ICES WGFS REPORT 2009

ICES RESOURCE MANAGEMENT COMMITTEE

ICES CM 2009/RMC:11

REF. SCICOM, SSGSUE

Report of the Working Group on Fishery Systems (WGFS)

12–16 October 2009

ICES Headquarters, Copenhagen

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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Recommended format for purposes of citation:

ICES. 2009. Report of the Working Group on Fishery Systems (WGFS), 12–16 October 2009, ICES Headquarters, Copenhagen. ICES CM 2009/RMC:11. 63 pp.
https://doi.org/10.17895/ices.pub.9046

The document is a report of an Expert Group under the auspices of the International Council for the Exploration of the Sea and does not necessarily represent the views of the Council.

Contents

Executive summary

Two main issues were discussed at the 2009 meeting of the Working Group on Fishery Systems (WGFS): participatory modelling and ICES' options concerning socio-economic advice. Experiences from research on participatory modelling relevant to water and river basin management and for fisheries management was presented and compared. A review on participatory modelling within water management provided useful categories for the *purpose* of participatory modelling, *how* stakeholders contribute and at *what stage* of the process the stakeholders are involved. The purpose of participatory modelling can be divided into improving management options and achieving collective learning and consensus-building on a complex problem. Stakeholders may have *direct* involvement by providing input to the model itself, either by framing the problem, i.e. defining the aim of the model, or by contributing with data or constructing the model, for example through influence diagrams. The more *indirect* roles of stakeholders would be at a later stage in the modelling process and can be divided into *model evaluation* and *model use*. Model evaluation is when stakeholders are asked to review the quality of the model's design in relation to a policy issue, because models depend on assumptions and priorities of those doing the modelling. Stakeholders can be involved in model use by either running the model or interpreting the outputs, or by deciding how the model is run through suggestions on scenarios or management options. In the report, we have several examples of the latter, where stakeholders contribute in developing long-term management plans for certain fisheries, which performance is then evaluated by a simulation model. Only few examples were presented on evaluating the quality of a model or on providing input to models.

Many positive experiences were reported. Participatory modelling has contributed to increased awareness of other stakeholder viewpoints, and inputs of various kinds have proven valuable for the process and outcomes. Collective learning has been achieved, meaning that also scientists have learned from stakeholders. In some instances, stakeholders have pointed to drawbacks of a specific modelling approach and suggested solutions and presented examples from US collaborative research show how fishers can contribute to the improvement of knowledge production. Furthermore, stakeholders have expressed appreciation for being invited and involved in the process. At the same time, researchers report difficulties in achieving good stakeholder representation. Participatory modelling can be challenging. Involving stakeholders does not necessarily mean that consensus is achieved. Also, opening for participation can be time consuming, both for the modeller and for the stakeholder, and sometimes stakeholders find it difficult to express their knowledge or their beliefs in the preset frames and formats. Then again, a certain model may not be able to capture the problems the stakeholders find important because of the boundary of the model or lack of data. During the discussion at the meeting it was noted that in general, engagement with stakeholders is slow relative to the life of a project, as relationships are built, trust is established and respect is developed. Once engagement is established it is important to maintain it into the future to ensure that the developments made during the project come to fruition.

There are three main options that ICES can choose from in respect to developing the capacity for social science advice. The first is to decline to become involved in providing socio-economic advice. The second is to act essentially as a broker passing on requests for socio-economic advice to existing fisheries social science institutions in the form of contracts then concatenating the products with the natural science advice.

The third is to integrate social scientists and their institutes into the ICES network, including the review and advisory processes, and seek to produce integrated advice. First of all, ICES must consider whether giving socio-economic advice is an appropriate role, or whether such research, which benefit mainly the fishing firms and fishing communities, rather should be funded and organized by the industry. The drawbacks from declining to develop socio-economic advice are that this may disappoint clients and ICES would lose the ability to influence scientific advice related to policy questions relevant to ICES mission. However, ICES has no experience on giving social science advice, there are potential ways of misusing such advice and quality control is very difficult. The benefit of option two is that ICES would not have the responsibility of the socio-economic advice itself. The main challenge is that the current organization of fisheries social science is very fragmented. Option three has the advantage that it has the possibility of providing integrated biological and socio-economic advice that can be reviewed and meet ICES quality standards for official advice. This necessitates finding incentives for social scientists for joining the ICES network, which is a challenge that should not be underestimated.

The three options should be seen as "ideal types" that ICES can use to consider possible strategies. While they are certainly different they are not mutually exclusive in the sense that case-by-case decisions can always be made about specific requests; although taking such an approach already implies that the second option is the dominant one. Perhaps the most important long-term consideration is that the provision of any kind of scientific advice depends on the institutional framework of fisheries management and that institutional framework is in flux. For example, the Green Paper on CFP reform is calling for the implementation of results based management and a reversed burden of proof. This may imply changes in the kinds of science being produced as well as the ways that science is being paid for.

1 Opening of the meeting

The meeting opened at 10:00 on 12 October at ICES Headquarters in Copenhagen, and closed at 15:00 on 16 October. The number of participants at the meeting was 20. In addition four people attended the web conference in relation to ToR c) and two participated by e-mail correspondence. There were 12 countries represented, and the meeting was chaired by Kjellrun Hiis Hauge, Norway.

2 Adoption of the agenda

The terms of reference for the 2009 meeting were:

a) review and generate recommendations about the future structure of risk evaluation and management strategy research within ICES toward greater inclusiveness across the fisheries system and greater usefulness in policy advice. This includes re-evaluating the role of WGFS in light of several other ICES groups involved in risk evaluation and management strategy;

b) catalogue successes, problems and approaches in participatory, bio-economic modelling of management scenarios as a stakeholder involvement tool in fisheries management? This includes an evaluation the links and synergies between participatory modelling and collaborative research;

c) develop options for ICES in respect to the possibility of having capacity for socio-economic advice in respect to bioeconomic management strategy evaluation, economic affect assessment and socio-cultural affect assessment. Including a description of what specific kinds of capacity would be needed and various models of how that capacity could be developed and supported;

d) evaluate the past contribution of WGFS activities on ICES as a way to inform future directions. (postponed to 2010)

ToR c) was included after a request at the open SCICOM SSGSUE meeting, ICES ASC 2009. This is the reason for postponing the last ToR. We later decided also to postpone ToR a), mainly because it is linked to ToR d), the already postponed one (see Chapter 3 for further reasoning).

3 Future structure of overlapping work between WGFS and other ICES expert groups

> ToR a) *review and generate recommendations about the future structure of risk evaluation and management strategy research within ICES toward greater inclusiveness across the fisheries system and greater usefulness in policy advice. This includes reevaluating the role of WGFS in light of several other ICES groups involved in risk evaluation and management strategy.*

This ToR was not addressed in great detail at the meeting. There were no given presentations in relation to this ToR, and it was discussed only at the end of the meeting with few remaining participants. We spoke only partly about structural aspects, which the ToR is very much about. The brief discussion emphasized the past and future roles of WGFS. Several expressed a wish for WGFS to become more visible in the ICES community. Given the broad expertise in the group, WGFS should be capable of assisting ICES to a greater extent than it currently does, in meeting the challenges on developing suitable advisory frameworks by providing a broader perspective and understanding of the challenges and possible solutions. It was difficult to address ToR a) without discussing the 2009 ToR that was postponed to 2010:

> Postponed ToR) *Evaluate the past contribution of WGFS activities on ICES as a way to inform future directions (postponed to 2010).*

When ToR a) was suggested at the last year's meeting, it was because people felt that there was some overlap between WGFS, SGRAMA and SGMAS, and that these possibly could merge. At the time we addressed these terms of reference, SGMAS had had its final meeting, and SGRAMA was going to have their final meeting later in 2009. A discussion on WGFS' future role on these matters would therefore partly depend on the not yet known contents and conclusions of the SGRAMA meeting. It was also concluded that the structure of research on other forms of advice relevant to the reform of the CFP 2013 could possibly be discussed in ToR a), such as marine spatial planning and results-based management.

