the degree of accuracy with which they reflect the real world. This view was confirmed by a member of the environmental focus group, who had had direct experience of using models, in stating that: "you can get a model that looks really good on paper but in the biological reality of the situation, it's not even remotely accurate" [UK Environmental Interests 2006].

Further, with regard to this idea that we should be cautious of model outputs, a member of the environmental interests focus group indicated that results can be misleading, seeming to offer more

certainty that is actually the case because they take a numerical format. He described the example of the model the Bank of England uses to forecast the economy:

If someone talked about computer models, very quickly you will get locked into fully quantitative things – have we got all the numbers? For example, the Bank of England is just about to put up interest rates, and they'll say 'according to the treasury economic model, this is what'll happen.' All the treasury economic model is, is a set of equations that links various factors – what people are spending and what they're saving and all these things – they are put into equations. So therefore when people talk about models they get locked into the numerical models very quickly and predict something happening. [UK Environmental Interests 2006]

A second and related key problem reflects a concern that featured throughout the topics covered by the focus groups – data-dependency. As with perceptions of science and fisheries science, participants emphasised that models are dependent on data – “A model is only as good as the information you feed into it” [UK Onshore Sector 2006]. A member of the women in fisheries focus group, for example, stated that:

The thing is with models, they're based on a set of assumptions. But your models (are) only as good as the data that actually goes into them. And if you're data's flawed, it's not just your assumptions that maybe incorrect, if your data's flawed then your model's not going to work.

Similarly, a member of the environmental interests focus group stated: “...you have an extremely complex system, which you're trying to make into a simple model so you can appreciate what's happened. But then you've got to have confidence in your results, but you also have to know how certain the information that drives that model is – you need to know the confidence (level)” [UK Environmental Interests 2006]. A member of the catching sector focus group also expressed concern about the misuse of data. He gave the example of a bioeconomic model that was using data in the model that was regarded by industry as “irrelevant”.

Thus, perceptions of the validity of data can have a significant impact on the acceptability of a computer model or its use in a fisheries management system. One member of the women in fisheries group gave the example of a single piece of data being used in model illustration in consultation with the fishing industry which they instantly refuted. As she pointed out, the particular piece of information “had no statistical significance in the results of the modelling that was done, it was irrelevant”, but ...“it was just one case of the number that made people go, 'whatever' and instantly turn it off” [UK Women in Fisheries 2006]. In this case, then, it becomes clear that the industry put a great deal of importance on the need for accurate data that reflects their fishery and their experience of it. A model which does not do that is not something that they wanted to engage with.

The capacity of models to reflect the complexity of fisheries was a key concern expressed by a member of the catching sector focus group. He stated that:

Fleet models run into difficulties because it's very difficult to get a meaningful average or representative type of vessel, because each vessel is so dissimilar in terms of catch rates, type of fishing, profitability. It's very difficult to actually get any sense out of a model that's based on an average performance and average types of vessels because within the fishing industry, with any sort of broad category that you want to try and describe such an enormous variation of employment: that is characteristic of fishing as a hunting industry. And there isn't really an average performer or an average class of vessel. [UK Catching Sector 2006]

For him, this limits the utility of economic computer models that have been developed in fisheries. A member of the environmental interests focus group reflected this view. He stated that while “models are great for telling you what you don’t know...even if you have all the data in the world, because of the vagaries of the biological system, the social system, you will never populate the model fully so your predictions in the model will never be as full as you want them to be” [UK Environmental Interests 2006].

However, a participant in the women in fisheries group pointed out that data and our knowledge is improving all the time. Citing the widespread implementation of vessel monitoring systems (VMS) within the fleet, she stated:

The way technology’s going now, there is the facility there for the scientific modellers to have access to more accurate data because we’ve got the VMS system, they’re talking about electronic logbooks and everything. We’ve already got the catch data coming in from landing declarations and everything. I think there is data there. There’s really no excuse for people sat in an office having to guess. [UK Women in Fisheries]

This example would also seem to indicate that the method by which models are communicated is a key issue which should be carefully considered. Presenting models in a misleading or unclear way can undermine the relationship between stakeholders, modellers and managers.

2.5.3 Recommendations for how computer models might usefully be applied

In terms of recommendations, using his own experience, a fisheries manager, giving the example of a computer model used to predict flooding, pointed out that the model, which has been in use for thirty years, has been improved by adaptations based on monitoring of the inaccuracies and, thus, the model has been improved over time.

A second recommendation ties in very closely with the comments made in previous topics regarding collaboration between scientists – in this case modellers – and the fishing industry. A member of the catching sector took the view that while they don’t use models themselves, they do engage with the outputs of models: “We’re more the end users of models when we’re having discussions with fisheries scientists or fisheries economists, academia or fisheries science” [UK Catching Sector 2006]. This was perceived by another member of the catching sector to be a problem. He took the view that the industry needs to be more involved from the start:

It certainly needs sorting out because I think there’s far too many people devising models who really do not understand the industry and understand what they’re doing. They come up with this fancy piece of hardware and give it to the government and say ‘That’s good isn’t it?’ ‘What does it tell us?’ ‘Well it tells you that.’ ‘Alright. We’ll apply this at Christmas.’ [UK Catching Sector 2006]

Similarly, a member of the women in fisheries focus group pointed out:

...how general or how specific is your model? Whose assumptions are involved in it? There’s more and more models being done in office space without people setting foot on a boat. And that is the worrying thing. And I think it needs to go the other way. There needs to be more involvement, more partnership again. One, it would produce a more accurate model. And two, it builds up a better relationship, trust and confidence wise, between fishermen – stakeholders, which is the word everybody likes to use now – and the people influencing the decision-making. I am very, very sceptical. I am very sceptical of scientific models unless I know...that the data that’s gone into them is

valid and that the people who have been making the assumptions or interpretations on that data have a good background knowledge and know what they're talking about. [UK Women in Fisheries]

Another member of the same group argued that by including stakeholders in the modelling process you can work towards an “accurate validation of your model”, which will both improve the model – in a similar sense to the recommendation regarding monitoring accuracy – and improve relationships between modellers and stakeholders. Meanwhile, a member of the onshore sector group maintained that stock assessment models are “necessary” in terms of information provision, but that “the best thing is to get more industry involved with data collection and the better and more accurate representation you’ll get” [UK Onshore Sector 2006].

2.5.4 Conclusion

While there was an acceptance of the potential of computer models to be useful in fisheries and fisheries management, this was tinged with caution. As one member of the women in fisheries focus group summed up: “I’m not saying don’t use them...some are useful tools. But I think there needs to be a greater level of communication between the actual people that it’s ultimately going to effect and the people that are producing the model” [UK Women in Fisheries 2006].

2.6 EFIMAS modelling framework

General Perceptions

- The EFIMAS modelling framework was regarded as being a potentially useful tool in fisheries management for considering the implications of alternative management options.
- The integration of different types of information within one modelling framework, such as biology and economics, was regarded as a positive development.
- EFIMAS was perceived by some as having the potential to underpin an ecosystem approach to fisheries management, by incorporating human and environmental knowledge, and objectives.
- Modelling of this nature would enable different kinds of information to be processed faster by fisheries managers, although there was some scepticism regarding how much added value there is to this approach, as opposed to using non-modelling techniques to take account of different kinds of knowledge.
- Modelling at this scale could provide a standardised basis for management decision-making across Europe.

Key Problems

- The quality of outputs delivered by the EFIMAS modelling framework will be determined by the quality of data that is put into the modelling process.
- The modelling framework is not going to be able to tell you what you do not already know.
- The assumptions of the models within the framework could be subjective or biased.
- This modelling framework could take a long time to develop.
- The capacity of this modelling framework to answer management questions could be overstated.
- The introduction of this kind of tool will not have any bearing on the context of fisheries management, which is inherently politicised. Therefore, this tool could be misused for political ends.
- The modelling framework does not offer any new management options or innovative practical instruments. Therefore, policies which are constructed using the model in whole or in part may not be regarded by industry as any more legitimate than policies developed via the usual decision-making process.

Recommendations

- Involve members of the fishing industry, and, where appropriate, other interested parties, in the development of models as early as possible, and preferably at the very beginning when objectives are set and assumptions are made.
- Address the objectives of those sectors who you want to use and buy into the modelling framework.
- EFIMAS would have benefited from earlier involvement of stakeholder groups.
- Ensure the modelling framework is as robust as possible and communicate uncertainty transparently and honestly.
- The modelling framework will need to be communicated to a variety of audiences in relevant and easily understandable ways. Visual illustrations can play a useful role here. It may be necessary to develop two 'faces' for the framework – one for model users and one for non-scientific audiences.
- More research on the structure of the fishing fleet of fishing communities will be required before outputs from this kind of modelling framework will be meaningful.
- The EFIMAS framework should consider ways to integrate social as well as economic knowledge into the modelling process.

The presentation regarding the EFIMAS modelling framework provoked a great deal of discussion in all groups regarding how this approach might work in practice. Participants asked a large number of

questions regarding the framework and then moved on to discuss how useful the framework could be, possible problems they foresaw and suggestions for improvements. Participants made a number of suggestions regarding practical applications of the EFIMAS modelling framework. This section addresses each of these issues in turn.

2.6.1 Questions about the framework

The questions raised by participants in response to the presentation of the model have a great deal to tell us regarding the sorts of information that stakeholders see as important. This knowledge can help to inform EFIMAS regarding which issues and parameters are important to convey to any audience of the modelling framework in practice. It may also be useful for project dissemination. Questions broadly related to the scope of the modelling framework, how it works, reliability, practical use and communication. One key issue was the need to explain in clear terms the nature of the EFIMAS product – that being a framework within which individual models can sit, rather than a ‘super-model’ that would attempt to answer all questions. Box 2.1 provides a list of questions asked during the focus groups regarding the EFIMAS modelling framework.

Box 2.1 – Participant questions about the EFIMAS modelling framework

Scope

- Is it broad & open enough?
- Is it dynamic?
- Is it worth looking at the past?
- What's new about this model?
- Where is the driver for developing the framework?
- Can it handle complexity?
- Can it take account of long-term trends?

How it works

- What data goes into it?
- How do you model climate change?

Reliability

- How robust is it?

Practical use

- What's the timescale for development?
- Who owns the model?
- Who will maintain the model?
- Who will use the model?

Communication

- How will it be communicated?
- What will outputs look like?

2.6.2 The usefulness of the EFIMAS modelling framework

In terms of how useful the framework could be, there was a general consensus that the EFIMAS approach to producing a modelling framework that can enable multi-disciplinary modelling for fisheries and better facilitate integration of different models is “potentially of use and application” [UK Catching Sector 2006]. In particular it can have a role to play in providing support to decision-making: “I think if a model like this is kept at the decision-support system level, which is what you’ve just implied. People have produced a model, it can guide people, it can help them take a decision, then I think that’s fine, I think that’s what people would be comfortable with” [UK Environmental Interests 2006].

In discussion of EFIMAS in the managers focus group, the view was expressed by one participant that this approach is not really offering anything new, but is instead merely updating our decision-making process. “...basically, what you’re seeking to do is create a model whereby the computer makes the decision for you... It’s more that you’re using modern technology to demonstrate something, to make decisions, which are currently made on a ‘handraulic’ fashion” [UK Managers 2006]. Yet, there was still support for such a development:

I can't comment about the fishing community, but I will say that if this gives you a better decision-making process, then we ought to be looking to use the best decision-making process that we can in our management approach. With regards to this contextually, I don't need it to be simple – I don't know how a computer works, I couldn't make one, or programme one, what I do know is it works – what I want to see then is that the results of this work...and if it's road-tested and it works in its factory then I think we can start to implement it. But I do recognise that the decision-basis we've had in the past is limited and we all want more information and more options and this maybe a door to giving us them. [UK Managers 2006]

And an awareness was expressed within the managers group of the added benefit of speed offered by computerised models: "...a computer can handle a lot more information a lot quicker than we can...I think the advantage here is that you can process more information a lot faster and a lot more scenarios as a result than historically, purely and simply because of computers" [UK Managers 2006].

The idea of management options being examined and investigated via the EFIMAS modelling framework was particularly well-received by participants. As one manager put it: "I like the principle of the model; I like the principle of having the opportunity to look at different options for addressing management situations" [UK Managers 2006]. Further, another manager emphasised that it will be important to "consult as widely as possible" with managers and industry in particular regarding possible scenarios [UK Managers 2006]. Meanwhile, a member of the environmental interests focus group stated that "this would be a tool for helping me understand how...different scenarios would achieve the aims we're trying to achieve for the fishery and different fish stocks" and said that, "absolutely, it's a tool I can use" [UK Environmental Interests 2006]. And another manager stressed the potential of being able to look at costs and benefits of different options: "It's not going to give you the answers, but what it will do is point you in the right direction...based upon the best dynamics applied to each of the different scenarios that you identify...It would tell you...where there are positive benefits; and where there are negative management implications" [UK Managers 2006]. Further, another fisheries manager suggested a tool such as this could help the industry to plan their businesses in the long-term, as long as there is a "reasonable degree of certainty" attached to its outputs.

Another potential benefit of the EFIMAS framework identified by participants was its capacity to take into account a range of aspects of fisheries, including fish stocks, ecology, economics, and social issues. As one member of the environmental interests focus group put it:

...why I'm kind of interested...in your toolkit is the idea that it seems to be giving...an ecological approach, taking account of all the various factors. And not being too one-dimensional in the way it's being done, which is what's happened before. And I've seen projects – professionally I was a social worker – and I've seen projects measured solely and exclusively on the economic consequences. They've never taken account of the social consequences, which are far and away the more important. [that's right, yes.] The measurement that was insisted upon was always a financial one, if you see what I mean, an economic one. For instance, coal mines. [UK Environmental Interests 2006]

In having this potential, the EFIMAS framework could offer the means to implement a broad ecosystem approach in fisheries that would take into account all these human and environmental factors.

A final benefit related to the potential of the framework to provide a standard basis for decision-making across Europe:

...one of the things about models is that they can bring a standardisation approach when you're dealing with a whole number of different parties, and if you're dealing with different parts of England, let alone different parts of Europe, to actually exploit the same fishery then you're actually wanting to use a standard method, standard information, a standard way of processing that information, standard recognition of an output to understand the fishing stock. I think there are potential, potentials for it. [UK Managers 2006]

2.6.3 Concerns regarding the EFIMAS modelling framework

However, participants did raise a number of concerns regarding the EFIMAS framework. Many of these concerns reflect the problems that participants had already identified with regard to the application of science and modelling in fisheries and their management. For example, data-dependency was a key issue. Achieving “buy-in” to the facts driving the model was described by one manager as “fundamental”, while several members of the environmental interests group stressed that the trust of the industry, and other parties, in such an approach would only be achieved by demonstrating that what goes into it is “valid” and by ensuring transparency throughout the process. As, one member of the catching sector focus group stated:

The concern is – clearly the output you get is only as good as the input. And the issue is within fisheries is how good that input realistically can be expected to be. And if the input isn't good then what you get out of it and what is acted upon is actually potentially very damaging because there's nothing worse than thinking you understand something when clearly...

The implication here is that the model is not going to be able to tell you things you don't know about the marine environment, or indeed about social, economic or fleet factors either. It's only going to be able to guess on the basis of what you've told it. A member of the onshore sector focus group pointed out that a model will not improve our understanding of the interactions of different species, which would be a very useful thing to know more about. While a participant in the catching sector group pointed out that such models would still require a much better understanding of the substructures of the fleet to produce meaningful findings.

Time was another issue. A manager took the view that modelling frameworks take a long time to develop and that this is not going to address the immediate concerns of the fishing industry:

The hard truth of that is that in some areas in order to achieve a sustainable industry some people will go to the wall...First of all you have to sell the industry that idea, sell them that idea in such a way that they accept it, in other words that you reduce the fisheries impact or cushion the impact. And then, if you've done that you then move on, once you have your sustainable profitable fishery, something like that would be acceptable. But for the time being, all they'll see is that it's not going to deliver – I think...there's a lot of people in the industry who still look to government to give the Midas touch to what they're doing for a living. There must be an easier way to catch fish and conserve stocks than what we're doing in immediate policies. So I agree with my co-participant: they're looking for something that will help them in the short-medium term. This is something that will provide a fix in the medium-longer term. [UK Managers 2006]

The assumptions underpinning any model were also regarded as likely to be a problem, possibly introducing an element of subjectivity to the process:

For me, what you've got there is high resilience and low resilience, how objective is the division between those two states? And if it's not robust then I can see it being used with a particular bent to sway it one way or another. Some politicians or some groups might push for a low resilient fishery, whereas others might say it's a high resilient fishery. It seems to make some difference in terms of the options that you've got there for managing the fishery. I don't know, but if you've got any subjectivity that could be brought into it then that could be used by different groups. [UK Managers 2006]

Another key concern related to the fear that by attempting to draw in all aspects of fisheries, the EFIMAS framework would over-reach itself:

This is the problem with all these models – when it tries to grapple with so many different variations, different disciplines, different information, different data, whether you can do it in a manner so that it's all singing and all dancing for whatever particular question you want to get out of it. And whether you might not be better developing the model in terms of the specific parameters you're trying to resolve. You build it for a specific purpose...rather than trying to develop something which is a huge model, and whatever you want, push it in, and you get the answer 47 at the end of it. [UK Catching Sector 2006]

Participants also expressed concern that the capacity of this approach to resolve management problems could be over-stated and misinterpreted by managers and decision-makers: “if the model gets a life of it's own, as models sometimes do, such that people then regard it as a decision-taking system – they put in the numbers and it comes out with number 42 – then I think they're probably deluding themselves about it” [UK Environmental Interests 2006]. Additionally, the fear was also expressed by a fisheries manager that this kind of model enables decision-makers to renege on their responsibility to manage fisheries: “It could also provide ministers with a useful tool in respect of their accountability...(if) you have a decision which is made by a computer (it) would be extremely convenient, I'm sure, on occasion” [UK Managers 2006].

Further, the view was expressed by one fisheries manager that the introduction of this kind of modelling framework does not change the political context in which fisheries operate and, therefore, that the same problems of trying to maximise national share of the resource in a common pool would prevail. He stated that: “There is a risk here ...because countries are competing. Therefore, one risk for the scenario approach, if you have three scenarios, is that you always end up with the one that allows the most fishing” [UK Managers 2006]. A member of the environmental interests group reinforced this concern when suggesting that this sort of approach runs the risk of being used for political expediency just like any other scientific tool. An onshore sector participant concurred with this, suggesting that an organisation like Greenpeace could use this tool to produce their own findings. Equally, concepts such as the precautionary principle would still be in play and could influence decision-making:

The use of the precautionary principle...on the basis that actually we will take the low resilience situation up there because that will create a precaution for the fishery. And if that's used or misused then that could also weigh on the tool. [UK Managers 2006]

Additionally, managers discussed what impact this approach would have on management in practical terms:

M1⁵: *I think the catching sector will see very little value in this as opposed to what we've already got. And they don't particularly like or accept what we have at the moment and I cannot see how this is going to sway that opinion. Yes, as a management tool, it's another arrow in our armoury but I don't see that the catching sector will have a great deal of enthusiasm for this because it's not giving them anything different from, I would suggest, from their perspective. You're still going to say we're going to have to reduce effort, or reduce the catching TAC, and that's not what they want.*

M2: *On the other hand, it might say something totally different, correct? It might say, we need to monitor, we need to control effort, but we're not going to do it the way we've been doing it, what this way is going to give us is a way of achieving that aim in a more socio-economically acceptable way. It's possible?* [UK Managers 2006]

Another manager commented that this approach would not alter the quota system which is based on a political agreement. Thus there was very much the sense that while this approach will offer more information about different management options, it is unlikely to alter the way in which decisions are made and the instruments that are used in management.

2.6.4 Recommendations for improvements to the framework

A key recommendation was that, if it is to become a part of the management system, both the modelling framework and the way it is used need to be easily understandable: "It's got to be simple – but don't want to use that word. But it's got to be a system that's in the simplest possible terms. If you want it to be a system that's used it's got to be easily understood" [UK Managers 2006]. A member of the environmental interests focus group, for example, who believed that the modelling framework is not beyond anyone's understanding, pointed out that scientific jargon is very off-putting and that "...somehow you need to give a clear picture of what you're trying to do that relates to everyday life" [UK Environmental Interests 2006]. One way of approaching this would be to target communication in different ways at different audiences, taking account of their local context and their particular interest. Another effective approach would be to use visual communication – this was endorsed by several different participants, each of whom suggested that small graphical images, rather than graphs per se, convey a lot more and are easily absorbed by a non-science audience. A particularly concrete and useful suggestion was to invite "representatives (from different sectors) in to talk about the angles you might take before you go out to a wider audience" [UK Environmental Interests 2006].

Discussion of communication in the women in fisheries focus group also highlighted some positive suggestions for ways in which modelling tools can be effectively conveyed. One suggestion was to focus on creating a baseline understanding of what the modelling is about, and then build from there. Another was that EFIMAS should take the opportunity to use existing publications – such as industry newsletters – to convey messages to industry as this will increase awareness of the existence of modelling tools. Further, they discussed the possibility that it may be necessary to have two sets of outputs from the EFIMAS process – one with a scientific face, for other scientists and perhaps policy-makers, and one with a non-technical face that can be easily interpreted by stakeholders.

⁵ M1 and M2 refer to two participants in the Fisheries Managers Focus Group

A second recommendation was that getting the industry involved in the framework's development would be advantageous. One participant in the environmental interests focus group suggested that it would have been better to do this right at the start of the project and that it is vital to work towards industry involvement in that as soon as possible. Another endorsed this view and stated that:

...the stakeholders don't have to know the technical aspects of how the model works, but we've all worked with fishermen who've questioned the initial assumptions that have been made...So I think to get stakeholders on board, if they're comfortable with the assumptions that you've made and the information, then I think they'll accept what comes out of the model. [UK Environmental Interests 2006]

A member of the onshore sector suggested that best level at which to start this process is with the national fishermen's organisations – the NFFO and the SFF – as working fishermen have very little time to get involved in developing concepts such as this. For this reason it would be important for the process and findings to be, as a member of the environmental interests focus group suggested, “communicated back...in a language that we could understand and then pass on” [UK Environmental Interests].

Another suggestion of how stakeholders could be encouraged to sign up to this approach as a management tool was to address their objectives: “...you'd have to show me that by getting involved in this I would achieve what I want to achieve. In this case I'm sure that's true, it's just consolidating that” [UK Environmental Interests 2006]. A member of the women in fisheries focus group endorsed this, suggesting that it is fishermen who have “what if?” questions to ask, such as changing mesh size or fishing ground and that this kind of model could provide them with a guide to likely impacts of such changes. The opportunity for participants in the focus groups to make suggestions for how the modelling framework could be put to use represent a first small step in that process of making the work the framework carries out applicable and relevant. This was endorsed by a fisheries manager who emphasised the need for industry and managers to be consulted with regard to appropriate scenarios to address. Alternatively, another member of the same focus group suggested, collaboration could become the key objective: “...it's all about trust and communication. I think, in the process of developing this tool, if it was seen to be to the benefit of all of the stakeholders involved, that a common objective (would be) the goal of everybody working together” [UK Environmental Interests 2006]. Broader participation was also advocated by another member of the environmental interests focus group: “...it seems to be a perfectly legitimate exercise that people involved in the fisheries have some kind of fisheries management tools. That seems to be ok. As long as the fisheries management tool opens up the questions that other people might have, the stakeholders” [UK Environmental Interests 2006].

There was also support for the involvement of other stakeholder groups in the process of development of this tool and this kind of integrated, collaborative approach was broadly welcomed and perceived as something of an opportunity, as one environmental participant suggested:

Have we got an opportunity to actually get a common agreement, a common language and a common understanding of what it is that everybody's doing which seems not to have been the case in the past? That seems, if we can achieve that, that in itself would be worthwhile. It's almost saying you're taking account of factors and variables that haven't been taken account of before. And if there isn't agreement about those variables they shouldn't be included in the model. As a consequence of

that when results come out there's some sort of acceptance of them. Working for an NGO you'd normally be sceptical of the process, but if I accept the validity of the model then there's the possibility of more agreement about things and more willingness to actually share and work together and collaborate. [UK Environmental Interests 2006]

However, it was also perceived that this kind of collaboration is not an easy thing to achieve. Getting the fishing industry to agree was described as being like: “trying to herd cats” because each vessel has traditionally been an individual business run at the discretion of the skipper.

2.6.5 Suggestions for applications of the EFIMAS modelling framework

Participants were invited to make suggestions for scenarios that could be usefully explored using the EFIMAS modelling framework. The suggestions were very varied and are reported in detail in Table 2.2.

Table 2.2 – Scenarios proposed by focus group participants that could be investigated within the EFIMAS modelling framework

Scenarios to investigate	Detail/rationale
Changing fishing patterns.	Fishermen are fishing closer to the coast and changing their fishing methods as a result of effort regulations. What impacts is this having? “That would be interesting: whether you could have a model that would be sufficiently sophisticated – rather than simply say, the boats are going to tie up because of the high fuel and therefore there’ll be less mortality out there; say instead they’re likely to convert and as a consequence of that there’s likely to be much higher pressure on this species or that species as a result of an increase in fuel.”
Increase mesh size in <i>Nephrops</i> fisheries from 80mm-100mm.	Fishermen already doing this “get the same profits at the end of the trip, with less prawns of higher quality, than landing the bulk of low quality prawns.” [Environmental Interests]
Retrospective analysis of historic fishery collapse and recovery.	Examining the case of herring might give us some indication of how much warning managers might have of stock collapse. Test the model using the case of cod to see whether it can predict the recent stock decline and any recovery trajectory.
Review the quota year.	Conduct stock assessments in a more seasonal way that would be more appropriate to each stock, as opposed to the arbitrary application of the calendar year to all stocks.
Economic impacts of reductions in fishing opportunities.	Use a bioeconomic model to “look at the economic impact on the fleet” of Commission proposals for cuts in TACs and effort. “I think it’s important that some sort of an understanding of the effects of decisions are taken on board.” [Onshore Sector]
Bio-economic impacts of high marine mammal populations.	“We hear a lot about seals and how much fish an adult seal will consume during its day or whenever.”

Scenarios to investigate	Detail/rationale
Economic threshold of fishing community/onshore sector viability.	“...at what point do the ancillary services capitulate surrounding it? And how does that affect communities? There are examples where this has happened so you can take information and put it in and formulate a model. And that would certainly have a value...Where does it just all fall apart? Because that’s something you don’t want to see”. The government can then act accordingly on such advice. [Onshore Sector]
Consider impacts of non-fishing activities and other external factors on fish stocks.	Fishermen are not the only influence on fish stocks.
Introduce a standard minimum mesh size across the board of 100mm.	At the moment there is an unfair advantage to foreign vessels fishing off the northeast England coast as local vessels are required to fish using 100-120mm mesh nets under the terms of their fishing license, while foreign vessels use much smaller mesh sizes of 60-80mm. This would reduce discards of juvenile fish.
Socio-economic implications of policies.	<p>“...if you tie a fleet up for three months and you’ve got a special workforce effectively unemployed basically, alcohol use goes up, the divorce rate goes up. There are other implications down the road that are social...(and)...that has real economic implications” [Women in Fisheries];</p> <p>“If a community is going to be affected by a reduction in vessels, then clearly there’s going to be a reduction in onshore jobs as well, so there are going to be impacts on communities. Some parts of the United Kingdom are very isolated communities which are fully dependent on the fish industry. And such, yes, it might be useful to do some sort of total assessment of that as well. Not everyone is going to be retrained to do something else.” [Onshore Sector]</p>
A discard ban.	“...a land what you catch scenario” would mean that “...we can get an even better picture of what fish stocks are like.” [Women in Fisheries]
Implications of fuel costs and relative efficiency.	Higher fuel costs have caused restructuring in the fishing fleet – for example, more twin-riggers and less beam trawlers. What kind of impact is this having on the fleet as a whole and on fishing effort?
Amend the cod recovery plan.	Change the cod recovery plan so that all fisheries are not governed by “king cod”. What would happen if more diverse objectives were addressed?
Investigate economic objectives.	The new element involved in fisheries management – well, one of the new elements – is increasingly being driven in the direction of agreeing long-term management approaches which set the targets of the stock, but not economic targets – the economics is a big gap and social science is a big gap in what we do.

Scenarios to investigate	Detail/rationale
Investigate impacts of non-fishing marine activities.	Windfarms, aggregate dredging, oil extraction etc. And consider cumulative effects of all these. “Somewhere, somebody has to come along and...get the overlay and then you can start to see the true effect of all these different workings and the effects on fishing” [Managers].
Investigate fishing opportunities related to marine developments.	For example, shellfishery opportunities offered by windfarm developments.
Examine the implications of UK vs. EU measures.	What difference would applying measures at a smaller or larger scale have on achieving objectives?
Assess broader environmental and human impacts.	<p>Move away from a sectoral approach and taken an ecosystem approach – for example, windfarm development could reduce trawling opportunities but increase recreational fishing and it could have benefits for climate change.</p> <p>“...I’m a witness, as many people here have been, to the impact of the loss of the inshore fishing on the communities that for generations have lived on it; self-sufficient communities of people who depend very largely upon it...This form of fishing is probably the most pure form of sustainable fishing you can get, in a way – arguable but you know what I mean. But somehow no-nobody’s taken account of this fact, wherever decisions have caused inshore fishing to go into decline, nobody seems to have taken any account of the sort of impacts on people. They’re monitoring the environmental impact of it and so on and so on. And it seems to be part of what you’re trying to devise is how you can accommodate those factors in a balanced way so people can take full account in both a human and an environmental sense, then it seems to me you’re onto something really worthwhile, because it’s not what’s happened in the past. If your tool, the tool you work with, is sensitive to those sorts of things then you’d be doing a great service” [Environmental interests].</p>

2.6.6 Conclusion

Overall, the message was one of cautious support for the EFIMAS framework as an additional management tool, as expressed by a participant in the onshore sector focus group: “As a tool for bringing stuff together it’s got to be welcomed. But I think there’ll be a health warning with it. It’s not infallible, it never will be infallible, but it’s still a tool, along with all the other tools” [UK Onshore Sector 2006]; and by a member of the women in fisheries group: “Provided you were using it with the idea that it’s a model, that it’s not perfect, that there are different models being made and that it’s not gospel, I’d see it as being a useful tool rather than a not so useful tool” [UK Women in Fisheries 2006]. It was also perceived that the framework does have the potential to attract support from all stakeholder groups as long as inputs, the process and outputs are all regarded as valid. The variety of scenarios proposed by participants for investigation within the EFIMAS modelling

framework speaks to the general sense that this tool offers potential benefits for exploring fisheries management options and meeting designated objectives.

2.7 Overall conclusions

The UK EFIMAS Focus Groups have provided a useful basis on which to take forward EFIMAS to consult key sectors in other European countries. They provided a key opportunity to adapt the focus group guidelines and ensure that they cover all the key issues (Appendix 3 details lessons learned). They also provided useful lessons about the communication of this modelling approach to different sectors.

The focus groups have deepened our understanding of participants' perceptions of science, fisheries science, the use of science in fisheries management, and of computer modelling, all of which have a role to play in the transition of the EFIMAS modelling framework from theory to practice.

The focus groups also demonstrated that stakeholders' perceptions of science, fisheries science, and the use of science in fisheries management are all intertwined. Further, these perceptions underpin their response to the idea computer modelling in general and to EFIMAS modelling framework in particular.

Key issues include the reliability of data and of outputs; the communication of uncertainty; and the usefulness of outputs from modelling in the real world of fisheries management.

Participants' recommendations speak to these three issues and send a clear message to the EFIMAS team that models should be as robust as possible, that modellers must be clear in communicating the limits of models and their inherent uncertainties, and that models should have a practical application which can be of practical use to fisheries managers and other actors. A first step towards addressing this third issue would be take account of participants' recommendations for management scenarios that they would like to see explored, as detailed in Table 2.

A key recommendation that should not be ignored is the need to involve industry and managers, as well as other stakeholders where relevant, in the development of models and in their use. The credibility and legitimacy of these kinds of management tools is likely to be undermined if key actors are excluded from the process of their development and application. Buy-in to the output of modelling work within the EFIMAS framework will be of paramount importance to its eventual successful use.

Chapter 3: Report from the Irish Focus Groups

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3.1 Introduction

The Irish focus group interviews were performed during November 2006. The focus groups were comprised of representatives from the five fisheries management stakeholder groups listed in table 3.1.

Table 3.1: Focus group participants

Focus group	Number of participants
Catching sector	8
Onshore sector	7
Women in fisheries	7
Environmentalists	6
Local managers	6
Total number of participants	34

In choosing the locations of the focus groups it was hoped to attract at least 6 participants to each group. Therefore, it was important to locate the focus groups as close to the participants as possible to make it more convenient for them to attend. The environmentalists’ focus group was held in Dublin as this is where the majority of those participants were based.

Killybegs fishing port located in Donegal along the Northwest coast of Ireland was chosen as the venue for the other four focus groups given its importance as the largest fishing port in Ireland and the level of ancillary industry located there. The harbour is particularly important to the Irish bulk fishing industry, as it specializes in the processing and freezing of pelagic species such as mackerel and herring.

The focus groups were asked about their perceptions in relation to five themes (see also Annex 1):

- Science in general
- Fisheries science
- The use of science in fisheries
- Modelling in general
- The EFIMAS modelling framework

The responses of the different stakeholder groups vary significantly, depicting the different perspectives and knowledge that result from their different positions in relation to fisheries management. For example all in the environmentalists' focus group were trained biologists or natural scientists. This shows in their statements about science and the examples they bring up as compared to the other focus groups. Knowledge and concern about the social and economic consequences of management, on the other hand, were very present in the other four groups. For what concerns members in the catching sector, onshore sector, and women in fisheries focus groups, the knowledge and concern reflects the fact that their livelihoods are directly linked up to fisheries management. In the local managers focus group the awareness of consequences for fishers can perhaps be explained by the fact that it counts two representatives from fishers' organisations and a former fishing skipper.

However, the discussions in all groups were well informed and characterised by a high level of engagement. This probably reflects the fact that members in all groups from their different positions in the field of fisheries and fisheries management are confronted with fisheries science and modelling in their daily lives.

3.2 Science in general

<p>General perceptions</p> <p>Science is</p> <ul style="list-style-type: none"> - a methodological process and way of argument that follows a certain logic - reproducible - the systematic collection of data - presenting data - observation of life <p>Science is useful for</p> <ul style="list-style-type: none"> - producing reports, statistics, surveys, population work and baseline studies - recommendations - aquaculture, technology and testing <p>Science should be objective and unbiased</p> <p>Problems:</p> <ul style="list-style-type: none"> - Science is often manipulated in order to serve a particular purpose - This raises general scepticism towards science <p>Participants' recommendations:</p> <ul style="list-style-type: none"> - The raw data should be accessible in order to enable people to make their own judgements.

When asked about science in general, the environmentalists' focus group was the only group that talked about science in more general terms. Responses in the other focus groups were specifically about fisheries science. This probably reflects that all participants are closely involved with fisheries and hence that this is also where they have their main point of contact with science. For what concerns the environmentalists' focus group, all of them were trained biologists or natural scientists and hence had a broader entry to science. The participants talked about definitions of science, its

use, expectations to good science and problems with science in practice. In the following we discuss their perceptions on these issues.

3.2.1 Science as a process

According to members in the environmentalists' focus group 'science' refers to a methodological process following a certain logic: *"Science is different to doing something intuitively; there should be a logic you can stand over."* According to one member this logic among other things refers to the way of argument: *"Presenting an argument in a logical manner ..."* Another member referred more specifically to the logic of data collection – science is *"The systematic collection of data to be analyzed."*

Some members of the same group referred to reproducibility: *"Science can also just be a methodology, a rigorous methodology that can be repeated."* Or *"Being able to reproduce the data or being able to stand over the data in some way."*

While most focused on the methodological approach when defining science, some also stressed the empirical inputs: Science is *"presenting data"* (Ireland environmentalists 2006) – or, as one member of the catching sector focus group argued: *"Observation of life"*.

3.2.2 The use of science

When asked about the use of science, members of the environmentalists focus group referred to outputs like reports, statistics, transcripts, surveys, population work and baseline studies. One member also argued that scientists can use their work to come up with recommendations, and members of the onshore sector focus group referred to more practical purposes like aquaculture, technology and product testing.

3.2.3 Objectivity

When asked about their expectations of good science or fisheries science, members of the catching sector, environmentalists and local managers' focus groups argued that science should be objective and unbiased. However, there was a general concern about this often not being the case, as in this dialogue in the environmentalists' focus group:

E 1: In many cases there is a lot of bias in how science and data is collected and presented. And the whole argument that is supposed to come as a result of objective science is often the starting point rather than the end point.