Taken these aspects together, we therefore recommend postponing ToR a) until 2010.

4 ToR b) Participatory, bioeconomic modelling

> ToR b) *catalogue successes, problems and approaches in participatory, bioeconomic modelling of management scenarios as a stakeholder involvement tool in fisheries management? This includes an evaluation the links and synergies between participatory modelling and collaborative research;*

This Chapter begins with summaries of the presentations given at the WGFS meeting in relation to ToR b. The first presentation was based on a literature review of participatory modelling within water resources and river basin management. Besides the usefulness of comparing the approaches within fisheries to approaches within management of other kinds of natural resources, the summary also provides categories for the *purpose* of participatory modelling, *how* stakeholders contribute and at *what stage* of the process the stakeholders are involved. The review shows that many approaches to participatory modelling have evolved, and it is not surprising that the term can have different meanings to different people.

The six presentations following the literature review represent experiences with participatory modelling within fisheries: Baltic herring, North Sea nephrops, and Mediterranean swordfish fisheries on the Great Barrier Reef, Northern hake and Western horse mackerel. The last presentation is on experiences from US cooperative research, which is a broader issue than participatory modelling. This allows us to reflect on whether experiences from participatory modelling can be generalized.

Chapter 4 ends with a brief summary of the presentations on fisheries, highlighting the successes, problems and approaches. The latter is categorized in terms of *why, how* and *when*, reflecting the typography of Table 4.1 in the literature review. The cases show that there is a range of different approaches to participatory modelling within fisheries as well. These approaches include using stakeholder participation to build a conceptual qualitative model, using stakeholders to evaluate the representation depicted in a model and engaging stakeholders with the application of model results. Concerning the scientific methods used in the various cases, we simply recommend reading the summaries.

4.1 Participatory modelling in water management: Some insights on issues of process design

Marion Dreyer

The JAKFISH project seeks to take advantage of experiences gained in other areas of natural resource governance. The purpose of the presentation was to present insights that the authors[1] have drawn from a review of studies concerned with participatory modelling techniques in *water resources and river basin management*.

The literature review has shown that experiences in combining modelling and participation in the context of water management are still restricted to a few exercises. Overall we found, that participatory modelling has been and is being used predominantly as a *method in applied research* into participatory water management; we did not find cases in Europe where this participatory approach has actually been used in water management decision-making. The majority of the participatory modelling research exercises have served the purpose of *scoping* a complex water management problem and creating a *shared vision* of this problem in a group of diverse stakeholders. Underlying this particular approach to participatory modelling – usually referred as the 'mediated modelling'– is the view that models are not merely tools assisting in identifying best management options or the most robust management strategies but also instruments of collective learning about the dynamics of a complex problem and consensus-building about the pros and cons of alternative options to manage this problem. This view has gained in importance in the past years in the literature about integrated water resources management.

From the body of literature reviewed we have identified the following issues as central to developing and effectively using participatory modelling techniques in the domain of fisheries governance. A fundamental requirement for a careful design of a participatory modelling process in natural resource governance is clarification of the *purpose of the modelling exercise* (we have proposed to distinguish between the main model purposes of knowledge integration and advancement; prediction; management and decision-making; and collective learning) and the *timing and purpose of stakeholder involvement*. There is no common agreement in the literature which form of participation in the modelling process should be labelled as 'participatory modelling'. Often the term is used to refer to the active involvement of model-users or stakeholders in the modelling process itself, i.e. in ***model construction***. Within model construction it is possible that participants provide information (relevant data or knowledge, e.g. through interviews) for the modeller to build the model. They may also actually model themselves, i.e. make decisions (or co-decide together with expert modellers) on the design of the model (cp. van Asselt and Rijkens-Klomp 2002, p. 172; Bots and van Daalen 2008, p. 397). Stakeholders may act as (co-)designers and/or information providers for the formulation of *conceptual (qualitative) models* (by identifying respectively informing the identification of the main variables characterizing a dynamic problem and the causal links established between them applying, e.g. causal-loop diagramming) or *formal models* (by estimating respectively informing the estimation of parameters, initial conditions and behaviour relationships that need to be specified precisely in computer models based on quantitative system dynamics and simulation), or both if the former are developed to serve as an early stage in the

1 Excerpt from JAKFISH Deliverable 2.4: Review of literature about participatory modelling in natural resource governance: Findings from forestry management (Part 1) and *water resources / river basin management (Part 2, by Marion Dreyer & Ortwin Renn).*

construction of the latter. In these cases, system component structures (e.g. stock and flow diagrams) are developed from conceptual models then functional forms are specified and parameters and behavioural relationships numerically estimated. To involve stakeholders as model designers does not mean necessarily to give every model decision over to them or include them at the earliest stage of model construction. In the case of modelling of bio-complexity in the Tisza River Basin (TRB), for instance, causal loop diagramming was applied by expert modellers and other researchers in advance of collaboration with stakeholders (Sendzimir *et al.*, 2007a; Sendzimir *et al.*, 2007b). The purpose of this "preliminary modelling" (Sendzimir *et al.*, 2007a, p. 608) was to prepare for facilitating discussion during group modelling exercises for actors and stakeholders in the TRB. The plan is to improve the causal loop diagram in such a participatory process and to use the refined conceptual model to build formal models for exploring the relative strengths with which different interactions affect system dynamics (Ibid.).

In a broader perspective, the linkage of modelling with participation can also refer to the indirect involvement of stakeholders in the modelling process. One way of indirect involvement is participation in ***model evaluation*** when stakeholders are asked to review the model's design in a process which would correspond to what has been called an extended peer review, denoting a process whereby the quality of the knowledge inputs to policy issues are assessed (Functowicz and Ravetz, 1990; van der Sluijs, 2002). The demand that stakeholders should be able to understand and review the various model assumptions and their implications for the modelling results has been described as an important trend in water resources management (Refsgaard *et al.*, 2005, pp. 1201–1202). One main reason stated for the reasonableness of involving stakeholders in model evaluation – also stated for involving them in model construction already – is that models are not (fully) based on factual objective scientific knowledge but are laden with (more or less implicit) judgments and choices and thus depend on assumptions and priorities of those doing the modelling. Therefore, models should not be treated as merely technical inputs to the management and policy process. Instead, modelling should be understood as a social as well as a technical process (cp. for instance, Smith Korfmacher, 2001; van der Sluijs *et al.*, 2005). The concept of interactions between the modelling process and the water management process proposed by Refsgaard *et al.* (2007) envisions the possibility of a continuous involvement of stakeholders in review dialogue processes throughout the modelling process. The concept envisages at each step of the main modelling process[2] assessment of the quality of results through internal and external reviews "that also provide platforms for dialogues between water manager, modeller, reviewer and, often, stakeholders/public" (Ibid., p. 1545). Whether stakeholders would directly contribute to the review or only act as observers, for instance, is considered as dependent on the level of public participation in a specific case (Ibid.).

Another way of indirect involvement is inviting stakeholders to provide inputs for ***model use*** in form of scenarios or policy/management options (co-)developed by the stakeholders themselves, or in form of knowledge to test the causal logic of these inputs. In the IRMA-SPONGE project dealing with the development of flood management strategies for the Rhine and Meuse basins, experiential and contextual knowledge of stakeholders was used to test the causal logic of scenarios which were

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2 It conceives data and conceptualisation, model set-up, and calibration and validation as the three basic steps of the main modelling process. These are preceded by model study plan (step 1 of the modelling process) and followed by simulation and evaluation (step 5 of the modelling process).

developed top–down by the researchers. This was done "both ex ante through storylines developed by stakeholders as well as ex post through stakeholder evaluation of the scenarios" (van Asselt *et al.,* 2001, p. 176). Within model use, stakeholders may also be asked to actually *run* model simulations and jointly explore, discuss and interpret the outputs that result from the alternative scenarios or policy options which can be tested in isolation of as packages generated by stakeholders (Brown Gaddis *et al.,* 2007, p. 621; Bots and van Daalen, 2008, p. 397). In the case of applying a participatory modelling approach to two villages in a watershed in northern Thailand, for instance, stakeholders were not involved in model construction but directly confronted with the model by assessing its assumptions (i.e. they got involved at the stage of model evaluation) and by suggesting scenarios and interpreting simulation results (Becu *et al.,* 2008). Finally, stakeholders could be involved in decision-making on management or policy measures being informed by the results and interpretations of the model run.

The basic modelling stages and their subcomponents to which stakeholders can make a contribution are summarized in *table 1* below. The table shows moreover that the case studies about involvement of stakeholders in model construction identify collective learning as the main model (-building) purpose, while research contributions dealing with stakeholder involvement in model evaluation and use identify management and decision-making as the key model purpose.

Table 4.1. Stakeholder involvement in modelling (drawing on and extending the distinctions proposed by Bots and van Daalen, 2008)

Direct Involvement Key model purpose: Collective learning	*Indirect Involvement* Key model purpose: Management and decision-making	
Model construction	**Model evaluation**	**Model use**
Provide inputs (data, conceptual considerations) for model construction	Review choices, assumptions and priorities underlying model construction (extended peer review) either only after the model has been built, or at each sub-step of the main modelling process	Provide inputs for model use (scenarios and/or policies)
Make decisions on model design		Interpret outputs from simulation runs
		Co-decide on policy/ management measures

The case studies reviewed suggest that these are further important issues for reflection when designing a process using participatory modelling techniques:

- lacking *links with decision-making processes* – and lacking transparency about these missing links – may negatively affect stakeholders' motivation to remain involved and fully engaged throughout the process (an issue relevant to all participatory processes);

- the *roles of professionals* included in the participatory modelling exercise need to be clearly defined and shared understanding about these roles among all participants produced; this requires a careful choice between the option to have the required modelling and facilitation expertise provided by a single person and the alternative option to have the facilitator and modeller roles segregated and fulfilled by different individuals;
- most notably in those cases where stakeholders are involved in quantitative computer-based modelling it requires reflection about whether mechanisms of *capacity-building* are required; while creating and using qualitative models with stakeholders may be less challenging, special competencies are required also here, in particular thinking in terms of complex and dynamic systems;
- in case of highly conflicting stakeholder perspectives in a decision-making context, it may be worth considering the use of a qualitative modelling exercise as a *pre-stage* of formal modelling. Qualitative modelling can help to develop common understanding of a complex problem and/or unfold the basis of controversy and conflict by construction of alternative models representing the plurality of (legitimate) viewpoints.

With regard to the issue of uncertainty, we have found that uptake of legislative demands to include uncertainty assessments in analyses of data and models is still low in water management practice. There is a clear need for developing new methodologies and user-friendly tools that can facilitate systematic treatment of uncertainty in model-supported water management. While more recent research into participatory water management usually highlights the importance of investing more effort in developing approaches to uncertainty treatment, there are only few contributions which provide concrete suggestions. One detailed proposal that in our view deserve consideration in the fisheries management context envisions that stakeholders are involved in the systematic treatment of uncertainty at an early stage in a modelling exercise, and ideally also in a continuous manner throughout the modelling process. The case studies of participatory modelling that we reviewed provide hardly any information about attempts of and experiences with dealing with uncertainty. Still, the growing emphasis of the role that models can play for collective learning and reflection may also increase attention towards the uncertainty issue in future practical exercises. This perspective suggests identification of uncertainty and ignorance as resources to explore the basis of diverse stakeholder views and open room for discussion and negotiations among different interest parties, for instance by exploring alternative future scenarios.

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4.2 Participatory modelling to enhance understanding and consensus within fisheries management: The Baltic herring case

Päivi Haapasaari, Samu Mäntyniemi and Sakari Kuikka

Introduction

The JAKFISH project (EU 7th framework program) aims at examining and developing institutions, practices and tools that allow complexity, uncertainty and ambiguity to be dealt with effectively within participatory decision-making processes. One of the interests is to develop participatory facilitation tools, like participatory modelling. Our case study deals with participatory modelling of Baltic Main Basin herring using the Bayesian networks (BNs). The focus is on factors behind the negative biomass trend and poor growth rates of this herring stock.

The aims of our case study are threefold. Firstly, we aim at deepening the understanding of the herring fishery. We examine which factors are believed to influence the herring stock and fishery by different stakeholders, what kind of models will be built based on the different hypotheses, and whether the different stakeholder models can be synthesized into a meta-model. It will also be tested whether parameters provided by scientific research can be embedded in the meta-model. Secondly, we examine and develop the methodology of participatory modelling. We study whether the validity and reliability of models can be enhanced through a participatory process, and whether and how the involvement of stakeholders in modelling can benefit the knowledge base and management of the fishery. Thirdly, we examine the potential of the BNs in participatory modelling.

The participatory modelling includes two parts carried out with the stakeholders. The first part focuses on a biological system model of Baltic Main Basin herring. We ask the stakeholders to name five most important ecological factors influencing the survival of eggs, growth and natural mortality of herring, and to define whether the effect of those factors is positive or negative. We ask the stakeholders to assess the strength of these effects, and finally to define uncertainty included in their assessments. The second part is about framing the problem of herring fishery management. The stakeholders are asked to point at variables which should be taken into account in herring fishery management. Then they are asked what should be the objectives for herring fishery management, and what kind of management measures could or should be used to reach these objectives. This part does not include quantitative information.

We engaged 6 selected stakeholders from 4 Baltic Sea countries. Our definition of a stakeholder was broad, and our modelling group included 2 researchers, a manager, a representative of a fisher organization, a commercial fisher, and a representative of an environmental NGO. Individual stakeholders were involved in the modelling separately, and each built their own model. Thus we got 6 different models. The modelling sessions took 4–6 hours each. Three people were involved in the modelling sessions: the stakeholder who made all the modelling decisions, the modelling expert as a facilitator of the process, building the model according to the views of the stakeholder, and a social scientist as an observer. The sessions were documented by pre-building the model structures, by recording the strengths of the links and uncertainties, and by recording the discussions. In addition, the stakeholders were asked to fill in a questionnaire enquiring their views about the modelling.

Our study is still in process. All the modelling interviews have been carried out but neither the models nor the process have been analysed yet. The models built by the stakeholders showed, however, that the participants were relatively unanimous on factors influencing growth, recruitment and natural mortality of herring. More differences emerged in assessing strengths of the links, which was regarded the most difficult task of the modelling. The modelling defining the boundaries and components for the herring fishery system was felt easier by most of the stakeholders, but the different perspectives of the stakeholders brought about much variability in the models created by different persons.

The next thing will be to compare the individual models and to build the meta-model using the BNs. The meta-model will be presented to the stakeholders. They will be asked to think whether they can adopt the information given by the model, to consider problems in accepting the assumption, and to assess how well the meta-model covers the important variables from their viewpoint. Then they will be invited to discuss major areas of uncertainty. Then, differences between views will be analysed, and the model will be updated according to these. It will be considered what kind of management actions the model would lead to. Another focus after the modelling process is finished will be to reflect the process as a whole and to consider the pros and cons about involving the stakeholders.

4.3 *Nephrops* in the North Sea: a Jakfish case study

Ewen Bell

The North Sea RAC was asked by the Jakfish project which, if any, fisheries they would like assistance with evaluating alternative management plans. As the RAC is currently drafting a long-term management plan (LTMP) for *Nephrops* fisheries, they decided that this should be one of the case studies for the project.

There are a number of technical difficulties and uncertainties within the scientific modelling of both the biology and fishery for *Nephrops*, and the tools to be used are particularly user-unfriendly, hence the level of participation involved in this case study is limited to stakeholders posing the questions to be answered by the models and assisting in the conceptual models of fishery operation rather than direct involvement with code composition and program running.