E 2: The methodology has to be unbiased. But as it is people handling methodology you can inadvertently come out with a biased result having not applied totally correct methodology.

E 3: It depends on where the scientist and data is coming from and the bias of the person who is presenting the data, particularly with statistics.

What it takes to be objective and wherein the bias and manipulation of data persists when it is not objective was discussed in greater detail when the participants were asked specifically about fisheries science. This is unfolded in section 3.3.2.2 below. However, a member of the local

managers' focus group shared some general reflections about this. The participant differentiated between 'raw' data and the subsequent data processing:

I would share the view that in an ideal world, science would provide the factual foundation. The problem is that over time we have become quite cynical about the use and abuse of science, because that basic information is manipulated too often and used to serve a particular purpose. If the raw material produced by research is made available for people to make their own decisions then I think science is useful, however the manipulation of those statistics is what has created the scepticism over science.

The participant here seems to make some interesting assumptions. First the participant seems to state that the manipulation of data is something that happens after the initial collection of data, i.e. that the 'basic information' or 'raw material' is more or less free from manipulation. Secondly, the participant apparently argues that this raw material will be sufficiently accessible for lay people to draw their own conclusions. Finally, the participant seems to assume that people in general have the scientific capacity to make sense of unprocessed data – and that this would be a means of preventing manipulation and scepticism towards science. As we discuss later, transparency and the involvement of lay people in the research process was recommended by several participants as a means of addressing problems with political bias in fisheries science and reducing scepticism towards it. The above quotation with its underlying assumptions reflects some of the complexities involved in the discussion.

While objectivity seemed to be the main claim of scientific validity, then, in general there was a major discrepancy between the participants' perceptions about ideal science and their perceptions about actual scientific practice. For some participants this resulted in a general scepticism towards science. One recommendation in order to ensure objectivity was to let people have access to the raw data in order for them to be able to make their own judgements.

3.2.4 Conclusion

The focus groups' very different responses to questions about science reflect their different positions in relation to science and fisheries science. The environmentalists' focus group members were all trained natural scientists and the only group talking more extensively about science in general. Members in the other focus groups mainly talked about fisheries science, which is perhaps also their main point of contact with science.

Most focus group discussions were characterised by some degree of scepticism towards science. The scepticism became more outspoken when it came to fisheries science and the discussions became more specific. This probably reflects that this is where most participants have direct experience with science and its impacts.

3.3 Fisheries science

General perceptions

Fisheries science is

- about different species of fish, where they can be found and the amount of fish,
- a mix of common sense and science.

Good fisheries science is

- independent in order to ensure objectivity. To be independent it should
 - o be performed by people that do not gain personally from it and have a strong personality that can't be leaned on,
 - o be performed by universities,
 - o be performed by national research units,
 - o be performed by ICES,
 - o not be performed or funded by stakeholders,
 - o not be performed by national research units,
- following a sound methodology,
- contributing to good ends,
- involving fishermen.

Members in all but the women in fisheries focus group had extensive experience with fisheries science from different positions in the field, and members in all groups had strong perceptions about it. For the catching sector, onshore sector, and women in fisheries focus groups fisheries science is indeed very present in their daily lives – as a member of the catching sector focus group put it: *“We’ve actually been captured by the scientific data for the last while. It has dictated precisely what we’ve done over the last 20-25 years.”*

One participant defined fisheries science in terms of its field of study: *“It should be about different species of fish, where they can be found and the amount of fish”* (Ireland women in fisheries 2006). Another defined it in terms of its underlying logic, which was described as *“a mix of common sense and science. I would have thought more common sense and a scientific programme should be based on common sense”* (Ireland catching sector 2006).

The focus groups talked about their perceptions of good fisheries science, a number of problems with fisheries science, and stakeholder involvement in science. We discuss these in turn below.

3.3.1 Perceptions of good fisheries science

A number of factors were mentioned as the participants’ criteria for good science or for trusting science and will be elaborated on in the following. The participants claimed to trust science or perceive science as good on the conditions that

- the science is independent and objective,
- hereunder that the scientist has a strong personality that can not be leaned on,
- the science is trusted by governments,
- the methodology is sound,
- it is contributing to good ends, and
- the research process involves fishers.

Some of these criteria were mainly mentioned in the negative, i.e. as critique of science that does *not* conform to these criteria. Hence they are only mentioned briefly in this section and treated more thoroughly in section 3.3.2 where we discuss the participants' perceptions of problems with fisheries science.

Independence was the most important criteria mentioned directly or indirectly in all focus groups as crucial to objectivity and hence to their trust in science. Independence was generally understood as not representing or not being funded by groups or institutions with particular interests in the research outcomes – however, as discussed below, one participant also defined independence as the uncorrupted personality of individual scientists. The dynamics of political bias stemming from not being independent engaged many participants, and the discussions were extensive. This is treated more comprehensively in section 3.3.2.2 – here just some of the participants' general reflections about the importance of independence.

The general perception was that independence is crucial in order to assure that the research is objective and is not informed by particular interests in the outcome. One local managers' focus group member argued that if science is not independent, either it will be biased or it will not be trusted:

I think that it has to be self initiated, that it is coming out of universities, centrally funded research institutes and is not linked to industry, because as [another focus group member] said whoever pays, the piper calls the tune basically. And there is truth on a number of sides of that argument, some people could put out a very serious piece of science and genuinely look for the facts but the other side of that argument is that people are never going to believe it because they paid for it. So it defeats the purpose.

As with this participant, the general perception was that an important factor determining the degree of independence is who funds the science. Independence was thus most often ascribed to research or researchers on the background of the employer or institutional affiliation. Perceptions differed, though, with respect to which employers and institutions they found supportive of objective and independent research and which they found to direct the research by interests and political motives. A number of participants believed universities to be independent and hence trusted them to do science. One member of the catching sector also trusted the Marine Institute. Two other members of the same group claimed to trust the International Council for the Exploration of the Sea (ICES), a multi-lateral institution tasked with providing the official scientific advice for EU's Common Fisheries Policy (CFP). The debate about the impact of the funding source and institutional affiliation on bias and objectivity was extensive and is discussed in greater detail in section 3.3.2.2.

In this way most participants mainly defined independent science as science not being performed or funded by groups or institutions with interests in the research outcome. As we describe in greater detail below in section 3.3.2.2, where the scientist's personal motivation was mentioned as relevant to the degree of independence and objectivity, this motivation was most often claimed to depend on the funding source, not on the individual scientist. However, one environmentalists' focus group member also defined independence in terms of the scientist's uncorrupted personality irrespective of the funding source. The participant claimed to trust

Anybody who isn't going to personally gain from it. I have a ranking order. The highest would be those that do something because they think something should be done, if it's pure research. Particularly when it comes to consultants, I would say choose someone with a strong personality that can't be leaned on.

Independence from interests, be it due to the funding source or the scientist's uncorrupted personality, was thus the most important criteria for the participants' trust in science. However, a number of other criteria were also mentioned. One interesting argument for trust in science was introduced by a catching sector focus group member. The participant claimed to trust ICES among other things because governments and NASCO (the North Atlantic Salmon Conservation Organization) trust them:

Well, from our point of view, ICES has been good fisheries science. It's not arguable, because the data collection methodology is objective. Anything that a government actually accepts, even though some parts of the methodology and statistics may be questionable, the general picture that triggers action is good science. I don't think any of the countries involved in NASCO have not accepted the science.

This argument does not necessarily reflect the participant's perceptions about the objectivity of ICES' science or the participant's actual experience with it – first and foremost it seems to reflect a trust in the judgement of governments and NASCO.

Sound research methodology was also mentioned as a criterion for good science. This was particularly discussed by members of the environmentalists' focus group. The discussion is treated in greater detail in section 3.3.2.1.

One criteria for good science stands out in the focus group interviews as it is not about the science itself, but about its use. An environmentalists' focus group member argued that good science is science that contributes to good ends. The participant evaluated the science in a particular project as good

...because the methodology was sound and the end result was scientifically good and the implications of the study were good in terms of informing and empowering local people to do something about the control of this species.

Finally, participants from the catching sector, women in fisheries and local managers' focus groups all argued that research where fishermen are involved in the process is often good science. Some referred to the extensive knowledge of fishers, others to the importance of fishers' acceptance of the scientific basis for fisheries management – be it in order to ensure a just, democratic and politically legitimate fisheries management or to increase fishers' compliance with it. As fishers' participation in science was a returning issue in all of the interviews this is dealt with more comprehensively in section 3.3.3.

As it appears, the participants made very different statements about what good fisheries science is. For most of the participants 'good' means accurate, independent and objective and following a sound methodology. For some of them, however, it also refers to ethical issues in terms of being just, democratic or politically legitimate and contributing to good ends. As mentioned, most of these criteria will be treated more comprehensively in the following sections, as they were mainly

discussed as criteria that science in practice tends *not* to conform to, hence triggering general scepticism towards fisheries science.

3.3.2 Scepticism towards fisheries science

Problems

- Fisheries science does not correspond to the experiences of fishers.
- The advice of ICES is characterized by a high level of uncertainty. This is problematic when livelihoods are at stake.

Reasons for failures

- *Technical* – problems with methodology and data collection:
 - o Failing survey design.
 - o Fish don't stay in one place. This makes them difficult to observe.
- *Political science* – problems with science directed by political or personal interests:
 - o Science is informed by the eventual interests of those who fund it.
 - o Scientists can act as hired guns
 - o Stakeholder-funded research tends to be informed by stakeholder-interests
 - o ICES and member-state level research is policy-driven. For example,
 - research funding priorities direct what is researched and what is not,
 - the government is the main employer, and researchers and students don't want to burn bridges for their career.
- *Scientists' attitudes* towards their own research and towards fishers:
 - o Scientists think they are infallible and won't listen to fishers.
 - o Scientists do desk-work and have no practical experience.
 - o Scientists talk down to fishers.

There was scepticism towards fisheries science in all focus groups. In the catching sector, onshore sector and women in fisheries focus groups the definitions of fisheries science were generally in the negative. What was particularly striking was that several expressed fear for fisheries science. For example, one member of the catching sector focus group said that *"as far as the word science goes, it frightens me and a lot of others"*. A member from the same group that was also representative for an angling and recreation member organization stated that people tend to associate scientific evaluations with restrictions:

When the Northern Ireland review came along we were told that the government would use scientific data that would be used to assess the current situation and what the future holds. The immediate reaction of our members to this was that they were using scientific data to start up licenses for sporting purposes. This is a natural reaction from ordinary people. And I would have to agree with [another focus group member] that once you talk to our members about scientific evaluations they shy off.

These expressions are perhaps an outcome of their particular situation in relation to fisheries science, namely that they have – as expressed in the quote above – *"been captured by the scientific data"*, and that *"It has dictated precisely what we've done over the last 20-25 years."*

Besides from fear and a feeling of being captured by fisheries science, there was also a general distrust towards it. One member of the women in fisheries focus group stated that *"We as fishermen's wives are sort of programmed to distrust science."* This statement is interesting as it is

not attached to any argument about the quality of science, but merely to their particular situation as fishers' wives. However, it is not clear whether fishermen's wives are 'programmed' because they have stakes in the outcomes, have particular experiences with fisheries science or have particular experiences that contradict fisheries science etc.

The members of the onshore sector focus group also could not come up with any examples of who they trusted to do science - *"Scientists make mistakes. They all make mistakes."* These answers are not surprising as members of these three particular groups have direct experiences of science resulting in fisheries management with negative consequences for their own or their colleagues' livelihoods. However, scepticism was also outspoken in the local managers' and environmentalists' focus groups.

Both in the catching sector, onshore sector, local managers and women in fisheries focus groups the scepticism was among other things explained with reference to fisheries science not corresponding with the experiences of fishers. Statements like the following from an onshore sector focus group member were common in all four focus group interviews:

It has generally been in conflict with the day to day evidence of stocks. The so-called scientific reports of management of fisheries and stock levels don't seem tally with what the fishermen are finding on the ground.

Another complaint was that the level of uncertainty characterizing ICES advice makes it unreliable, which is particularly problematic when livelihoods depend on it. A catching sector focus group member stated that *"a lot of the advice from ICES comes with a plus or minus thirty percent at the bottom. That is a livelihood. There is a big discrepancy and that's not very factual."*

Fisheries science was perceived to conflict with fishers' experiences, to be inaccurate, and to have informed a failing fisheries management. A number of diverse reasons were put forward for the failures of fisheries. Roughly they can be divided into three main points of critique. One is directed towards technical failures – that is, failures related to data collection, methodology and analyses. Another is directed towards the political features of science, and a third towards the attitudes of scientists. These main points of critique will be elaborated on in greater detail in the following sections.

3.3.2.1 Technical failures

Several participants pointed to the failing methodology and data collection of fisheries science. A main concern in several groups was surveys not taking account of variations like the dynamic of the waters and the changing seasons when sampling. An onshore sector focus group member argued that

All the surveys done mainly on mackerel and herring by the Marine Institute are done in May, June, July and August but all the mackerel doesn't appear off our coastline from September until April. It is like doing a survey of swallows in the month of December.

In relation to baseline studies for Natura 2000 closed areas one member of the environmentalists' focus group stated that

... you get situations where consultants assess an area in a particular season and miss out on seasonal species, so seasonality not being taken into account is a huge problem.

Two members of the onshore sector focus group even argued that scientists chose the sampling seasons on the background of when they found it most convenient to go out on boats or when fishermen were free and willing to do the surveys.

The survey design was a main point of critique in most focus groups. However, a member of the women in fisheries focus group also pointed to the very object of study as a factor that complicates data collection. The participant pointed out that fish in the sea are difficult to observe: *“I think one of the difficulties is that fish don’t stay in the one place. In agriculture everything will stay put but in the sea everything moves around.”*

While there were many concerns about the data collection, few commented on the preceding calculations and the different theoretical frameworks in use in fisheries science. This might be due to data collection being more directly accessible and, for what concerns members in the catching sector, onshore sector, and women in fisheries focus groups, more directly comparable with their own everyday experiences with the resource. What is more, the data collection process is the main point of contact between scientists and fishers and fish workers.

3.3.2.2 Political bias

A central theme throughout all focus group interviews was the political dimensions of science. That is, the ways the fisheries science, its funding, presentation, manipulation, use or neglect is directed by political or personal interests.

As mentioned it was the general perception in all focus groups that, as a local managers’ focus group member put it, *“whoever pays the piper calls the tune”*. That is, that science and research is directed by the eventual interests of those who fund it. The funding was perceived by various participants to inform both what is researched and which conclusions and recommendations the research arrives at. A local managers focus group member even claimed that *“whoever is paying for the research gets the result that they want.”* There were particular concerns about both stakeholder-funded and government science, but also universities – although generally perceived as the most independent sources of science – were claimed to some extent to be interest-driven.

For what concerns stakeholders’ use of science, one catching sector focus group member argued that

Science is seen as a bad, dirty word where you can find your own scientist to produce a report to support your case. Scientists are seen as hired guns to negate reports from other scientists and to muddy the water.

As an example the focus group member, who was part of a lobby group, reported to have

... used science to say we want recovery or we want money or we want government action. But to the other side of the lobby science has been decimation, complete and utter wipe out and they have seen it as the end of an era and a livelihood. If the other side could use science to their own end then they would.

This description of scientists as mere representatives of their employers is very far from the scientific ideals of independence and objectivity agreed to by most participants. A similar argument was put forward by an environmentalists' focus group member who mentioned EIAs as an example of interest-driven research:

The most frequent and likely poor application of science is in EIAs. ... Because, in Ireland and many other European countries the environmental impact assessment is paid for by the developer. Very often port companies need an environmental impact assessment for dredging and often 'don't find' such things as wrecks or mud flats.

A perception among some participants thus was that stakeholder-funded research tends to be informed by stakeholder interests. As mentioned, one argument in support of this was that research should be done by universities or governments and not by stakeholders. Still, there was general support for some degree of stakeholder involvement in science. A catching sector focus group member for example argued that government science is just as enmeshed in politics. The argument was here that government science should be supplemented by stakeholder-driven research in order for stakeholders to be represented, to offer other perspectives on the issue or to conduct some kind of democratic control with science:

Ultimately it's a government funded report and therefore it can be politically interfered with. The lobby groups on both sides should have the opportunity to conduct their own analysis on the data that would be agreed as a basis or a measuring stick for future policy. Because we can't argue with scientists as once the data is found it's not open to question, unless you are lucky to have someone who is qualified in that area.

There were many other perspectives on stakeholder involvement in science – these are treated more comprehensively in section 3.3.3.

Even though science funded by stakeholders was generally perceived as the most interest-driven research, a widespread perception in most groups was that also ICES or member-state level research priorities are policy-driven. A catching sector focus group member directly stated that “*the consultant groups are being told the answer to come up with*” (Ireland catching sector 2006). Several referred to the political motives behind which research is funded and which is not. For example, one environmentalists' focus group member argued that

There can often be political objectives towards the research that is carried out by state agencies because the boards are appointed by a government minister. If you put 20 million into the health benefits of apples and 2 million into the health benefits of oranges then you are going to find the health benefits of apples are greater! You can skew the research that way.

The same argument was put forward by a local managers' focus group member who compared the dynamics of government research funding with science in the tobacco industry:

It is a little like the tobacco industry because they had all the money. The bottom line is that there was no research into the linkage between smoking and lung cancer because who was going to pay for it. So they were always able to say there is no causal link between the two. So if you don't do the research you are never going to get the results, even if everyone knows what the results will be likely to show. So is a politician going to justify paying for research that might underline his political position? Not in my experience.

These statements all refer to governments' intentional use of science for political purposes. One environmentalists focus group member, however, held that rather than being intentional manipulation it is simply a matter of having to prioritise sparse resources: *"It's not so much a case of being suspicious, it would be just that a lot of the state agencies are limited in resources by the department of finance and the time to do something."*

Besides from directing what is researched and what is not, research priorities of state agencies was also perceived by some participants directly or indirectly to bias the scientist in his or her work. Governments, a local managers focus group member argued, *"have a lot agendas and it's not necessarily in everyone's interest to be honest."* One of the environmentalists' focus group members with a natural scientific background claimed that *"You get more suspicious as you go along and there are very few who are beyond reproach or who won't cut corners for something."* The participant also argued that even students might be cautious about what they do, *"because if a student wants to get into an area they are not going to burn bridges in their final thesis."*

An onshore sector focus group member argued that even scientists not working for the government are biased in their work because in the long run the government is their ultimate employer:

If you take some guy who wants to have a career as a scientist, [the state is] his ultimate employer, the one who is going to give him a good job and a good pension. So does he become troublesome at the beginning and make a bad name for himself with his future employer? Because two things can happen, first of all he upsets them and secondly they become reluctant to employ him at a later stage. So there is no room for balanced science. To me science is a project to achieve the aims of Brussels.

A widespread perception in most focus groups, then, was that government funded science is also enmeshed in political agendas – partly because there are political motives behind which research is funded and which is not, and partly because scientists and students tend to be led by career considerations and other motives when they do research.

Members in all focus groups thus agreed that while independence is a precondition for objectivity, the main driver for dependence and independence is who funds the science. Most agreed that universities are most independent, government-funded research less independent and stakeholder-funded research the least independent. And according to some participants governmental research agendas are the most dominating as it also impacts research outside direct governmental control.

3.3.2.3 Scientists' attitudes

A third reason put forward for the failures of fisheries science is related to the attitude of scientists towards their own research and towards fishers. This argument was presented in the onshore sector, catching sector, and local managers' focus groups.

One complaint about scientists' attitudes was related to scientists' conviction about their own infallibility. According to a catching sector focus group participant, *"The one thing about scientists is that they don't like to be proved wrong. They are like the law and you are not supposed to question them."* Another member from the same group was concerned that *"there has been an over reliance on the science"*, and a local managers' focus group member claimed that *"Basically they seem to*

come out of their universities and think that they know it all, when the one thing they are lacking is practical experience.”

This attitude, it was argued among several participants, kept some scientists from listening to the experiences of fishers. According to a local managers focus group member such scientists

... seem to be pure scientists or just lack the communication skills, they do a project or produce a document and as far as they are concerned it is written in stone and you cannot have any input into it.

Several participants argued that this created the feeling of being talked down to and created mistrust among fishers towards scientists. The mistrust is for example evident in the following statement of a local managers' focus group member:

As a former fishing skipper, we have had very bad experiences over the years. If you ask any skipper of my age, they would say science is just a bunch of figures made up to suit the scientist. We could never say that we believed a scientist. There was no interaction between fishermen and scientists and I was never asked my opinion or what I thought should be done. They never talked to us but they talked down to us and told us what to do. I would say 95% of the fishermen in Ireland would tell you the exact same story although it is slowly changing.

As is elaborated on in the next section, these statements not only refer to ethical or political issues of democratic and just management – they are also about the quality of the science, i.e. that scientists should listen to fishers in order to do good science.

During the focus group discussions all participants thus expressed varying degrees of scepticism towards fisheries science. The criticism covered three issues: the methodology and data collection, the political bias of science, and the attitudes of scientists. Stakeholder involvement in fisheries science was by a number of participants perceived to be a means of addressing all of these issues.

3.3.3 Stakeholder involvement in science

Participants' recommendations

Fisheries science should involve stakeholders because:

- Fishers' experience-based knowledge is different from and in some respects more useful than theoretical knowledge.
- Due to their everyday practice fishers do more frequent samplings than scientists. This is required if one is to gain knowledge of a dynamic system.
- It increases trust, legitimacy and compliance both in relation to the science and in relation to the management informed by it.
- It is a means of ensuring democratic control with otherwise government controlled research.
- Scientists are safe and far from the consequences of their research. It is fair to ask those who will be impacted by it.
-

Notwithstanding the above, stakeholder involvement in fisheries science should be treated with caution because:

- Fishers have stakes in the outcome and will not always provide reliable information.
- For competitive reasons fishers are not always eager to share their information.
-

Stakeholder involvement in science can involve:

- Making the research process and outcome accessible so that everyone knows how it is conducted.
- Including fishers' own knowledge in the process.

A general perception put forward in all but the environmentalists' focus group interviews was that fishers should be involved in the research process. When asked about examples of good fisheries science, most came up with examples of research where fishers had been involved. Three different assumptions underpinned the argument, namely that fishers' involvement ensures 1) the accuracy of the science, 2) fishers' trust in science and compliance with the management it informs, and 3) a democratic, just and political legitimate fisheries management.

3.3.3.1 Stakeholder involvement for scientific accuracy

For what concerns the first argument about accuracy, a number of the participants in the onshore sector, catching sector, local managers and women in fisheries focus groups claimed that fishermen know certain things better than scientists due to the practical experience from their daily work at sea. As one member in the women in fisheries focus group said, *"We think the fishermen know best, they are there 24-7."* Scientists, on the other hand, were by some claimed to have no direct experience and to have achieved all their knowledge at school. A women in fisheries focus group member claimed that

... it's hard to get true facts. It's like sending a nurse to college to learn how to nurse when she is not on the shop floor nursing, she can't do it. Or sending a scientist out to find out about fishing, when he's not hands on as a fisherman is.

The everyday practice of fishers was by members of most focus groups perceived as central to knowing about fish and fisheries. First of all participants referred to the *kind* of knowledge, i.e. that fishers' hands-on experience is different from and in some instances more useful than knowledge achieved in school or by modelling and other kinds of desk work. A more concrete example of this

was given by a catching sector focus group member. The participant complained that scientists would not listen to fishers' knowledge about how mesh sizes work in practice:

From my own experience from talking to fishermen, controlling mesh sizes just doesn't work as diamond nets just close up under tow. Yet scientists say that larger mesh sizes result in younger or smaller fish escaping.

A second difference stressed by a women in fisheries focus group member is the frequency of the samples: The everyday practice gives fishers a daily update, which the participant perceived as important to knowing about a constantly changing environment. Scientists "are only seeing what's going on on a certain day when there may be very little caught."

Notwithstanding the arguments for fishers' involvement in science, some stated that the stakes fishers have in the outcomes of fisheries science are an obstacle to getting reliable information from them. As an example one catching sector focus group member mentioned the stakes of fishers' representatives in the Regional Advisory Councils which have a yet to be determined advisory role in relation to the EU's fisheries policy:

The problem with the RACs is that the delegates are fishermen's organisations etc. and they feel obliged to resist any cuts or restrictions in catch for the people they are representing. So there is a bias there straight away.

A member from the same group stated that fishers with particular interests in the research outcome would be encouraged to misinform the scientists:

The fisherman can take scientists to particular locations depending on whether they want to show them good or bad stocks. The scientist is reliant on the fisherman to be objective too.

Another obstacle that was mentioned in relation to getting accurate information or information at all from fishers is that they are not always eager to share their information. The quotation here from a catching sector focus group member is about anglers:

... there is no way you are going to get accurate data within our own fraternity and it's presumably much more competitive in the commercial sector. And if you find a good patch you are not going to let it go into a report that will be published.

Despite these obstacles, the general perception put forward in most focus group interviews was that fisheries science involving fishers would be more accurate.

3.3.3.2 Stakeholder involvement for trust, compliance and legitimacy

A second and more widespread argument for involving fishers in research was that fishers' participation in science increases trust among fishers in fisheries science and hence encourages compliance with the management it informs. First of all, fishers' trust in fisheries science was seen as highly dependant on the degree of their involvement in the research process. For example a catching sector focus group member stated that:

The only way you can get trust is through stakeholder involvement from the very start, rather than just producing data at the end. If all parties get involved from the initial stages and have an input, such as the RACs', then you can develop trust and get better data too.

The same message was put forward by a local managers' focus group member who stressed that it is the particular research process, not the person or agency doing research, that creates trust:

Rather than who do you trust, how the science is done or how it is compiled is perhaps a better way of putting it. If you could include everyone in it and start from the bottom up then you might trust it more. Like in fisheries for instance, if you take everyone's views and you are working together rather than someone coming along saying there's your plan, there's the science and this is how I see it going forward, take it or leave it. Then you don't trust that person or that science but if everyone is included from day one there is a good possibility it will be trusted.

According to a catching sector focus group member, such an inclusive process did not necessarily have to involve fishers' knowledge in order to build trust. What is important, it was stated, is that "everyone is involved in it and knows what's going into it, how it's conducted and the reason behind the science." However, most participants recommending fishers' involvement in science perceived it as more than a process of mediation from scientists to fishers. They stressed the importance of taking fishers' knowledge into consideration.

Secondly, a widespread perception in most focus groups was that fishers' trust in fisheries science is closely connected to their compliance with the fisheries management that it informs. If fishers are not included, one member of the women in fisheries focus group argued, "They are taking their own lead, coming up with things and passing the law." A catching sector focus group member argued that

... you are asking people to buy into something they know nothing about. Otherwise it's a take-it-or-leave-it scenario when people are told that's the science (which may or may not be factual) and you are asked to buy into it. If people know about the science and what's going on then they are much more likely to buy into it.

An inclusive research process was among other things claimed to put aside the acrimony among those whose resource use is restricted. A concrete example such of a participatory research project that encouraged compliance was given by a member of the local managers' focus group:

The fishermen met the scientists and told the scientists when the area should be closed, when the juvenile fish were there and how it should be approached. The scientific body backed it up and collectively they worked on it. It turned out to be a very good project. The fishermen moved away from the ground when the fish were spawning or juvenile and came back when the cod were bigger. That type of bottom-up approach seems to work.

3.3.3.3 Stakeholder involvement for a democratic and just knowledge base

Finally participants argued that stakeholder involvement in science is central to ensuring a democratic and just knowledge base for management. As quoted in section 3.3.2.2, one argument put forward by an onshore sector focus group member is that while science is just as "politically interfered with", stakeholder involvement can be a way to ensure democratic control with the research. As a consequence of the political bias of governmental science, the validity of science here becomes a question of democratic representation rather than of objectivity and independence.

A related argument put forward by an onshore sector focus group member was that fishers should be involved in science because they are the ones that will be impacted by the management. Scientists are safe and far from the consequences of their actions; "these people have no idea of the consequences of their actions, the consequences on communities, the knock on effect of poor science,

part science or their science." This argument also builds on the assumption that science is informed by the personal interests of scientists.

To sum up, participants argued for stakeholder involvement in science from three perspectives:

1. In some respects fishers know more than scientists. Their involvement in the research process will ensure a more accurate knowledge base for management.
2. There is a close connection between fishers' compliance with fisheries management and the degree to which they trust the science behind it and have been involved in the research process. Fishers' involvement in the research process will ensure a fisheries management that is more efficient and backed up by fishers.
3. Government science is informed by political agendas, and scientists are informed by their own personal perspectives. Fishers' involvement in the research process will ensure a more democratic and just knowledge base for management.

Even though many participants claimed that fishers' involvement in science is important, very few members of the women in fisheries and catching sector focus groups could recall having had interactions with scientists. One of them claimed that *"you never really seem to hear much about it"*; another was *"struggling to think of any time when I've seen fisheries science"*. However, one catching sector focus group member stressed that fishers surely want to participate. The fishers in the participant's local area *"took the scientists out to sea at no charge, and some of it was even funded by the Killybegs Fishermen's Organisation. And fishermen want to take part in these studies."*

3.3.4 Conclusion

All focus group discussions on fisheries science were characterised by a high engagement in the subject and strong perceptions. What is more, most participants came up with multiple examples to illustrate their statements. While addressing fisheries science from very diverse perspectives, all focus group discussions were characterised by some degree of scepticism towards it. Particularly striking was that some even expressed fear for science with reference to the impact it has on livelihoods. According to the participants, the problems causing scepticism was technical failures in the research process, political bias in science, and a widespread arrogant academic attitude among scientists. Stakeholder involvement in science was by members in all but the environmentalists focus group advocated as a means of addressing a long range of these problems.

3.4 The use of science in fisheries management

General perceptions

Management must be backed up by science in order to:

- Ensure the ecological soundness of management.
- Ensure that management measures with drastic consequences for stakeholders are only enforced when there is a sound scientific basis for it.

Problems:

- Management is often enforced with no scientific basis. This results in:
 - o Management with no ecological effect.
 - o Lost livelihoods for no good.
 - o Fishers not accepting and complying with management.
- Managers and officers tend to resort to the precautionary approach when interpreting science.
- Science is used to support interests in management.

When asked about the use of science in fisheries management three issues came up. The first was about the general perception that it is important that management is backed up by science and a number of concerns about the consequences of this often not being the case. The second was a concern for the precautionary interpretation of science in management, and the third a concern for the use of science to support interests in management. The three issues are discussed in turn below.

3.4.1 The scientific basis for management

Members of the environmentalists', local managers' and catching sector focus groups shared the perception that science should form the basis for fisheries management measures. The points that were made are centred on two issues. One is about ensuring the ecological soundness of management; another is about the legitimacy of management.

For what concerns the ecological soundness, a catching sector focus group member stressed that the government should listen to science but do not always do so:

Well when you look at the salmon numbers everyone acknowledges the way the graph is going. That should trigger government action. Over the last 4 years there has been 30 million in a kitty to develop the nursery pool habitat that is being ignored. Government is not reacting to science leading to frustration on all sides.

Likewise several argued that the management measures that are in fact taken should be backed up by science. For example, an environmentalists' focus group member stressed the importance to assess the needs for and effects of management measures in order to make sure that the right steps are taken. The participant gave an example of a 2 months closure of an area that was not followed up with assessments:

One example recently at the NWW RAC, there has been a closure off the Trevoze head where fishermen came forward to close an area for 2 months to all fisheries because it was a known spawning ground. It was closed and respected but no assessment was made and now the Commission has suggested a recovery for the whole area is put in place. The fishermen asked the

scientists what assessment was done and they were told nothing had been done because they weren't asked. There was no link-up between what was happening on the ground and the scientists.

A sound scientific basis for management was thus perceived by some participants to be crucial in order to ensure that the right management steps are taken in relation to conservation and stock recovery.

For what concerns legitimacy, participants argued that management measures must be backed up by science in order to be perceived as legitimate by those it applies to. A local managers' focus group member gave an example of a blanket closure that was not substantiated scientifically:

Looking at it very generally, bad science, or maybe the bad implementation of science would be where if you take a blanket closure of a particular area on a political basis with no scientific back-up of that closure. It was done purely for a political reason. For example, the cod closure off the west coast here. Very little science was done on that but because of the whole 'cod is being wiped out - we must do something' so there is a blanket closure.

Hence, lack of scientific back-up was by some members used as an argument for the lack of legitimacy of cuts and closures, and the perception that such management is 'political' or 'a political appeasement' was shared by members in the catching sector focus group. Some members of the local managers and catching sector focus groups particularly perceived scientifically approved legitimacy to be central when management measures have drastic consequences for livelihoods. A catching sector focus group member stated that *"If they are going to do something drastic like this – close down and limit the income of people ... – they have to come and give the appraisal, something more than one line and it probably has to be scientific."* What is more, several argued that this scientific basis for management measures must be sound. A member of the same group argued that

... if the science they are putting up is not factual then of course they are not going to accept a cut, and that is what's happening. You are talking about ICES there but when they come in with a one-liner saying no cod fishing, when there is no basis for it, that is not acceptable.

This point tended to be accompanied by arguments about compliance – that is, that cuts and other management measures with consequences for fishers' livelihoods must be well supported by science for the fishers to comply with it. As this catching sector focus group member argued:

We are not saying we don't want any cuts. If the science is backed up and the stocks are down the fishermen will be the first to introduce conservation.

Whereas members of the environmentalists, catching sector and local managers' focus groups shared the perception that management should be backed up by science, then, the reasons put forward differed slightly. Members from the environmentalists' focus group mainly pointed to the need for ecologically sound fisheries management. While this was also central to members from the catching sector and local managers' focus groups, the argument was put slightly different: Science must ensure that management steps with consequences for livelihoods are only taken when there is a sound ecological basis for it. What is more, a sound scientific basis for management was also believed to be crucial for fishers' acceptance of and compliance with it.

3.4.2 Precautionary interpretation of science in management

Members from the onshore sector focus group in particular complained that managers and local officers tend to resort to precautionary interpretations of science in order to cover themselves. The concern was not directed towards scientists; *“You know, the scientists that brought it out they probably have the best intention of a scale.”* Rather, it was the implementation of the science that raised concern. They were mainly referring to officers in the onshore industry:

People at the level of officers on the ground cover themselves. They go to the extreme on everything because they don't want to take a chance. So if it means closing you down over a very small thing they will sooner do that than take a chance so it doesn't reflect back on them.

3.4.3 Science is used to support interests in management

Finally, some members mentioned the use of science to support interests in management. A member of the catching sector focus group argued that in order to use science, *“I would need to know personally what it can do to help my end of the business”* (Ireland catching sector 2006). Other examples given by the participants to illustrate the use of science to support interests are mentioned in section 3.3.2.2. These political drivers of science, be they informed by government, stakeholders' or scientists' personal interests, contributed to general scepticism towards science in all focus groups. For example, a member from the catching sector focus group described scientists as *“hired guns”* and argued that as a consequence *“Science is seen as a bad, dirty word”*.

3.4.4 Conclusion

The general perception in all focus groups, then, was that the main task for science in fisheries management is to form the basis for management measures – be it in order to ensure ecological soundness, legitimacy or compliance in relation to management. However, some expressed concern towards the ways science is used in practice – i.e. the lack of reaction to alerting stock assessments, precautionary interpretations of science in the implementation process and the use of science to support interests. The latter concern was particularly outspoken in all groups.

3.5 Modelling in general

General perceptions

- Models simulate reality and forecast the effects of different scenarios
- The predictive ability of models is useful
 - o before investing in something,
 - o when planning or following up on major changes, and
 - o when assessing environmental impacts.
- Models can act as a participatory tool.
- Models can be used as retrospective evaluations of failing management.

Problems

- The use of models is inappropriate when the purpose is
 - o to use up funds,
 - o to drag the political process or confuse people to exclude them from the process,
 - o to sell unpopular initiatives, or
 - o for managers to come up with seemingly exact outputs that you can act on – as opposed to the scientists' less definitive answers.
- A model is only as good as what goes into it - its success depends on the quality of two kinds of input, namely the basic assumptions it is based upon and the data fed into it:
 - o *The data* used in modelling is often of bad quality.
 - o Political motives sometimes inform the selection of data.
 - o *The basic assumptions* tend to be generalized, failing to marry up pure science with day to day practicalities.
 - o If the basic assumptions are wrong, it will not help that the proceeding calculations are correct.
- Models are theoretical desk-work and does not allow for inputs like the intuitive and experience-based knowledge of fishers.
- Models tend to be ascribed too much authority.
- Different models on the same issue can come up with very different outputs. It can seem accidental which one is chosen. And if so, why trust either?

Participants' recommendations

- Models should not be ascribed too much authority. They should merely be seen as part of the process and be supplemented with other inputs.

Many of the participants' statements about models reflected their perceptions about fisheries science in general. During the focus group discussions, the participants expressed their perceptions about what a model is, their own experiences with using models, what models can be used for, when the use of models is inappropriate and finally their perceptions about problems with models. We discuss these in turn in the following.

3.5.1 Simulation and scenarios

According to participants from the onshore sector, catching sector and local managers' focus groups a model does two things: First, it is a 'simulation' of reality. Secondly, it forecasts the effects of different scenarios - according to an onshore sector focus group member "*You can forecast knock on effects by changing some variables to see what happens.*" A catching sector focus group member gave some concrete examples of modelling scenarios: "*What would happen if there as an increase in*

fishing mortality or if there was an increase in catch rates then what would happen.” According to a local managers’ focus group member the forecasting can be used to search for scenarios that gives the requested effect: *“It’s sort of role play to achieve an outcome”*.

3.5.2 The participants’ experiences with models

Members of the onshore sector generally did not have any experience with models – one stated that *“I don’t even turn on a computer.”* Conversely only one member of the environmentalists’ focus group had not been using models. This is probably due to all of them having a background as biologists – the models they had been using were all biological, i.e. *“flooding models and estuarine models”, “Climate change models”, “Sewage discharge, plume dispersal, dredge spoil”, “GIS based models, the impacts of tourists on national parks”, “Stock assessment models and fishing activity models based on VMS data.”*

Some members of the local managers’ focus group had been using economic models. One participant had for example been using financial modelling:

If you are investing in anything you want to understand the worst case and best case of what is going to happen over the next year, two years or five years time. In one business I am involved in, the consequences of stress on metal are critical. So you want to run models to see under certain circumstances of use at what point is it going to break, and will it break sooner if you use this type of metal and will it break later if you use a different type and how much will that cost. So you are trying to anticipate what will happen in the future under certain circumstances.

A catching sector focus group member who was part of a lobbying group also had experiences with modelling:

We work with the North Atlantic Salmon Fund using the North Atlantic model that interprets the ICES data which estimates how many fish will be taken by each sector. This helps us know what we need to do at a river level.

As it appears and perhaps not surprising, the participants’ experience with models was closely related to their occupation. Only members of the environmentalists’ focus group had extensive experience with models, and they had mainly been in touch with biological models. Members of the local managers’ focus group had very little experience with modelling, and the rest of the participants except one in the catching sector focus group had no experience.

3.5.3 The usefulness of models

When talking about the usefulness of models, several mentioned their predictive ability. This was seen as useful in different contexts. The local managers’ focus group member above mentioned modelling before investing in something. Another member from the same group stated that modelling is useful in relation to major changes: *“If you are going to attempt to make any major change or if a major change has already taken place then you should follow that up.”* A catching sector focus group member mentioned some concrete examples of scenarios modelling could explore: *“What would happen if there was an increase in fishing mortality or if there was an increase in catch rates? Then what would happen?”*

Environmentalists' focus group members perceived modelling useful for "population impacts", "as a predictive or diagnostic tool", for "prediction and populations in the context of invasive species", "to look at the level of treatment required for sewage outflows" or "when they are needed to predict a certain outcome or manage the way forward".

Again the environmentalists' focus group members particularly mentioned situations related to biological modelling – however, one member also perceived models to have a potential participatory role to play: "For example, taking people out of old social housing and letting them see the 3-D models of potential new houses, so using models in a more participatory role."

A local managers' focus group member suggested that models can be used to back-test retrospectively to learn from the past, for example to consider what went wrong when management has failed and what could have been done to prevent it. The member argued that this among other things could serve to cure fishers' lost faith in management by showing that past failures are taken into consideration as well as future consequences:

At one stage, certainly within a generation of memory there was a fleet of lobstermen in the Swilly. Now there is one person that throws pots here and there because that is all that's left. ... What happened? Everyone has an opinion but none of it is scientifically based and it depends on the bias. ... There are all sorts of rural mythology to explain what has really happened to change things in the marine because we have no real knowledge about anything and no one tells us anything. So if you talk to the fishermen, they just get told that their quota is off. ... I think it is hard to over estimate the level of cynicism among fishermen in Ireland. I can't really speak for anyone outside the Swilly but in that part of the world I can tell you that they are so cynical about anything coming from the authorities because they just don't believe them anymore. So ... I think if you were able to go back and be able to say that this is what probably happened, because there is no way to establish any certainty to that. Now if we wanted to re-establish a lobster industry in the Swilly this is what has got to change because this is what destroyed it in the first place. ... But if we don't know what caused the damage in the first place, how are we going to make sure that we avoid it in the future. So that is why I think going back and saying how could we have managed this particular part of the coastline differently to achieve a different outcome and using that knowledge, see where we go in the future.

Thus a number of participants found modelling useful in order to improve management. Where the environmentalists' focus group members particularly talked about taking future consequences for the ecosystem into consideration, the other focus groups – the catching sector focus group in particular – also talked about the consequences for the fisheries.

3.5.4 Inappropriate use of models

Members from the local managers' and environmentalists' focus groups also mentioned a number of occasions where modelling would be inappropriate. All examples that were mentioned were about the purposes for using models. For example, a member from the environmentalists' focus group claimed that modelling is sometimes used to use up funds:

When what you should be doing is staring you in the face and it is used to use up funds and time. When I was in Kosovo the scientists came in and modelled various things when the funds could have been better spent directly on immediate measures such as schools and local management which would vastly improve the situation.

Another member of the same focus group claimed that modelling is often used to drag the political process:

There is a general tendency, particularly when there is a political dispute over something modelling is used to drag it out over a longer period. For example with the nitrates directive, the evidence was there and the information and pollution levels had been collected but it was renegotiated under pressure by the farming lobby so they drew up new models.

In the environmentalists' focus group it was argued that modelling is sometimes used to confuse people, push them out of the political process and get something through:

It's my feeling that if you throw a big enough model at a problem it will confuse enough people and many won't understand it and will not participate. This reduces the numbers that get involved and increases the likelihood of getting something through.

In line with some of the concerns for political uses of fisheries science in general, a local managers' focus group member claimed that "... models can be taken to sell something, in the same way as science. It's all about who pays for the model. ... So models are like everything else, they can be manipulated."

Finally, a member of the same group claimed that models are also inappropriately used by managers because they come up with seemingly exact outputs that you can act on, whereas scientists would otherwise be less definitive in their answers:

If you were to speak with any scientist with integrity their problem is that they will never give a definitive answer so in an effort to try and take that on board the people who have to implement the science use the model and that is where a lot of the problems and distrust come from.

Thus environmentalists' and local managers' focus group members gave several examples of occasions where the use of models would be inappropriate, most of them occasions where models according to the participants have in fact been used. Hence, notwithstanding the positive perceptions about the potential use of models, there was some scepticism towards the actual use of modelling.

3.5.5 Problems with models

Besides scepticism towards particular uses of models, members from the catching sector and local managers' focus groups in particular also expressed scepticism towards the validity of the model itself. Most of the concerns raised reflect the concerns that were expressed in relation to fisheries science.

A local managers' focus group member reminded of the shortcomings of desk-work modelling as opposed to the qualities of fishers' experience-based knowledge. As a consequence the participant stressed the importance of merely seeing the model as part of the process:

I have huge respect for long term fishermen, what they know from intuition about weather conditions and where the fish are has very little to do with science and a lot to do with experience. The problem is with a lot of sophisticated mathematical modelling it doesn't allow for that kind of input, so it's not supposed to work that way because that's not the way the model is designed. Well sorry, that's not the way nature works all the time. So a sophisticated mathematical model as a dashboard for what

may be happening is one thing, but as a rule book for the way things should happen – I think those are two very different things. And I am not sure that in the history modelling for various things in the coastal area has gained a lot of respect, because they get it wrong so often.

This quest for humility towards models was particularly shared among members of the local managers and catching sector focus groups. Nevertheless, one catching sector focus group member argued, models were often ascribed too much authority – *“Computer graphs, or graphics are presented to us with various bells and whistles.”*

One argument in the quest for humility was that the model’s success depends on what goes into it – as a local managers focus group member put it: *“I am not saying that a sophisticated mathematical model is useless, but it is garbage in, garbage out.”* Two kinds of input were mentioned in relation to this: The basic assumptions of the model and the data fed into it.

The basic assumptions were by a local managers’ focus group member perceived as the most important factor for the success of a model. If the basic assumptions are wrong, it will not help the model that all the proceeding calculations are accurate. As an example the participant argued that

... if we make the assumption that water temperature is not relevant to cod breeding, but we know that’s rubbish even though it’s an extreme example ... it only has to be out by half a degree over a long enough period or whatever was wrong with the one in the mackerel fishery. It may not have been distorted very much at any one point but that becomes magnified over a longer period.

In line with this, a concern towards modelling raised by a local managers’ focus group member was the tendency to generalize the assumptions and hence failing to *“marry up the pure science with day to day practicalities”*.

For what concerns the data input, particularly members of the local managers’ and catching sector focus groups held that *“the model is only as good as the data that goes into it”*. What is more, the reliability of data collection both in relation to modelling and to fisheries science in general was questioned in most focus groups. One catching sector focus group member gave an example of the use of unreliable angling catch data in a modelling process:

There’s one thing with angling clubs though, as they are local clubs everyone knows what everyone does and the catches were always reasonably well known, but that data was never used. However, when the tagging system came in 2001 we asked for that sort of information to be included as well. However, because the department didn’t want to involve clubs and get into the politics with clubs every angler should post their catches into the department at the end of the year. This went from a situation of our rivers recording 400-500 fish per year in the first year it only showed 78, because people didn’t return their tags. What I’m saying is that this was a bad model to use, as against an existing data source that was there.

One reason put forward for the unreliability of data in modelling was politically motivated selectivity in the collection of data. A member of the catching sector focus group gave an example of the selection of salmon data:

What happens when data is used politically is that it’s changed around and used to suit the people who are requesting it. From my point of view Salmon is different because the production unit inland has never been assessed, even though it’s right there in front of you on the river beds and you can have very close, accurate data. For all the hard evidence and reports there, there are no accurate

ones or no refinement of data. Right up to this year they didn't want any more damning data that would add fuel to the fire of having no replacement, diversification or buyout money available for an industry that has been closed down.

The scepticism towards data used in modelling, i.e. the discussion about scientists' theoretical desk-work versus fishers' experience-based knowledge, the quest for humility towards data and the concern for politically motivated selectivity in data collection, is very much in line with the scepticism towards data collection in fisheries science in general.

Much scepticism, then, was directed towards the inputs in the model. Another concern was the model itself. A member from the local managers' focus group argued that different models can produce very different outcomes, and that it can seem rather accidental which model is used. This raised scepticism towards the validity of the model:

It's the different models that are going to be the issue, and how they are run. Again I go back to the example of the mackerel fishery two years ago. ICES were running their models for the past 15 years in a particular way and the quotas were going up and down. Then they had to bring in peer reviewers from Canada. They said that they had been doing it all wrong and therefore there was a 27% cut in one year. So where is the faith there? And that was just because they said our model is right and your model is wrong.

Very much in line with what was expressed about the use of fisheries science in general in management, the participant argued that the lack of validity of the model was particularly problematic as it formed the scientific basis for cuts with drastic consequences for fishers' livelihoods:

But that had a serious impact on the fishermen, their livelihood and the entire community, but no regard whatsoever was given to that. Just because one or two scientists felt that it should be done a different way. So who is right, who is wrong?

Hence, just as with fisheries science in general the scientific validity of models were by some participants perceived as central to the legitimacy of the management they informed.

Particularly members of the catching sector and local managers' focus groups, then, were sceptical about models. Their concerns were both directed towards the inputs, namely the basic assumptions and data, and the model itself as different models produces very different outcomes. These concerns also raised questions about the legitimacy of the management based on modelling.

3.5.6 Conclusion

Few participants except the environmentalists' focus group members had extensive experiences with using models themselves. However, members in the catching sector and local managers focus groups knew of several examples of the use of models in fisheries science and fisheries management, and many participants had strong perceptions about models and their use in management. When asked about their potential use, many participants pointed to their predictive abilities – however, there was some scepticism towards both their inappropriate use in practice and towards the validity of some models. The participants' perceptions of models in many ways reflected their perceptions of fisheries science. For example, there was a particular concern for the political use of models or the political selection of the data used in modelling. And as with fisheries science, some participants stressed the

limitations of the theoretical desk-work of scientists in their work with modelling, the qualities of experience-based knowledge of fishers and the consequent need to incorporate fishers' knowledge in the process.

3.6 The EFIMAS modelling framework

During the focus group interviews the participants were given a PowerPoint presentation of the EFIMAS modelling framework (see Annex 2). After the presentation they were asked to share their thoughts about the model. During the earlier stages of the interviews the participants put forward a range of potential uses and a range of concerns for models in general. Some of these might also apply to the EFIMAS model. However, very few commented on the particular EFIMAS modelling framework other than asking questions. The modelling framework is very complex, and the model presentation held during the interviews was kept in rather general terms. The fact that very few commented on it might be due to many participants having difficulties with understanding the details of the model. However, this did not prevent them from coming up with general recommendations for how to make modelling inclusive and make suggestions for simulation scenarios that could be explored in the modelling framework. In the following we present the questions raised to the modelling framework, the participants' recommendations for how to make modelling an inclusive process, and their suggestions for simulations to be tested in the framework.

3.6.1 Questions about the EFIMAS modelling framework

After the presentation, a range of questions were asked in the different groups. The questions perhaps reveal some uncertainty among the participants about what the framework is about. They can provide guidance in what the participants find relevant and how the model should be mediated in order to get an informed dialogue with stakeholders. The questions addressed very different issues – they were about the variables, the comparability between diverse types of variables, the geographical scale of the model, the institutional affiliation of the model, how it will be applied if at all, and the time scale of the project. The questions are displayed in Box 3.1.

Box 3.1 - Questions about the EFIMAS modelling framework

Variables:

- “Is it based on a single or multi-species model, fleet or what?”
- “Predator-prey relationships, can they be taken into account?”

The comparability of variables:

- “If you are going to allow input for all stakeholders, are there any degrees of information that can go into it? For example, the economic data (first point of sale), how is that going to be matched by people in the angling end of things. Will they be comparable?”

Scale:

- “Is it from international to local level?”
- “Do you apply it to a particular area or location?”

Institutional affiliation:

- “Is this an independent body? Where is this going? Is it something that you are doing to recommend to government or is it something that is the request of Europe or government?”

Implementation:

- “Will the government take it on board?”
- “How will it be applied?”

Project time-frame:

- “How long would it be envisaged that the project will be going on before the results can be produced?”

3.6.2 Participants’ comments on the EFIMAS model

Apart from the more concrete suggestions for simulations that are displayed below, one participant came up with some more general thoughts about the use of the EFIMAS modelling framework. According to a catching sector focus group member fishers do not want to buy into management measures if they are based on bad data and it is uncertain whether it will work. Hence, the participant found the EFIMAS model useful if it could project future consequences of management measures:

10 years ago we had the salmon management taskforce report that convinced nets men to buy into a recovery programme and they feel very hard done by because they bought into something that never materialised. There was no 20 year plan that said only a certain portion of your industry will be able to fish this resource in 5, 10 or 20 years. There were no graphs really to say this is what we plan for the next 20 years. It may not work out but this is what we want you to buy into. In our case we’ve gone down to the root and it won’t come back for a long time. And when it does it has to be a sustainable practice and can’t be fished in the same manner. If this EFIMAS project can project what might happen 15 years down the line then...

The task of the model seems here to be to prevent management failures and ensure a higher degree of acceptance among fishers towards management. The same suggestion about preventing management failures was brought up during the discussions of models in general in all focus groups when asked about the usefulness of models.

3.6.3 Participants' recommendations for an inclusive modelling process

Participants' recommendations

Stakeholders should be involved in the modelling process. This can be done by:

- *Including fishers' knowledge*: Fishers' knowledge is intuitive and experience-based, modelling is theoretical and mathematical. Models should be treated as part of the process rather than the final output, and the process should be open to other kinds of input, particularly from fishermen.
- *Making the models accessible*: The basic assumptions, reasoning and inputs behind the modelling outcome should be made accessible to expert peers and outsiders in order to allow critical scrutiny and dialogue on the validity of the model.

As described, members of most focus groups pointed to stakeholder involvement as a means of addressing some of the failures of fisheries science in general. Likewise some participants argued for stakeholder involvement in the modelling process, and a number of concrete recommendations about how to do this emanated from the focus group discussions. Two different kinds of inclusion were suggested. The one was to include the fishers' knowledge – either in the modelling process itself or as a supplement to the modelling. The other was to make the modelling accessible in order to allow stakeholders and experts engage in dialogue about their validity.

The first suggestion about how to include fishers' knowledge was the least concrete. A women in fisheries focus group member simply stated that:

I think the fishermen know themselves what should be done. It's them that you need to talk to. You need to try and get them to work together with the scientists.

Likewise a local managers' focus group member argued for the importance of allowing for other kinds of inputs, particularly from fishermen:

... I think that the cumulative knowledge of the people engaged in the fishing activity around the coastline to me is of a lot more benefit than the most sophisticated, theoretical model. I would say a model is probably useful because you've got so many variables to plug into it that you can't – no human can compute all that. And I think it does makes sense to put all that in and try and see what that means and understand that, but there needs to be a lot of tolerance for adding other common sense judgements into that process. Rather than a 56 page document lying on your desk signed by the minister saying this is how the world is going to work for the next ten years. I think that using the model as part of the process rather than as the definitive outcome is a more sensible way.

The second suggestion about the accessibility of the models was put forward in the local managers' and, particularly, the environmentalists' focus groups. An environmentalists' focus group member argued that

I would find it useful if models were more accessible and they explain how they have been drawn up. So if you have a model that's predicting fish stocks I'd like to know if it takes into account the possibility of climate change, nutrient overloads, pollution spills etc. because I am not able to read that much into it. I'd like it to be done in such a way that it's accessible and it tells me what's being used and what these predictions are based on.

This claim for transparency as to how the model has been drawn up corresponds to a general claim of scientific credibility, namely that the method must be accessible so that the outcomes can be

tested and reproduced and that the basic assumptions and calculations behind them can be reviewed and commented on by expert peers. According to an environmentalists' focus group member, climate change modellers are beginning to work for such accessibility as a response to the wide range of different approaches in the field:

That is actually starting to happen now for the first time in climate change models because so many scientists have different views and they are stating that 'my' model of x is based on the following predictions. That is about the only time when you see many teams working on a similar theme but coming up with very different results.

A local managers' focus group member also argued for accessibility, but put it slightly different:

What I am saying is that just to trust a mathematical model isn't enough and I would not understand the mathematics, but I would understand the basic assumptions and that is where the link between the modeller and the man on the street is important. You have got to make the model understandable to me and to others. If I am going to buy into it, it can't be a black box. I am not going to buy into a black box because I don't know that you know what you are talking about. I can't make the assumption that the modeller knows what they are talking about. If I can trust the assumption they are making about the area I know about then I am more likely to trust the mathematical model.

Where this argument resembles the former, the latter participant seems particularly occupied with facilitating dialogue and trust between the expert and 'the man on the street'. This is perhaps a consequence of their different roles in relation to science – the environmentalists' focus group member has a scientific background and hence plays the role as peer, whereas the local managers' focus group member more often plays the role as stakeholder or the public.

Some obstacles to inclusive modelling processes were also mentioned. For example, a local managers' focus group member had experienced that people are less likely to trust models if their outcomes does not correspond to people's expectations or immediate experience:

We have an ongoing problem with shell ... Everyone is taking the drift of currents on the surface drift. But we are trying to explain to them that there are three stages of drift. There is the surface drift that can be either wind driven and/or tide driven. ... Everybody will buy the first model for the surface waters but nobody was convinced that the model was correct for depths below the surface. ... And I think the reason for that was that people have a good idea of what is going on at the surface because they can see it every day, but very few actually know what is going on underneath, unlike a trawler man who would know. If people can't see it, they don't believe it.

According to another member of the same group an obstacle to making modelling an inclusive process is that "you find that suddenly so many of the public become experts." According to an onshore sector focus group member another obstacle to including stakeholders in time-consuming modelling processes like those related to the EFIMAS modelling framework is that participation is costly:

It's very hard, because we are all small businesses and we don't have the luxury of this setup here or backup staff. It is costing us money to be here today, our phones are turned off. This is the problem. We haven't got the wherewithal to affect what these people are doing.

The inclusive process, then, was mainly suggested to consist in making the models accessible. This was perceived important in order to allow others to make their own informed judgements about the

models and engage in dialogue about their validity. Fishers' contribution to the very modelling process, however, was only mentioned by two participants.

3.6.4 Suggestions for simulations

The focus groups came up with a range of suggestions for simulations in the EFIMAS modelling framework. The environmentalists' focus group came up with most suggestions. One reason could be that the other focus groups have less experience with modelling and hence would need more time to imagine their potential uses and come up with suggestions. The suggestions are listed in table 3.2 below.

Table 3.2: Participants' suggestions for scenarios to be explored in the EFIMAS modelling framework

Scenarios to simulate	Details
The impact of a mussel bottom growing industry	Ireland environmentalists focus group
How to move towards maximum sustainable yield for fisheries by 2015	An environmentalists' focus group member found it important to explore which management measures should be taken to implement MSY by 2015 – <i>"Should we increase technical conversation measures, reduce effort etc?"</i> (Ireland environmentalists focus group)
The optimal size of marine reserves	Compare different sizes of marine reserves in order to define the optimal size. An environmentalists' focus group member referred to an example of a process of setting up marine reserves <i>"where they made contact with fishermen and predicted that in 3 years time there will be more fishing effort outside the reserve than is currently going now in the reserve. And if that doesn't happen the reserve will be gone."</i> The participant was concerned about this – <i>"My gut feeling would be that it's too small, but on the other hand, politically it's all we can get."</i> (Ireland environmentalists' focus group)
The effects of draining marshes	Wetlands <i>"are important nursery grounds and in Ireland there is an old law that allows you to drain wetlands and estuarine marshes without needing planning permission. There has been no work done on this and it would nice to be able to model the impacts to see what would happen the fish stocks if these marshes were drained and on the other hand what would happen if we opened the dykes and allowed water in to maximise the nursery potential."</i> (Ireland environmentalists' focus group)
The effect of razor clam fisheries on the seabed and the breeding grounds of fish	<i>"Conflicts between different fisheries, for example the razor clam fisheries off the coast where they basically destroy the seabed and how these affect the breeding grounds of fish."</i> (Ireland environmentalists' focus group)
The bioeconomic aspects of razor clam fisheries' effects on the seabed and the breeding grounds of fish	<i>"... you've got the razor clam fishery competing against the cod fishermen for example and the financial implications of this. ... I could see this being very useful at the local level by the Local Advisory Committee's to compare potential management measures for the inshore fisheries before submitting these to the Species Advisory Groups, and these could also compare the different submissions from each of these local groups."</i> (Ireland environmentalists' focus group)
Different scenarios with the marine protected areas	Specifically off the West Coast and with the proposed closure of Rockall. (Ireland environmentalists' focus group)
What should be done to bring back the Shannon mussel fishery	<i>"... the Shannon mussel fishery in the Boyne Estuary ... was wiped out due to dredging. But now that the port is moving it would be very interesting to try and see what should be done to bring this back."</i> (Ireland environmentalists' focus group)

Scenarios to simulate	Details
	group)
<p>Indirect impacts of water quality coming from land:</p> <ul style="list-style-type: none"> - The effects of the nitrates directive and nutrient loading - The implications of the water framework directive meeting and not meeting certain criteria 	<p><i>“The indirect impacts of water quality coming from land, tied back into things like the nitrates directive and nutrient loading and how that would affect nursery habitats. That’s useful then for things like the implications of the water framework directive to look at potential benefits of meeting certain criteria or the drawbacks of not meeting them in a fisheries context.”</i> (Ireland environmentalists’ focus group)</p>
<p>Different options and scenarios for re-establishing the Swilly fishery</p>	<p>Back-testing retrospectively what happened to the Swilly lobster fishery and on this background test different options and scenarios for future management. The purpose is two-fold: 1) To find out how to move on and re-establish the fishery and 2) for fishermen to get an explanation and regain trust in management. (Ireland local managers’ focus group)</p>
<p>The effect of climate change on stocks, species and landing costs</p>	<p><i>“Climate change and how it would affect stocks, species and the costs of landings perhaps as a result of needing to travel further” is “one of the big questions for fishermen at the moment and is really knocking them for six.”</i> (Ireland women in fisheries focus group)</p>
<p>The possibilities for coordination of landings</p>	<p>The effect of <i>“everyone going in together on Monday and having to land and everyone landing together”</i> is that <i>“The prices fail for everyone then because the factories are flooded and don’t want to buy the fish at high prices and the fishermen are left with all the fish to sell.”</i> Landings should be coordinated. (Ireland onshore sector focus group)</p>

3.6.5 Conclusion

While there was positive interest in the EFIMAS modelling framework, there were many questions and few comments to it. This might reflect the fact that the modelling framework is complex and that the participants might have had difficulties in grasping it beyond the general idea. However, the participants contributed with a range of suggestions for how to make modelling an inclusive process and stressed the importance of this. Moreover, members of all focus groups came up with suggestions for simulations to be explored in the modelling framework.

3.7 Overall conclusions

The Irish focus group discussions with fisheries management stakeholders were characterised by all members being in close contact with fisheries science – and for what concerns members in the women in fisheries, catching sector and onshore sector focus groups, fisheries science has major influence on their livelihoods. Hence, the discussions in all focus groups were informed and engaged, and the participants had strong perceptions both about fisheries science and modelling. Thus there are several lessons to learn from the interviews.

The participants’ perceptions of science, fisheries science, and modelling were closely related. Criteria that were found important to good science were also found important for the validity of fisheries science and models. The concerns raised in relation to fisheries science in general were also

raised in relation to models. And the participants' recommendations for inclusive modelling were very much in line with their suggestions for the improvement of fisheries science.

Perceptions varied according to the participants' positions in the field of fisheries, and sometimes they directly contradicted each other. Differences were particularly outspoken between the different focus groups – most notably the local managers', onshore sector, catching sector, and women in fisheries focus groups shared a number of perceptions where the environmentalists' focus group stood out. Particularly outspoken the environmentalists' focus group members seemed more concerned about environmental aspects of science and management whereas the other groups tended to focus on the social consequences. What is more, the perceptions and examples brought up in the environmentalists' focus group tended to reflect their natural scientific background, whereas a particular sympathy for the experience-based knowledge of fishers and a more outspoken scepticism towards expert knowledge characterised the discussions in the other focus groups.

In general there seemed to be much more consensus among members of the same focus group – however, some of this can also reflect a unifying effect of the focus group interview approach. Notwithstanding, the general perceptions, problems and recommendations listed in the boxes does not express a unified view from all the participants, but a mixed pile of different statements. This is particularly evident in the first box in section 3.3 where fisheries science is in turn claimed to be independent if it *is* performed by national research units and if it is *not* performed by national research units. Some general messages, however, can be extracted:

Participants across focus groups stressed the importance of basing management on sound science, be it to ensure that the steps taken are ecologically sound or that steps with serious consequences for fishers are scientifically justified. And participants found objectivity and independence central for the validity of science, fisheries science and modelling. Moreover, most participants were particularly concerned about fisheries science and modelling being politically influenced. This reveals a general discrepancy between the ideals the participants set up for good fisheries science and their perceptions about the actual scientific practice. Members in all focus groups also expressed particular concern about some of the data collection processes in fisheries science.

Another thing that stands out from the focus group discussions is an apparent gap between scientists and fishers. According to members in the women in fisheries, catching sector, onshore sector, and local managers' focus groups scientists tend to behave arrogantly towards fishers, resulting in lacking communication between the two groups and the failure of scientists to include fishers' experiences in the process.

In line with this, members in all focus groups except the environmentalists' focus group recommended that fisheries science and modelling should be an inclusive process – be it in order to improve the accuracy of fisheries science and modelling or to democratise it and ensure fishers' acceptance of and compliance with the fisheries management it informs. For what concerns fisheries science, there was particular focus on the integration of the experiences of fishers in the research process. When it came to modelling, however, more attention was given to making the models accessible to expert peers and the public in order to enable others to make an informed judgement of the validity of the models and facilitate dialogue between the modellers and others.

When it came to the particular EFIMAS modelling framework, participants perhaps had more questions than comments to the model – something that might reflect some difficulties in understanding the model. However, participants expressed moderately positive interest for the EFIMAS modelling framework and had multiple suggestions for scenarios to be explored.

An important lesson, then, is that there are multiple advantages connected to developing and using modelling tools like the EFIMAS modelling framework in consultation with stakeholders. According to the participants in the focus group interviews such consultation can ensure that fishers' experiences are taken into consideration in the research process, that the social as well as the ecological aspects are considered in management, that management measures are perceived as legitimate among those it applies to, and that fishers are more likely to comply with them.

Chapter 4: Report from the Danish Focus Groups

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4.1 Introduction and methodological considerations

The Danish focus group interviews were performed during the spring of 2007. The focus groups were comprised of representatives from the four fisheries management stakeholder groups listed in table 4.1 beneath.

Table 4.1: Focus group participants

Focus group	Number of participants
Catching sector	8
Processing industry	3
Environmentalists	3
Managers	3
Total number of participants	17

4.1.1 Setting up the focus groups

The original intention was to have five focus groups: the four mentioned above and one with women in fisheries. Based on information from our contacts in the sector, it was however at an early stage concluded that it would be difficult to gather a relevant group of interested women. To confirm that this was indeed the case, contact was also taken to a key person in the North Sea Women's Network NGO, who was likewise not able to point to women in fisheries to contact in Denmark. After this, no further effort was made to set up a women's focus group in Denmark. In fact, in all the Danish focus groups combined only one woman was present (an environmentalist), something that to a large extent reflects the male dominance in the fisheries sector in Denmark.

It was hoped to attract five to six participants to each group. In choosing the locations of the focus groups it was considered important to set up the focus groups as close to the participants as possible to make it more convenient for them to attend. Two focus groups (managers and environmentalists) were held in Copenhagen, which was considered most convenient to these categories, as the fisheries management system in Denmark is highly centralised and basically being managed from there. The other two focus groups were held in Hirtshals, which is a major fishing harbour and processing centre in the northern part of Jutland. Hirtshals is located within 150 kilometres of most other major fishing ports in Denmark as well as several processing centres, which made this location relatively convenient for processors and representatives of the catching sector.

As indicated by table 4.1 above, the number of participants in three of the focus groups was somewhat lower than hoped for. There are multiple reasons for this. In relation to the focus group with managers, the explanation relates to the fact that the Danish fisheries management system is highly centralised. Consequently, there are no local management institutions in Denmark, and there are basically only two central institutions to resort to: the Ministry for Food, Agriculture and Fisheries and the Directorate of Fisheries. Each of the two institutions agreed to participate with two persons but unfortunately only one person from the Ministry was in the end able to make it. In relation to environmentalists, the small size of the country limits the overall number of environmental NGOs with a focus on marine fisheries issues. In total we only identified five relevant NGOs; moreover, the total number of people dedicated to issues of marine fisheries in these organisations is likely below 10. Four NGOs were interested in participating with one person each but unfortunately one organisation had to withdraw due to a competing arrangement, which came up after the focus group had been scheduled. The relative centralisation of fisheries management in Denmark is probably also an explanatory factor in relation to the low presence of NGOs because no real local NGOs are operating in relation to marine fisheries. The processors' focus group also suffered from a very late apology, which brought the number of participants down from four to three.

In contrast to the three other focus group interviews; the turnout for the fishermen's focus group interview was actually larger than aimed for. This is related to the much higher number of fishermen than for the other categories as well as to the fact that we decided to 'over-invite' to make sure that at least some turned up even if the weather was good. Of the participants approximately half of them were active fishermen and the other half were former fishermen now having others to fish for them and /or working as full-time fishermen's representatives.

4.1.2 Focus group protocol

The focus group interviews were conducted in Danish, taped and transcribed. The analysis has been based on the Danish transcripts. Quotations are in the authors' English translations of the Danish transcripts. In the process of translation the quotations have been made coherent and readable and should as such not be regarded as word-by-word quotations. When doing the transcripts it was generally not possible systematically to tell who was who of the stakeholder participants present. Therefore, only when quoting discussions (as opposed to individual statements) will we attach numbers to the stakeholder participants to indicate whether only one or in fact more participants were involved in the particular discussion.

Present at the focus groups besides the interviewer, who had a background in social science and acted as focus group leader, was a natural scientist with knowledge about and experience in the use of scientific (computer) models in fisheries management in general and the EFIMAS model in particular. The social scientist present was responsible for the focus group protocol being respected (see Annex 1). The natural scientist was present to answer technical questions on the issue of computer models as well as to introduce the EFIMAS modelling framework. The focus groups all took between 1½ and 2 hours.

At the focus groups the participants were asked a number of questions to explore their perceptions in relation to several themes. This report is structured along the following headlines, which to a significant extent reflect the main themes discussed in the focus groups:

- Science in general
- Fisheries science and its application in management
- Scientific (computer) models in general
- The EFIMAS modelling framework in particular

4.1.3 Experiences

Despite the low turnout in some of the groups, the discussions in all groups were characterised by a (maybe somewhat surprising) high level of engagement. This probably reflects the fact that members in all groups from their different positions in the field of fisheries and fisheries management are confronted with fisheries science and modelling in their daily lives, although some of the participants were not really aware of this before they actually got into the discussions at the focus groups.

However, the responses of the different stakeholder groups vary significantly, depicting the different perspectives and knowledge that result from their different positions in relation to fisheries management. For example all participants in the environmentalists' focus group were trained scientists. This shows in their statements about science and the examples they bring up as compared to the other focus groups. The discussion in the processors' focus group was to a significant extent guided by what the processors saw as future preferences of the market. Knowledge and concern about the social and economic consequences of management, on the other hand, were not surprisingly very present in the fishermen's focus group; whereas the managers' focus group in many respects evolved around the practicalities of using fisheries science and the EFIMAS modelling framework in management (determined by politics) in an efficient and acceptable way.

Occasionally in some of the focus groups the discussion strayed significantly from the main themes of the focus group even though the interviewer as far as possible tried to stick to the agreed protocol. This tendency was most pronounced in the processors' focus group where the participants were very eager to get their view points across to the EFIMAS team; sometimes so eager that they simply disregarded the protocol. This may also to some extent reflect the fact that the participants of this focus group were corporate executive officers, who are used to sit at the end of the table with the power that entails. Nevertheless, this also happened, although to a lesser degree, in other focus groups and the impression was that this tendency related to a feeling among the participants of having input to contribute with in relation to fisheries management in general that did not naturally follow from the focus group protocol. Finally, in several of the focus groups the natural scientist present had a tendency to become dragged into (or in some cases initiate) digressions. This was simply because the discussions on the focus group themes led to other discussions that were highly relevant for the natural scientist present. These digressions are not reported here but they must nonetheless be considered added value of the workshops. In none of the workshops time was an issue; all participants proved prepared to take the time needed within reason.

4.1.4 Reporting on the focus groups

It should be emphasised that no systematic attempt has been made to synthesise what the participants could agree on across the focus groups. In recognition of the different paths that the discussions took in the different focus groups we did not consider it to be fruitful to systematically look at how the stakeholder groups agree and disagree on various issues. Rather this report illustrates some of the issues that there was agreement on, some issues that there was not agreement on - but most importantly the report offers an insight in the range of issues that that were brought up by the various stakeholder groups in the course of the four focus group interviews.

4.2 Science in general

<p>Perceptions</p> <p>Science should be</p> <ul style="list-style-type: none">- independent- relevant- accessible- substantiated- transparent <p>Specific problems:</p> <ul style="list-style-type: none">- Science is often presented in thick reports, that nobody bothers or has time to read- Conclusions are sometimes determined prior to the research- Conclusions based on unrepresentative, small surveys are often presented as science- Conclusions are often taken out of their context <p>Participants' specific recommendations:</p> <ul style="list-style-type: none">- Science should be presented so that it is easily accessible to the end-user- Limits to and assumptions behind the research should be openly presented- Science should openly report who has paid for it

When asked about science in general, participants in many of the focus groups were quick to turn to issues of fisheries science more specifically. This probably reflects that fisheries issues is what fills most in their lives but probably also the fact that they arrived at the focus group interview with the expectation of discussing fisheries science. The environmentalists' focus group was the group that talked most about science in more general terms; likely because of the fact that this specific group was comprised of trained scientists. However, some discussion about science in general also took place in the other focus groups. The participants talked about definitions of science, its use, expectations to good science and problems with science in practice. In the following we report on and discuss their perceptions in relation to these issues.