Modelling/Science issues

There are several biological and fishery feature to *Nephrops* which make this a particularly interesting (and challenging) case study. *Nephrops* are burrowing, decapod crustaceans which inhabit sediments with high levels of silt and mud. Redistribution occurs during the larval phase and after settlement individuals are essentially sedentary. This almost sessile lifestyle and restriction to habitat types makes *Nephrops* particularly vulnerable to overfishing. Growth of *Nephrops* is by periodic moult of the exoskeleton and consequently there are no calcified parts to the individual which retain information regarding growth and age. Direct age-base assessments such as virtual population analysis are not possible for this stock and due to the paucity of growth data, length based assessment is also of limited utility.

There is a strong spatial element to the *Nephrops* case. Within the North Sea there are 8 stock units currently identified by ICES (so called Functional Units, FUs) which cover >90% of the landings. In addition to these FUs there are also landings coming from minor mud-patches. The single largest FU in terms of both area and landing potential (~45% of landings) is situated offshore. Whilst there is no interchange of adult *Nephrops* between these grounds some larval interchange is considered to occur between neighbouring areas. Of the 8 FUs, only 5 have regular scientific surveys. These surveys use underwater TV cameras to produce video transects of the seabed from which are determined the number of *Nephrops* burrows. The remaining FUs are assessed qualitatively using trends in fishery capture rates and mean sizes of individuals from port sampling exercises.

The ICES advice generated by the assessment process is relevant to each individual FU; however the management is by single area TAC (covering all of ICES Subarea IV). In effect this means that fishing effort on each FU is relatively unconstrained, leading to overexploitation of some inshore units and under exploitation of offshore units.

The *Nephrops* fisheries are predominantly trawl fisheries although a small amount of creeling (pot-fisheries) takes place. A large number of small boats utilize the inshore grounds whilst the larger boats move between the inshore and offshore grounds depending upon weather, catch rates, fuel prices etc. In recent years there has been an influx of effort into these fleets as a result of TAC pressure and technical measures imposed on more traditional stocks (i.e. cod). Vessels move in and out of the *Nephrops* fishery during the year in response to the availability of other stocks as well as the *Nephrops* themselves (which exhibit seasonal emergence patterns which vary between FUs). The catch-composition of "*Nephrops*" trawls also varies and often the white-fish bycatch (cod, haddock and whiting) forms an invaluable part of the economics of the *Nephrops* fisheries.

Stakeholder issues

There have been a number of RAC subgroup meetings in which the creation and structure of the LTMP have been discussed. Witnessing the evolution of the plan has produced a number of interesting observations regarding the make-up of the stakeholders, their decisions and factors which may influence their decision-making process.

- Stakeholder make-up. A wide number variety of stakeholders were present at the meeting, including producer-organizations, individual fishers, industry support organizations, scientists, policy-makers, a processing facility and an NGO.
- Incomplete stakeholder participation. The last meeting was only attended by UK representatives. Although the UK generally takes >85% of the quota, representation from the other nationalities with direct interest (Netherlands, Belgium, Denmark and Germany) was lacking and indeed caused some paralysis in decision-making in that it was unanimously felt that without their participation, any conclusions made by the group would be unilateral and therefore invalid.
- Focus. The remit of the RAC is to focus on *fisheries*, whereas much of the discussion focused on *stocks*.
- Objectives. No consensus was reached as to what the objectives of the LTMP should be. All participants agreed that biological objectives should be a key element (probably the most fundamental element) of the LTMP. Beyond that, however, there was no consensus as to what form a future *Nephrops* fleet might take.
- Vision for the future. Whilst a LTMP for the fishery might be expected to contain an objective for future fleet structure there was a great reluctance among the assembled stakeholders to make such a commitment. The extremes of fleet structuring run from a few, highly efficient boats prosecuting the fishery and extracting the maximum profit to a large number of smaller, less efficient boats providing maximum employment but with limited profitability. The group were unwilling to decide which was the more attractive route and opted to propose maintenance of the status quo fleet structure. One observation is that many of the persons sat round the table were (or had been) successful fishers and therefore had direct experience of efficient, profitable fishing operations and enjoyed the associated profits. To recommend the few-vessels, high-efficiency route would allow others to achieve the same success as themselves, whilst denying a fishing-based livelihood to others. Conversely the recommendation of a larger number of less efficient boats would be to deny others (and themselves) the opportunity for greater personal gain.
- Future Effort. The conclusion of discussions around future fleet structure was that the current fleet structure/capacity was fine and should be maintained. In order to achieve this caps on effort/capacity are proposed. This decision was relatively straightforward to achieve with the implication that deciding *who* can join this "club" is simple but prescribing *what* they can do is more an infringement of their rights.

- Wider stakeholder participation. The previous point directly leads into the question of who actually *are* the stakeholders. It could be argued that the stakeholders are not just those currently operating the fishery but also those who might want to join in future but would be prevented from doing so by those already within the fishery, many of whom have entered in the past few years. In addition, if the LTMP is going to have repercussions for employment, then local and national governments possibly need more specialised stakeholder involvement so that the implications of the plan are understood on a broader scale.
- Spatial issues. ICES scientists are continually stating that management should be at the level of the individual FU. The RAC appreciated that some regionalisation of the fishing opportunities is required but are reluctant to adopt individual area TACs (or effort caps). The preferred solution is for a whole area TAC but "of which" clauses for particular areas of concern (i.e. 20,000t TAC of which no more than 2,000t can come from FU 6). Evidently this would offer some protection to those units already in danger but may shift effort to neighbouring areas resulting in their depletion. This approach seems at odds with their desire to ensure that all stock units are maintained above biological limit points.

The participation

The data requirements for the biological modelling are either already met or too complex to be easily solved through simple collaboration. Data regarding fishing operations such as effort and landings by FU are already collected as part of the national data collection schemes. Data regarding the factors contributing to the decision of where and when to fish for *Nephrops* are not routinely available to scientists and therefore routes for their availability need to be sought.

Once the technical difficulties of modelling the biology and the fishery have been overcome then the participatory element of this project will step up. The plan for this case study is to offer modelling services to the RAC in order to evaluate whatever management plans they come up with. It would appear that this approach (i.e. saying "what would you like us to model") is quite challenging in that there has only been one suggestion to date. One approach might be to come back to the table with not only the requests they have asked for, but some additional management options, which may well be dismissed very rapidly, but gives the opportunity to develop discussion and help target the exact questions that the RAC want answering.

4.4 Participatory modelling in the case of the Mediterranean swordfish

George Tserpes

Swordfish is a commercially important highly migratory fish, globally distributed between the latitudes 45° N to 45° S. Research results have demonstrated that Mediterranean swordfish compose a unique stock separated from the Atlantic stocks, although there is incomplete information on stock mixing and boundaries. However, mixing between stocks is believed to be low and generally limited to the region around the Straits of Gibraltar. In the Mediterranean Sea, fishing for swordfish is carried out throughout the year, but it is most intensive from late spring to middle autumn and is heavily exploited by several countries which target swordfish using surface drifting longlines and/or gillnets. Overall catch levels have been relatively stable during the last decade. While the most recent assessment carried out by the

International Commission for the Conservation of Atlantic Tunas (ICCAT) indicated that recruitment showed little variation over the past twenty years, in the same period spawning-stock biomass (SSB) has shown a decline between 24% and 38%, depending on the assessment model used. In addition, the main catch is of juveniles that have not yet spawned and assessment results clearly indicate growth overfishing and that at current levels of fishing mortality drastic stock declines could be seen within a generation (7–10 years).

Management of Mediterranean swordfish is within the Convention area of the International Commission for the Conservation of Atlantic Tunas (ICCAT), whose Convention states that "The Commission may, on the basis of scientific evidence, make recommendations designed to maintain the populations of tuna and tuna-like fish that may be taken in the Convention area at levels which will permit the maximum sustainable catch". Until recently there were no Mediterranean-wide management measures for swordfish although various technical measures have been imposed at a national level in attempts to reduce fishing pressure on the stock and juvenile catches. Recently, ICCAT has decided to implement short fishery closures during the recruitment period of 2008 and 2009 and has asked for the evaluation of the affect of those measures, as well as, of other technical measures including gear modifications and capacity reduction schemes.

Approach

As the stock is managed by ICCAT, it was decided to consider ICCAT as the main stakeholder and try to address the questions that have been raised by its commission and scientific committee regarding the rational management of the stock. Apart from ICCAT, there are also considered the fishers' views on the appropriate management actions, through an interactive process achieved by means of meetings with fishers groups.

Based on the above, the work carried out in the frames of the "JAKFISH" project includes the development and evaluation of different management scenarios through simulations. The scenarios that are evaluated include:

- Temporal fishery closures
- Effort reduction schemes
- Combination of the above
- Gear modifications
- Quota schemes

Although the analysis focuses on the affect on stock size and landings, certain economic aspects, such as the value of landings and the net revenue from fishing are also considered, when the necessary data are available.

Evaluations include uncertainties on: (a) parameter estimates and states of the nature (e.g. S-R relationship, assessment output, and random "noise"), (b) fishery data (catch misreporting) and (c) management implementation. The risk was expressed as the probability not to achieve ICCAT convention objectives (stock rebuilding) within two generations (15–20 years).

Management scenarios are simulated using the FLR framework (the Fisheries Library in R), throughout an operating model consisted of three components: the population, fleet and observation models.

4.5 Participatory Fisheries Management and Research on the Great Barrier Reef of Australia

Richard Little

The Great Barrier Reef (GBR) Reef Line Fishery (RLF) comprises socially and economically important commercial, charter, and recreational fishing sectors. The fishery has been undergoing some change over the last decade, particularly in the implementation of an ITQ management scheme. There also is potential for increased recreational fishing pressure along the GBR coast simply because of population growth and increased tourism.

Conservation management of the GBR Marine Park has also undergone significant change with the introduction of the Representative Areas Program (RAP) which resulted in about 32% 'no-take' areas in the amount of coral reef habitat closed to the Reef Line Fishery. These factors, combined with limited historical information about the fishery or its main target species, present significant problems for planning appropriate management strategies of the fishery and the GBR World Heritage Area.

These factors, combined with limited historical information about the fishery or its main target species, presented significant problems for the development of appropriate management strategies for the fishery and the GBR World Heritage Area. We have quantified some of the primary affects of the RLF on targeted stocks and assessed secondary impacts on other components of the GBR ecosystem, and evaluate the prospects for alternative mixes of strategies for conservation and fishery management in the region to realize the objectives of diverse stakeholders (Mapstone *et al.*, 2004, 2008, Little *et al.*, 2008, 2009a, 2009b).

We evaluate prospectively the relative merits for managers and stakeholders of alternative strategies for fisheries management on the GBR. These simulations were performed in a model ('ELFSim') that captures the population dynamics and harvest of common coral trout and red throat emperor on the GBR. The population dynamics model is spatially structured, depicting nearly 4000 reef-associated populations interconnected via larval dispersal.

Objectives for the future status of the stocks and for the RLF were developed by a diverse set of stakeholders in the fishery and the GBR World Heritage Area, in association with the Reef Line Fishery Management Advisory Committee (ReefMAC). Contributing stakeholders included state and federal managers, commercial, charter and recreational fishers, conservation organizations, and researchers. Stakeholder objectives included preserving spawning biomass of the major species on reefs closed to fishing, ensuring satisfactory levels of populations available for harvest, maintaining economically viable commercial catch rates and recreationally rewarding recreational catches of coral trout, and minimizing variation in harvests from year to year. Quantitative articulations of these and other objectives were derived and agreed with stakeholders, together with associated performance indicators.

The same set of stakeholders advised on the mix of potential strategies to be considered for achieving their respective objectives. We were asked to compare the efficacy of three levels of fishing effort, ranging from half of 1996 levels to 1½ times 1996 levels, and three levels of area closure, ranging from the 16% pre-RAP current closures, the RAP area closures to 50% closures. Other strategies included examining changing spawning closures, and minimum legal size. The outputs from these Management Strategy Evaluations provide comparative assessments of the likelihood that each of the stakeholder objectives will be met by each management strategy combination.

The results are not intended to prescribe which strategy mix should be adopted, but to provide a basis for stakeholders to negotiate such an outcome based on the degree to which different combinations of strategies meet their needs. Harvest-related objectives (e.g. maintaining CPUE, increased chance of catching a large fish, preserving biomass available for harvest) were most likely to be achieved when effort was lowest, but were less likely to be achieved as increasing amounts of area were closed to fishing. The principle stock-conservation objective, represented by preserving the spawning biomass of the whole population, was most likely to be achieved by increasing the amount of area closure and was only relatively slightly impacted by increasing fishing effort within each area closure strategy.

The increase in area closures under the Representative Areas Program likely exacerbated the depreciation of fishery performance, but our results suggest that growth in fishing effort will be considerably more influential than changes in areas available to the fishery. Our results suggest that the currently elevated levels of effort (~1.5 time 1996 levels) will reduce significantly the prospects of fishers in all sectors realizing their objectives in future years, irrespective of the inevitable increases in protected areas under the Representative Areas Program.

Reducing effort, conversely, was the strategy most likely to realize direct fisheries-related objectives. The conundrum in these results, however, is that the improved prospects from effort reduction would apply only to those fishers remaining in the fishery. We are unable to assess the magnitude of financial costs likely to be incurred by those fishers excluded through the effort reductions that would now be necessary to achieve the two lower effort scenarios we considered.

This research lays bare some of the inevitable trade-offs among different scenarios for managing the RLF in the GBR World Heritage Area in a decision table format. Most importantly, the trade-offs have been assessed in relation to objectives and performance 3indicators specified by diverse stakeholders in the fishery and the World Heritage Area. We present the trade-offs in ways that allow direct comparisons among disparate objectives, essentially providing a common currency for comparing performance across fundamentally different types of objectives. In so doing, we hope that the costs and benefits of different management options are more transparent to all stakeholders than might otherwise have been the case. We hope that such transparency aids in the negotiation of acceptable and effective future management arrangements for the Great Barrier Reef World Heritage Area and the Reef Line Fishery.

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4.6 Implementing a Long Term Management Plan (LTMP) for the Northern hake

Martin Aranda

The Northern hake is one of the most important species in terms of catches and economic value in the mixed fisheries in ICES zones V, VI, VII, and VIII. The fishery is exploited by a variety of gears that include trawling, pair-trawling, long-lining and gillnetters belonging to several member states. In 2007, Spain accounted 59% of the total. France took 27%, UK 7%, Denmark 3% and Ireland 3% while other countries such as Norway, Belgium, Netherlands, Germany, and Sweden contributed small amounts. According to ICES, the stock is at full reproductive capacity and being exploited in a sustainable manner (ICES 2009).

Management measures previous to the LTMP

Since mid 1990s and early 2000 the spawning-stock biomass was reduced to such low levels that it even fell below the Blim threshold. An emergency plan was implemented to deter overexploitation of the stock. In 2000, catches were even greater than the TAC. Council Regulation 1162/2001, 2602/2001 and 494/2002 introduced the following management measures, a 100-mm minimum mesh size for otter trawlers in Subarea VII (SW of Ireland) and in Subarea VIII (Bay of Biscay). The limit Fpa was fixed in 0.25. In 2004, the emergency plan was replaced by a recovery plan (EC Reg. No 811/2004). The main objective was to increase the quantities of mature fish to values greater/equal than/to 140,000 tonnes, which is the precautionary biomass (Bpa). One of the most notable features of the recovery plan is the intended introduction of a Management Plan if SSB ≥ 140,000 tonnes for two consecutive years (Article 3). TACs are set when quantities of mature northern hake have been estimated by the STECF, in the light of the most recent report of ICES, to be equal to or above 100,000 tonnes. It also included a clause on imposing a constraint on 15% reduction/increase in TAC.