4.2.1 What is science?

The environmentalists' focus group reflected - together with the managers' group - a little bit on what defines science in general. One issue that was mentioned by the environmentalists was that facts based on surveys were only based on science if the surveys were representative. This reflects

the understanding that for something to be considered scientific it must adhere to certain 'rules of science'.

Another measure of whether something is science or not, that was mentioned in the environmentalists' focus group, was the question of whether the work had been (or could have been) presented in a peer reviewed scientific journal. Also this way of measuring science to some extent reflects the need to adhere to the 'rules of science'. Being accepted in a peer reviewed scientific journal presupposes that you have adhered to the rules that your peers believe to be in force in your field of science.

4.2.2 'Good' and 'bad' science

The issue that was most discussed in the focus groups in relation to science in general was what defines 'good' and 'bad' science respectively. In relation to this, one environmentalist expressed the following:

Good science is something that can really be substantiated, so that you can trust what is being said - and trust that it is not guided by interests and so on. To be good science it also needs to be relevant, what you are talking about. So those two dimensions need to be there. (Environmentalists' focus group)

The participant argued that one or both of these dimensions were often missing in relation to claims that presented themselves as being scientific.

Also the managers focussed on the practical level on the need of science to be relevant and lead to results, although they also emphasised that basic research was also valuable providing it led to something that would in the end lead to useful research. One participant also mentioned that good research has to be based on acceptable methods.

The catching sector focus group was the one that seemed to have the most critical view of science in general - or at least the participants were able to give more examples of bad science than the opposite. A particular point that the participants expressed was that scientific conclusions tend to change over time: "First you hear that you should eat this particular type of margarine - and the next you know it is not so healthy anyway" (Catching sector focus group). In other words, the participants argue that the conclusions of good science should not change over night. A related problem that the participants of this focus group pointed to is the question of who funds the research:

When you hear some scientific news [...] then the first thing, I think, is: 'I wonder who has paid for that?' Because that little corner of research that we are dealing with in fisheries; well, we know how it works. You know, there are some institutions, and they need money to keep the system running. And then you need to apply for money in that place, and that place and that place. And the pools of money that those places have available; they are developed with a political background, if it is public money. And if it is private funds, then they are set up to create some income to those making the money available. So that is the first I think: 'Who has paid for it?' Every time. And it doesn't matter if it is medical research or traffic or what the hell it is. [...] I'm not saying that you cannot trust it... I'm just saying that with this in mind - that the money has been given based on this and this and this - then you are going to get a result that is in that direction. It might very well be that it is the right result, but you are in fact defining the agenda for the research. (Catching sector focus group)

In other words, this participant questions the extent to which 'independent' research actually exists and concludes that research should be viewed in the light of who is paying.

Although the processing focus group only discussed science in general very briefly, they did come up with a significant point, which was less clearly expressed in the other focus groups, namely that to be good science, the conclusions need to be presented in a way that makes them accessible to those that should use it. The impression of the participants was that a lot of useful science is wasted because it is presented in an inaccessible way, such as thick research reports, which nobody has the time to read.

4.2.3 Discussion

In general the focus groups did not spend much time reflecting on science in general - most focus groups moved more or less directly on to discuss fisheries science specifically, which seemed to be where they felt at home.

Most of the few focus group discussions that did take place on this topic were characterised by some degree of scepticism towards science - or claims that present themselves as being based on science, which was more the angle in the environmentalists' focus group. As we shall see in the following section, the scepticism did not exactly become less outspoken when it came to fisheries science and the discussions became more specific. Fisheries issues are where most participants have direct experience with science and its impacts - this, however, did not reflect in a significantly more positive view on fisheries science compared to science in general.

Although the discussions were mainly reflecting a sceptical perspective, the discussions revealed nevertheless that the respondents did have some ideas about what made science good and how science could be improved. Key-words for good science, which can be distilled from the discussions, include: independent, relevant, accessible, substantiated and transparent. Furthermore, at least three specific suggestions for improving science in general were presented in some shape: 1) science should be presented so that it is easily accessible to the end-user; 2) limits to and assumptions behind the research should be openly presented, and 3) science should openly report who has paid for it.

4.3 Fisheries science and its application in management

Perceptions

Fisheries science should

- consider all elements of the eco-system and the interactions between those elements
- make use of fishermen's knowledge whenever reasonable - but it should be kept in mind that fishermen are stakeholders
- not be restricted by conclusions of previous research
- be acceptable to the fishermen - and this is the case when fishermen have been involved
- when applied in management allow for real-time management

Specific problems:

- The research agenda of fisheries science is too narrow; sometimes because it follows the money but also because of traditions
- Fisheries science often asks the wrong questions
- Fishermen's knowledge is sometimes taken out of context and used against them
- The insights gained from fisheries science are limited by the surrounding management framework
- The political process in itself sometimes makes it difficult to use science appropriately in management

Participants' specific recommendations:

- Fisheries science should take vessels' energy-consumption into consideration
- Fisheries science should focus more on areas closed for fishery
- Fisheries science should develop its research agenda in collaboration with the industry
- Fisheries science should use the knowledge of fishermen
- Fisheries science should focus more on how the best quality of the catch is achieved
- Fisheries science could benefit from using an action research approach
- Fishermen should assist in interpreting fishermen's knowledge when used in management

All of the focus groups had extensive discussions on various aspects of fisheries science. Most participants had significant experience with fisheries science from different positions in the field, and members in all groups had strong perceptions about it. Particularly the catching sector focus group seized the opportunity to discuss the many faults that they saw in the way that fisheries science is carried out today. However, they also reported on what they saw as recent years' improvements and how things could be made better.

4.3.1 What is fisheries science?

Discussions specifically on what constitutes fisheries science were few. However, in the environmentalists' focus group ideas about what fisheries science is can be deduced from the discussions over what constitutes respectively 'good' and 'bad' fisheries science and how fisheries science could be improved.

What emerged from the discussions in the environmentalists' focus group was that traditionally fisheries science is a discipline, which often has a relatively narrow focus on individual, commercially interesting fish stocks and the question of stock size. However, the participants also indicated that this had to some extent been changing in recent years - as eco-system-thinking is increasingly finding

its way into fisheries science. This was a development that the environmentalists strongly encouraged.

4.3.2 'Good' and 'bad' fisheries science - and how to improve science

Particularly the catching sector focus group had lengthy discussions on what constitutes respectively 'good' and 'bad' science - perhaps particularly the latter. A significant element that was mentioned is the fact that for something to be considered good fisheries science it has to be accepted by the end-users (i.e. the fishermen). It was argued that this accept cannot be achieved unless fishermen are actively involved in the research process at an early stage - actually already when the research questions are formulated by those making the research funds available. One participant put it like this:

It makes a huge difference, what kind of questions you seek to answer: 'Can you rule out that something has a negative impact on the stock size?' No, you never can. It would be better if the industry also influenced what kind of questions to ask: 'Is it a crisis for a specific stock if it is halved in size or drops below certain limits?', for instance. 'Or is it actually a way of cultivating and using the resources of the sea that might be more productive than keeping the stocks at a high level?' That could easily be. (Catching sector focus group)

In line with the above, the participants in the catching sector focus group also argued that good fisheries science demanded that fishermen's knowledge was included:

Catching sector representative 1: [...] *Earlier on nobody took into account what the fishermen thought, did they? That is done more nowadays. And that is good research because that builds on cooperation.*

Catching sector representative 2: *And you also get more correct results that way.*

Catching sector representative 1: *Yes, you do.*

Catching sector representative 2: *Because then it is not only research for the sake of research. (Catching sector focus group)*

The participants in this focus group agreed that they were being included more than some years ago but they still felt that they had a long way to go before they could be considered partners in research to the extent they felt would be fair. This issue is discussed more in the section on *Perceptions of involvement in and exclusion from science* beneath.

In the environmentalists' focus group a main criteria for something being considered good science seemed to be the ability of fisheries science to expand from a narrow focus on individual fishstocks to a broader agenda where systemic interactions are taken into consideration. One of the participants focussed not only on the interactions within the marine eco-system but argued that even issues related to climate change had to be seen as a part of good fisheries science. Good fisheries science needs in that respect to be very interdisciplinary and the concept of sustainability needs to be broadened from single stocks to the whole eco-system:

You know, when you discuss sustainability in fisheries then you are talking about how many fish there are - and in fact you are talking about how many of a specific kind of fish, namely those that can be sold to consumers. That is very narrow... It might be correct that you have increasingly begun to

discuss interactions between species, and that is also a good thing and a step in the right direction. However, if you really want to think in terms of systemic interactions, then you need to include the entire marine eco-system. And not only the eco-system but actually the entire atmosphere, you know: 'How much Co2-emission do we create?' That would constitute a much broader perspective on sustainability. And then you could also include the social aspects that you at your institute focus on. Of course you probably miss some basic knowledge to do this, but to think that everything is OK because you apply some multi-species models, I do not think that is enough [...] You know, if you take the Danish Institute for Fisheries Research, then they have a very narrow traditionally defined research focus. (Environmentalists' focus group)

Another participant argued for a broadening of the perspectives of fisheries science by increasing the focus on areas closed for fisheries, which would allow fisheries science to observe how the whole marine eco-system would react if no fishing took place whatsoever. The participant expressed that he knew that part of the explanation for this lack of focus was that there are few closed areas to do this kind of research on in Denmark. However, he added that it was in fact in part up to the researchers to demand that such areas were created to facilitate their research and that they failed to do so. The same participant also criticised fisheries research for being guided by commercial interests, which meant that once new species became commercially important you had to start from scratch in relation to data. He argued that this was a clear example of *"how research follows what is commercially important"* (Environmentalists' focus group). This highlights that good fisheries science needs to be at least to some extent independent and able to have access to free funds to do research in issues that are not of immediate economic importance.

Another precondition for good fisheries science, which was brought up in the catching sector focus group, was the question of accuracy of data:

Generally you could say that the data that is behind all these stock assessments is - to put it mildly - of a highly variable quality. And when you then put that data into some sort of simulator then you could get very variable results. And we can only get out of that situation in one way: That is if the data that is put into the models are 100 percent correct. (Catching sector focus group)

However, instructions on how to make this happen was less clear. Nevertheless, in the catching sector focus group it was mentioned that involvement of fishermen in the effort to get data to be accurate is important. The participants expressed also that the biologists were more than welcome onboard the vessel; however, the fishermen often felt that the biologists were not genuinely interested in this, something we will discuss more in the section beneath on *Perceptions of involvement in and exclusion from science*. Moreover, the fishermen expressed that they sometimes felt that the data they had been part of creating was misused in management, which was clearly not a fruitful way of fostering a partnership. In the section on *Feelings of Inappropriate use of science in management* beneath we look at a couple of examples that the fishermen mentioned on how data was misused in management.

The managers focussed to a large extent on the ability of science to deliver input that was useful in the political context where the managers operated. They seemed to some extent to feel that sometimes a lot of scientific effort was put into looking into issues that in the end did not matter because the conclusions just underlined something that people already knew and that could not be changed anyway due to the political realities. However, overall the managers seemed to have a

positive view of fisheries science. The managers also mentioned that the ability to involve stakeholders in a reasonable way was also something that defined good science.

In the processing industry focus group other aspects of fisheries science, which were closely connected to the quality and availability of product that they have to sell, came up. One issue that the processing industry emphasised was the need for continued effort on making fisheries sustainable to ensure future supplies for the processing industry overall. In relation to this they thought that good fisheries science should focus more on how to bring down discarding and other unsustainable practices. Moreover, they advised that more research (as well as management efforts) should focus on when during the year it made most sense to land the different species taking into account the preferences of the market, the quality of the fish and reproductive pattern of the different species. An aspect that they also emphasised was research into the qualities of different types of fishing gear *vis-à-vis* different species:

And the last thing that I also find extremely important, that is fishing gear. That you have to work towards getting... of course the best possible fishing gear - but also that the gear is gentle on what it catches. Naturally, the fishermen must be able to live from it economically, that is self-evident, and carry out a reasonable fishery, but it needs to be done so that we get as good raw material for the industry to work with as possible - no matter if we cut the fish into filets or sell them whole. Because this is what makes the total economy for all involved parties as good as possible. We can't all fish with hooks, I know that perfectly well. But we also know that if we are talking about bottom trawling - and I am no opponent of bottom trawling, not at all - but you can see that it can be extremely hard on the fish you catch - and it can be hard on the whole environment. Fishing with nets is of course also problematic in another way if the fish dies in the nets, we are not interested in that. So there is a huge task ahead of us in determining what is from fishery to fishery the best way to catch the fish. (Processing industry focus group)

The 'quality of the catch-aspect' as a neglected element of fisheries science was not brought up by other focus groups. This seems to be related to the fact that the processing industry focus group can to some extent be understood as the voice of the market in the series of focus groups. They also expressed that their voice was often ignored compared to the voice of the fishermen.

A final requirement for good fisheries science, which deserves to be mentioned, was put forward by a participant in the catching sector focus group, who clearly indicated that he did not always feel that this criterion was lived up to by fisheries science:

If you are a researcher, and you have done some research where the conclusion is different than what you anticipated, then you have to change your opinion and course. It simply does not work that you just stick to something and simply keep on saying: 'This is so and so and so', if reality says something different. (Catching sector focus group)

This indicates that the participant has an impression of fisheries researchers as being stubborn and unwilling to change opinion. However, it may also reflect the fact that fisheries scientists are to some extent caught in a situation where the combination of huge uncertainties and a precautionary approach (and generally very low stock levels) often prevent them from making new recommendations even though the indications may point in that direction.

4.3.3 Perceptions of involvement in and exclusion from science

In the catching sector focus group the fishermen agreed that they were being involved more in fisheries science than they used to be and that this was to be considered a good thing:

When you had these biology assistants onboard on fishing trips, they should look at everything, then they told us - and this was 5-6 years ago - that the real biologists they were too scared to come on a fishing trip with us. Anyway, that is what we were told. I don't know if it was true, though. However, now we do talk together all the time, and they come with us on fishing trips in this fisher-scientist project, where you meet and talk, right? I am not sure that everything the fishermen say is true - but we talk together and use each others' knowledge. And I think it is important that you have at least come that far. (Catching sector focus group)

However, as we discuss more in the section on *Feelings of inappropriate use of science in management*, the participants in this focus group also occasionally felt that they - even though they were being included in the production of data - were often excluded from the interpretation of the same data, which meant that the data was taken out of the context that it had been produced in; the fishermen feel therefore that they are not being cooperated with as equal partners but to some extent used as instruments.

A participant in the catching sector focus group mentioned that the way that fishermen's representatives were now invited to take part in ICES working group meetings was a good way to involve stakeholders. The participant mentioned in particular that the catching sector could help to determine how reliable the data that the working group was working from was:

Whether you can expect that all the data is correct. Whether all the catches are caught exactly where it has been noted that they have been caught and that kind of things. It is a good thing that this kind of knowledge is now brought further into the system. (Catching sector focus group)

The feelings about fishermen's involvement in science were more mixed in the environmentalists' focus group, where there was agreement on the fact that it was often necessary to involve fishermen. However, one of the participants also mentioned that there was often a tendency to equate fishermen's knowledge with science and if the fishermen did not agree with the 'formal' science then it was often projected as if there was no clear signal from science even though all the scientists agreed:

Sometimes you have to listen to one perspective [the fishermen], and other times it is perhaps more the scientific perspective that you have to rely on. And what I want to say is that the problem in this is that this is often mixed up in the public and the media and so on. That the perspective of one fishermen has the same weight as a scientific research project that has been running for 30 years or something, you know? It is sort of being projected that then you cannot... Science cannot come to a conclusion. (Environmentalists' focus group)

However, in the group there was nonetheless agreement on the fact that increased involvement of fishermen had significant perspectives in relation to a number of issues, for instance in relation to identifying nursery areas and spawning patterns.

In relation to the involvement of stakeholders one of the managers suggested that fisheries science let itself be inspired more from *action research*, which has been an accepted approach in social sciences for many years. The understanding that the manager has of action research seems to some

extent closely related to large-scale experiments to see how changed framework-conditions affect behaviour among stakeholders. The suggestion to carry out an experiment with effort-regulation in Kattegat was mentioned in this context. This proposal came originally from the catch industry itself.¹ A significant point is also that action research is something that is done in collaboration with the stakeholders and that contributing to a process of behavioural change is as important as the actual scientific output. The manager mentioned the Kodeks-project², which aims to create 'code of conduct' for Danish pelagic fisheries, as a good example in this respect. The Kodeks-project in itself must be expected to lead to a change in behaviour because the industry itself is active in formulation of what is the 'right' way to fish and thereby discuss these issues.

The participants in the processing industry focus group expressed that they to a wide extent felt excluded from influencing what fisheries science deals with. They felt that they had priorities for science that were not being reflected because they were often mistakenly taken to be represented by the catch industry. In some cases they had overlapping priorities but often the processing industry had different perspectives than the catch industry when it comes to priorities for science:

You know, it feels like the processing industry... They just - hmm, now I have to be careful since this is being taped - but they just have to figure out on their own, and they have to go their own way. And maybe that is the way it has to be when we are talking about the fishery, which is the source, the place of capture for the goods that we are all working with, but that is where all the efforts are spent. And there is no doubt that the processing industry has opinions on what is going on, especially today, stuff that I at least think that it is important is reflected in all this. And that is issues such as discarding, minimum landing sizes, types of gear, and time of catch - when over the year should it be allowed to catch fish? We are at least a couple of companies that are astonished that you some places in this country can get away with catching roe-plaices in a big way. Both when they are protected and when they are not; because if we want the stock to recover, which would be in the interest of all parties, not least of the fishermen, then we at least have to get some common sense into the catch policy that we are applying in this country today. There is no doubt that if you allow fish to spawn, there is a larger likelihood that there will be more fish in the sea than if they are caught with roe and then just dumped in the water. That is just natural. (Processing industry focus group)

In other words, the participants in the processing industry focus group expressed that they often felt that they were not really being heard compared to the fishermen (in relation to science as well as in relation to management).

Overall in the focus groups, involvement of fishermen in fisheries science was viewed as a positive thing but both in the processors' and the environmentalists' focus groups scepticism was also expressed. The environmentalists were concerned that the influence of fishermen in some cases threatened the power of traditional science, and the processors argued that the influence of fishermen sometimes came at the expense of other stakeholder groups with competing but equally important priorities for fisheries science.

¹ The Kattegat-experiment has not materialised yet - and after the introduction of an ITQ-like system in the Danish fisheries, it is questionable if it ever will.

² See: www.fiskerkodeks.dk.

4.3.4 Feelings of inappropriate use of science in management

The participants in the catching sector focus group described in various ways how being involved in fisheries science, which was generally considered a good thing, as we described earlier, was no guarantee that the science was not used in inappropriate ways when it eventually fed into management. One fisherman argued that a problem was that the whole cycle of research and management was simply too slow to reflect reality, which meant that protective measures put in place based on science was always a couple of years behind. This was argued to be a general problem but the problem is of course perceived as most pronounced in relation to short-lived species with highly variable patterns of abundance. The catching sector representative argued that this problem demanded more real-time management - or alternatively that for some species management should be removed more or less altogether because the vessels only fish for these species whenever they were plentiful anyway.

An example of a short-lived species of the kind described above is sand eel, which the Danish catch industry was relatively occupied with at the time of the focus groups.³ The representatives used experiences relating to this species as an example of how they sometimes felt that the information they provided was misused, first by the biologists and secondly by the management system. In relation to sand eel the catching sector representatives expressed that they had been very helpful with mapping where the species was but that they had been punished in the end because the scientists and managers did not take their information fully into account but sorted in it and only used the information that would lead to restricted fishing:

Catching sector representative 1: The result that has come from all the efforts that the fishermen have made; that has become negative towards the fishermen. It has been used in a negative way, because all the results the scientists have arrived at, they were arrived at based on samples that the fishermen had delivered. All those dots and points that they have on their maps that tell them where the sand eel are, they are some that the fishermen have provided. And then one year you experience a situation where there really aren't any sand eel - or two years. And then they conclude something about this fishery based on some measurements that the fishermen themselves have made. It is the fishermen and not the biologists that have made these observations, is it not? What I am saying is that we have told them that here is a lot of sand eel, and that was also the case in that year and that year and that year. And then suddenly there are two years where there are none. And then suddenly things flip around. Then they come and say that the stock is going down and that it is in a critical condition, in danger and what do I know. And there need to be a complete stop for fishing. And they do that based on measurements that they have received from the fishermen, without taking into consideration that the fishermen say that this has been the pattern since the dawn of times! The sand eel fishery goes up and down. Until now they just did not have numbers for it and points indicating where they are. Then you just did not have this knowledge about where the sandeel were and in what amounts, and where the largest amounts were found. And when they suddenly aren't there then they are in danger - and they want to close the entire fishery.

Catching sector representative 2: What you are saying is that if you had data for an even longer period, then you would see that this is a pattern that repeats itself?

³ Sand eel is a species that is of significant importance for those of the Danish fishermen landing fish to be reduced to fish meal or oil, so-called industrial fisheries.

Catching sector representative 1: *Yes, exactly.*

Catching sector representative 3: *I was not trying to go in detail with the sand eel. I was just saying in general that if we had not agreed to that cooperation at that time then we might not have had any industrial fishery altogether today. For sure, what has happened is definitely not OK. We definitely agree on that, and it should be much better.* (Catching sector focus group)

As this relatively long quote indicates, the fishermen have mixed feelings in relation to the way their knowledge is included in fisheries science and management. They feel that they have to cooperate, and they also think that is the right way to go, but they feel also that they are not cooperated with on an equal footing. They are forced to cooperate and they cannot prevent their information from being misused - they just have to smile and be happy that the outcome is not even worse. They express a feeling of being included and excluded at the same time. Their information is taken in by the scientists and managers but at the same time it is also taken out of the context that the fishermen's full range of knowledge constitutes and used in ways they do not condole.

In the managers' focus group another example of inappropriate use of science in management was presented, although the example might in reality more relate to the failure to use science in management when it would in fact have been appropriate. However, the example is illustrative on a general level because it highlights the perception that the actual political process behind management decisions in itself contributes to inappropriate use of science because it does not allow for science to feed in in a rational and organised way. The rules of the game in politics are in that way perceived a problem for science:

The classical example of what not to do, I guess, was when the Commission or the Council some years ago introduced the days-at-sea system. In the beginning you more or less only considered, as far as I remember, 6-7 types of gear. Along the way that has been expanded to 15-16 but basically there has been no research into whether this was the right way to go in relation to the cod recovery plan. Then afterwards the STECF has been asked to take a look at it and they are completely confused and have no... Virtually nobody, it has become so complex and the reports that are coming out aren't much to the point either. So that is at least an example of something going completely wrong, I would say. And all of it was also invented by a single person in the Commission over a weekend, at least for starters down in Brussels. And it shows, doesn't it? [...] It was a completely wrong approach just to throw something like that on the table without having even been in touch with anybody, not even managers. It was directly at the political level that this proposal came wandering in the door. (Managers' focus group)

What is described here is a political decision-making system that experiences a need for politically acceptable solutions with short notice. This reality does not always leave much room for science even though this is often part of what makes a solution politically feasible. When politicians know beforehand that they will be in need of scientific advice then they can have that prepared in advance. That is for instance the case with the annual TAC-negotiations, where scientific advice is prepared continuously. However, when the realities demand an answer for a political problem with short notice, which is often the way that the political system works not least in the EU, then there is little time to look around and evaluate different scientific solutions - not to speak of asking for scientific studies to be carried out, which takes for ever in the context that decision-makers find themselves

in.⁴ A solution has to be found quickly and it has to live up to the rules of politics - meaning that it is able to gather a majority. This entails a clear risk of inappropriate use or in many cases *non-use* of science.

4.3.5 Discussion

The catching sector focus group was the most critical towards fisheries science. Although the participants acknowledged that fishermen's knowledge were increasingly taken into account, they felt that their information was occasionally used in ways that they did not condole. Moreover, they argued that they were not involved in setting the agenda for research, which meant that the questions asked were often negative towards the fishing industry. Finally, the catching sector focus group participants were also concerned about how fisheries science was applied in management, where they experienced that it was misused in various ways.

In the environmentalists' focus group the discussion centred for a large part around the priorities for fisheries science, which were criticised for being too narrow. A basic message from this group was that research should be much more focussed on systemic interactions - even to the extent of including effects of fisheries in relation to climate change. The group also discussed involvement of fishermen in research but there was no clear conclusion on whether involvement of fishermen improved or compromised research - this had to be determined on a case to case basis.

The managers' focus group discussed to some extent fisheries science in general, but not surprisingly they were more occupied with the use of fisheries science in management, which we will look more at in the coming sections. However, they did emphasise that involvement of stakeholders already in early stages of fisheries science was important to get useful results that could be implemented. A manager moreover mentioned action research as a way to involve stakeholders in a positive way while also creating desirable behavioural changes.

The participants in the processing industry focus group expressed that they to some extent felt left out *vis-à-vis* fisheries research - and that the fishermen often seemed to be regarded as their representatives even though they had different priorities compared to them in relation to a number of issues. Nevertheless, the participants in this focus group had a less negative view on fisheries science even though they had several ideas on how to make the science more relevant for them.

⁴ In fact this is partly the problem that the EFIMAS modelling framework approaches, although it is probably not going to be able to come up with answers over the weekend like the Commission official did.

4.4 Scientific (computer) models in general

Perceptions

Models should

- be fed with accurate data.
- contain detailed knowledge of the dynamics of the system modelled.
- recognise their uncertainty.
- not replace political decisions.

Specific problems:

- The data fed to the models are often incorrect.
- Political decisions can be hidden within models.
- The dynamics of the sea are unpredictable.
- It can be difficult to 'get out of' wrong models.
- Models deliver uncertain and variable results.

Participants' specific recommendations:

- Data fed into models must be 100 percent correct.
- Models should be applied to limited problem complexes.
- Models should be discarded if they do not reflect reality.

To a significant extent the participants' statements about scientific (computer) models reflected their perceptions about fisheries science. However, there was much less certainty on what scientific models in fact were. During the focus group discussions, the participants expressed their perceptions in relation to questions relating to: what is a scientific model, their own experiences with using models and what they can be used for, and last but not least the pitfalls in the use of models. However, in most focus groups the participants went almost directly from fisheries science to a more specific discussion of the EFIMAS idea and what scenarios that would be interesting to put into the EFIMAS simulator.

4.4.1 What is a scientific model?

In the catching sector focus group the participants had a relatively long discussion on what a scientific model is. A conclusion, which came to a surprise to the participants themselves, was that the fishermen to some extent choose where and how to fish based on semi-scientific models that they store in their heads:

Catching sector representative 1: That would be great - and OK, I do not go out on the sea at the moment - but this with: now the wind comes from the north and the current from the south and the sun shines; boom, where do I have to go to fish, right? That would be nice. And you could probably make a model for that. It is just not given that it would work...

Catching sector representative 2: No, a model like that - well exactly that model we probably all have in our heads, don't we? I remember one of the last things we had made was a table of currents, we put arrows into a computer, so that you could monitor the direction of the current. I guess that is in principle also a model, where you could say: Well, at that time, there the current starts to change, and then tomorrow we could try to do the opposite of what we did today [...] I guess that is also a model, is it not a model too? (Catching sector focus group)

These experience-based models, which are developed based on experience and stored in minds or in logbooks and so on, are used to process information about the weather, the time of year, and the current etc. and thereby choose where to fish and with what gear. In the case of the sandeel fishery a catching sector representative argued that it was crucial to choose one's fishing strategy based on some sort of model:

Yes, but you know, we do use models, also in... If we are talking the current, right. If you do not know the patterns of the current and change of currents for the sandeel fishery in the southern part of the North Sea, then you can be lucky to get a good haul. But you are damn sure to get a lot without anything. It is so concentrated and it is so important that when the current shifts. And where are you - and where do you need to be when it shifts? Do you need to be in one end or the other? Do you need to be on that side of the sand bank or the other side of the sand bank? And the guys fishing out there - they use those models. If they do not use those models correctly, then they do not stand a chance. (Catching sector focus group)

However, although the fishermen attributed great value to these models they also emphasised that they did not always work and that it was important to be ready to change your mind and strategy if realities suggested that you were “operating based on an outdated model” (Catching sector focus group). The fishermen argued that this was something that the scientists had a hard time doing and once something was considered a scientific truth and used in the models it was extremely difficult to change. The participants underlined that if the model output does not reflect reality it is likely not reality that is wrong but the model and its output...

4.4.2 Own experiences with scientific models

A common denominator for several of the experiences with models that were described in the focus groups seems to be the inability of models to provide results with the necessary certainty - or at least that a significant element to keep in mind is the uncertainty that relates to outputs from models.

Based on his own experiences a participant in the environmentalists' focus group expressed a general scepticism towards scientific models that try to predict the future:

You often worry that these models fail. You know, even very simple relationships like the demographic development of society and so on, how many kids will start in preschool in 10 years and so on. You are hardly able to make computer models that can predict that. And that sort of tells me that when you are not even able to tell how many children that will be starting in the first grade in six years - no, I mean before they are born - then how can you believe that you can say anything about the development of the fisheries in the North Sea? I mean, it ought to be pretty basic to say: 'Okay, there are so and so many women between the ages of 20 and 35, and there are so and so many between the age of 10 and 20, and when they are so and so old they will get so and so many children, and we know the development in the educational pattern'. So you should be able to tell this without any doubt. But time and again it turns out that they miss completely, so it is worrying that the scientific models aren't better than they are. (Environmentalists' focus group)

This participant is clearly not convinced that the use of models can solve the problems of fisheries management. The main issue here seems to be uncertainty. Even in relation to issues where you have relatively good grasp of the relationships at play, which is arguably less the case in fisheries, the

uncertainties of the modelling approach seem to be so great that the usefulness of the output is often questionable.

The above point found resonance with a participant in the processors' focus group whose company had cooperated with a scientist to get some predictions on what their supplies of a specific species would be in the future. However, although it was interesting and solid science, the output was not precise or applicable enough to really be useful for planning in a business perspective.

Also in the catching sector focus group own experiences with the inability of models to deliver sufficiently credible results were an issue. A fisherman mentioned that he had kept a diary with all kinds of observations relating to all his fishing trips (weather, current etc.) for many years so as to be able to predict/model how, when and where he should fish. However, even though he tried to predict/model where the fishing would be good based on the observations of the past, it always turned out that there was a significant element of chance involved in any case - so eventually he had given up keeping the diary, as it was clearly not possible to model your way to a good catch with the necessary certainty. Of course experience told him in general terms where to go and when, but the experiences could not guarantee a good catch, anyway.

The experience that this fisherman expresses of the sea as unpredictable of course contradicts strongly with the idea of using models to predict and manage on the background of. Impressions of the sea as being unpredictable and full of surprises were also expressed by other participants in the catching sector focus group in various contexts, as well as by participants in the environmentalists' focus group, who also questioned how much we really know about the dynamics of the sea - not least viewed from an eco-system perspective.

4.4.3 Advantages and problems in the use of scientific models

In the catching sector focus group it was among other issues mentioned that the applied models were sensitive to management measures put in place because the data fed to the models were affected by these measures. This means that even though the data that is used is in principle correct it is sometimes not interpreted correctly. For instance, the fishermen can be unable to catch their quota because there are fewer fish; however, a fisherman argued that the reason might as well be that the many restrictions put on the fishermen (e.g. days-at-sea) hinder them from fishing as they used to. If then the models read this inability to catch the quota as an indicator of a worsening of the state of the fish stock, then the management authorities imposes even greater restrictions and the landings decrease even more creating a vicious circle.

The fishermen also emphasised that it was a problem that the models are often fed with incorrect data, which affects the usefulness of output from models negatively. One fisherman mentioned a specific problem, which draws a thread back to the problem of regulatory measures affecting the data input for the models:

You know in relation to many species, then when you put in data for landings and catches, then this is not in any way a picture of reality - it is a picture of what is legal [...] If you ask me how much cod I will catch this year, then I can put that down on a piece of paper for you right now, because I know that already now. (Catching sector focus group)

Although the fishermen were generally very sceptical towards models they also expressed an interest in the models and the promises of predictive power. This was also the impression when the different fishermen were invited to the focus group. However, the fishermen was less than happy with models standing behind political decisions because they were afraid that they would get caught in faulty models, which it was difficult to get out of:

I believe that most of us around this table, we find it interesting with some models. What we are afraid of is [...] if it suddenly turns out that they do not fit with reality, then we cannot get out of them again. That is what I think we fear the most - because it is interesting and fun with some models trying to predict how we think it twill be in the future - but if the politicians are going to manage and decide based on it, and it then turns out that it is not correct, that there is a wrong formula in it, then we have a problem. (Catching sector focus group)

One of the participants in the environmentalists' focus group argued that models were sometimes used to disregard input from NGOs, which in some cases felt that they had difficulties getting their point across because they where faced with conclusions coming from a - claimed to be - objective model, which in reality was not the case, as the models often had political choices inside them: *“That is one of the real disadvantages of models, that you hide a lot of political decisions within some variables in the models, that somebody cannot really understand”* (Environmentalists' focus group). However, the same environmentalist also expressed optimism regarding the use of models in other contexts:

But otherwise they are good for... They are typically good at more limited problems: how do we minimise the use of energy per kilo of caught fish in the Danish fisheries? There you could perhaps make some variables, looking at if we change the quotas so that we get more species on a lover trophic level then how could that contribute to lowering the energy consumption. It would be obvious to take that dimension in as well, right? (Environmentalists' focus group)

4.4.4 Discussion

As mentioned, the participants' statements about scientific (computer) models reflected their perceptions about fisheries science to a significant extent. Especially the catching sector focus group was critical but also the environmentalists expressed significant concerns in relation to the use of models.

The reservations that the participants had related to concerns about the accuracy of the data that the models were fed with as well as to doubts whether the knowledge of the dynamics of the system was detailed enough to really model the system. Moreover, there was the concern that political decisions were sometimes hidden within the 'black box' of a seemingly objective model and the fact that once accepted as the truth it might be difficult to scrap a model if it turns out to be wrong or eventually becomes outdated due to changes in the system.

A notable conclusion in the catching sector focus group was that fishermen themselves to a significant extent use semi-scientific models in their own minds to process information about current and weather etc. in the planning of their fishing operations. This conclusion seemed to de-mystify the concept of scientific models somewhat for the participants in that focus group.

4.5 The EFIMAS modelling framework

During the focus group the participants were given a presentation of modelling in general and the EFIMAS modelling framework in particular (see Annex 2). After the presentation the participants were encouraged to share their thoughts about the EFIMAS modelling framework. During the earlier stages of the interviews the participants discussed uses and concerns for models in general. Some of these might also apply to the EFIMAS model. However, very few commented on the particular EFIMAS modelling framework other than asking questions. The modelling framework is arguably relatively complex, and the presentation held during the interviews was kept in rather general terms, which might have made it difficult for the participants to understand how the EFIMAS framework stands out compared to other less integrated models.

The fact that very few commented directly on it might be due to many participants having difficulties with understanding the details of the model. However, this did not prevent them from making suggestions for simulation scenarios that could be explored in the modelling framework. However, in the processing industry focus group the discussion became mainly related to the question of how to include the processing industry in modelling frameworks. In the following we present the participants' suggestions for specific simulations to be tested in the framework as well as a few selected comments on the EFIMAS framework

4.5.1 Suggestions for simulations

The focus groups came up with a range of suggestions for simulations that could be carried out within the EFIMAS modelling framework; these are listed in table 4.2 below.