The LTMP

A preliminary evaluation of a LTMP was carried out by STECF in 2007 in two meetings, June and December. A consultative process by the Commission has attempted to incorporate stakeholders views through the EC non-Paper on the LTMP and final communication COM (2009)122FINAL. The non-paper proposed a target fishing mortality equal to Fmax = 0.17 by 2015 and 10% maximum annual variation in F. Increment in mesh size of some fleets in order to improve the overall selection pattern and to reduce the discarding of juveniles. The final communication 122 suggests fixing Fmax in 0.17 when Bpa is achieved or surpassed (Article 6). The LTMP is consistent with the plan of implementation of the World Summit on Sustainable Development held in Johannesburg 2002, subscribed by the EC and member states (EC 2006/360). One of the recommendations of the plan of implementation is to restore fish stocks to MSY levels no later than 2015.

Stakeholders views on the LTMP

The management plan produces concerns to stakeholders (NWW-AC and S-RAC, 2009) since they consider that the resource has satisfactorily recovered. Taking into account current biomass levels, stakeholders fear the potential of Communication 122 (Article 6) to establish Fmax 0.17 from 2010. They consider such a cut in Fmax to produce a heavy economic impact due to potentials cuts in the TAC in 2009–2010 (NWW-RAC and S-RACs 2009). Instead, they propose a gradual reduction of 5% until 2015 (Fmax = 0.18) and to accompany it with technical measures to improve selectivity. Stakeholders request evaluating other scenarios that allow for reduction of fishing capacity due to decommissioning schemes currently carried out and its positive impact on fishing effort. They consider taking into account these factors may smooth reductions in F levels (NWW-RAC and S-RAC).

Stakeholders and scenario modelling

Participation of stakeholders in the modelling of scenarios for the LTMP has been limited because they have only played a consultative role. Several exercises have been carried out to show the diverse scenarios of implementation (Garcia, Prellezo, Santurtun, and Murillas) and presented in diverse fora. They have used the tools developed in EFIMAS and compare alternative HCR to the HCR proposed by STECF in 2007. Thus these exercises have mimicked the HCR contained in the non-paper and its likely outcomes. Others exercises have gone further and simulate the effect of introducing technical measures such as mesh size increments by zone, or harmonization of mesh size to 100 mm in diverse zones and to include discarding. The latter has been suggested by stakeholders (NWW-RAC and S-RAC 2008). It is remarkable that stakeholders consider scenario modelling and specially MSE as useful in the context of LTMPs and recommend their wider use (ARVI 2009). Stakeholders request more comprehensive analysis of socio-economic issues but it seems extremely complex due to the lack on data and the large amount of factors to be taken into account for the diverse fleet segments (prices, costs, fleet adjustment programs, etc.). The Communication 122 is still under consideration and stakeholders suggest not implementing it before the Benchmark workshop, on the improvement of data collection for assessment and reduction of the sources of uncertainty, is carried out by ICES in 2010 (NWW-RAC and S-RACs 2009).

Final considerations

- The case requires taking into account the relation of Northern hake with other species and the interaction among the diverse fleets.
- Discarding is considered to be high and brings considerable uncertainty.
- Even though consultation may retard implementation it encourages industry to participate proposing alternatives scenarios.
- RACs provide a good platform for stakeholders to participate in supplying input for scenario modelling through their WG and focus groups.
- The MSE arises as a very versatile and dynamic tool able to be adjusted to the requirements by the groups interested.

- Interesting to see how the concept of MSE has been understood and adopted by stakeholders.
- Incorporating social and economic aspects is a big challenge due to large amount of aspects to take into account and lack of data.
- Much effort is needed from both industry and science to quantify discards and incorporate it into the analysis.

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4.7 An Alternative Way to Employ Science under the Common Fisheries Policy: Western Horse Mackerel and the Pelagic RAC

(This contribution is a slightly modified and highly condensed version of T.J. Hegland and D.C. Wilson (2009): Participatory Modelling in EU Fisheries Management: Western Horse Mackerel and the Pelagic RAC. In: Journal of Maritime Studies. Vol. 8(1): 75–96)

Introduction

In 2006 the stakeholders of the Pelagic Regional Advisory Council (Pelagic RAC) contacted scientists with expertise on western horse mackerel and asked them to assist the RAC in developing a long-term management plan. The stakeholders on the RAC were in doubt if the western horse mackerel stock was being harvested optimally and suspected that the development and adoption of a management plan was not a priority for the fisheries managers in DG MARE. Moreover, the Pelagic RAC wished to explore ways to develop management plans by stakeholder consensus, rather than waiting for a plan to arise from the International Council for the Exploration of the Seas (ICES).

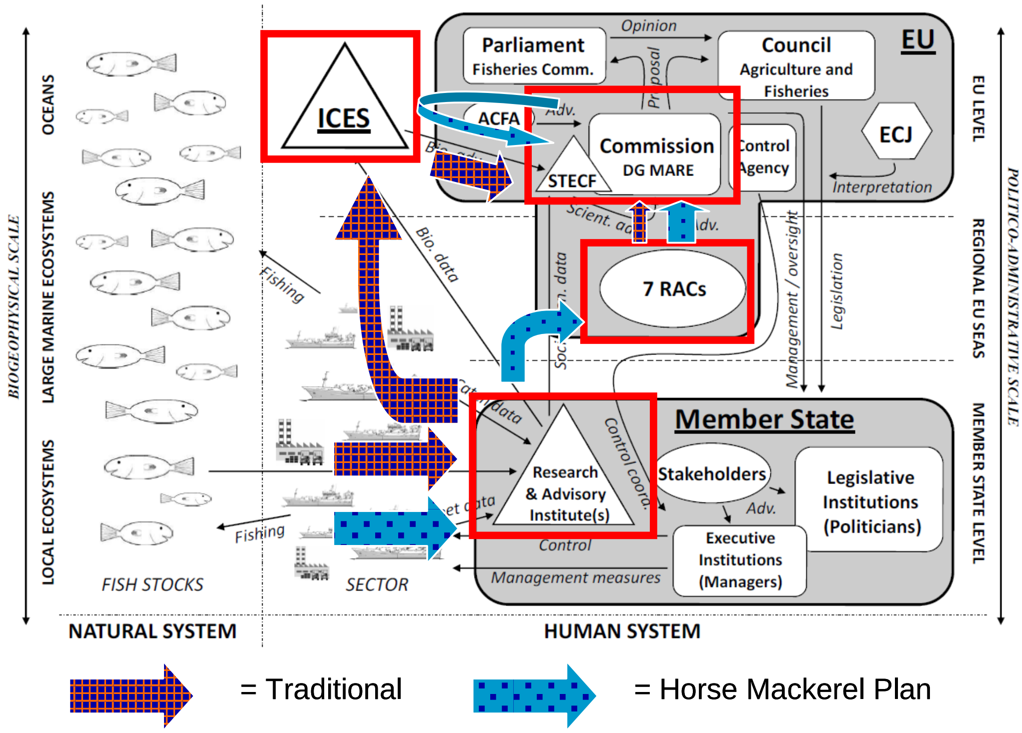

Figure 4.1. Traditional way of using scientific advice under the CFP compared to the western horse mackerel process.

Overall, the participants considered the process, which led to the first step of the implementation of the management plan from 2008, as a considerable success and the process could as such serve as an inspiration for stakeholders, researchers and policymakers wishing to do similar exercises.

Figure 4.1 above illustrates how the horse mackerel process differs from the traditional way of using scientific information to arrive at policy-advice under the Common Fisheries Policy (CFP) (in this case policy-advice in the form of a suggestion for a long-term management plan for western horse mackerel).