Table 4.2: Participants' suggestions for issues / scenarios to be explored in the EFIMAS modelling framework

Scenario	Details	Group
Closed areas	Investigate the impact of closing areas completely for fishing or closing areas for fishing with specific types of gear	Environmentalists
Impact on seabirds	Investigate the impact on the breeding success of seabirds of the fact that fisheries remove hundreds of thousands of tonnes of fish each year	Environmentalists
Impact of cormorants on fish stocks	Investigate if cormorants eating dab do not in fact improve the plaice stock since they reduce the number of competitors to plaice	Environmentalists
Effect of catching fish from lower trophic levels on co2 emissions	Investigate how much the energy consumption in the fisheries would be reduced if the quotas are changed as to target fish from lower trophic levels	Environmentalists

Scenario	Details	Group
Effect on safety at work of changing gear types	Investigate how many accidents at work that could be 'saved' by fishing with one gear type as opposed to another	Environmentalists
Effect on employment of changing gear types	Investigate how the employment level is affected by the type of gear employed	Environmentalists
Effect of days at sea	Investigate what would be the outcome if all fisheries were managed by days-at-sea	Environmentalists / catching sector
Auction fishing rights	Investigate what would be the outcome if all fishing right were put on auction	Environmentalists
Double the cod stock	Let the result be fixed: double the cod stock; and then present a number of different scenarios that would facilitate that	Environmentalists
Discards in different fisheries	In some plaice and sole fisheries the discarding rates are higher than in others: Investigate who carries the cost of the extra fishing mortality created by the fisheries where the discarding rates are the highest	Managers
Fishing mortality relative to market value	Define different fisheries targeting nephrops and investigate what market value they create compared to the fishing mortality they impose	Managers
Effect of new actors entering into a fishery	Investigate the effects in Norway and Sweden of Denmark entering into a fishery for shrimps to be boiled at sea	Managers
Fishing up a certain fish stock	With the costs involved in carrying out fisheries for sand eel, is it then at all possible to fish the stock under sustainable level?	Catching sector
Changing mesh size regulations	Investigate how changing certain mesh size regulations will affect the system	Catching sector

As can be seen in table 4.2, the participants presented a number of ideas for scenarios and issues that they thought would be worth looking at through the EFIMAS modelling framework. As

mentioned earlier, the processing industry focus group did not come as far as to identifying issues and scenarios but spend more time discussing with the modeller present how the processing industry could be incorporated into the EFIMAS modelling framework.

4.5.2 Selected comments

In the environmentalists' focus group it was suggested that whenever a scenario is run in the model, the modelling output should include a list of the possible shortcomings of the model in relation to the test of this specific scenario, as well as suggestions as to make the model more robust in its calculations of this specific scenario.

In the managers focus group it was mentioned that in many cases the problem is not that you do not have knowledge about what will happen if you do one thing relative to another. The problem is often that certain decisions are not politically feasible even though they make logical sense. The EFIMAS model may provide information in a better or more elegant way but it cannot remove political obstacles to change.

In the managers' focus group it was also mentioned that the data that the EFIMAS model has to be fed with is to a large extent shaped by the present management system. This means that under other management scenarios the data would be different, which - it was argued - makes it difficult to investigate 'imaginary' management scenarios. The demand for accurate data was also discussed in the managers' focus group, where the participants expressed a concern whether the EFIMAS model was not too demanding in terms of accuracy of data.

Several participants in the catching sector focus group were sceptical towards the EFIMAS modelling framework with reference to the fact that it involved modelling relationships that are unpredictable and change over time.

4.6 Conclusion

Overall the participants in the Danish focus groups had strong and largely well-founded opinions about fisheries science and modelling. The participants' perceptions of science, fisheries science, and eventually modelling were not surprisingly closely related. Criteria that were found important to provide good science were also found important for the validity of fisheries science and scientific models. The concerns raised in relation to science in general and fisheries science were also raised in relation to models.

From the discussions in the Danish focus groups it is clear that a certain degree of scepticism towards science in general and fisheries science in particular exists. However, in none of the focus groups was it suggested that fisheries science or modelling was altogether not useful but the impression that remains is that many participants feel that fisheries science is not carried out or used in management in the optimal way. This view was particularly prominent in the catching sector focus group, which stood out as the group with the most critical perception of fisheries science and modelling.

During the focus groups several suggestions were made that according to the participants would improve science, fisheries science and modelling. These suggestions are reported on in detail in the respective sections.

Chapter 5:

Report from the Hellas Focus Groups

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5.1 Introduction

In the Geek case, five focus groups were gathered in Hellas, each of them bringing together various individuals and stakeholders involved in the fisheries industry. The first focus group consisted of representatives from six main non-governmental organisations acting for the conservation of marine species and ecosystems. The second focus group was composed of women associated with fisheries originating from Nea Mixaniona village, an important fishing community in the northern part of Hellas, as well as members of the Pan-Hellenic Federation of Fisherwomen (PEGA). Women were wives, sisters or daughters of fishers. Members of the Pan-Hellenic Federation of Boat Owners (PEMPA) made up the third group, which represents what the Hellenics call, the 'middle scale fleet', which refers to purse seines and trawlers which operate within national waters. This focus group was composed mainly by owners of trawlers.

The fourth focus was constituted by local fisheries managers from Chania which is situated on the island of Crete. In Hellas, fisheries managers, local or national, are called ichthyologists and primarily work in district fisheries agencies or in Directorate of Fisheries at Athens formulating fisheries policy. Most ichthyologists have a background in biology with a specialisation on fish and are in charge of the implementation of national fisheries legislation but without any decisional-making powers. They are in charge of all the administrative work concerning fishing fleets, subsidies, and so on. The other local administration in charge of fisheries monitoring is the port authority, which is under the Ministry of Marine Merchants authority. The fifth and final focus group was composed of small scale fishers from Chania; mainly sword fish fishers and two medium scale trawl fishers.

The discussion within the five focus groups concentrated on six main questions (see annex 1) with minor changes according to the composition of each group. Taking into consideration that fisheries management in Hellas is not based on a quota system as well as the current national fisheries management system, a discussion on mathematical models used for fisheries management in other parts of Europe among the focus groups proved difficult. For these reasons, social and fisheries scientists in charge of the realisation of this task decided to modify our presentation by showing at the end of the discussion the sword fish model prepared by EFIMAS scientists. The sword fish model allowed focus group participants to understand (1) the work of fisheries scientists, (2) what constitutes a model, and (3) how models can be used in fisheries management. The fact that a model takes into account different scenarios was perceived as something good. The sword fish model was

largely discussed by Focus Group 5, which comprised a number of sword fish fishers. Fishers made comments or criticisms on the four alternative scenarios presented by the model, but by and large found modelling to be an interesting tool for the future of the fisheries industry.

It must be emphasized here that it was not possible to organise a focus group of processing industry producers due to the small number and wide dispersion of such industries in Hellas. Moreover, only a few of these producers use Greek fisheries products, with others using aquaculture products or frozen fish from other parts of Europe or the world. These reasons show the difficulty in bringing the many fisheries stakeholders together. This focus group was replaced by face to face interviews.

The following two tables show the composition, the number of participants, and the location and duration of each of the focus groups.

Table 5.1: Composition of the focus groups

<i>Composition</i>	<i>Number of participants</i>	<i>Location</i>	<i>Duration</i>
FG 1 Environmental NGOs	8	Athens	1,51
FG 2 Fishers' women	5	Mixaniona	1,36
FG 3 Trawl fishers	7	Mixaniona	1,40
FG 4 Fisheries managers	5	Chania	1,16
FG 5 Fishers	9	Chania	1,58
Total	34		8,35

Table 5.2: Participation of each focus group by gender

<i>Number</i>	<i>Men</i>	<i>Women</i>
FG1	5	3
FG2	0	5
FG3	7	0
FG4	3	2
FG5	9	0
Total	24	10

5.2 Perception of science

Science represents a hope for a better future.

Science should be objective and independent of politics.

Science has a negative impact on society.

The first question seeks to understand how participants define, perceive and use science in their daily life on a private or professional level. These issues were largely discussed without making any references to fisheries sciences only in two focus groups: environmental NGOs and women's groups. In the other three focus groups, composed by fishers and fisheries managers, participants after giving a short definition on what "*epistimi*" (science) should be, were able to easily move on to discussions about fisheries sciences. The differences between the focus groups can be interpreted as follows.

First, environmental NGOs have a direct link to science because all of them considered themselves as scientists; second they are involved in marine animal conservation without having any direct links to fisheries sciences. Women participants have, in general, ideas about sciences but they are not familiar with fisheries sciences. Matters happening at sea (such as harvesting), which they associate to be in the men's sphere, are alien to them.

The following issues will be developed under this chapter: definition of science, the use of science and criticisms to science.

5.2.1 Definition of Science

Two participants gave the etymological significance of 'science', which comes from the ancient Hellenic language and refers to the *"general and specific knowledge on some issues"* (FG2 and FG4). So science is when a specific subject is analysed and studied in depth with the intention to go further (FG1).

The definition of science, given by the other participants is similar to the previous definition. A number of participants focused on the fact that sciences are based on studies and mainly on experiences. Scientific results are proven by experiences. Experiences and demonstrated results are the two characteristics which legitimize science (FG2, FG1).

Another concept discussed by the focus groups was that of the future of society being based on science. *"Sciences should improve the life of human beings"* (FG4), which is parallel to one of the fisher's response to the first question: *"sciences represent the hope of the future"* (FG3).

Some other words were used by participants to define science and they are: observations, transcription, make experiences, formulate results. Science is searching to build a better future (FG4). Science should help to ameliorate the lives of human beings and the universe.

5.2.2 Use of Science

Sciences are useful because they help society to improve and progress. Sciences are used to benefit society both at an individual level as well as at a global level. One of the participants noted that the first question was very 'large' and needed a correspondingly 'large' response. Within this context *"science is a big umbrella covering everything. Under such context we are always related to sciences directly or indirectly, even when we are preparing the budget of our organisation or the methodology for our field work. I found your question very large and by consequence our response is also large"* (FG1).

For the environmentalists, science has a history and they always feel the need to refer to them for different reasons. One of these reasons is to find the scientific foundations and the second is the need to find methodologies or tools to be used for their projects. Analysing and discussing scientific research foundations are indispensable *if we want to advance and progress in what we do and how we do them* (FG1). One part of their work is related to sciences, where a participant noted, *"in our work we collect data which we analyze and compare with results from other scientists"* (FG1). Hellenic environmental NGOs are often leading applied research projects or other types of projects

financed by the European Union, and in doing so they often refer to science, particularly when they are in contact with scientists.

Nowadays, users of science have easier access to scientific results and data through new technologies. Thus environmental NGOs have the possibility to analyse the available scientific information which interests them.

The main use of science by the environmental NGOs serves to justify their action towards society. *"We use sciences to prove our action"*. As the NGOs action is directly relating to the civil society, they need to use scientific work to legitimize or justify their activity. *"We need to use science and I mean all scientific disciplines including economics and social sciences"*. For NGOs, sciences are often used to explain to local communities why and how they should protect marine species (monkfish or turtles) which benefit from their protection.

But scientific results given by international institutions such as ICATT or ICES about the state of fisheries resources can also be used by NGOs, at the national or international level, to create awareness with the aim to alert public opinion on the state of the stock of some fish species. One such campaign on Mediterranean tuna stock organized recently by Greenpeace is a good illustration of this. The report edited by WWF highlighting the state of the different fisheries stocks is also another example. This issue will be further developed later in questions two and three.

Fisheries managers, fishers and women find that science is indispensable to the society because it represents the hope of progress. Medicine is the most scientific discipline quoted by participants of all focus groups. It seems that they regard medicine as the leader of all scientific disciplines. This preference can be ascribed on the one hand to the fact that in modern society people are most often in direct contact with medicine, and on the other hand to the mass media which publishes information about medicine evolutions that keep civil society informed about such issues. *"In the past, American scientists explained that it is good to consume meat, while later they tell us that the best nutritional habits are those of the Cretan population, which consumes a lot of vegetables"* (FG 2). This example shows the role played by radio or television on the dominance of medicine within the scientific world. Even if the results of science often changes, participants from FG2 considered sciences as indispensable to the society progress.

5.2.3 Innovation

Innovation is considered a result of the scientific work. It is often related to the simplification of work done manually or to ameliorate productivity. Agriculture and fisheries are the two economic activities on which innovation has an impact. The use of chemical products in agriculture was aiming to improve production and is perceived as a guarantee of food security. *"Scientists discovered chemical products and now they come to tell us that we should stop using them because they are harmful to human health and the environment"* (FG 2). The excessive use of chemical products is the result of *"farmers' wishes to increase profits"* (FG2).

In fisheries, technology introduction facilitates some difficult tasks. Some participants referred to the use of satellites for locating fish shoals. The case of sword fish was presented by FG5. Locating fish shoals helps them in their activity. As one participant states, *"we don't need to run behind the fish,*

we know where it is located and we go". Another notes, "Our objective is to increase our production and I found that the satellite system helps us to track down sword fish". Another participant replies to this argument by saying, "Yes but we destroy the resources" (FG5).

5.2.4 Independence of science

Science should be independent from the society and more specifically from politics. This is also an argument heard within different focus groups. *"Science, if we recourse to the definition should be objective; at the very least, it should try to be objective through use of methodologies. But fortunately or unfortunately science isn't independent from the society which is producing it. We should not forget politics and the role of politicians in the formulation of scientific results"* (FG1). This position will be more explicit later when fisheries scientists' involvement in the management decision making process is presented.

5.3 Fisheries sciences

Good fisheries management should be based on marine sciences.

Ichthyologists perform administrative tasks and not research.

National fisheries management is not based on research.

Need of collaboration between all stakeholders.

In Hellas, fisheries sciences are considered as new sciences in comparison with other scientific disciplines. Fisheries research institutes do not play a direct role in the decision making process of national fisheries management, even though the first marine research institute was established in 1946. For years this research institute concentrated mainly on oceanography. Only recently the National Centre for Marine Research (NCMR) developed researches on fisheries. After the admission of Hellas into the European Community in 1983, one more institute was established in Crete, called the Institute of Marine Biology of Crete (IMBC). The two institutes didn't have the same legal status; NCMR was a public institute financed by the ministry of research, while IMBC was financed by European Funds through research programmes. In 2003, the two institutes were merged and formed the Hellenic Centre for Marine Research (HCMR). HCMR is a public institute and one part of its finances is provided by the Hellenic Ministry of Research. During the 1990s, a new institute called the Fisheries Research Institute was established in Kavala with a different legal status. This foundation institute is under the authority of the ministry of Agriculture. These institutes have the same feature; the great part of their resources is coming from EU through research programmes or studies. The research developed by these institutes is based on the ability to access European funds. Researchers conduct programmes according to their own research interests.

Hellenic research institutes do not make interventions on the request of national fisheries management and as they do not have any formal obligation to respond to the need of national authorities as they are not linked to them. But, some fisheries scientists are well known to the stakeholders of the fisheries industry as they give the scientific point of view in all the events concerning the industry. These persons are the leaders of the Hellenic fisheries sciences and in

general when people mention fisheries scientific research they always refer to them and not to the research work done by the institutes. This parenthesis on Hellenic fisheries research was necessary first to understand the lack of information about national research and second to understand the relations between Hellenic fisheries industry stakeholders.

One further clarification is necessary to provide a better understanding on the perception of fishers on fisheries scientists. Fishers consider fisheries scientists as “*ichthyologists*” working at the district or regional level enforcing the fisheries regulations set by the ministry of agriculture. For years, such activities were under the authority of Fisheries Direction and “*ichthyologists*” were in charge of implementing national fisheries regulations, making suggestions on fisheries management to national authorities and other administrative duties regarding helping fishers access European subsidies. Today, district fisheries agencies fall under the jurisdiction of district administration but they still have to perform the same duties as in the past. This clarification is necessary to understand the position of fishers during the discussion on fisheries sciences. They immediately think of fisheries scientists as *ichthyologists* and fisheries inspectors who study biology and then follow a specialisation in fisheries biology.

The following issues will be developed: definition of fisheries sciences, confidence in fisheries sciences, and collaboration between different types of status of knowledge (fishers, conservationists and fisheries sciences) without forgetting the criticisms made towards fisheries sciences.

5.3.1 Fisheries sciences definition

The definition of fisheries sciences was raised by the participants of FG 1. An EFIMAS fisheries scientist was asked by participants to give his definition of fisheries sciences. “*Fisheries sciences are all sciences related to fisheries stocks management*”. (EFIMAS fisheries scientist) This narrow definition was considered too restrictive by environmental NGOs “*our action doesn’t have any direct link to fisheries*”. But some of their actions could be connected to fisheries through fishers’ activities. In order to protect marine species, environmentalists need often to convince fishers to change fishing techniques or move to another fishing area.

“*By opening the definition to marine sciences, I can say that our action is to link biological, ecological and marine species management*”. This last observation made by one of the participants offered the opportunity to open the discussion on fisheries sciences. Another person continued on the same thinking: “*Our action takes place in fisheries communities and we need information and results coming from fisheries sciences to interact and negotiate with local populations who are linked to the fisheries industry*”. The interpretation of the above quotation means that NGO activity usually has an impact on fisheries activity by reducing or adding restrictions on fishers in order to preserve marine species (monkfish or turtles).

Women participants had only few ideas on fisheries sciences as they are less familiar with the situation at sea. Two of the participants explained to the others that *ichthyologists* working at the local level are fisheries scientists and some of them are knowledgeable.

For other focus groups, fisheries sciences are of interest as they are related to the evolution of marine micro-organisms and the life cycle of marine life, fish reproduction, evaluation of fishing

stocks, and knowledge about the seasonality of fish reproduction. This last information *will help us as fisheries managers to impose seasonal bans on certain species*. Other participants from the fisheries managers focus group consider fisheries sciences as important *to fish and the marine environment and on how fishes live and behave within this environment* (FG4).

Fisheries science is an applied science and not a fundamental science and this point was discussed by participants in FG1 and FG4. For many participants, fisheries management should be based on all marine sciences and not only on fisheries science. *“If we want to accomplish a good management system we need to involve a lot of disciplines and not only stock assessment scientists”*.

Fishers see fisheries sciences differently. *“In Hellas, when we speak about fisheries sciences, we should not think of persons doing research but persons who have just finished university and are assigned to carry out various tasks which do not involve research. For me a good ichthyologist is a person who is doing research. But in Hellas, we recruit scientists just to accomplish administrative tasks; this situation corresponds to the Hellenic reality”* (FG3). This quotation illustrates the confusion between fisheries inspectors (ichthyologists) who are in charge of administrative tasks and researchers working in fisheries institutes who are also called ichthyologists.

5.3.2 Criticisms

Fisheries industry stakeholders who are directly or indirectly involved in fisheries criticise fisheries scientists for a number of reasons while at the same time claim collaboration with them. One of the participants asked the EFIMAS fisheries scientists *“why the Hellenic research leaves Hellas?”* It took sometime to understand what motivation was behind this question and respond to it. This question should be interpreted as follows: why are the results of scientific research taking place in Hellas not applied at the national level to help fisheries management as is happening in other countries. The following will clarify this question.

5.3.2.1 Relations between fishers and fisheries sciences

Fishers underlined that fisheries research centres or institutes finance their research from the European Commission and the ministry of agriculture which commissions studies. This financing relation *“makes Hellenic research dependant on both institutions”* (FG3). For fishers, national research institutes are only interested to access European research funds and the European structural funds managed by the Hellenic state. Fishers accuse research institutes as not being independent but, at the same time, they collaborate with them by submitting proposals for scientific studies funded by national structural funds. The management of structural funds at the national level raises new opportunities for collaboration between fishers' organisations and research institutes. It is the easiest way for both to access structural funds. For example, at the last call for proposals the National Federation of Artisanal Fishing Boat Owners (PEMPA) submitted a proposal in collaboration with the Fisheries Research Institute to study fish stocks in the Gulf of Thermaikos.

However, the PEMPAs then contests the results of another study carried out by the Fisheries Research Institute for coastal fishers' organisations as it shows that fishing traps used for octopus fishing are selective gears. One PEMPAs member notes, *“this is not true and I demonstrated it to them but*

researchers don't want to change their opinion. For me, good scientists should be able to accept their mistakes" (FG 3).

5.3.2.2 Call for recognition of fisher's knowledge

Ichthyologists' knowledge is theoretical *as much of their knowledge is learned from universities*. They lack practical knowledge and experience, and for this reason they need the practical knowledge from fishers. Often, fishers allow ichthyologists to conduct training on board their ships: *"In 1981, I brought two ichthyologists out to sea who believed that trawling is an unselective method of fishing and destroys fishes. I decided to show them that all fishing gears have an impact on the resources. We went fishing with gillnets every day at the same place the first day we caught 120 kilos of red mullet, the second day 60 kilos and the third day less. I explain to them that when we are fishing with trawler, and we are going every day on the same place the results are different, the first day we get one kilo, then second two, etc This means that trawling regulate more the catches than gillnets."* (FG 3)

Another argument by fishers is that scientists should be able to listen to fishers and not reject their knowledge. *Fishers know when and where fish is reproducing and when is a good time to stop fishing activity.* (FG3) Trawlers in Hellas stop fishing every year between June and the end of September. During this period, trawl fishers have the desire to convince scientists and the ministry to forbid the use of gillnets in the entrance of some close bays which are nurseries for hake. Gillnets operated at the entrance of the bay blocks the entrance of hake as they make their way to their spawning areas. *"But scientists don't want to hear our arguments because they considered our arguments as part of competition between us and small scale fisheries"*.

Some participants from the women's focus group believe that some experienced fishers have a better knowledge than some scientists. *"A fisher who knows his job well and carries it out with conscience has a better knowledge than the scientist. Scientists could have a lot of problems convincing this type of fisher who has the knowledge and the experience"*.

5.3.2.3 Confidence in Science?

Participants from environmental NGOs accept that fisheries science is indispensable but at the same time do not have much confidence in it. *"I am reacting to the word confidence because we need to be sure on the manner that scientists find their results. Results should be based on transparency which is not guaranteed through the use of models"*. Models are believed to be open to manipulation and lack transparency. They consider also that the use of data by scientists is influenced by the results they want to have. Some other participants *"have confidence in science as they have the capacity to analyze, discuss and criticise the results of the scientists"* (FG1).

Uncertainty is also another factor which adversely affects confidence in fisheries science. *"As environmental NGOs we need scientific research but uncertainty is always an issue because in models you cannot find all the dimensions you expect to have."* But science is accepted if we take into account its limits and base our analysis and reflection within these limits. (FG1)

Environmental NGOs contest the interpretation of scientific results based only on a single scientific discipline. Today, no single discipline is able to reply with certainty to existing problems. *“When we are working with fishers we need to take in account not only the fisheries stocks but also their wives and families, as well as all the stakeholders working on the same issue. Scientific results will be better if they integrate different disciplines during research work. This involvement constitutes the only guaranty for more objective and positive results”*. Environmental NGOs, fishers and fisheries managers ask for greater integration and collaboration between scientists of different disciplines, between scientists and fishers, and between fisheries managers and scientists.

5.3.3 Collaboration

Local fisheries managers (fisheries inspectors) noted that do not have any formal contact with fisheries scientists and their main information comes from, fishers. Contacts with scientists are scarce and they are based on a personal level. Telephone is the main communication tool between fisheries managers and scientists. When they need information concerning a certain issue, they usually just call a friend working in a fisheries research institute and they get a response. Fisheries managers regret the fact that Hellas lacks an institutional framework where they could exchange views and information with scientists. As they have a lot of information coming from fishers they will like to combine this with the information from science and carry out their real role as a link between fishers and scientists.

Fishers will like also to collaborate with scientists because they want to transmit their knowledge to scientists and, if possible, to integrate it into various management measures. Environmentalists want also to collaborate with fisheries scientists for different reasons. Research results can be used in their work within fisheries communities. The use of some fishing gears or areas where fisheries take place can damage the environment and they want to discuss these issues with local populations. For them, fisheries activities, tourism and water pollution through agriculture or industry all have negative impacts on the conservation of marine species, and they need to access to scientific results if they want to have a holistic view in the place they are working. This can be realised by taking what is already published or to establish collaboration with fisheries scientists or other disciplines related to fisheries management. *“I think that the evolution of the situation requires such collaboration; it is impossible to live separately within our world”* (FG1). Contact with fisheries communities requires different scientific disciplines and not only fisheries sciences. Sociology can be one of those.

Participants from environmental NGOs think that it is possible also to establish another kind of collaboration with scientists at the marine resources management level. Environmentalists are better able to act in a political sphere compared to scientists, by carrying out international campaigns and other such activities better than scientists are able to. The results of such collaboration can lead to better fisheries management systems. An NGO's action towards “tuna fishing” reflects this trend; they try to integrate society into the action for the conservation of tuna stocks. *“Our action is situated at the political level and is based on scientific data of the international institutions working on fisheries management (ICCAT or ICES). Our action should be considered as complementary to their (scientists’) work; it is time to communicate to the civil society on the state of some fisheries stock. Some must react if we want changes”* (FG1). This issue will be discussed again later in the text.

The organisation of the focus group is considered by environmental NGOs as the first step for the establishment of this necessary collaboration: *“ten years ago it was impossible to find any fisheries sciences research programme which included discussion with the NGO”*. For them this discussion now takes place because of the need to incorporate the society and the needs of society into such research. Society needs to participate in the debate on matters concerning the sea and the integration of social sciences into this debate is an obligation (FG1). This initiative is good but still limited and they will like to see it evaluated and improved. Their dream is to bring all fisheries stakeholders in the same meeting room. *“It is more interesting to mix the four groups: managers, scientists, fishers and environmentalists. We need this frame if we will like to avoid the existing chaos within national fisheries directorate”*.

5.4 Fisheries management

Fisheries management is a political game.

Fisheries management objectives need to be transparent.

Local fisheries management is necessary.

It is difficult to mention fisheries management without a reference to fisheries sciences and to models which are the main tools to carry out fisheries management. In Hellas, fisheries management is not based to mathematic models and for this reason only a few persons, environmentalists, mentioned mathematic models. We will try here to develop again the main issues which appear during this discussion. Fisheries management will be the fist issue discussed, and then we will move to other sources of knowledge which are necessary to accomplish good management. The main elements used to illustrate these issues are related to the national level with some also coming from the European level. In Hellas, fisheries management is based on geographical and seasonal interdictions of gears. It can be also noted that in Hellas, the EEZ is fixed at six miles and the national fleet is divided in two main categories, the small scale and medium scale, which includes trawl and purse seine.

5.4.1 Fisheries management

Fisheries science is an applied science and they are linked to the decision making process as the basis for fisheries management measures. *“But the main issue is to know what the main management objectives are and then which methodology was used to improve these results”* (FG1). For one participant, fishery sciences can manipulate results just to satisfy the objectives fixed by politicians. Doubts on the objectivity and the transparency of results and on the methodology used by scientists are expressed during focus groups. Environmental NGOs would like to know how fisheries scientists *“integrate environmental interests in their research”*.

For local fisheries managers, fisheries management should be as follows: *“Within one region or one zone we must know what its production capacity and have the means and the possibilities to intervene on the determination of the caught quantity, etc. The objective is to fish and to maintain the stocks. Fisheries management needs information and we don’t have it”*. (FG4) It is difficult to

access scientific information and sometimes its availability is uncertain. These points will be developed later when local fisheries management is covered.

Women associated with fisheries and fishers perceive fisheries management as a political game. For them decisions concerning fisheries management and fisheries policies are always related to politics. The number of fishers in each fleet category is determinant for the designation of fisheries policies. *“Small scale fisheries and aquaculture are good lobbyists in comparison with medium scale gears (trawl and purse-seines) because they are numerous and usually have good relations with politicians”* (FG2). Women and fishers observed that the high number of small scale fishers always plays to their favour because when new management tools are implemented, such as the closure of some fishing areas or others, politicians are looking for votes in the next election. Medium fisheries are numerically less than fishers and they have the feeling that they do not benefit from the favour of politicians. Aquaculture is a big business and they have the capacity to move the national political circle in their favour; some fishers justify this situation by the fact that some former ministers invested in this activity.

Fishers considered European Union fisheries management also as the result of political games between countries. *“They negotiate fisheries against telecommunications or other industry and if fishers loose money, it is due to such policy”*.

Fisheries management in Mediterranean is difficult because *“when Greek fishers stop fishing (trawlers or swordfish), boats from others countries (Turkey and Italy) still continue fishing”*. They mentioned these two countries because are the closest and they see these boats operated in the international waters close to their country. There is also a competition between Greek and Turkey fishers because the latter sells fish at very low prices. This year Greek authorities attributed fishing licences for sword fish boats to fish in international waters and each licence is cost 3500 € for a four-month period. Some are able to afford this high cost of the licence but they do not understand why they have to pay it as they are always fishing outside of the 6 miles.

5.4.1.1 National fisheries management

Participants noticed in a number of occasions that the results of national research are not used for fisheries management purposes. *“A European fisheries policy does not mean that national states cannot use national research to edict national rules. However, such research is never used”*. Hellenic fisheries management is based mainly on European fisheries policy and particularly to a *“very old legislation”* dated 1966 with some recent texts (FG4). Fishers also complain against national fisheries legislation and they ask to replace this old legislation with new legislation based on scientific results. *“Often scientists complain that our legislation doesn’t take in account their results. As fishermen we want to know the impact of bay closure to the renewal of marine resources. We (trawlers) don’t work four months per year because our fathers thought that this is a good practice. When we start fishing in October I noticed that fishes are more important than in the end of the season in May”* (FG3). National legislation is a document which compiles fishers’ observations and knowledge. Trawlers do not fish four months per year since the late fifties.

Nowadays fishers asked for more scientific legislation because they want fisheries management to be based on empirical and scientific knowledge. Two fishers, one with many years of experience and the second who has not started work yet note, *“They tell us that we don’t collaborate with scientists but scientists don’t want to hear us and make an effort to understand what we tell them”* (FG3). Each fishing closure should be justified by scientific data explaining why it is necessary to stop fishing between this date and this date, or why this gulf is closed, etc.

5.4.1.2 Local management

The possibility of implementing local fisheries was discussed within three focus groups. This presents some of the arguments put forth during the discussion.

It appears difficult to have any formal local fisheries management in Hellas. First because the only existing information is that which comes from fishers and scientific data if it exists is often late. Second and more important is that only the national authorities are entitled to edict regulations.

Local fisheries managers wonder what their role is; *“They expect us to manage, but I can say that we are not the local fisheries managers. We don’t feel like scientists; it is a long time since we finished university, and today our responsibilities are limited to administrative matters”*. This quotation is similar to what the fishers said about ichthyologists in the previous question. Fisheries inspectors are informed by fishers about the stock situation and when the situation is serious they ask the Ministry to react by taking some decisions. The timing of these decisions is also an issue. If the proposal is not accompanied by scientific data, it is difficult to convince politicians. A few years ago there were problems with sea urchins in the Chania bay area and we had to act. *“We submitted a proposal to the fisheries direction and we were waiting them to take any measures. We still wait. We cannot ask the support of research institutes because we do not have the money to pay them to do the study and even if we have the money it will take a long time before any results arrive”*. In theory an institutional framework should exist giving the possibility to edict local rules in a short time, but *“we don’t know why there is not one and we have to go through Athens”*. (FG4)

Fishers also are favourable to local management because they believe that each fishing zone has its own ecosystem which must be taken in account. Finally fishers benefit more freedom from local managers because communication is better and it is easier to stop fishing activities if there is a problem. This decision isn’t easy because they need to convince all fishers and organisations of the necessity of the proposed actions. One cooperative grouping of trawl fishers decided from last year to stop fishing on Saturday night. *“It is one management model. Our choice was based on multiple reasons first to sustain the resources and second to get a better price on Monday”*. Fishers decided within their organisation to stop fishing Saturday during the 8 months fishing period. They are successful where fisheries managers have not been. *“Fishers are not stupid; they understand why we need to stop fishing on Saturday but every year we need to argue this decision”*. This year this rule is followed by all trawlers of Northern Aegean Sea except of those of one city.

Fishers prefer to make informal rules and not formal ones because they want to have the choice if they are going fishing or not. If the Ministry intervenes by making the decision formal they will lose the possibility to return back in the previous situation. All national decisions cannot change. They

want to keep the choice to decide if they need to work on Saturday or not. Some winters, weather is bad for several days and “*we may need to fish on Saturday*” (FG3). Decisions are made at the general board each Saturday and then other harbours are informed. Last year they didn’t fish on Saturday during the entire trawl season. This corresponds to one month work but nobody complain because they earned enough money.

Fishers (trawlers) complain against European fisheries policies which call for fishers to reduce their activity to protect fish but do not finance them to valorise their production by making some processing on board. They complain against the European fisheries funds which gives this possibility to small scale fisheries but not to trawlers. Valorisation of the production is a new concept for fishers and it should be given more attention.

5.5 Computer models

Models are the best tool to represent a complex reality.

Models can be manipulated.

Fisheries models are focusing only on fish stocks.

Models seem to be unknown to the great majority of focus group participants. Issues include what is a model, why the production of such models is necessary, and also criticisms to models were developed within FG1. Other participants have a vague knowledge on what models constitute. This general lack of knowledge is due to the fact that Hellenic fisheries management is not based on a quota system but on seasonal and geographical bans or on fishing gear size. Within this context, knowledge on models and their use in fisheries management is very limited and much of it is based on information coming from Brussels (DG Fish). It was difficult to concentrate the debate within focus group only on models. Generally participants easily evoked the main problems with fisheries management that they faced at local and national levels. Focus groups were held during the period when Brussels (DG Fish) was discussing the Mediterranean fisheries regulation and it is understandable that those fishers preferred to speak about their actual problems rather than about fisheries management based on models. The second difficulty was the division of focus group information between questions. Often discussion moved from question 3 to question 4 or question 5. Under such a context, the choice was made to divide the available information on an arbitrary base. It is for that reason that you find some of the same ideas under different questions.

This section will examine the main aspects coming out from the discussions on models.

5.5.1 Use of models

For environmental NGOs computer models are useful not only in fisheries but also for environment sciences. “*Recently our organisation was conducting an assessment of the ecological resources of one region and we use models. Models are useful and are good tools especially when there isn’t something else to use! But we must take in account their limits!!!*” (FG1)

Models are considered *as tool to facilitate one study subject having multiple parameters. It is a method to facilitate a complex reality. Models should be taken as methods or tools because if you*

give them a bigger weight or value then it becomes problematic as they do not represent the full complexity of the reality. It is for those reasons that environmental NGOs insisted during the meeting on the implication of different scientific disciplines within the decisions making process especially in fisheries

5.5.2 Critics of computer models

Again here participants criticised the excessive use of models because they do not represent reality and usually because the data used is not transparent and can portray a different picture of the same situation.

5.5.2.1 Models can be manipulated

Fisheries scientists are accused of producing different models from the same data, and because fisheries are an economic sector there are often existing economical stakes involved. *“Some scientists through their models try to show that the stock of single specie is in a good state and some others by using the same information are showing that it being depleted. Fisheries scientists justify their model by using uncertainty as the cause of the difference between their models. This contradiction and difference in the results are more important within fisheries sciences than other sciences.”* (FG 1) The use of data in the production of models is considered as lacking transparency and is one reason that *environmental NGOs should not place as much importance on scientific results regarding fisheries*. They should take them, analyse them and then develop their own activity.

Computer models are perceived as the best tools and help to obtain a good picture of one situation. But *“if you use different models to explain the same situation the picture can be different”* (FG 1). These critiques are also noted in the development of the other questions.

5.5.2.2 Fisheries models focus only on some parameters

The issue of the parameters used to produce fisheries models came out in different focus groups. For one participant of the women’s focus group, if water pollution does not constitute one of the parameters of models, this means that fishers are considered by models as the main source of the destruction of fisheries stock. For this participant fishers have one part of the responsibility in fisheries stock depletion but there are also other sources which should be taken into account by models.

Fishers participating in FG3 also complain against models, noting that models take into account only the issue of fish stocks conservation without giving any importance to fishers’ livelihood and survival. They asked the fisheries scientists the following question: *“Does the survival of fishers exist in your scientific philosophy? Or do you just look at the conservation of fish stocks? For us models should determine first how to assure the survival of fishers and then how to protect fisheries stocks. Otherwise fishers will disappear in the next ten years”*.

One final item calls for the introduction of economic and social parameters into fisheries management. *“Good fishers”* know that for their survival they should protect fishes and fisheries stocks.

Finally, before ending the discussion on computer models, it seems necessary for us to give some information about the discussion within FG2. Only one of the participants had some knowledge about models. For the other women, this subject was new, and during the meeting we decided to give them some information about models and the use of models to establish fisheries quotas in the other parts of Europe. After the explanations given by an EFIMAS fisheries scientist, the women asked the following question: *“Do scientists calculate quotas on the basis of the previous consumption of fish or do they look at the needs of the market before setting the quotas?”* This question is relevant because it expresses the thinking of fishers that fish production should satisfy at least the national demand in fish. They cannot understand that the quotas are fixed on another basis.

5.6 The EFIMAS Model

EFIMAS model is more transparent.

Models having economic and social components are more complete.

Open use of EFIMAS model.