As mentioned—and indicated in the figure above—the long-term management plan for horse mackerel was developed with the Pelagic RAC as a central actor. In practice the plan was developed over number of meetings between the horse mackerel scientists and stakeholders from the Pelagic RAC. The plan was eventually submitted (through the Commission) for review by ICES. In comparison, under the traditional procedure ICES would play a more substantial role and the input from stakeholders would be more indirect. Our research highlighted a number of emerging practical and procedural issues in regards to the alternative way of employing scientific advice. In the following we present selected issues.

Scientist/Stakeholder Interactions

Fisheries scientists and industry stakeholders approach modelling from different perspectives. Scientists want accurate scientific models; industry stakeholders are concerned with practical output rather than accuracy. The traditional argument in favour of keeping scientific modelling separated from the influence of industry stakeholders is, of course, the concern that stakeholders' own short-term interests will lead to undue influence on outcomes. If industry stakeholders are continuously arguing based on a notion of achieving highest short-term yields while scientists are arguing based on merits of the science and the accuracy of the model without taking input from the industry seriously, then the cooperation will not be fruitful.

Although the general picture is that the industry did not seek to push the limits of the precautionary approach, our questionnaire revealed that at least one scientist had more mixed feelings *vis-à-vis* the way that the industry stakeholders approached the process:

My impression is that Industry worked out which harvest control rule had the potential of providing higher yields in the short term and therefore favoured a particular strategy on that basis. So, the worse elements are linked to the very different perspectives/interests stakeholders and scientists may have. This is to be expected but communication and mutual trust may not be easy as a result.

Here clear differences arise between the two groups about the basic meaning of using science to support policy goals. The same scientist also indicated that he does not 'think stakeholders are particularly concerned about the science and that is a concern'. Industry stakeholders were reluctant to take decisions based on the 'quality' of the models alone. They wanted to know the policy implications up front, that is to see the implications of various harvest control rules (HCR) for the size of the total allowable catch (TAC). The scientists, however, would have preferred that the stakeholders could make a decision about an HCR 'in principle' then thereafter review the result of the calculations. It is of course a very different approach to choose a specific HCR based on the TAC it can deliver, compared to the scientific approach of choosing a specific HCR based on its 'scientific merits'—then thereafter calculate the size of the TAC. But what needs to be understood here is that these 'scientific merits' are to a large extent about the application of the precautionary approach, which is itself a political decision often packaged as a scientific one.

Role of ICES

Besides the fact that dissatisfaction with ICES was part of the argumentation for starting the process altogether, the presence of the organization as the final reviewer of the plan may very well have affected the way the participants acted and related to each other as well, which may also add to the explanation of the 'communication success' described above. Consequently, pushing the limits of the precautionary approach or in other ways challenge ICES' standard norms would jeopardize the approval and implementation of the management plan. Moreover, having the plan turned down in ICES would discredit the Pelagic RAC and the scientists involved. Consequently, the presence of ICES as a final reviewer of the plan probably functioned as a disciplinary measure particularly *vis-à-vis* the industry stakeholders.

Funding

The RACs have recently been accepted as 'bodies pursuing an aim of general European interest', which has entitled them to a permanent budget (Commission 2006). Although this relieves the RACs of the uncertainty of not knowing where future funds should come from, which was a concern under the earlier arrangement where the initial 'basic' EU funding was decreasing year by year, the amount under the new scheme is adjusted to make the RACs able *'to effectively pursue their advisory role within the Common Fisheries Policy'* (Commission 2006, p. 10). Consequently, if a RAC wishes to assume a wider, more proactive role extending beyond the purely advisory, for instance by assuming a greater role in developing management plans, funding will likely remain a challenge.

Planning

Several of the scientists felt that the process had been rushed because of the desire of the industry stakeholders to have the plan ready by July 2007 to allow implementation by 2008. The resulting relatively short time between the five meetings held from February to July 2007 meant that there was little time for the scientists to work on the simulations between them. However, this was not the only problem related to the speediness of the process. One scientist added that the tight schedule between the last couple of meetings in reality meant that stakeholders who were unable to take part in a meeting and/or needed documents to be translated were effectively sidelined in relation to the final discussions on the management plan.

The scientists' feeling of being short on time is probably also related to the fact that the scientists had to fit the simulation work in with their other work. Notably, although the national fisheries institutes paid the salary, the scientists were not convincingly relieved of their day-to-day work to allow them to concentrate on the development of the long-term management plan. Several respondents indicated that they believed a main problem was that the scientists did not have sufficient time allotted for the horse mackerel work. A recommendation was therefore that in future processes the national fisheries institutes' commitment to pay the salary of the scientists should also include a commitment to relieve them of other work (see also Wilson and Hegland, 2009).

Conclusion

The horse mackerel process offers a number of useful lessons for stakeholders, scientists and policy-makers as well as insights to the knowledge behind participatory modelling. On the most basic level the positive result suggests that it is possible to develop a long-term management plan without following the CFP standard procedure of having it developed within ICES—and that industry stakeholders are alongside scientists able to contribute positively and actively to the development of a biologically sustainable management plan.

While recognizing that the Pelagic RAC may represent an extreme case in respect of variable institutional capacity between the industry stakeholders and other interest groups, it still seems that this imbalance represents a challenge on a more general level in processes of participatory modelling—at least if the exercise shall extend to all legitimate stakeholders. As evidenced by the horse mackerel case, conservation groups, primarily representing diffuse interests, find it difficult to stretch their resources and expertise to the entire range of issues and arenas that potentially is of relevance to their objectives. As a result these groups opted out of the horse mackerel process to focus their attention on issues with higher public impact factor; the process of interaction between stakeholders and scientists became in this case effectively a process of interaction between industry stakeholders and scientists.

A related question is an ongoing discussion in European fisheries management about the placement of the burden of proof on fishing activities (Lassen *et al.,* 2008). If the industry stakeholders were required to show that they are meeting standards of sustainability as a condition of their license to fish then the stakeholders with revenue from fishing would be funding part of the scientific process and its public review. In the current situation the public is setting the limits on fishing, demonstrating that these limits meet standards of sustainability, as well as funding the monitoring of the fishing activities. If the burden of proof were reversed the public would be responsible only for setting the standards of sustainability.

The participation of scientists represented another side of the resource and funding problem. The scientists in this process found themselves having partly to base their participation on creative *ad hoc* funding sources, which hardly constitutes a useful permanent model, and they had problems fitting the involved work with other tasks. Consequently, as long as the RACs (or other science dependent actors) are unable to fund the scientific expertise needed to develop a proactive role and strengthen the upstream processes in policy formulation under the CFP—then their contributions risk lacking in quality. Anyway, in relation to fisheries scientists a possible solution to this problem has to allow for the general shortage of qualified manpower within this field. The way forward must therefore also involve a rethinking of the policy design of the CFP, which has created a demand for scientific support that exceeds the available capacity.

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4.8 Lessons from US Cooperative Research

Teresa R. Johnson

Like participatory modelling, cooperative research offers a mechanism for improving understanding necessary for decision-making, in part through improved communication and knowledge sharing among stakeholders, scientists, and policy-makers. Cooperative research emerged in the northeast US beginning in the late 1990s in response to conflict between fishers and scientists and as way to improve the knowledge base of management (Hartley and Robertson 2006; Johnson in press). Prior to that time, with few opportunities to contribute their knowledge, often due to its dismissal as irrelevant or anecdotal, fishers grew distrustful of scientists' stock assessments and resulting management decisions. In particular, fishers were concerned about the credibility of the government's resource survey that produced assessments and management advice that often conflicted with their experience and observations. Consequently, managers, a group that includes members of the industry, were unable to implement effective rules to reduce fishing mortality, while scientists similarly grew distrustful due to the industry's dismissal of their expertise, increasing the barrier to communication and knowledge exchange. This "great divide" between fishers and scientists, and their views of the resource, remains a critical impediment to successful marine conservation in this region. The US Congress allocated millions of dollars to fund industry-science cooperative research with the intent of improving industry-science relations, improving the knowledge base of fisheries management, and providing supplemental income to fishers impacted by the fisheries crisis. While these funds focused on the New England groundfish fishery, similar collaborations emerged in the Mid-Atlantic surfclam and ocean quahog fishery (Johnson 2007; Bochenek *et al.,* 2005), the *Illex* and *Loligo* squid fisheries (Johnson 2007, forthcoming; Johnson and van Densen 2007), and the sea scallop fishery (NRC 2004). Most of these efforts go beyond simply chartering fishers' vessels as research platforms and instead involve fishers in meaningful ways throughout the scientific research process (Johnson *in press).* The case of cooperative research in the northeast United States is presented here to illustrate the value of involving fishers in science. Most notably, cooperative research can improve knowledge production and build capacity for stakeholder participation in the science and management (Johnson *in press).* Two case studies of cooperative research are presented here: an industry-based survey to collect fishery-independent data (the Maine-New Hampshire Inshore Trawl Survey) and a gear selectivity study to reduce bycatch and discards (the Ruhle Trawl).