The introduction of the EFIMAS model was followed by the presentation of the specific EFIMAS model for sword fish for the reasons explained in the introduction of this report. Both during and after the presentation, focus group participants asked questions or gave their ideas on the models or their perception of national fisheries management. The main ideas, arguments and perceptions are presented here. Again environmentalist participants were more active than other participants.

5.6.1 More transparency

The EFIMAS model is more transparent compared to traditional models because the use of data is clearer. *“It doesn’t have a ‘black box’ and that is positive. It is changing the general idea about models”*. Until now some fisheries management models are functioning for years without to be subject of evaluation. A model which appears good today can be unsuitable to conditions existing ten years from now, but will still be used if no evaluation is carried out. For this reason models should be assessed with aim to avoid such situations.

The fact that the EFIMAS model proposes different scenarios was considered a good advance compared to old style models. But the term of *“better scenario”* was criticized by environmentalist participants. For them scenarios are not neutral concepts because they correspond to choices. *“We must take care because if our choices are limited then fisheries management can be limited. In a case of ambitious choices, results are different”*. (FG1) For the environmentalists, models should be evaluated with prudence because they are based on individual choices or they are made just to satisfy some specific interests.

5.6.2 Economic and social data

Presently, fisheries models have to incorporate economic and social data if they want to be effective. It is impossible to impose fisheries management measures without knowing the social and economic conditions of fishers. *“That these types of models provide scenarios and take into account the social*

and economical parameters is interesting. It will permit us to understand how the fleet will behave in a case of a ban.” Research which does not take in account socio-economic parameters suffers as it does not take in account certain vital factors. EFIMAS is considered, by the fisheries managers group, as a positive project even if it is still in its infancy because it can help to facilitate fast management decisions at all levels. *“If we have [this tool] in our possession; it will be possible to take local management measures more rapidly than today”.* (FG 4) Local fisheries managers, complain about the lack of collaboration with scientists (see section 5.3.3) and about the lengthy process required before seeing the application of management measures at a local level. *“When the decision finally arrives, we don’t face the same problem”.*

5.6.3 Comments on the presented sword fish model

Sword fish fishers (FG5) were surprised by the presented model that the Mediterranean sword fish stock is maintained at the same level as in the past. They think that it is difficult to manage a stock that is moving around the Mediterranean Sea and is fished with different gears at different times by different countries. While Hellenic fishers stop fishing for 4 months per year, fishers from other countries continue fishing. This situation complicates the implementation of any measure at the Mediterranean level and makes fishers regard national measures as an injustice. For this reason they feel that the EFIMAS sword fish model is a *“good approach without providing any measures”.* (FG5) Hellenic fishers think that management measures should be the same in all Mediterranean countries if we want to avoid stock depletion and concurrence between fishers; they don’t like to see Italian fishers fishing just outside of Hellenic national waters during the seasonal stop observed in Hellas. Gears and seasons should be harmonized between all countries and measures should be enforced.

As strange as it might be, trawl fishers gave the same arguments as sword fishers. It is because they also observed a seasonal stop and during these four months, they see the Turkish fleet operating in the Aegean Sea. *“The use of all kinds of models by the EU cannot be successful if the fishers aren’t convinced that these new models are better than the existing ones. You should show to them that the new measures are fair and objective and that they are equally applied to everybody in all countries”* (FG 3).

5.6.4 Use of EFIMAS model

The EFIMAS fisheries scientist explained to the participants of Focus Group 1 and 4 that the EFIMAS model will be accessible to all persons who are interested in the model. Environmental NGOs and local managers receiving this information asked questions on how they can use the model and what data is required if they want to run the model. Both groups have the theoretical background to run models if the model is using a simple language.

5.7 Discussion

We will conclude by commenting on some of the elements coming out of the different debates. Hellenic fisheries legislation may be regarded as “old” and mostly legalizes customary rules. Seasonal and geographical closures have been used since the mid 1950s and a licence system was introduced in 1966 for all medium sized fishing boats. Until European Commission legislation came into force, there were no major changes to legislation. European fisheries regulations were added onto the

existing frame. Under this context, fisheries scientists did not have a direct link to national fisheries management matters. As they said, no institutional frame obliges them carry out fisheries management and they also do not possess the scientific data required for this objective. For fishers and others stakeholders, fisheries sciences is represented by “ichthyologists”. Models and all other scientific data are distant to them apart from the representatives of environmental NGOs who also use these tools. During focus group debates, the discussion concerning models and fisheries management focused on local or national issues more than models. Fisheries managers also believe that they can read and understand models and they would like to use them as a tool for local fisheries management decisions.

But for all of them fisheries management is a political affair and the use of models in the decision making process led some participants to have a negative reaction toward fisheries scientists and models. The main criticisms coming out are that the data is not transparent, data can be manipulated, and model can be used to achieve some interests at the expense of others, etc.

All agree with the introduction of the economical and social parameters into the decision making process but question why environmental or ecosystems parameters are not also incorporated. For environmentalists and fishers, a good fisheries management should also take into account environmental issues as fish are living the ecosystem as part of it. Environmentalists and fishers wish to take part in the decision making process concerning fisheries management. They accused fisheries scientists of keeping this privilege only for themselves. Environmental groups think that fisheries scientists protect fishers more than fish. *“When, we are arriving at the decision level in fisheries management usually the final decision favours fishers”*. (FG1) This means that politicians who have the final decision making power want to avoid contestations by fishers by keeping the social peace. *“Decisions favoured fishers and never nature”*.

The EFIMAS fisheries scientist explained that he does not play any role in national or European fisheries management. At the national level, it happens that fisheries managers ask him and his colleagues for advice informally, usually by phone. *“If I have available data I give my opinion; if not I cannot satisfy their demands.”*

Scientists do not take any management decisions, but they can provide scientific information and advice to the decision makers. For example, the EFIMAS sword fish model was presented to ICCAT, but the decision does not belong to the scientist. This clarification facilitates the debates and environmental NGOs call for scientists to collaborate with them. The aim is to change the national situation and avoid the *“existing chaos in the fisheries directorate”*. *“The scientific world should contribute to modify the existing culture and help direct fisheries management towards discussions with all stakeholders”*. Environmental organisations require greater scientific support to influence politicians and other ‘final’ decision-makers on the depletion of fisheries stocks. *“Only scientific data can convince them that fisheries stock situation is serious”*.

Environmentalists perceive the organisation of the focus groups as the first stage of this collaboration. As it was noticed before, fishers and fisheries managers also claimed the need for greater collaboration with scientists and more involvement in fisheries management. All fisheries

stakeholders are claiming a need for greater collaboration amongst themselves and even with the fisheries directorate in its need for scientific support during the negotiation process with Brussels.

It seems that all stakeholders involved in fisheries are not satisfied with the existing situation, even fisheries managers at the national levels because they feel that the final decisions do not rest with them. Politicians have the final power to make decisions and these decisions are often dominated by client relationships.

Chapter 6:

Report from the Spanish Focus Groups

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6.1 Introduction

A series of three focus groups and seven independent interviews were held in the Basque Country of Spain over a one-month period during October, 2006. These interviews were comprised of stakeholders in the fisheries sector in this region with the goal of obtaining insight and feedback on the EFIMAS (Operational Evaluation Tools for Fisheries Management Options) modelling framework. In an effort to acquire data from the entire sector, interviewees and focus group participants were selected from a representative composite of stakeholders, including the catching sector, onshore fisheries sector, women in fisheries, fisheries managers, and environmentalists.

This report examines a series of discussions between these stakeholders structured around a formal interview and focus group protocol (see Annex 1). The findings in this report detail the significant themes that emerged during the analysis of transcribed interviews and focus groups as they relate to the themes outlined in the interview structure. These themes are: 1) perceptions of science; 2) perceptions of fisheries science; 3) perceptions of fisheries management and the incorporation of science; 4) perceptions of modelling; 5) issues of uncertainty in fisheries management and computer modelling; 6) potential applications and enhancement priorities of the EFIMAS modelling framework.

Due to the disparate levels of knowledge with regard to mathematical and computer modelling among the various groups and individuals, different themes emerged from each discussion that at times differs significantly. However, the salient theme of bio-social integration in fisheries management proved a unifying factor among all participants, and will serve as the foundation of this report.

6.2 Geographical orientation and background

The Spanish Basque Country (*País Vasco / Euskadi*) is located on the Northern Iberian Peninsula on the Bay of Biscay, with a surface area of 7,089 square kilometres. The current population is 2.1 million inhabitants, with the most significant growth occurring prior to 1981, after which there was a one percent decline in the population until 2003. From 2003 to the present, population has seen a rising trend.

The region is separated into three provinces: Bizkaia, Gipuzkoa, and Alava. The Basque government is located in Vitoria-Gasteiz, which acts as the administrative capital. The Basque Country is an autonomous community within Spain. There has been much historical debate around the definitions of the autonomous community status and political structure, with a strong Basque separatist

movement. The current laws give the community a federation status of three constituent provinces, which have been ruled since the incorporation to Castile in 1200 by the *Foral System*, which is an independent set of laws and institutions. Under Franco, this system was largely suspended, though restored under the Spanish constitution of 1978.

The constitution gave historical rights to autonomous communities within Spain. Initially, the Constitution did not intend to make every Spanish region an autonomous community, though with significant regional opposition, all regions gained the right to become autonomous. They have wide legislative and executive autonomy, with independent parliaments and regional governments. Each community differs, however, given the distinction between historic communities (Basque Country, Catalonia, Galicia, Navarre and Andalusia) and the others. Historic communities are granted significantly more autonomy. The Basque Country Parliament elects its own president who forms a government following traditional parliamentary procedures. All presidents to date have been members of the Basque Nationalist Party (*Eusko Alderdi Jeltzalea*). The Basque autonomous community has its own police force, education, health systems, and television.

The economy of the Basque Country has grown significantly over the past decade. The Basque Country is one of the wealthiest regions of Spain, with a GDP per capita 20.6% higher than that of the European Union average in 2004 (\$30,680 USD). The high GDP can be attributed to industry and construction in the region, contributing 38.18% to the total GDP, compared to the EU average of 26.41%. There has also been rapid development of the business sector, including a rise in tourism.

The industrial sector in the Basque Country has become more internationalized in recent years, becoming competitive within European and international markets. The capital goods industry is one of the most important for the Basque Country, primarily iron and steel, power generation and distribution, chemical and petro-chemical production, telecommunications, transportation, water treatment and supply, waste management, and environmental impacts and civil engineering.

In 2004, the GDP in the Basque Country (3.3%) was slightly higher than that of the rest of Spain (3.1%). The fishing industry within the primary sector has followed the European trend of declining catches and fleets. In the Basque Country, catches have decreased by 30.9% over the past 10 years. Industrial production has grown (3.7% in 2004), as has the service sector.

Though the industrial sector predominates in the Basque Country, the service sector is gaining pace, mostly in construction and agriculture. Currently, 53,852 Basques work as co-owners of their businesses and participate in the management of more than 2,150 cooperatives and worker cooperatives. Cooperatives have become an important business strategy in the region, and are represented by the Confederation of Cooperatives of the Basque Country, comprised of firms in the agriculture, consumer goods, credit, education and transport sectors.

The Basque Country has had an increase in employment in 2006 by 1.8%, with a total unemployment of 3.6%, led by the provinces of Bizkaia and Gipuzkoa. The increase has primarily been in the industry sector, followed by the service and primary sectors, with a decline in net jobs in construction. The fish processing sector has been growing, and to date accounts for 2,000 jobs in the region, which is increasing at an annual rate of 5%.

The Basque primary sector provides employment for 1.19% of the population. The Basque rural fishing environment is described as three quarters of the Basque territory and the inhabitants of its villages, who are largely connected to work on land or sea or both. Much of the region’s local food production comes from this sector, including cereals, dairy, meat, and produce. The Basque Country is committed to maintaining a competitive fishing sector. The government is investing heavily in technological innovation in all categories related to commercial fishing in order to maintain the Basque presence in the seafood trade.

6.3 Interview methodology

This study is a combination of both focus groups and individual interviews. The interviews were performed to both compliment the existing focus group data, as well as to substitute for two stakeholder groups where focus groups were not possible due to time and geographic constraints. The three focus groups that were accomplished are outlined in table 6.1, and the individual interviews in table 6.2.

The focus groups were conducted using a standard protocol across each group (see Annex 1). Following a pre-established and tested script, the focus group leader introduced the EFIMAS project, the individuals involved in the presentation, and the concept of focus groups in general. The focus group leader then commenced with a series of questions, interjecting only to keep the discussion focused, allowing the participants to discuss the topics among themselves. After discussing the concept of science and computer models and their role in fisheries science, an expert in computer modelling presented a sequence of Power Point slides. These slides were designed to illustrate the concept of bio-economic computer modelling with regard to the simulation of alternative scenarios for fisheries management.

The focus group and individual interview participants were selected based on shared characteristics of knowledge of the subject, as well as being representative of one of the five designated stakeholder areas (catching sector, onshore sector, women in fisheries, fisheries managers, and environmentalists). Though the goal was to have five to nine participants in the focus groups, cultural, political, and geographic issues were a significant factor in prohibiting this objective. Despite the low number of participants, the findings were comparable to EFIMAS focus groups conducted in other countries where the number of participants reached the goal.

Table 6.1: Composition of focus groups

<i>Composition</i>	<i>Number of participants</i>	<i>Location</i>
Catching sector	4	Fishermen’s Union Building - Ondarroa
Onshore sector	3	AZTI – San Sebastian
Women in fisheries	4	AZTI – San Sebastian
TOTAL	11	

Table 6.2: Individual interviews

<i>Sector represented</i>	<i>Form of interview</i>
Pelagic Biologist	Face to face
Environmentalist	Telephone
Fisheries Inspector	Telephone
Pelagic Biologist	Face to face
Manager, Distribution	Telephone
Resource Director	Telephone
Assessment	Telephone

The three focus groups and seven individual telephone interviews were recorded using digital audio equipment. In the case of the telephone interviews, the method of recording was a program through which calls made via the internet can be recorded into a .wav file. Additionally, a member of the research team took written notes of the proceedings to serve as back-up to the electronic format.

The electronic recordings of the focus groups and individual interviews and were then transcribed using electronic transcription software programs to create a text file. The text files allowed for detailed text analysis using the software program QSR Nvivo, wherein all files were stored and ultimately analyzed by identifying salient themes and particular areas of interest by the researcher to produce this report.

6.4 Perceptions of science

Science should be objective not subjective. Science should be trusted, free from political influence. Science is not used in fisheries management. Science produces faulty data and can lead to uncertainty.

The first section of the interviews was meant to gain an understanding of how participants view science in general, and not as related to fisheries management. This was meant as a precursor to discussing fisheries science in order to gain an appreciation and an understanding for the overall concept of science, and how it fits into a fisheries management regime in terms of its contribution toward effecting policy and change.

The focus groups began with a discussion of general definitions of science. In general, this discussion was more difficult for the participants than when presented with fisheries science. It appeared that overall “science” was often conflated with management, and serious effort was necessary on behalf of the focus group leader to differentiate the two. The majority of the participants was not trained scientists, and therefore felt that science was best left to others, and concentrated their concerns and expertise on areas in which they felt more comfortable, namely, fisheries science and management.

After some very basic definitions, a member of the catching sector focus group remarked “*We really don’t have a lot more to say. We’re fishermen. I think that’s it*” (Spain 2006). Similarly, members of the women’s focus group replied: “*Seriously? I have no idea how to say it, really. It is something, I don’t know. I don’t know how to explain it well. The truth is I really don’t know how to explain it. We don’t know this stuff!*” (Spain 2006). One important theme that emerged within this introductory section was that science was a tool used to extrapolate the truth, and that it could generally be trusted or at least should be trusted. Even though they themselves were not trained scientists, members from the onshore sector focus group were more vocal on the subject compared to other participants, exemplified by this statement: “*Science is an activity with a rational base of methods or theories or explanations of reality that can demonstrate in a way that is valid for everyone*” (Spain 2006).

The topic of science in general was not explored further among the three focus groups, as frustration and anxiety proved to be hindrances to prolonging the discussion. Even among the onshore sector participants, the topic was quickly diverted to fisheries science, in which case the focus group leader made the decision to move on to the following questions, rather than risk the overall outcome at the expense of this question.

6.5 Perceptions of fisheries science

Politics need to be excluded from management.

Management needs to be fair and equal.

Management should see long term, not just in the present.

Fisheries science is ineffective.

Fisheries science is not comprehensive.

Fisheries science is ignorant of reality and does not communicate with fishermen.

Fisheries science is based on inaccurate data.

During the discussion of fisheries science, the focus groups became markedly more animated. When the fisheries theme was introduced, the comfort level of all focus group participants was elevated and the discussion therefore extended over science as a separate entity. Again, the women’s group had the least to say, and reverted back to the activity of fishing, though they introduced scientific concepts without a realization of doing so. One woman said: “[fishermen] *don’t think about the fact*

that fish are disappearing. We need to think about it in another way" (Spain 2006). The groups and individuals with the strongest link to fisheries science and scientists were the most vocal and articulate when it came to their perceptions of fisheries science. The overall consensus, however, was not favourable to fisheries science and the mechanisms that drive this science to effect management.

6.5.1 Fisheries science in general

The consensus was that fisheries science is comprised of two major components – biology and management. While it was generally acknowledged that these are both important factors to consider, a member from the catching sector pointed out the necessity of his knowledge as a third component. He stated that: "[Science] *creates an empirical and formulaic value about what exists in the environment*" and later on he added: "*I'm also giving an extension of general knowledge to this formulaic and empirical study*" (Spain 2006). It was this respondent's opinion that fisheries science in general lacks a human component, essential to validating empirical studies.

Overall, the groups responded with an overwhelming consensus that fisheries science is, in general, ineffective. At fault are government and scientific agencies and their practices of managing fisheries without practical experience:

Last year in December in Brussels they made a decision to stop hake fishing below 200 meters. I, as a ship owner, was surprised. The thing is that the report didn't have any truth to it. . . . Well, when the scientists from IFREMER went on the boats to evaluate the situation, they were stunned at how much hake they actually saw, without profound analysis of the situation, and it appears to be pretty arbitrary. (Onshore sector, Spain 2006)

Another salient theme that emerged to support the argument of ineffective fisheries science was the preoccupation and bias in favour of national interests. The groups agreed that scientific studies conducted on behalf of national agencies tended to favour the interests of the country in which the agency was based. For example, the onshore and catching sectors both accused IFREMER of such practices. As one participant put it, "*they should just not take themselves so seriously. It is just trendy, these studies and stuff, but in the end, they take them too seriously. I think it really is something political in the end*" (Onshore sector, Spain 2006). The members of the catching sector were more articulate in their opposition to politically oriented studies. An example cited by a member of the catching sector exemplifies this sentiment:

To say and give value to, and what's more, support biologic and physical measures saying that the closest part to the coast, which is the part that we fish, has a large concentration of juveniles [hake] that we have to preserve, and they impose a net size of 100 mm, when the reality is that the juveniles get caught in a net size of 70 mm, farther away from shore, as evidenced by these men [fishermen] with years and years of experience on the coasts. But IFREMER has decided how to manage this, which is to defend the interests of the French artisanal coastal fleet. This biological study puts doubt into all the European science, and personally doubt the objectivity of the scientists. (Spain 2006)

Here, the respondents agreed that there is an over-dependence on scientific studies that are generally incongruent with reality, in their opinion. The science is seen as either arbitrary or biased toward national interests, based on politics rather than science. Part of the reason for describing

science as arbitrary comes from the belief by those involved in the stakeholder sectors who are involved directly with fishing (catching, onshore, women) that science can not accurately account for reality. Members of these groups believe that “*very few scientists are going to show them [fishermen] what they have seen in the sea*” (Catching sector, Spain 2006). A general complaint is that most fisheries scientists do not ground-truth their findings by either consulting with fishermen or actually going out to see. The fishermen and other stakeholders see this as a significant flaw in data validity used by fisheries scientists and managers to produce regulations.

Well, things like age and breeding patterns are now known, but in reality I think that the sea is a world totally unknown, and it is extremely difficulty to understand. They are getting closer and closer to the reality of what is actually happening in the sea. In my job as a manager, I see discrepancies all the time, like skippers coming in with a ton of hake while the scientists are saying there are no hake. What, are the fish hiding from the scientists? There are a lot of times when it fails. It depends on who pays for the study. (Onshore sector, Spain 2006)

The objectivity of science in general is not in question, but rather the validity of the variables and perceptions that are involved in studies governing fisheries in various contexts. To one fisheries scientist, the largest issue facing fisheries management is extractive capacity “*defined by the quantity of boats and the quantity of their potential catch. . . I think that over-exploitation is an element*”. This same scientist also blamed environmental factors as a contributor to ineffective fisheries management. He said:

I don't think it is over-fishing. Maybe a little, but a lot has to do with bad luck in terms of environmental consequences. It isn't that the fleet is too large, but that the conditions for regeneration aren't so good. In this case, the effort has to be reduced. . . many of these decisions about fleet size, etc., are political. (Spain 2006)

This was the only instance where the environment was mentioned. The general theme was to talk about knowledge among the various stakeholders, scientists, and managers, and biases toward these various sides of the equation. However, the sentiment with regard to effort was repeated by a member of the catching sector focus group who said, “*Here in Ondarroa, we used trawls, and the scientists said that the fisheries disappeared by using this technology. . . then they came back and changed the technology, and tons of fish came back*” (Spain 2006).

6.5.2 Issues of data validity in fisheries management

A primary concern among all groups is the validity of the data being collected in fisheries science.

The science, objectively seen, is good. No one doubts that this pen is an excellent invention to be able to put the thoughts of a human being on paper. But, in the hands of a sick person, this pen can say things that aren't true. ... Science, as material, is necessary. However, what it does is not always objective, and it is sometimes corrupted. (Spain 2006)

This statement by a member of the catching sector exemplifies the general sentiment among the stakeholders in Spain that there is a significant problem with regard to accurate and valid data collection and application. This belief also factors into the discussion of who the members of the focus groups trust to do science.

The members of the onshore and catching sector focus groups specified AZTI as being the only fisheries science institute to be objective and valid. A member of the catching sector stated, “*what we have seen is that the AZTI biologists are the only ones that let us work because they get out there too*” (Spain 2006), which was confirmed by a member of the onshore sector in his comment that “*the best qualified information about the fish we are fishing has come from AZTI. They know more than us in reality, and even more than the skippers, because they only know about their particular fishery*” (Spain 2006).

While the participants in the individual interviews were not asked questions relating specifically to data in fisheries science and management, comments did arise on the topic. A government fisheries inspector explained the difficulty management encounters as a result of faulty data reporting and collection.

Fisheries from this perspective are difficult. They are particularly difficult to get a handle on because of the error in reporting. We make sure that all of the rules are followed when we inspect the landings, and that all the fish are regulation. It is difficult for us to understand the real facts and figures, and it seems as though a lot of the time we are working from data that are incorrect. I know in general that we are not told the truth, and it is therefore really hard to make recommendations when we know we are working from bad data. . . The system is so complicated that it is difficult to have a real idea of what is going on, and each country seems to have its own biological data. (Spain 2006)

This sentiment was seconded by an environmentalist who understands that the biological data are flawed due to a variety of factors. False reporting of landings and other data is the root cause of these flaws, according to some, but politics often supplants scientific recommendations, even when based on the best available data.

6.6 Perceptions of fisheries management

Management ignores scientific advice and social issues.

Politics need to be excluded from science in management.

Management needs to be fair and equal.

Management should have long term perspectives.

The three focus groups and the participants in the individual interviews were asked questions regarding fisheries management and its use of science as a management tool. In general, the consensus was that fisheries management is ineffective, and that scientific factors, both natural and social, were underrepresented or ignored completely in the regulatory and decision-making process.

6.6.1 Politics and fisheries management

In order to trust science and scientists, politics needs to not be a variable in the planning, investigation and observations of scientific studies. For example, a member of the onshore sector focus group said, “*the more independent from politics an institute is, the better the outcome. If they only want to know the truth, and only the truth, then it tends to have a good outcome*” (Spain 2006).

An environmentalist said *“it is quite normal that they put political views ahead of biologically-based data”* (Spain 2006), and a fisheries scientist believes that his work is not incorporated into the political decision-making process. *“In science, we are responsible for detecting, for example, stock collapse. A lot of times, though, it seem as though the socio-economic considerations are given more attention. The decisions they make are not based on the science we do, for the most part. If a fishery is in danger of collapse or not, it seems like they don’t pay attention to the recommendations that we make with regard to the most sustainable fishing strategy”* (Spain 2006).

The stakeholders directly involved in the fishing sector, namely members of the catching and onshore sector focus groups, felt similarly, though they deny that any attention is actually being paid to social concerns.

What is management? It is the bureaucratic system that pretends to quantify what we can fish. We need to incorporate the economic, structural, and other resource variables to make good management, using precaution and consensus. Now they don’t think about anything, and reject important socio-economic variables that are critical to good management. (Catching sector, Spain 2006)

Another concern is that fisheries management legislation is applied on an individual basis. A member of the onshore focus group said: *“to be effective, management would have to apply to everyone, and everyone would have to comply”* (Spain 2006). A dialogue from the catching sector focus group explains this:

Onshore sector representative 1: *We need better communication between the scientist and the fishermen, because they study empirical information without going to sea.*

Onshore sector representative 2: *This is important because they should have our information so that their management plan will work better.*

Onshore sector representative 3: *We see that we are all using different systems. We think that the scientists use various systems of management, but if we were to all use the same management scheme, things would be much better in fisheries. If we all restructured into one system, we could get rid of 90 percent of the problems. We are in a European Community, but only for some things. Other countries make judgments based on no scientific knowledge. In the EC, some people live better than others, but this is based on faulty science.* (Spain 2006)

The fisheries inspector concurred, stating:

The system is so complicated that it is difficult to have a real idea of what is going on, and each country seems to have its own biological data. I would like to see a study that sets the TAC based on real data that is actually based on the activity. It seems now that it is mostly political. (Spain 2006)

6.6.2 Short term visions

It was generally agreed upon that fisheries management focuses almost entirely on the future, whether this be accurate or not. While in reality some fisheries management plans are based on long-term strategies, most stakeholders see these strategies as being reactionary, with a view to immediate returns. The environmentalist said that

...there is a short-term vision. Now, they are just putting patches on the problem. A lot of these patches are way too late, when the problem has already happened. (Spain 2006).

This same individual asserted that the precautionary principle was not employed enough, making these plans even more volatile through spontaneous decisions based on outdated data. The manager of the fish distribution centre contributed to the short-term vision concept in fisheries management by adding that the decisions are also hastily made.

If there are doubts, you shouldn't do it, especially when it affects people. Five years ago no one was thinking about any economic factors, for example. In Brussels, they decided everything in a marathon meeting of two nights, which I never understood how they could make decisions that affect so many people over such a short amount of time! (Spain 2006)

6.6.3 Problems with accuracy of data

Fisheries from this perspective [fisheries inspection] are difficult. They are particularly difficult to get a handle on because of the error in reporting. . . For us, we have great difficulty in trying to understand the real facts and figures, and it seems as though a lot of the time we are working from data that are incorrect. I know that in general we are not told the truth, and it is therefore really hard to make recommendations when we know we are working from bad data. (Fisheries Inspector, Spain 2006)

This sentiment was salient throughout the interviews in particular, though it was not without mention in the focus groups as well. Most people were discouraged not only by corruption of the fisheries management process by politics, but also by internal corruption by the fishermen themselves. The one group exempt from statements along these lines was the catching sector, for obvious reasons of the potential for self-incrimination. There were various examples as to why fishermen felt the need to cheat the system, ranging from necessity for survival to having beliefs incongruent with biological findings. A manager from the fish distribution centre said, *"We know that there is always a certain level of fraud going on because of things like this"*, referring to by-catch regulations.

6.7 Perceptions of modelling

Modelling is not something one knows about.

The concept of modelling is difficult to understand.

Modelling is a step forward to a holistic approach.

Modelling is a good principle with a good potential.

The potential of models depends on the data that feeds them.

Modelling is not suitable for dealing with the complexity of human dynamics.

The participants of the focus groups and individual interviews were asked about computer models in general, as well as their utility for each individual sector. They were also asked about the frequency with which they had contact with computer modelling to perform their professional duties. With the exception of the fisheries scientists, the respondents overwhelmingly answered that they did not in

fact come into contact with computer models in their daily activities. Some remarks even suggested a level of frustration at the question: *“We don’t see them. We don’t and we’re not interested”*, and *“We think that they make computer models with the information that we give them, but we’re really not interested”* (Catching sector, Spain 2006). The women’s group was the most impatient with the question. The dialog went as follows:

Women’s group representative 1: *Excuse me, what? Model what? You should ask it another way, or move on to the next question, because this makes no sense to us.*

Women’s group representative 2: *What, computer models in our life? We don’t.*

Women’s group representative 3: *No, I don’t see anything like this.*

Women’s group representative 4: *Me neither.*

When probed, however, the onshore and environmental sectors indicated that computer models were useful to them in certain instances. For example, a member of the onshore sector said that computer models influenced his work in terms of catch restrictions by monitoring resource levels. He also thought of computer models as conducting bio-physical analysis of resources, though in the end he admitted, *“basically, I don’t understand the concept”* (Spain 2006). The environmentalist acknowledged understanding of the concept, though concluded that he only used them in the form of data that came from other scientists for analysis, since their work *“is on a more political level, and since we aren’t using first-hand data as they relate to fisheries, it doesn’t make sense to use models here”* (Spain 2006).

Even a member of the catching sector said *“the principle is good, that we should use them to improve management, especially when they take our catch statistics and use them to make scientific models”* (Spain 2006). However, there seemed to be at this stage of the interviews, the tendency to conflate the concept of computer modelling for predictive measures with the incorporation of scientific data in traditional management plans, suggesting an overall misunderstanding of the concept. The fisheries inspector said:

Well, we support the fact that fishermen should have records of landings and sales. That could make a type of centralized database that would help management. It would be a great source of information to help the scientists evaluate the stocks. A viable system would be really helpful here, and it would be the responsibility of the EU participants, but it is something that is improving at this point. You suppose that a TAC is based on scientific data, but if you have bad data from the docks, it makes the TACs wrong. What I see is a lack of unified policy. (Spain 2006)

The two fisheries scientists interviewed understandably had the most accurate perception of computer modelling, having both participated in the development of and use of computer models. One comment from this group was that while computer models are an excellent tool in theory, their utility can be dramatically undermined should the data be unreliable.

Simulation models were not seen as being as useful as stock assessment models by the scientists. Their opinion was that simulation modelling is new, and their experience is generally with available

data for evaluation in order to provide recommendations for politicians. Stock assessment modelling, on the other hand:

... are very important, especially in communication with politicians. To be more useful, they would need to have other information involved, like economics, ecosystemic data, and multi-species considerations, but another thing would be to have better information of the same kind we already use. If the models we used now were based on good and viable information, the quality of evaluations would be sufficient enough that we wouldn't have to struggle with all of these other components. . . . We end up with something simple and of poor quality. (Spain 2006)

They did agree, however, that the concept of integrated models was a step forward in fisheries management, noting that a more holistic approach would be a more accurate representation of fisheries. They did mention the difficulty in dealing with human populations due to the diverse variables associated with human dynamics. Further, they echoed the overall sentiment of collaboration among the sectors, stating,

...models have to help resolve problems in all sectors, including with the fishermen, in order for them to be a useful tool. People said that we should just close the anchovy fishery this year. I said, wait! We need to manage the whole fishery, not just the fish! It is important to look at the whole picture. We forget this sometimes as biologists. (Spain 2006)

Generally, the consensus among participants is still regarding data validity and accuracy. Despite the good intentions of computer modelling in all of its potential derivations and applications, it is widely understood and agreed upon that unless the quality of the data is high, and accuracy confirmed, the exercise is futile.

6.8 Issues of uncertainty in fisheries management and implications for computer modelling

Fisheries statistics should be valid and correct.

Uncertainty is ubiquitous in fisheries.

Underreporting of landings leads to uncertainty.

Uncertainty cannot be quantified and is difficult to calculate completely

For the fisheries scientists, uncertainty is ubiquitous in fisheries. Part of what contributes to uncertainty, to them, is the diverse management strategies world-wide, and the reliability of the data used in the conceptualization of these strategies.

I don't actually think there will ever be a way to calculate uncertainty completely. In practice, what we do is not necessarily quantitative. If we know we are getting bad data out of Taiwan, for example, we do what we can to try to get better data, but uncertainty can not be quantified. (Fisheries scientist, Spain 2006)

Another fisheries scientist seconded this opinion:

The level of biomass and the level of exploitation are two major issues to consider when thinking of uncertainty. The latter is reflected in the landings, and most of the time those are not the real numbers. Therefore, if the numbers reported are false, it is extremely difficult to get an accurate

assessment of biomass. With Mackerel for example, they think that it is captured a lot more than what is reported. . . . It is very important that fisheries statistics are valid and correct. This is difficult. (Spain 2006)

The environmentalist felt similarly, stating his concern for unreported catch and the black market, which make management challenging when strategies are primarily based on inaccurate data.

This is always relative to the quantity of the catch. The quota doesn't always correspond to the actual stock. The black market is a big problem, and creates a huge amount of uncertainty because you can't count on stock statistics to be accurate, and therefore, what can you do? (Spain 2006)

6.9 The EFIMAS modelling framework

<p>The models should have more data - not just from fishing logs.</p> <p>The model should have situational data on the state of the fisheries.</p> <p>The model should have rules that are respected.</p> <p>The model should be considerate of the extra workload it puts on fishermen.</p> <p>The model complicates things unnecessarily.</p> <p>The model is way for some people to preserve their superiority.</p> <p>There is a need to test and regulate rules better.</p> <p>Women should be invested with power to look after the cheaters.</p>

After they had been introduced to the EFIMAS model, the participants were asked for their reactions and their suggestions on how to enhance the model. Both the onshore and the catching sector group would recommend better data to start with and they thereby turned the focus back onto the data issue:

Modeller: What elements should be in the model that haven't been?

Catching sector representative: Situational data. The actual state of the fishery. There is a saying, that if you put crap into the computer, crap is what you will get out. You need data, and the more data, the better, but that isn't what we're seeing. With the exception of AZTI, nobody has given any data. Everything is political and scientific. The only data they have are what we put down in our fishing logs. Now they are good, but that hasn't always been true. The more data and quantifiable information, the better the models. (Spain, 2006)

The first reaction from the onshore focus group was similarly focused on the need for better data, but there were also some precautionary thoughts on the extra workload such a model puts on the fishermen:

Onshore sector representative 1: We need to find better data.

Onshore sector representative 2: I think the focus is good. We have been saying for a long time that it is important to take into account the ideas of the fishermen. Now it has turned into a lot of work

though. The effort to be a fisherman is huge, and we have to report things all over the place, to ICES, but it is a good tool because if you consider the economic consequences of new technology or quotas in how it will affect the fishermen, it is a good idea. (Spain 2006)

The onshore group went on to present arguments in favour for a bottom-up approach and for consulting boat owners about measures. They saw some potential in the model and they considered its experimental character as a relevant approach as fishery itself is about experimenting, and they hoped the model would benefit the industry:

Onshore sector representative 1: A tool like this would let us see what is happening or going to happen with the resource that we depend on, and that is good.

Onshore sector representative 2: Experimentation is good, too. I think that is what is going on here, and the skippers are experimenting all the time, which is why management should do the same.

Onshore sector representative 1: Fishing is not attractive right now, basically for what it pays, but this model might work for making the fleet profitable in terms of paying the crew what they deserve.

The reactions to the model in the catching sector focus group were, however, more sceptical. They questioned the very premise of the endeavour, stating that such a model seemed to complicate things unnecessarily. After he had been presented to the EFIMAS model, a participant commented:

We're trying to understand what it is you're presenting here. We don't think it is so easy to create a solution to the problem. We already have the answers. You don't have to complicate things so much. The solution is to take a series of tests we could have a sustainable Basque country without complicating things so much. All of this computational stuff really doesn't do a thing. Something that would make this better would be to test and regulate all these rules a little better. (Spain 2006)

When asked about which elements ought to be added to the model, another skipper chose to remind the group about the interconnection of knowledge access, control and power:

I'll give an example. When man started to learn and have knowledge, the church managed that, as well as writing, etc. They selected what people could know in order to preserve their superiority over the community. What models are trying to do has something to do with this. I don't want to say that there are some people who are doing things right, but what the majority are doing is saying that they are the only ones who know everything and should be able to manage everything. (Spain 2006)

The catching sector thereby argued that the solution to the sustainability problem is not necessarily another model. On the contrary, there is reason to be sceptical towards models like EFIMAS, because they work to maintain the superiority and the management rights of the ones who access them. It would be better to regulate and test the rules better instead.

When the women were asked if they had any additional comments, they also chose to emphasize the problem of rules and rule enhancement. There was a strong opinion, that the same rules had to be applied to everyone. The entire fishing sector suffers from the problems of non-compliance and insufficient enhancement:

Women representative 1: They need to put rules in that are respected, because if they change the net size, then it won't do anything to help fisheries.

Women's representative 3: *I'll say what I already said, that they need to make the same rules for everyone, because then it would work a lot better, and even hake would return.*

Women's representative 1: *But now we're getting worse.*

Women's representative 4: *They need to penalize and fine people who don't follow the rules.*

Women's representative 3: *Yes, and this is everyone. They hide stuff, and don't follow the rules.*

While same rules for everyone would be the best, it is very hard to realize that ideal and it was therefore argued that a shift of power is necessary. A consensus then developed, that women would be especially well equipped to take on the power and the responsibility to watch for cheaters:

Women's representative 2: *What they really need to do is put the same rules in place for everyone. That would be ideal.*

Women's representative 3: *Yes, but this is very hard! It is ideal, but very hard. They also need someone else in power. A woman!*

Women's representative 1: *Yes, a woman needs to be the person to watch for cheaters. They are the best, really.*

All in all, the question about how to enhance the EFIMAS model was received differently by the different focus groups. The onshore sector called the model a good principle and pointed at its different potentials. The catching sector suggested the adding of situational data on the state of the fleet, but it was also sceptical towards the model due to its obscurity; such type of knowledge for the initiated works to cement the superiority of some groups over the community at large. The women suggested the adding to the model of rules that are respected. Their line of advice was quickly directed towards the issue of rules and compliance and they pointed towards the necessity for a shift in power to women.

6.10 Conclusion

Science is seen as a tool to extrapolate the truth which ought to be trustworthy. Fisheries science however was often felt to be faulty, corrupted and/or biased towards national and political interests. It cannot be trusted and is furthermore considered ineffective as it suffers from the lack of practical expertise in government and scientific agencies. Fisheries science does not only consist of biology and management, it also includes fishermen's knowledge. But this human aspect, as a catching sector representative put it, often lack from the fisheries science. Fisheries management is effected by these circumstances; it relies on faulty data and the planning is reactionary with a view to immediate gains. But fisheries management also relies on inaccurate data because of error in reporting and the internal corruption by fishermen themselves. If management is to be effective, it should be free from political interests, it should apply to every one and everyone would have to comply.

Modelling seemed a distant subject to the focus group participants who were not scientists themselves. To begin with, many did not recall being exposed to models in their daily activities. Fisheries scientists however, viewed integrated models as a first step towards a holistic approach,

but they also voiced an ever present problem of uncertainty. The focus groups agreed; a model is only as good as the data that feeds it, and when asked about how to enhance the EFIMAS model, most focus group participants referred to the need for better data. The catching sector suggested situational data focusing on the state of the fleet and the women suggested putting in rules, which were respected by everyone. Onshore and catching sector representatives also called for careful handling; the fishermen are already overloaded with registration demands, a computer model might complicate things unnecessarily and the preservation of management privileges might be at the heart of the matter.

Chapter 7:

The public understanding of modelling – a selective summary of focus group results

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7.1 Introduction

Computer models are ever more widespread tools in science informing policies, and they hold a number of advantages. Once up and running they are efficient and cheap tools for management in areas in need of extensive or continually updated information. For example, experience from models on pesticide behaviour in the environment shows that “Even the most sophisticated runoff simulation model can be set up and run for a fraction of the cost of a field experiment.” (Wauchope 1992, p. 753) Within fisheries management, policymakers and managers have in some cases even been able to run the models themselves (Yearley 1999). Furthermore, by simulating future scenarios models provide a useful basis for decision making. They also provide a standardised basis for decision-making that can be useful in particular policy areas. Finally, as Steven Yearley points out, modelling holds some new possibilities for public participation:

... the increased availability of computing power could be offered as grounds for anticipating the heightened democratization (or at least accountability) of modelling precisely because ‘consumer’ groups may be able to offer their competing modelled knowledge. (Yearley 1999, p. 845)

Experience in other science-based policy arenas has shown that of ‘participatory modelling’ can allow decision makers and other interested parties to help scientists to choose the most useful simplifications of reality. Because the focus of the discussions is on crafting carefully coordinated strategies rather than horse-trading options into a lowest common denominator strategy, less time will be spent battling over fundamental values (Andrews 2002). Another important aspect of participatory modelling is that the process of fitting things into a model presupposes clarification, for example when choosing assumptions. Hence, it forces stakeholders to clarify their objectives and explicitly address the trade-offs implied by various strategies (Wilson & Pascoe 2006).

From an even broader perspective computer models are both an important and a problematic tool for producing science in support of policy. One way to think about the role of science in policy is that what makes “science” so important is not so much that it gives the right answer about what is going on in nature – in fact it often does not – but that the scientific method is a technique for giving the most transparent answer possible. Radical transparency is what the ideals of hypothesis testing and replicability are out to achieve. This transparency in turn makes the information suitable as the basis for decision making. This role of science is often mischaracterized in policy circles as one of providing “objective facts” that are separate from the negotiations over subjective values and interests. This

idea is often expanded to the understanding that scientists should remain separated from the negotiations in order to retain their “objectivity”. This is an error, however, in the sense that what scientists could potentially contribute with in the process is a procedure for transparency of understanding, not a truth which all reasonable policy stakeholders can be expected to acknowledge because it comes from an objective source.

This perspective sheds light on some of the problematic aspects of using models in support of policy making. In the fisheries management context, for example, many of the models that are used actually involve a broad and definite step away from the ideal of the scientific method. They involve predictions based on past experience that are not falsifiable, as the non-occurrence of the prediction can always be ascribed to assumptions or external factors (Corkett 2002). What is more, the techniques – particularly but not exclusively quantification – involved require so much skill and background knowledge that they create obscurity in practice (Wilson 2008). Further adding to the obscurity, it can be difficult to grasp or be transparent about what the numerous transformations, translations and reductions involved in the process of quantifying and modelling means for how the outcome reflects the piece of reality it addresses. Computer models, then, add new kinds of difficulties to the relation between science and the public. Particularly there are difficulties concerning the accessibility and flexibility of the model and the perceived legitimacy of the outcomes among stakeholders. If models are meant to serve as a tool informing policies without reserving the task of defining the objective truth to the scientists, a range of challenges have to be considered.

When considering the relation between science and the public, these challenges are particularly urgent in the context of fisheries policy. The combination of high stakes and high scientific uncertainty (Ravetz 1999) in fisheries policy suggests that extra steps are needed if science using models is to succeed in facilitating policy by providing a transparent picture of the condition of nature. Fisheries science is often the subject of intense debate about the science among stakeholders, and that raises particular concerns about how uncertainty is translated into policies. For example, an important issue is who should have the burden of proof and whether the precautionary approach should be employed in order to protect the environment or livelihoods in the fishing industry. In this respect fisheries management resembles other policy-areas characterised by high scientific uncertainties and high stakes, climate policy being the most outspoken example. Another factor particular to fisheries management with respect to the public understanding of science is the high levels of experience-based knowledge (EBK) that can be found particularly among fisheries dependent stakeholders. What is more, the practices that form the basis for fishers’ EBK resembles the data gathering methods – e.g. sea samples, catch data and echo sounder surveys – forming the basis for research based knowledge (RBK) in fisheries science. This, too, makes fisheries dependent stakeholders engaged and informed participants in the debate on scientific results, just as fisheries research also depend on their contribution with for example catch data and VMS¹ data.

¹ Vessel monitoring systems (VMS) are satellite-based systems enabling regulatory bodies to monitor the position, time of position, speed and direction of fishing vessels. In the EU all vessels exceeding 15 metres must provide automatically transmitted data. The data is transmitted every one to two hours depending on the

This is a highly volatile arena and participatory modelling can be understood as a mechanism for increasing the transparency of the modelling in order to allow the science to accomplish what we need science to do to facilitate decision making in an arena where declarations about the possession of objective knowledge will always be met with intense scepticism. Considering the challenges above, however, success with this approach is no simple matter. Accordingly, if the outcomes are to be perceived as legitimate and stakeholders are to find them useful, it is of vital importance that this is considered in the very development of the model.

Several studies have been carried out on the public use of geographical information systems (GIS²), for example as a participatory tool (Mark 2000; Jankowski and Nyerges 2001; Fischer 2000; Priest 1995). GIS mapping have among other things received attention for its visualizing qualities that for example make modelled knowledge accessible to lay people and provides a means of capturing local knowledge. Several studies have also pointed to some of the pit-falls of using GIS as a participatory tool – for example that the particular ways things are visualized can manipulate the participants' perceptions on the subject (Jankowski and Nyerges 2001). However, despite the growing importance of modelling in regulatory sciences, and despite the particular kinds of prospects and difficulties modelling holds for the relation between science and the public, there are still only few case-studies on other kinds of modelling within the Public Understanding of Science (PUS) literature. Hence, in this chapter we set out to explore some of these perspectives and list some main issues of public concern for and interest in computer modelling.

This paper reports the work of a small group of social scientists who were part of a much larger effort to develop a new generation of models for use in the evaluation of fisheries management strategies. We were charged with two main objectives. The first was to talk about modelling to the people who would use such models and report what they told us to the model developers to help guide their efforts. The second objective was to try to learn what we could about how models can and are being used to facilitate decision making in fisheries and elsewhere.

The focus group interviews reported on here were the central part of this effort. They were performed in Spain, Greece, Ireland, UK and Denmark. Five stakeholder groups were targeted: the commercial fish harvesting sector; the onshore fish processing sector; women in fisheries; marine conservation groups; and, local-level government fisheries managers. A total of 22 focus groups were carried out (Table One). In Spain where it was not possible to gather managers and conservationists, individual interviews were performed. In Greece the harvesting sector was divided into off-shore trawlers and inshore, semi-artisanal fishers. A number (~25) of individual interviews were also performed with fisheries scientists, and national and EU-level fisheries managers.

particular system. The data can for example inform authorities about traffic in areas where fishing is illegal or where the particular vessels do not have license to fish.

² Geographical Information Systems (GIS)

Table 7.1: Focus group participation

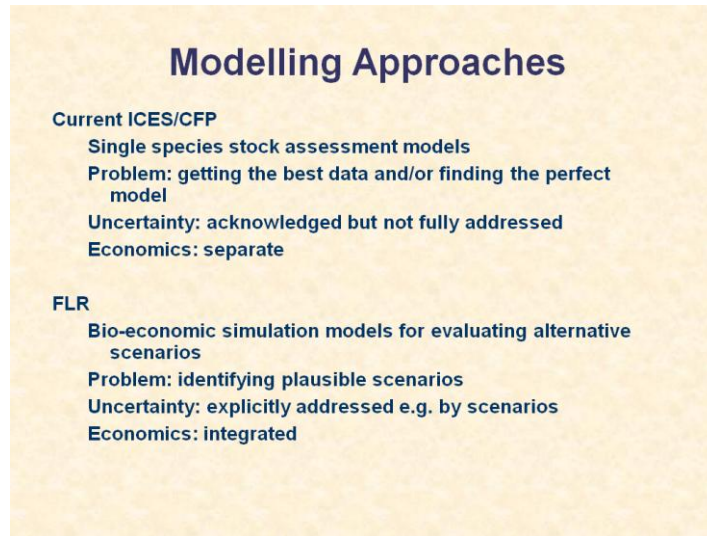
Stake-holder group	Country					Total
	UK	Ireland	Denmark	Greece	Spain	
Fish Harvesting	3	8	8	7	9	39
Fish Processing	5	7	3			18
Women in fisheries	4	7		5	4	20
Marine Conservationists	7	6	3	8		24
Local Managers	7	6	3	5		21

The interviews and focus groups all focussed on five themes:

- The idea of what science in general is and is used for,
- The idea of fisheries science in particular,
- How science is used in fisheries management,
- The idea of computer modelling in general,
- The FLR modelling framework.

As an introduction to the last theme, participants were first given a brief introduction to the FLR modelling framework. FLR stands for Fisheries Library in R. A main objective of FLR is to put together a common language for biologists and economists across Europe to work together. FLR is an open source set of sub-routines that can be mixed and matched to address specific problems, and which has the benefit of being continually developed by the modellers as they use it on more problems. The differences between the FLR approach and the standard modelling approach used in the Common Fisheries Policy was presented with the following slide:

Illustration 7.1: Slide from FLR presentation for focus groups



The idea of using alternative scenarios in situations where scientists interacted with stakeholders was explained and the reactions of the participants recorded. Considerable emphasis was placed on the attempt to address uncertainty directly by assessing its implications for the alternative scenarios. The use of focus groups in this case has been particularly inspired by Steven Yearley's focus group approach in a study on citizen's perceptions about air pollution modelling in northern England (Yearley 1999, Yearley 2002). This is mainly due to similarities in the purposes of the two studies. As with Yearley's study, the objective of the EFIMAS focus group interviews has been to gain feed-back from stakeholders on the use of a particular model in environmental management. What is more, the two studies both explore public perceptions about science and computer modelling and hence operate within the research field of PUS.

We begin this summary report of our research with a brief description of the fisheries management situation in Europe and the relationship of our respondents to that system. We then go through the main challenges that were discussed in the focus groups in relation to modelling. In section 4 we argue that most of the concerns and interests expressed during the focus group interviews touched upon a common theme, namely features about models that make the research process difficult to access and join for outsiders. In this light we then list the participants' main recommendations. We conclude by listing the main challenges models in the regulatory sciences pose to the relation between science and stakeholders and by suggesting some ways forward.

7.2 Positions in the field

The fisheries science informing fisheries management in the EU is facing serious challenges, both at EU and member state level. Since the very first Common Fisheries Policy (CFP) regulation in 1983, EU fisheries management has failed to reach its own aims. A long list of fish stocks are below safe biological limits, and the fishing industry is continually struggling with overcapacity and low quotas (Hegland 2006; CEC, COM (2001)). These shortcomings affect the legitimacy of fisheries

management. Particularly among fisheries management stakeholders, be it fisheries dependent groups whose livelihoods are at stake or environmental interest groups with concerns about the drastically declining status of stocks and habitats. Part of the blame is given to the advice system laying the scientific basis for the CFP. The main actor here is the International Council for the Exploration of the Sea (ICES) – a multi-lateral organization providing the official advice for the CFP. Fisheries science is for various reasons, some of which we touch upon later, characterised by high levels of uncertainty – something fisheries scientists are the first to admit. In fact dealing with the intense uncertainty has had a number of quite negative implications for scientists morale and working conditions (Wilson 2008) Accordingly the advice system is increasingly met with scepticism, not only among policymakers, managers and researchers, but also – and perhaps particularly – among stakeholders and the wider public.

Computer modelling has long been a central part of the scientific advice informing the CFP. Most importantly, TACs (Total Annual Catch) – maximum catch quotas for particular species – are the most common management tool in the EU CFP. The size of the quotas are decided annually on the basis of fish stock assessments and then distributed among member states and fleets. The fish stock assessments are based on Virtual Population Analysis (VPA) models. The TACs form the basis of EU fisheries management. So, as the EU CFP has been in need of continual fish stock assessments, this has also become the main fisheries scientific activity in the EU scientific advisory system. Stock assessments have shown useful for fisheries management particularly because they ease the decision making process and are more or less directly transformed into policies that can be implemented. However, critics of TACs have pointed to this as part of the problem. Holm and Nielsen (2004) have coined term the TAC Machine to describe the co-evolution of the management imperative to calculate TACs to divide the fish and the stock assessment models that has been developed to solve these problems. They argue that the CFP has been an institutional success because it solves political problems even while failing to conserve resources. TACs are receiving increasing critique, also among the scientists providing the scientific advice for it, particularly because of the questionable validity of individual fish stock assessments based on VPA models. Computer modelling, then, is a pivotal point in the debate about the declining legitimacy of scientific advice in EU fisheries management, and as will be evident in the following many stakeholders are well-informed and have strong opinions on the issue.

Perhaps not surprising, the focus group discussions were characterised by the participants' different relationships to the TAC machine – that is, by their stakes and experiences. Before we dive into the details of the discussions, we first provide a brief overview of the different positions in the field and their impact on the focus groups' general attitude to the discussion themes.

As the five discussion themes are closely related, the participants' perceptions and concerns in relation to each theme tended to be so too. Some differences, however, appeared. One important difference between participants' attitudes towards science in general and fisheries science in particular is the extent to which participants engaged in the discussion and felt familiar with the issue. When asked about science in general, a widespread attitude among most focus groups – except the environmentalists' focus groups – seemed to be that the theme was beyond them. This was particularly outspoken in some of the Spanish focus groups, where some participants even

expressed discomfort with the question. After some very basic definitions, a member of the catching sector focus group stated that ‘we really don’t have a lot more to say. We’re fishermen. I think that’s it’. Similarly a member of the Spanish women’s focus group replied:

Seriously? I have no idea how to say it, really. It is something, I don’t now. I don’t know how to explain it well. The truth is I really don’t know how to explain it. We don’t know this stuff!

Generally most answers were very brief, and participants from the Greek focus groups tended to conflate science and management. Finally, most participants understood the question about science as a question about fisheries science in particular. This probably has something to do with the participants not being familiar with science outside fisheries science – the latter being where they are confronted with science as a concrete reality they can relate to. In all five cases the environmentalists focus groups were the most engaged in the discussion about science in general. Here the participants were generally knowledgeable about the issue and offered multiple and detailed examples to illustrate their views. This is hardly surprising as most were trained natural scientists.

When the discussion moved on to address fisheries science in particular, participants generally became more vocal. For the largest part, participants felt more comfortable about the issue, had strong opinions about it and participated on an often well-informed level, drawing on multiple examples to illustrate their points. This is not surprising as most participants have extensive experience with fisheries science from different positions in the field.

One exception from this is the Greek case. Here fisheries science is a rather new discipline, and fisheries research institutes do not play any direct role in national fisheries policy decision-making. A major part of these institutes’ resources comes from the EU and they do not have any formal obligations towards national authorities. This might be one of the reasons why a major number of participants in the Greek case not being as vocal about fisheries science as in the other cases. What is more, there was some tendency to confuse fisheries scientists with district fisheries managers and fisheries inspectors. This is probably because these make up the main point of contact between fisheries dependent groups and marine and fisheries biologists. This is illustrated by a statement by a member of the Greek trawl fishers’ focus group:

In Hellas, when we speak about fisheries sciences, we should not think of persons doing research but persons who have just finished university and are assigned to carry out various tasks which do not involve research. For me a good ichthyologist³ is a person who is doing research. But in Hellas, we recruit scientists just to accomplish administrative tasks; this situation corresponds to the Hellenic reality.

Also in the Spanish case science was often conflated with management, and the focus group leader put a serious effort into differentiating between the two. The focus groups expressed very different

³ In Greece, an ‘ichthyologist’ is a person who has studied biology and then followed a specialisation in fisheries biology. Ichthyologists play a central role in the administration and implementation of Greek fisheries management.

attitudes to fisheries science and modelling depending on their positions in the field. When it comes to the catching sector, onshore sector, and women in fisheries focus groups, fisheries science is indeed very present in their daily lives and conditioning their livelihoods. This is captured very well in a quotation from the Ireland catching sector focus group: ‘We’ve actually been captured by the scientific data for the last while. It has dictated precisely what we’ve done over the last 20-25 years.’ This ‘dictation’ and the often drastic effects it has on livelihoods have resulted in science being accompanied with unpleasant associations among a number of participants. An equivalent to the feeling of being captured by data was expressed by a member of the Irish catching sector focus group who argued that ‘as far as the word science goes, it frightens me and a lot of others’. Another less radical expression of a general ‘bad feeling’ about fisheries science came from a UK managers’ focus group member who claimed that ‘To a working fisherman, science is something that grates on the fisherman, because it means restriction in one form (or another).’ In line with this, an Ireland women in fisheries focus group member stated that ‘We as fishermen’s wives are sort of programmed to distrust science.’ As these quotations suggest, the ‘bad feeling’ about science is not merely based on a mistrust in the validity of science, but among fisheries dependent stakeholders just as much on a general experience of science being accompanied with unpleasant restrictions. This perception was also expressed by an Irish catching sector focus group member, who is also a representative of an angling and recreation member organisation:

When the Northern Ireland review came along we were told that the government would use scientific data that would be used to assess the current situation and what the future holds. The immediate reaction of our members to this was that they were using scientific data to start up licenses for sporting purposes. This is a natural reaction from ordinary people. And I would have to agree with [another focus group member] that once you talk to our members about scientific evaluations they shy off.

This bad feeling about fisheries science characterised most fisheries dependent focus groups and also some managers’ focus groups. In contrast the environmentalists generally expressed more positive views on science, fisheries science and modelling than the other participants. This could be due to their backgrounds as natural scientists – however, it could also be due to the role they as environmentalists ascribe to science or a general feeling of their interests being backed up by science. Where arguments about livelihoods and economic impacts tend to be central to fisheries dependent stakeholders, environmentalists depend much on the scientific rhetoric. As members of the Greek environmentalists’ focus group put it: “We use sciences to prove our action”, and “Only scientific data can convince them [decision makers] that fisheries stock situation is serious”. Another member of the same focus group even saw their work as complementary to that of the scientists:

Our action is situated at the political level and is based on scientific data of the international institutions working on fisheries management (ICCAT or ICES). Our action should be considered as complementary to their [the scientists’] work; it is time to communicate to the civil society on the state of some fisheries stock.

When the discussion moved on to the use of modelling in fisheries science and management, the environmentalists’ focus groups were again the most vocal on the issue. This is particularly due to most of them having concrete experiences with modelling as natural scientists. Other focus groups

were less vocal on the issue than they were on fisheries science. A participant from the Spain catching sector stated that “We think that they make computer models with the information that we give them, but we’re really not interested.” A Spanish managers’ focus group member claimed that “basically, I don’t understand the concept”, and for participants from the Spanish women in fisheries focus group the question about modelling made no sense at all:

W1. Excuse me, what? Model what? You should ask it another way, or move on to the next question, because this makes no sense to us.

W2. What, computer models in our life? We don’t.

W3. No, I don’t see anything like this.

W4. Me neither.

However, most participants quickly became engaged in the discussion, and for the most part their statements were very much in line with their perceptions about fisheries science in general. Once again the Greek focus groups were an exception – here only few participants had vague ideas about what models are. This is probably due to the Hellenic fisheries management not being based on quota systems, but mainly on seasonal and geographic bans or on fishing gear sizes.

In this way, there are important differences between the approaches different focus groups took to the discussion themes. In most respects the focus groups have more in common with the equivalent groups in the other country-cases than with the other groups in the same country-case. The main divide is between the environmentalists’ and the fisheries dependent focus groups. The differences are not only due to their stakes in the outcomes, but also due to their particular experience with science and the marine environment. The environmentalists depend more on the scientists’ interpretations as these often help to advance their causes, and most of the environmentalist participants have insider knowledge about science as natural scientific practitioners. The fisheries dependent groups are often restricted by science and experience the marine environment through their everyday practices and communication with others in the field. The fisheries managers’ perceptions seemed to balance between the two, sometimes being in line with those of the fisheries dependent groups and sometimes with those of the environmentalists.

7.3 Stakeholder perspectives on modelling in fisheries management

Most of the environmentalist focus group participants had a natural scientific background, why many of them also had experiences with modelling. Participants in the other groups generally had no direct experience with working with modelling. However, many could relate to models due to modelling being an integrated part of the science informing fisheries management. In particular the models used in fish stock assessments received much attention. Hence, despite the fact that many participants had no direct experience with modelling, the discussions in most focus groups were engaged. The issues relevant to modelling that were touched upon during the discussions can roughly be divided into four themes: The technical features of models, the use of modelling in policymaking, scientific knowledge versus fishers’ knowledge, and various recommendations for participatory approaches to modelling. We discuss them one by one below.

7.3.1 Technical features of models

Discussions on the technical features of models touched upon models' capability to grasp complexity, inputs like data, basic assumptions and variables, biological bias and concerns about accessibility.

7.3.1.1 Grasping complexity

Several participants argued that in comparison with other research areas, the object of study of fisheries science is difficult both to observe and to model. The main argument was that the sea is dynamic, fish are migratory, and there are many interdependent variables – something that is difficult to embrace altogether in a model. For example, a UK managers' focus group member argued that:

All these types of models are excellent – the pollution model, the river basin modelling – but when it comes to models in terms of fisheries science and fisheries biology, it's an absolutely different kettle of fish. ... When you start to work with natural parameters and dynamics, it's hugely problematic. ... The difference is the dynamics and being able to get accurate information on things like recruitment, natural influences, fishing mortality, natural stock mortality – all these things are hugely, hugely difficult to quantify. Whereas with things like oil pollution, you can get all your criteria, accurate criteria, reasonably quickly – you've got wind speed, tidal direction, tidal speed – and all those type of factors can all be put into the model and they're reasonably accurate. But when it comes to fisheries modelling it's hugely inaccurate.

A member of the Irish managers' focus group stood out by arguing that the very complexity of the marine environment is what makes models useful – that is, computer models have the capacity to grasp the many variables: "I would say a model is probably useful because you've got so many variables to plug into it that you can't – no human can compute all that." However, there was general scepticism about the capability of models to grasp the many variables and dynamics of the marine environment. A few participants based their scepticism on the argument that models require standardised units, which does not allow for complexities and variation. For example, a participant from the UK catching sector focus group argued that fleet models do not take account of variations in the fishing fleet:

Fleet models run into difficulties because it's very difficult to get a meaningful average or representative type of vessel, because each vessel is so dissimilar in terms of catch rates, type of fishing, profitability. It's very difficult to actually get any sense out of a model that's based on an average performance and average types of vessels because within the fishing industry, with any sort of broad category that you want to try and describe such an enormous variation of employment: that is characteristic of fishing as a hunting industry. And there isn't really an average performer or an average class of vessel.

Another concern in relation to modelling complex objects of study was that it reduces the complexities to the point where the outcome does not make sense anymore. Hence, a UK catching sector focus group member suggested that models should be built for particular purposes, reducing the amount of relevant parameters:

This is the problem with all these models – when it tries to grapple with so many different variations, different disciplines, different information, different data, whether you can do it in a manner so that

it's all singing and all dancing for whatever particular question you want to get out of it. And whether you might not be better developing the model in terms of the specific parameters you're trying to resolve. You build it for a specific purpose ... rather than trying to develop something which is a huge model, and whatever you want, push it in, and you get the answer 47 at the end of it.

The discussions here point to an important dilemma: On the one hand, models need to embrace all the relevant variables and dynamics in order to resemble reality – on the other hand, models becomes more intelligible the more variables they include. These and other concerns about the ability of models to capture the complex and dynamic character of the marine environment and fisheries were raised both by fisheries dependent stakeholders, managers and environmentalists. Some recommended reducing the amount of relevant parameters by building models for particular purposes. Others suggested that models should not be taken too seriously, but merely be seen as part of the process and supplemented with other kinds of information.

7.3.1.2 Model inputs

Another important theme was the inputs to the model – that is, the basic assumptions and the data. A general perception in most focus groups was that the validity of the model depends on the validity of the inputs. As a member of the Irish managers' focus group put it; 'I am not saying that a sophisticated mathematical model is useless, but it is garbage in, garbage out.' To start with the basic assumptions, some participants warned that if the starting point is wrong, the failure can be multiplied as it moves through the model's chain of calculations. A member of the Ireland local managers' focus group argued that:

In the example [another participant] gave of the cod and sea temperatures, it only has to be out by half a degree over a long enough period or whatever was wrong with the one in the mackerel fishery. It may not have been distorted very much at any one point but that becomes magnified over a longer period.

What is more, a member of the Danish environmentalist's focus group stated that even in areas with much fewer variables than in fisheries, it is difficult to get these basic assumptions right. Hence, the participant questioned the very idea of predictive modelling:

You often worry that these models fail. You know, even very simple relationships like the demographic development of society and so on, how many kids will start in preschool in 10 years and so on. You are hardly able to make computer models that can predict that. And that sort of tells me that when you are not even able to tell how many children that will be starting in the first grade in six years - no, I mean before they are born - then how can you believe that you can say anything about the development of the fisheries in the North Sea? I mean, it ought to be pretty basic to say: 'Okay, there are so and so many women between the ages of 20 and 35, and there are so and so many between the age of 10 and 20, and when they are so and so old they will get so and so many children, and we know the development in the educational pattern'. So you should be able to tell this without any doubt. But time and again it turns out that they miss completely, so it is worrying that the scientific models aren't better than they are.

For what concerns the data fed into the models, this was a major issue. This is perhaps because the data collection methods, as mentioned earlier, resembles the everyday practice of fishers, onshore fish workers and managers, and that they can therefore more easily relate to and comment on this

part of the research process. First of all, some participants stated that data in fisheries science will necessarily often be uncertain – or, as a UK catching sector focus group member put it, ‘the issue is within fisheries is how good that input realistically can be expected to be.’ This was among other things ascribed to the dependence of fisheries scientists on data from fishermen, and that fishermen for various reasons are reluctant to share their data or motivated to manipulate the data because they have reasons on the outcomes. According to a member of the UK managers’ focus group, for example,

...marine scientists in particular are dependent on data which they collect, which is either given voluntarily or statutorily from the stakeholders, from the fishermen. Other areas of science, I would imagine, the scientist is responsible for the integrity of his experiments of his data collection. With fisheries science, the scientists as I understand it use the information which they gather from the fishermen and there must surely be perhaps a question mark over the validity of that data. Particularly if the fishermen realise that data is going to impact either good or bad on their opportunity of earning a livelihood. I think that that's possibly where fisheries science differs slightly from other forms of pure science.

This concern about the validity of data coming from fishermen was not only expressed by managers and environmentalists, but also by a few participants in the fisheries dependent stakeholder groups.

Several members from the fisheries dependent stakeholder groups pointed to problems with the sampling methods used in particular fisheries research projects. For example, participants pointed to samples taken at wrong times of the year, in wrong places, not taken often enough and hence not taking account of the dynamic changes, not taking account of tidal changes etc. For example, a member of the UK catching sector focus group gave an example of samples taken in the same way every year, hence not taking account of changes in the marine environment:

...we've found their practices disconcerting. Now there was a degree of defence on that ... question of time series: they've fished every week in November in this particular spot for the last thirty years using this gear and this gear configuration. And the fact that they were doing that was a defence. We started raising issues: three years ago the state of the tides, which has a lot to do with catching, was entirely different than it is this time, have you taken that into account? No. Have you taken into account sea temperatures, weather conditions? No. Do you realise that the fish is shoaling differently, there's different ways of catching it now? And whether they were aware of that or not they would disregard it because they felt that to adopt new fishing techniques which demonstrate a high perhaps sustainable sustained catch per unit effort was inappropriate to the way in which their modelling of the science had been set up forty years previously.

This rigidity was among other things ascribed to institutional rigidity within the advisory system. In order for the annual assessments to be comparable with each other, ICES has set out a number of standards for the data collection such as which gears should be used etc. This was deplored by several participants in the fisheries dependent stakeholder groups. For example, a UK catching sector focus group member complained that

...the gear research vessels are using ... is incapable of catching fish. Because of that it cannot produce a meaningful time series through the years which it's spread. We knew the gear was not right two or three years ago, and were assured by scientists that nothing had changed, it was the same gear that it

always has been. Then we discovered, or we got an admission from the scientists that it had in fact changed in 1992 and that is when the assessments started diving. The problem with the gear is that they have a configuration which is decided in Brussels. And they're not allowed to change it.

Another problem with the data used in models mentioned by participants in the Danish case is that the catch data does not only reflect the amount of fish in the sea, but also the management measures in play. According to a member of the Danish catching sector focus group,

You know in relation to many species, then when you put in data for landings and catches, then this is not in any way a picture of reality - it is a picture of what is legal ... If you ask me how much cod I will catch this year, then I can put that down on a piece of paper for you right now, because I know that already now.

The data, then, might be correct in principle, but it should not necessarily be interpreted as depicting the state of stocks. If for example fishers are unable to catch their quotas, it can indicate a decline in the state of stocks, but it can also reflect the effects of various other restrictions, e.g. days-at-sea, on the catch. Hence, it was argued, a misinterpretation of the data can result in a vicious circle between continuous declining catches and an increasingly stricter management.

Again, the recommendation was not to take models too seriously – they may be however accurate, but the outcomes will be no better than the data that are fed into the model. What is more, one must be careful about the basic assumptions; a little failure can be magnified when run through the calculations.

7.3.1.3 Biological prejudice

A recurring theme was the need to supplement the biological knowledge in fisheries science with social and economic perspectives. This argument was promoted not just with the fisheries dependent stakeholder, but also by several environmentalist participants. For example, a member of the Greek environmentalists' focus group argued that not only fisheries stocks, but also the fishers, their wives and families and other stakeholders should be taken into account: 'Scientific results will be better if they integrate different disciplines during research work. This involvement constitutes the only guaranty for more objective and positive results.' In the Greek trawl fishers' focus group the same argument took a slightly other form – putting social considerations before the conservation of stocks:

Does the survival of fishers exist in your scientific philosophy? Or do you just look at the conservation of fish stocks? For us models should determine first how to assure the survival of fishers and then how to protect fisheries stocks. Otherwise fishers will disappear in the next ten years.

A Spanish fisheries scientist also stressed the need to take other disciplinary perspectives into consideration. The scientist described the lack of other perspectives in fisheries science among other things as a tendency among biologists to focus too narrowly on their own research field:

Models have to help resolve problems in all sectors, including with the fishermen, in order for them to be a useful tool. People said that we should just close the anchovy fishery this year. I said, wait! We need to manage the whole fishery, not just the fish! It is important to look at the whole picture. We forget this sometimes as biologists.

A recommendation, then, was to integrate social and economic parameters in models used in fisheries science and to supplement modelling with other kinds of research and data.

7.3.1.4 Transparency

A final concern expressed during the focus group discussion on the technical features of models was about accessibility. A number of participants stated that in order for science to be democratic it must be transparent so stakeholders can review and discuss the process behind the results. However, a widely shared perception was that this is particularly problematic to models – something that also affected their confidence about the models. For example, a member of the Greek environmentalists' focus group stated that "I am reacting to the word confidence because we need to be sure on the manner that scientists find their results. Results should be based on transparency which is not guaranteed through the use of models." This link between transparency and confidence was also stressed by an Irish managers' focus group member:

What I am saying is that just to trust a mathematical model isn't enough and I would not understand the mathematics, but I would understand the basic assumptions and that is where the link between the modeller and the man on the street is important. You have got to make the model understandable to me and to others. If I am going to buy into it, it can't be a black box. I am not going to buy into a black box because I don't know that you know what you are talking about. I can't make the assumption that the modeller knows what they are talking about. If I can trust the assumption they are making about the area I know about then I am more likely to trust the mathematical model.

Besides from causing distrust, the lack of accessibility also caused some participants to withdraw from the discussion on modelling. For example, when the issue of modelling was introduced a UK managers' focus group member stated that

... what you're now going to do is talk about computer models and how effective are they in your work and how do you use them? There's an important answer, I know how to switch a computer on and I know how to do various things with it. If you're going into scientific modelling, I'll take a backseat.

Most remarkably participants in the Spanish women in fisheries focus group were, as showed in section 2, rather alienated by and even uncomfortable about the issue. The lack of accessibility of some models, then, can be an important obstacle to stakeholders' understanding of and trust in the models and to their possibilities for engaging in dialogue about the validity of models.

7.3.2 The use of modelling in policymaking

While several participants addressed the lack of accessibility of models, there were also several concerns about the consequences of this when models are used in policymaking – the most important being that this makes models open to misuse. Another theme that received particular attention in discussions about the use of models in policy making was about basing important decisions on uncertain science.

7.3.2.1 Features of models that invite misuse

Many participants pointed to different features of models that can be problematic in political decision making – because they look convincing and can be taken too seriously and, as a

consequence, because they invite misuse. The arguments mainly referred to three typical features of modelling. First, a number of participants argued that while models tend to be inaccessible black boxes, they can be used to marginalize stakeholders and the wider public from the discussion and hide uncertainties and underlying political intentions. For example, a member of the Irish environmentalists' focus group argued that modelling is sometimes used to confuse people in order to push them out of the political process:

It's my feeling that if you throw a big enough model at a problem it will confuse enough people and many won't understand it and will not participate. This reduces the numbers that get involved and increases the likelihood of getting something through.

In line with this, another member of the same group stated that NGO's sometimes have difficulties getting their point across because they are up against seemingly objective models that, due to their complexity, can cover over political decisions: 'That is one of the real disadvantages of models, that you hide a lot of political decisions within some variables in the models, that somebody cannot really understand.'

A member of the Irish managers' focus group stated that models are inappropriately used by managers because they come up with seemingly exact outputs that you can act on, whereas scientists would otherwise be less definitive in their answers. Likewise, a UK managers' focus group member argued that models, particularly those used in stock assessments, are applied because they produce the kind of outcomes that are needed in management – irrespective of their questionable validity:

...a lot of the problems are where the scientists don't know – they can't answer the question they're being asked. One example of where that applies, which tends to be classified as bad science, is the annual quota decisions, which has been set up to require that scientists tell us exactly how many fish can be taken out of the sea next year. It's by no means clear that scientists know enough to be able to do that for a lot of stocks with a lot of confidence. But in the end, we want a single number we can agree on the 21st December.

A third concern was on models as entities that can have, or be perceived to have, agency on their own. For example, a member of the UK environmentalists' focus group argued that models can 'take over' the political process:

If the model gets a life of it's own, as models sometimes do, such that people then regard it as a decision-taking system – they put in the numbers and it comes out with number 42 – then I think they're probably deluding themselves about it.

Likewise, a member of the UK managers' focus group argued that using models can be a means of hiding responsibility: 'It could also provide ministers with a useful tool in respect of their accountability... [if] you have a decision which is made by a computer [it] would be extremely convenient, I'm sure, on occasion.'

Models, then, were perceived to have potentially deluding features because what happens between input and output is difficult to access, because they produce outcomes that can look unjustifiably convincing and certain, and because they can act as convenient scapegoats for political decisions.

Where models are used, it was argued, these features can be an obstacle to the democratic decision making process.

7.3.2.2 Basing important decisions on uncertain science

It was a widespread perception that the questionable validity of stock assessments is particularly problematic because it has influence on livelihoods. The following perception expressed by a UK onshore sector focus group member was shared among a number of participants, particularly from the fisheries dependent focus groups:

I think ... there is clear evidence that the scientific methodology used for stock assessments is greatly flawed. And therefore people are basing assumptions, and therefore the economic impact of that assumption – job losses or whatever it may be – on something that is not proven.

The output is typically numerical and the numbers tend to obscure the uncertainties that are involved in the calculation (Wilson 2008). For example, a member of the UK environmentalists' focus group gave an example of the treasury economic model employed by the Bank of England:

If someone talked about computer models, very quickly you will get locked into fully quantitative things – have we got all the numbers? For example, the Bank of England is just about to put up interest rates, and they'll say 'according to the treasury economic model, this is what'll happen.' All the treasury economic model is, is a set of equations that links various factors – what people are spending and what they're saving and all these things – they are put into equations. So therefore when people talk about models they get locked into the numerical models very quickly and predict something happening.

An Irish managers' focus group member gave an example from the mackerel fishery where ICES had brought in peer reviewers from Canada to review the model they had used for years. The model was exchanged with another, resulting in a sudden drastic cut in the quotas. In line with many other participants, the manager argued that such consequences for the fishing industry are difficult to accept when the scientific basis seems so uncertain or accidental.

So where is the faith there? And that was just because they said our model is right and your model is wrong. ... But that had a serious impact on the fishermen, their livelihood and the entire community, but no regard whatsoever was given to that. Just because one or two scientists felt that it should be done a different way. So who is right, who is wrong?

Recommendations from the fisheries dependent stakeholder groups and some managers' focus group participants were that where the science is uncertain, decisions should be taken in precaution for the livelihoods in the fishing industry. The precautionary approach is normally employed in favour of conservation objectives – however, the issue was not raised during the discussions in the environmentalists' focus groups.

7.3.3 Research and experience

A final important discussion evolved around the differences between research based (RBK) and experience based (EBK) knowledge. First, scientific knowledge, hereunder modelled knowledge, was often claimed to be theoretical and remote from what happens on the ground. Secondly, according to some participants scientists tend to be arrogant in their attitude towards fishers.

7.3.3.1 Scientists' lack of on-the-ground knowledge

Particularly participants in the fisheries dependent stakeholders', but also some in the managers', focus groups shared the perception that scientific knowledge, including modelled knowledge, tends to be theoretical and remote – that is, not being in touch with what happens on the ground. This was often contrasted with the experience-based knowledge of fishers, and multiple examples were given on situations where, as an Irish onshore sector focus group member put it, 'the so-called scientific reports of management of fisheries and stock levels don't seem tally with what the fishermen are finding on the ground.'

According to participants in some of the catching sector and women in fisheries focus groups, one of the differences between scientists and fishers is that scientists simply are incapable of catching fish when taking samples. As a member of the UK women in fisheries focus group pointed out, "the trawls that they're doing, they're not setting the gear up right, they're not doing the right speed, they're not fishing the right places for it to actually mean anything." One Irish onshore sector participant even argued that scientists would do the samples at the wrong times of the year because that is when they found it most convenient to be on the water.

Scientists' lack of on-the-ground knowledge was not only claimed to show in the way they take samples, but also for example in their choice of variables and basic assumptions when building models. An Irish catching sector focus group member gave an example on scientists' basic assumptions about the effect of mesh sizes on the catch:

From my own experience from talking to fishermen, controlling mesh sizes just doesn't work as diamond nets just close up under tow. Yet scientists say that larger mesh sizes result in younger or smaller fish escaping.

The concerns about scientists' lack of on-the-ground knowledge combined with frustrations about scientists not listening to the experiences of fishers gave an overall impression among many participants of a top-down advisory system. A UK catching sector focus group member complained that

It certainly needs sorting out because I think there's far too many people devising models who really do not understand the industry and understand what they're doing. They come up with this fancy piece of hardware and give it to the government and say 'That's good isn't it?' 'What does it tell us?' 'Well it tells you that.' 'Alright. We'll apply this at Christmas.'

These frustrations were accompanied with positive assessments of research projects where fishers have been involved in the research process and recommendations for different kinds of involvement. As this was a major issue we discuss it in a separate section below. First, however, we discuss another frustration expressed by the fisheries dependent participants:

7.3.3.2 Scientists' attitude

A widespread feeling among participants in the fisheries dependent stakeholders' focus groups was that scientists tend to be too confident about their own infallibility and approach fishers with varying degrees of academic arrogance. According to an Irish catching sector focus group member, 'The one thing about scientists is that they don't like to be proved wrong. They are like the law and you are

not supposed to question them.’ According to an Irish onshore sector focus group member this attitude is particularly problematic because they lack the kind of information that fishers can give them: ‘Basically they seem to come out of their universities and think that they know it all, when the one thing they are lacking is practical experience.’ This attitude, it was argued among several participants, keep some scientists from listening to the experiences of fishers. Something that made a member of the Greek trawl fishers’ focus group wonder how they were expected to cooperate: “They tell us that we don’t collaborate with scientists but scientists don’t want to hear us and make an effort to understand what we tell them.”

Furthermore several participants argued that they and their colleagues felt that they were being talked down to, and that this created mistrust towards scientists. As in this statement from an Irish managers’ focus group member:

As a former fishing skipper, we have had very bad experiences over the years. If you ask any skipper of my age, they would say science is just a bunch of figures made up to suit the scientist. We could never say that we believed a scientist. There was no interaction between fishermen and scientists and I was never asked my opinion or what I thought should be done. They never talked to us but they talked down to us and told us what to do. I would say 95% of the fishermen in Ireland would tell you the exact same story although it is slowly changing.

Again, the core recommendation was to involve fishers in the research process. It is time, then, to look into the different arguments put forward for fishers’ involvement:

7.3.3.3 Arguments for fishers’ involvement

Fishers’ involvement was in turn claimed to improve scientific accuracy, encourage fishers’ confidence with the results and their compliance with regulations informed by them, and finally to ensure a more just and democratic management. We go through the arguments one by one:

First, some participants claimed that fishers should be involved in fisheries science because they in some respects know better than scientists due to the practical experience from their daily work at sea. Scientists, on the other hand, were by some claimed to have achieved all their knowledge at school – a member of the Irish women in fisheries focus group claimed that

... it’s hard to get true facts. It’s like sending a nurse to college to learn how to nurse when she is not on the shop floor nursing, she can’t do it. Or sending a scientist out to find out about fishing, when he’s not hands on as a fisherman is.

Hence, RBK and EBK were by many participants in the fisheries dependent and managers’ groups claimed to be different *kinds* of knowledge – that is, fishers’ hands-on experience was claimed to be different from and in some respects better than knowledge achieved by modelling or other kinds of desk work. As described above, numerous examples were given of situations where scientists had been wrong because they lacked on-the-ground knowledge – like being incapable of catching fish, not knowing how mesh sizes function in practice etc. Moreover, the frequency of fishers’ everyday observations as opposed to that of the scientists’ was argued to be central to knowing about a dynamic environment in constant change. Scientists, a member of the Irish women in fisheries focus group argued, “are only seeing what’s going on on a certain day when there may be very little

caught.” On this background, then, fishers’ involvement in the research process was argued to improve scientific accuracy.

Secondly, fishers’ involvement was by participants in most focus groups, including some environmentalists’ focus groups, believed to enhance fishers’ trust in and confidence with the results. An Irish local managers’ focus group member contrasted partnerships between scientists and fishers with top-down science:

If you could include everyone in it and start from the bottom up then you might trust it more. Like in fisheries for instance, if you take everyone’s views and you are working together rather than someone coming along saying there’s your plan, there’s the science and this is how I see it going forward, take it or leave it. Then you don’t trust that person or that science but if everyone is included from day one there is a good possibility it will be trusted.

According to a member of the UK women in fisheries focus group the trust-building works both ways: “... from a few cases [of partnerships between science and the fishing industry], a lot of fishermen have a better relationship with scientists as a result and vice versa. You really do see that building a trust.” Moreover, it was argued that fishers’ compliance with regulations is closely related to their involvement and trust in the science that informs it. If they are not included, a member of the Irish women in fisheries focus group argued, “They are taking their own lead, coming up with things and passing the law.” From a pragmatic point of view, then, fishers’ involvement was believed to build trust and ensure compliance with the regulation informed by the research

Thirdly, fishers’ involvement was argued to ensure a more just and democratic knowledge base. An Irish onshore focus group member argued that fishers should be involved in fisheries science as they are the ones whose livelihoods are at stake. Scientists, on the other hand, are safe and far from the consequences of their research; ‘these people have no idea of the consequences of their actions, the consequences on communities, the knock on effect of poor science, part science or their science.’

Naturally all these arguments were most outspoken in the fisheries dependent stakeholder groups, but also managers and environmentalists supported the claims.

7.4 Models as boxes and how to open them

Although many participants could see the potential of or need for using models in fisheries research, most were also very sceptical. However, a highly positive outcome of the focus group interviews is some very clear recommendations. What is more, whereas there were a number of differences in the concerns about modelling, particularly between those of the environmentalists and those of the fisheries dependent stakeholders, most perceptions about what could improve the use of modelling in fisheries research were shared across all stakeholder groups involved. The core messages were mainly related to enhancing transparency, with the idea that models should be accessible to the critical scrutiny of both scientists and lay people, and that stakeholders should be involved in the research process. Furthermore a key concern was that the models should either embrace or be supplemented with socio-economic knowledge. We go through these recommendations later in this section. However, as these should be seen in the light of the participants’ conceptions of contemporary modelling, we first provide a broader look at these issues of transparency.

7.4.1 Black boxes

Most concerns and recommendations presented during the discussions on modelling evolved around one underlying theme, namely features of models that tend to make the research process inaccessible to outsiders and the consequences of this. Likewise, positive evaluations of concrete research projects were mainly on processes where attempts have been made to open this process for outsiders' participation and critical scrutiny. Finally, as we discuss later, most recommendations for improving the use of models and the public understanding of them were on different ways of doing so. As quoted earlier, one participant hit the nail on the head:

I am not going to buy into a black box because I don't know that you know what you are talking about. I can't make the assumption that the modeller knows what they are talking about.

The participant refers to the model as a black box in the meaning that the internal features for different reasons are not accessible to outsiders. This requires that outsiders, who in this way are deprived from the possibility to make their own judgement of the validity of the model and engage in discussions on its improvement, have to trust the modellers. And as the former chapter illustrates, they often don't. One participant argued that scientists might not even know themselves what happens between input and output; 'they put in the numbers and it comes out with number 42'.

As the discussions in section 4.1 show, there were a range of concerns about the technical features of models making them inaccessible to others. Some core perceptions in this regard were that:

- Models are complex and hence difficult for outsiders to enquire into.
- Models are numeric and theoretical and hence require particular skills to be understood.
- Models can process enormous amounts of data and operate with multiple variables and still come up with answers that seem certain and simple – promising more 'factuality' than the process behind it can justify.

In section 4.2 a number of participants list some consequences of these black boxing features of models for policymaking. The main concerns here are that black boxing features:

- make models useful tools for manipulation,
- marginalize people from the debate,
- facilitate top-down management, and
- raise suspicion and demotivate people to comply with regulations informed by it.

Finally, in section 4.3 fisheries dependent stakeholders held that modelled knowledge tends to be theoretical and mathematical and operate in a language or jargon that is intelligible to outsiders. Black boxing features in this respect were claimed by different participants to:

- deprive non-scientists the possibility to subject the model to critical scrutiny and engage in debates about its validity and improvement,

- exclude other kinds of knowledge, in particular fishers' experience-based knowledge, from the process, and
- give fishers the feeling of being talked down to.

The philosopher and science anthropologist Bruno Latour also uses the term 'black box'. Although the meaning he gives to it in some respects differs from the participants' concerns about modelling, it still provides a useful entrance to the discussion. In his book *Science in Action* Latour uses the term to describe how facts are established from complex research processes (Latour 1987). Latour argues that when a research outcome is generally accepted, nobody feels the urge to enquire into the research process behind it, with the multiple negotiations, uncertainties, disagreements and choices involved. On the other hand scientific controversies take the form of pushing these black boxes back towards the conditions of their production (Latour 1987). Black boxes are, therefore, a critical part of the growth of scientific knowledge. What results are black boxed, and the criteria they create for the black boxing of subsequent results, are a critical part of the background knowledge of scientific cultures because they determine what (and who) will be initially trusted or viewed with scepticism (Barnes et al. 1996). One of the most critical impacts of legal and policy contexts on the practice of science is that the pushing of black boxes becomes so acute (Smith and Wynne 1989) that the tacit skills and background assumptions that any scientific activity must use are problematized in a way that even the best science can be made to look unprofessional. The idea of the black box that emerged in these interviews and focus groups was closer to that found in legal contexts than that found in research contexts. Particularly when uncertainty is hidden or underemphasized – as in many stock assessment models – the constant pressure on the conditions of their production leaves no common basis for discussion. Part of this is the error of thinking that science is “objective knowledge”, which then means that any judgement used in its creation calls its legitimacy into question.

The focus group results indicate that this scepticism is the heart of the problem that the participatory modelling programme represented in FLR must confront. The participation that is required is that which allows the scientific process to achieve transparency through activity. This will still mean that a level of trust between scientists and lay people will have to be built up because quantitative skill in particular is always going to be a block to full transparency. This can certainly be overcome, however, as we have long recognized that the public is comfortable with a division of labour based on legitimate levels of ignorance (Michael 1996). What is not acceptable, as is strongly revealed in these responses, is when lay people are constructed as being ignorant of things they are not and when everyone's ignorance, in the form of uncertainty, is not given the prominence it requires for decision making.

While some participants, then, warn that the features of models can be deluding, they are certainly not deluded themselves; rather the lack of accessibility raises suspicion. Hence, an important insight from the focus group discussions could be that when it comes to the use of models in fisheries science, what creates trust in the outcomes is not black boxes, but opening them. And this particular task is precisely what most recommendations for the use of modelling were about.

7.4.2 Recommendations

Whereas the main concerns, then, all evolved about how models function as black boxes and the effects of this, the main recommendations all were on how to open up those boxes. According to participants across all stakeholder groups stakeholders, fishers in particular, should in some way be involved in the research process. In the following we discuss the participants' perceptions about how this involvement should take place and which precautions to take:

7.4.2.1 Accessibility

As mentioned in section 4.1, many participants were concerned about models often being too complicated for peers and outsiders to understand, hence depriving them the possibility to subject them to critical scrutiny. This, it was argued, creates scepticism towards their validity and hence also towards the legitimacy of the regulations they inform. Hence, all stakeholder groups stressed the importance of allowing peers and outsiders to subject the modelling process to critical scrutiny. A UK environmentalists' focus group member argued that

...the stakeholders don't have to know the technical aspects of how the model works, but we've all worked with fishermen who've questioned the initial assumptions that have been made...So I think to get stakeholders on board, if they're comfortable with the assumptions that you've made and the information, then I think they'll accept what comes out of the model.

As has also been an experience from the particular participatory modelling exercises of the EFIMAS modelling, making the modelling process accessible to outsiders is a difficult task. Two barriers to outsiders' access to the modelling process were mentioned during the focus group interviews: That most computer models are complicated, and that they operate and are presented in a language that can be intelligible for outsiders.

As for the first, some participants suggested that the model should be simple in order to be easily understood. However, some participants acknowledged that this is not necessarily doable. Two participants argued that the very condition that the model is made on a computer made it inaccessible to them. Hence one of them argued that there would be no need for making it simple:

I don't need it to be simple – I don't know how a computer works, I couldn't make one, or programme one, what I do know is it works – what I want to see then is that the results of this work...

While some recommended making models simpler, others argued that they should be explained in understandable ways – for example, an Ireland environmentalists focus group member wanted to be informed about which variables are taken into account:

I would find it useful if models were more accessible and they explain how they have been drawn up. So if you have a model that's predicting fish stocks I'd like to know if it takes into account the possibility of climate change, nutrient overloads, pollution spills etc. because I am not able to read that much into it. I'd like it to be done in such a way that it's accessible and it tells me what's being used and what these predictions are based on.

An Ireland environmentalists focus group member pointed to climate change modellers as a good example. As a consequence of the wide range of different approaches in the field they are beginning

to work for such accessibility; 'because so many scientists have different views and they are stating that 'my' model of x is based on the following predictions.'

As for the second barrier to accessibility, some participants suggested that the language or jargon used in models and in the presentation of models is too internal or theoretical to be intelligible to others. A UK environmentalists' focus group member wondering why fishers get disillusioned with fisheries science suggested that it is due to

...the ease with which people use jargon – and I started doing it just now; the ease with which scientists are very happy talking to scientists, and, I guess, fishermen talking to fishermen? It's that interface – and we're not very good at bridging those, at moving across the different disciplines. We've each got our own language, we've each got our own terms, each got our own methods.

Hence a member of the same group suggested that in order to mediate modelled knowledge to fishers, '...somehow you need to give a clear picture of what you're trying to do that relates to everyday life.'

7.4.2.2 Fishers' involvement

The second main recommendation for improving the use of models in fisheries research was, as mentioned in section 4.3, to involve fishers in the process. Participants pointed to involvement at different stages. A Danish catching sector focus group member stressed that fishers should be involved should be from the very start, when formulating questions:

It makes a huge difference, what kind of questions you seek to answer: 'Can you rule out that something has a negative impact on the stock size?' No, you never can. It would be better if the industry also influenced what kind of questions to ask: 'Is it a crisis for a specific stock if it is halved in size or drops below certain limits?', for instance. 'Or is it actually a way of cultivating and using the resources of the sea that might be more productive than keeping the stocks at a high level?' That could easily be.

Others argued that fishers should be involved in collecting the data, either by joining research vessels or by scientists learning from visiting fishing boats. One Danish catching sector participant argued that fishers' knowledge is useful when judging the validity of data, for example catch data:

Whether you can expect that all the data is correct. Whether all the catches are caught exactly where it has been noted that they have been caught and that kind of things. It is a good thing that this kind of knowledge is now brought further into the system.

As mentioned in section 4.1, many participants also argued that involvement is important when choosing variables and formulating the basic assumptions.

Whereas participants argued for involvement in and access to the development of research questions, collection and validation of data and choosing variables and basic assumptions, few argued for involvement in or access to the development of the internal features of the model – that is, how the various inputs are processed. This is perhaps due to this part of the model being rather technical and difficult to understand for outsiders. As we have seen in section 4.1, many participants were concerned about whether models can compute all the various variables and data in a valid way,

but nobody became particular about the subject. When nobody argued for involvement in and few for access to this part of the process, it can be because it was not really believed to be doable. And, as we have seen, some participants also argued that they trusted this part of the process – if they agreed on the inputs, like basic assumptions and data, they would also be confident about the outcome.

A final stage at which some participants argued for fishers' involvement was after the modelling process, by supplementing the modelled knowledge with other kinds of data. For example, a member of the Irish local managers' focus group stated that:

I think that the cumulative knowledge of the people engaged in the fishing activity around the coastline to me is of a lot more benefit than the most sophisticated, theoretical model. I would say a model is probably useful because you've got so many variables to plug into it that you can't – no human can compute all that. And I think it does make sense to put all that in and try and see what that means and understand that, but there needs to be a lot of tolerance for adding other common sense judgements into that process. Rather than a 56 page document lying on your desk signed by the minister saying this is how the world is going to work for the next ten years. I think that using the model as part of the process rather than as the definitive outcome is a more sensible way.

However, there were mixed feelings about fishers' involvement. Particularly the environmentalists' groups, but also participants in other groups, mentioned a number of limitations. First, participants from most stakeholder groups argued that one must be alert about fishers having interests in the outcome. For example a member of the Irish catching sector focus group argued that when scientists go out on fishing boats, fishers could be encouraged to misinform the scientists – hence, 'The scientist is reliant on the fisherman to be objective too.'

Secondly, a Danish environmentalists' participant complained that fishers' knowledge was often equated with science, resulting in disagreement between fishers and scientists being displayed as disagreement among scientists:

Sometimes you have to listen to one perspective [the fishermen], and other times it is perhaps more the scientific perspective that you have to rely on. And what I want to say is that the problem in this is that this is often mixed up in the public and the media and so on. That the perspective of one fishermen has the same weight as a scientific research project that has been running for 30 years or something, you know? It is sort of being projected that then you cannot... Science cannot come to a conclusion.

Thirdly, it was argued that fishers can be reluctant to share data for fear of how it will be used or for competitive reasons. A member of the catching sector focus group for example argued that 'if you find a good patch you are not going to let it go into a report that will be published.' Fourthly, participants from the UK catching sector and environmental interests focus groups stressed that fishers' knowledge is perhaps most relevant on issues at the local level, but that it might be problematic scaling up such collaboration to for example the European level. Finally an Irish onshore sector focus group member argued that participating in time-consuming modelling processes can be costly for stakeholders:

It's very hard, because we are all small businesses and we don't have the luxury of this setup here or backup staff. It is costing us money to be here today, our phones are turned off. This is the problem. We haven't got the wherewithal to affect what these people are doing.

Despite all these concerns, however, the general perception was that fishers' involvement was important. And there were several positive statements about this beginning to happen. For example, a member of the Danish catching sector focus group argued that

... now we (fishers and scientists) do talk together all the time, and they come with us on fishing trips in this fisher-scientist project, where you meet and talk, right? I am not sure that everything the fishermen say is true - but we talk together and use each others' knowledge. And I think it is important that you have at least come that far.

7.4.2.3 Socio-economic knowledge

A last recommendation was that models should embrace or be supplemented with socio-economic knowledge. While this was most frequently advocated in the fisheries dependent focus groups, also managers and environmentalists stressed the importance of taking livelihoods into consideration. And in the Spanish case, where two individual scientists were also interviewed, one of them expressed concern about a tendency among modellers to focus on the fish:

... models have to help resolve problems in all sectors, including with the fishermen, in order for them to be a useful tool. People said that we should just close the anchovy fishery this year. I said, wait! We need to manage the whole fishery, not just the fish! It is important to look at the whole picture. We forget this sometimes as biologists.

7.4.3 Challenges for trust and engagement

To sum up, a core issue for the focus group participants in relation to the use of models in fisheries science is features of models that make them inaccessible. That is, features that function as barriers for peers and outsiders' possibility to judge and debate the validity of models and participate in their development. In line with this, some core recommendations were on how to make models more accessible and involve fishers in the modelling process. Another core recommendation was to make models embrace or supplement them with socio-economic knowledge.

7.5 Challenges for future use of models

Modelling holds some possibilities, not only for making the decision process and regular updating of information informing management more standardised and efficient, but also for helping participation in the scientific and political processes behind management. However, if models are not developed and used in careful consideration of the particular challenges they add to the relation between science and the public, they can be an obstacle to the inclusive process and to the public legitimacy of decisions informed by them. The focus group interviews discussed here provide us with some insights into a number of the challenges that need to be taken into consideration and some recommendations for the future development and use of models. As models used in the advice for the EU fisheries policies were met with considerable scepticism by all stakeholder groups involved, the interviews also hint some urgency of considering these challenges in the particular context of EU fisheries management.

The main challenges models add to the relation between science and stakeholders are related to the features of models that tend to black box the research process, excluding outsiders to review and participate in the process. For example, models were said to be complex and to operate in mathematical and theoretical languages. What is more, they were claimed to transform multiple interdependent variables and data into simple answers, hence making outcomes seem more exact and certain than the process behind them can justify. This lack of accessibility and tangibility was in turn claimed to make models useful tools for manipulation in decision-making processes. They can be used to marginalize people from the debate, to justify policies on seemingly sound scientific grounds, and to remove responsibility from managers and politicians to the computer. Finally, modelled knowledge was particularly by fisheries dependent stakeholders associated with theoretical, mathematical knowledge detached from what happens on the ground. It was juxtaposed with the experience-based knowledge of fishers and hence claimed to exclude such kinds of knowledge. In order to meet these challenges, three recommendations were put forward during the focus group discussions:

First, a core issue that needs to be considered is the accessibility of the modelling process – that is, the intelligibility of the data collection process, variables and basic assumptions to outsiders. According to participants approached in this study, access to this process will enable stakeholders and peers to make their own judgements about the validity of the model and to contribute to the debate about their continued development. The black boxing features that tend to characterise models were claimed to create scepticism towards their outcomes – hence, increased accessibility was expected to improve the legitimacy of the results among stakeholders. Accessibility was in turn argued to be obtained by not making the models more complex than needed, letting the research process be transparent and mediating the process in ways that are understandable to outsiders.

In line with this, a second core issue is fishers' involvement in the research process. That is, fishers' participation in the formulation of research questions, data collection, validation of data, choosing variables and formulating basic assumptions – and, in the end, supplementing modelled knowledge with other kinds of data that cannot be embraced by the model. According to participants in the fisheries dependent stakeholder groups, fishers' experience based knowledge was claimed to hold some advantages over research based knowledge. Involvement was in turn claimed to improve accuracy, enhance stakeholders' confidence in the results, ensure a more democratic knowledge base and improve fishers' compliance with the management informed by the model. Some participants, particularly in environmentalist focus groups, also stressed that fishers' bias should be taken into consideration in such a process, that fishers' knowledge is more relevant in some contexts than in others and that it should not be equated with scientific knowledge.

A third core issue that according to participants across all stakeholder groups should be taken into consideration is the socio-economic aspects of fisheries management. That is, participants in turn argued that socio-economic variables should be embraced by the models or that modelled knowledge should be supplemented with socio-economic knowledge. The environmentalist participants were least outspoken on this, but fishers' involvement was mentioned during the discussions as an integrated part of an ecosystem based approach to management and as a means of ensuring cooperation and compliance.

Fisheries science is characterised by high levels of uncertainty, and the stakes in the outcomes are high. And in the context of EU, fisheries management has failed to meet its own objectives since the first CFP. Moreover, fisheries dependent stakeholders often hold high levels of experience-based knowledge. On these backgrounds, fisheries science stakeholders are often more well-informed and alert about the science, its methods and uncertainties than in a range of other regulatory sciences. Accordingly, while many participants warned about the deluding effects of the black-boxing features and seemingly certain outcomes of models, these features do not seem to have had any efficient pervasive effect on the participating stakeholders. On the contrary, the potentially deceiving abilities of models raise suspicion among stakeholders about the scientists' good intentions and the scientific validity. What was in stead perceived as pervasive among the participants in the focus group interviews was the still more persistent attempts within fisheries science to open black boxes – by making research processes accessible by outsiders, including fishers in the process and opening for dialogue on for example the variables, basic assumptions, data collection methods and outcomes in the modelling process.

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Annex 1: Standard EFIMAS Focus Group Topic Guidelines

In the following the bold italic text is for the staff and regular text guides the questions to be asked.

The focus group has three staff each with a different role:

- 1. Focus group leader: gives the introduction, asks the questions, and steers the proceedings.*
- 2. Second leader: makes sure the recorder is working, takes enough notes so that the recording can be easily transcribed; and, most importantly, watches out for interesting threads that should be followed up on and then asks the appropriate questions. This is necessary because the leader will be focussed on the guidelines and may or may not catch an interesting comment.*
- 3. The scientist: Presents the EFIMAS model in Section Five below; answers any technical questions that come up in subsequent discussions; asks the questions in the final part 6.*

The focus group topic guidelines are divided into six sections. The sections represent the topics that the leader is responsible to see get covered. The individual questions are suggestions for how the topic might be covered. They can and often should all be asked, but they are all to some degree optional. The main reason for this is because if a good discussion gets going the questions not yet asked may be covered spontaneously.

The main thing to remember is that the point of the focus group method is to get participants to talk with each other about a topic in their own terms.

Introduction: Hello, and thank you for making your time available to us. We are social and fisheries scientists working with the EFIMAS project, which is a large research project, funded by the European Commission and charged with developing a specific kind of fisheries management model that includes both biological and economic information. Part of the EFIMAS project is to hear from people who might use or be affected by the model so that we can make it as useful as possible. These focus groups are part of that effort and we are also doing individual interviews with fisheries managers.

The discussion here will be confidential, meaning that in our reports we will only identify you as a person in a focus group and never as an individual person. We will not quote you as an individual even if you want to be quoted. We would like to ask your permission to record the focus group. This makes our analysis much easier.

The reason that social scientists sometimes decide to use focus groups is that it is the best method we have for hearing how people we are talking to see the issues before the social scientist defines what they are about. It avoids having to have questions already made up that may or may not mean the same thing to different people. We are going to suggest some topics and we would like, as much as possible, for you to feel free to discuss these topics with each other. In some ways the best focus group would be one where the leaders only listened and did not ask any questions.

We are going to begin by talking about some general topics and then we will move toward a more specific conversation about the model work we are doing.

1. First let's talk for a while about the meaning of "science" in general before we start talking specifically about fisheries science. What is science to you? When do you use science? In your daily life? At work? When have you had the feeling that something really deserved to be called science? When have you felt suspicious of

something that someone was calling science? Who do you trust to do science? Who do you not trust to do science?

2. Now let's talk specifically about fisheries science. What things come to mind when you think about fisheries science? What do fisheries scientists do? What kinds of products do they make? When have you run into what you thought was very good fisheries science? When have you run into fisheries science you thought poorly done? Is there any way that you think fisheries science is different from other kinds of science?

3. What are different ways that fisheries science is used in fisheries management? When is it particularly helpful for management? Are there times when it is not so helpful? What other sources of knowledge are important for fisheries management? Do these sources work well or poorly with fisheries science?

4. Now let's talk about the general idea of a computer model. **Show Slide One.** Where do you run into computer models in your daily life or work? When do you find them useful? When do you find them unhelpful? Where have you found them helpful or unhelpful in respect to fisheries? What are the qualities that make a computer model for fisheries useful? When should a model be used in fisheries management? Are there things that should be modelled that are not being modelled? Are there times when models are being used inappropriately in fisheries management?

5. Now we are going to spend a few minutes presenting the particular model we are developing in the EFIMAS project. **Here the scientist presents remaining slides. It is critical here that he or she stays away from evaluative statements even at the level of "we think this would be useful for X" Nothing should be said to support, defend or criticise the model or its possible use. The presentation should be 'just the facts, mam': This is the model, this is what it does, this is how we have used it in this one case.**

Are there any particular thoughts that struck you while you were listening to the presentation? What do you think are the strengths and weaknesses of this approach? Are there things you would want to make sure are included in the model. In what situations would you like to see it used? Are there any situations where you are afraid it might be used and would not like it to be?

6. **Scientists' questions. Here the scientist may ask any specific questions that have come to his or her mind during the proceedings that he or she feels could help improve the usefulness of the model.**

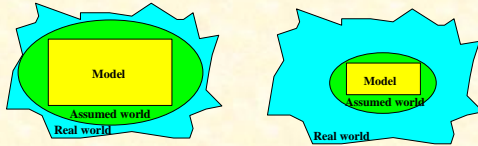
It is unlikely that all these questions will have to be raised specifically, as participants tend to refer to the subject matter in their own way. However, the Guidelines serve to aid the focus group leaders to facilitate, monitor and intervene if necessary.

Annex 2: Standard EFIMAS Presentation Slides used in Focus Groups

Slide 1

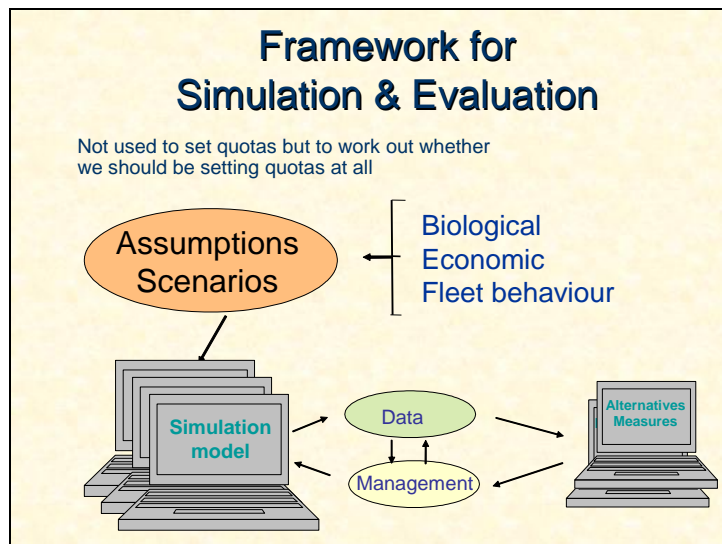
Scientific Models

- A model is a way to try to represent reality
- There are many kinds of uncertainty that have to be confronted when building models, nor can all important relationships can be modelled



**All models are wrong, some are useful
But which!**

Slide 2



Slide 3

Modelling Approaches

Current ICES/CFP

Single species stock assessment models

Problem: getting the best data and/or finding the perfect model

Uncertainty: acknowledged but not fully addressed

Economics: separate

EFIMAS

Bio-economic simulation models for evaluating alternative scenarios

Problem: identifying plausible scenarios

Uncertainty: explicitly addressed e.g. by scenarios

Economics: integrated

Slide 4

Bio-Economic Applications e.g.

Data Collection

- *TV surveys v Landings*

Technical Measures

- *Increase Mesh v. Separator trawls v. Minimum Landing Size*

Salmon

- *Effort offshore v. inshore v river*

Climate change

- *Cod +1% + 2°*

Temporal & spatial measures to protect spawning stocks

- *North Sea whitefish*

MPAs & displaced effort

- *North Sea beam trawl closures*

Annex 3: Lessons learned during the pilot process

What went well?

Venue/Organisation

- People went away happy...but pleasantly surprised.
- Have a local contact/association who will help and support you – tap into other people's networks.
- Think about why people should give up their time? What would encourage people to come along? Local relevance.
- Regional approach.
- Having a scientist present to make the presentation, clarify any queries and answer questions – you need someone to answer technical questions or you lose people's confidence.

Perceptions

- Trust in science was an important angle.
- Participants talked about fisheries science willingly from their own experience
- Questions on 'What is science?' should be reduced, with more focus on 'What is fisheries science?'
- The issue of who participants trust to do science should be addressed within 'What is fisheries science?'
- Leave in management and what is effective management.

What went not so well? (plus any advice)

- Introductions are vital in every focus group – this helps the note-taker enormously. Lay out ground rules. Start the recording at the beginning.
- Backup equipment, Audio Visual assistance, batteries, power points etc.
- Catching sector/women attendance – attract more people than you need to your catching sector group – they're less likely to turn up.

- Homogeneity of sector within groups is important.

Suggestions

Powerpoint

- Add 'framework' and, maybe, 'language' to the PowerPoint.
- A good way of describing the framework was: "...it is not about finding out how many fish are in the sea; not about setting quota but deciding whether we should even set quotas at all."
- Examples should be as general as possible in the PowerPoint presentation; but the scientist needs to make it relevant.
- 'Contrasting survey methods/data' instead of '*Nephrops*' as a header.