A number of cooperative research efforts in this region have taken the form of industry-based surveys, which, as the name suggests, are surveys conducted with industry vessels (Johnson and van Densen 2007). Some of these are species-specific, such directed monkfish, cod, and yellowtail flounder surveys, while others target multiple species in a geographic area smaller than that of the large-scale government survey. An example of the latter is the Maine-New Hampshire inshore trawl survey, coordinated by the Maine Department of Marine Resources (ME-DMR). This industry-science collaboration emerged with concerns that the large-scale government survey did not sample in the inshore, state waters of Maine and New Hampshire. Fishers and scientists collaborated on the design of an industry-based survey with randomly stations and fixed stations. This survey contributes data collected at a finer spatial scale than the federal survey. After initial setbacks due to distrust within the lobster fishery, this effort has continued since 2000. Most notably, data from this effort contributed to the development of a new lobster stock assessment model and provided improved understanding of other resources in areas previously not sampled (Chen *et al.,* 2006). Chen *et al.* (2006) further concluded that, "In order to have an adequate representation of the lobster population, it is necessary to include data from both sampling programs to describe the lobster population dynamics in the Gulf of Maine."

The most common form of cooperative research in this region has been gear selectivity studies. Bycatch and discards pose significant challenges for ecosystem-based management, in part because they are often poorly documented or easily avoided. In this region, many cooperative research efforts seek ways to allow fishing on abundant or healthy stocks, while avoiding the capture of depleted or weak stocks. One of the most successful examples of this is a haddock rope separator trawl, initially known as the Eliminator but later named after one of the innovative fishers who helped design and test the gear, Captain Phil Ruhle. This collaboration between fishers and University of Rhode Island Sea Grant Extension scientists sought to develop a technical solution to allow fishers to catch haddock (a healthy stock) while protecting cod (a weak stock). The captains of the two vessels involved in this study were experienced in another gear selectivity study and other collaborations, illustrating that they previously had gained the capacity for doing science. The project proved successful; the gear resulted in less bycatch of the stocks of concern, while not reducing the catch of the target species, haddock (Beutel *et al.*, 2008). In addition, in 2007 the World Wildlife Fund recognized this effort for its contributions to conservation in its international smart gear competition. After extensive field testing, the Ruhle Trawl was implemented into policy in the form of approval in two innovative special access programs. However, implementation into management proved to be a lengthy and arduous process. Although the gear was developed and tested in the US in this effort, it first was implemented in EU waters as an approved gear before it was available to US fishers, much to the dismay of the industry participants in this study. Nevertheless, this case illustrates the innovative tools and management approaches that can be emerge from industry-science cooperative research.

These cases illustrate the value of participatory research approaches in fisheries management. The case of the ME-NH survey illustrates how including fishers in science can improve the spatial scale of knowledge production about resource conditions, while also providing opportunities for creating new assessment tools necessary for improved decision-making. Effective communication between cooperative research participants and the fishing industry was critical to the success in this effort. The case of the Ruhle Trawl further illustrates how cooperative research can lead to innovative management tools and approaches for fisheries management. In this case, an effective tool was developed for reducing bycatch and discards, a key goal of ecosystem-based management. These kinds of tools are increasingly in demand as we shift towards new participatory, ecosystem- and area-based management approaches. Both cases involved creating capacity for fishers and scientists to work together to produce new knowledge necessary for improving fisheries management. Like participatory modelling, fishers can identify new hypotheses for testing, which can be tested through cooperative research. The capacity that develops in cooperative research, such as improved communication, knowledge sharing and trust building, can contribute to participatory modelling efforts. Cooperative research can also provide new information, collected at multiple spatial and temporal scales, needed for testing new hypotheses and for modelling alternative management scenarios. As such, cooperative research complements and supports participatory modelling efforts, strengthening science and stakeholder participation in policy-making.

4.8.1 References

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4.9 Summary

The case studies outlined in this section cover the range of stages of stakeholder input from a) model building, b) through model evaluation to c) model use. The following list summarizes the successes and shortcomings of involvement in each of these stages as applicable to the case studies. The involvement level (a, b, or c) matches the categories outlined in Table 4.1, Section 4.1.

1. *Baltic Herring*

   a. Involvement in model building (stock assessment model)
      - ✓ Increased awareness of other stakeholder viewpoints
      - ✓ Increased appreciation for engagement process
      - ✗ Time intensive (interviews and computation)
      - ✗ Stakeholders found it difficult to specify different causal strengths.
      - ✗ Stakeholder fatigue

2. *North Sea nephrops*

   c. Involvement in model use (developing long-term management plans)
      - ✓ Dialogue process has actually begun
      - ✗ Lack of consensus due to different management objectives.
      - ✗ Fragmented representation of wider stakeholder community.

3. *Mediterranean swordfish*

   a. Involvement in model building (effect of fishery closures)
      - ✓ Stakeholders brought attention of additional uncertainty to modellers– which was used

   c. Involvement in model use (effect of closures and other management measures)
      - ✓ ICCAT considered the model results (partially) – e.g. closures
      - ✗ Implementation uncertainty – 3 months closures suggested, 2 months closures implemented
      - ✗ Lack of economic data from stakeholders that could strengthen the model results they use
      - ✗ Stakeholders want models to extrapolate beyond their design specifications

4. *Australia Great Barrier Reef*

   c. Involvement in model use (developing management strategies for fisheries)

- ✓ Collaboratively derived operational management objectives and strategies from stakeholders that allowed the evaluation.
- ✓ Cooperative learning – learned from each other.
- × Ultimately chose something completely different!
- × Time consuming process.

5. *Northern Hake*

   c. Involvement in model use (developing long-term management plans)
   - ✓ Provided harvest control rules
   - ✓ Asked scientists to explore management strategies
   - × Asked for analyses without the proper economic data

6. *Western horse mackerel*
   a. Involvement in model building (to evaluate long-term management plans)
   - ✓ Consensual decision not to include recruitment pulse in the model (precautionary management)
   - × Unsure how to handle uncertainty in recruitment pulses (leading to the above consensus)

   b. Involvement in model evaluation (evaluating long-term management plans)
   - ✓ ICES (facilitator) evaluation of work was critical to the process being seen as credible

   c. Involvement in model use (developing long-term management plans)
   - ✓ Stakeholders happy with the tool
   - × Model designed for EU and Norwegian waters but used for EU waters only = model misuse!

The stakeholders' key role in participatory modelling in the majority of the case studies in this Chapter is to use the models (level c, by suggesting long-term management plans etc.), while there is limited involvement of stakeholders in model building (level a) and evaluating models (level b). The examples from US collaborative research, on the other hand, show how fishers can contribute to the improvement of knowledge production. It is unclear to what extent there is a desire among stakeholders or scientists to have engagement at this level, but the US cases provide examples where participation at this key stage has been a benefit to all parties. The purposes of involving stakeholders in cooperative research and participatory modelling as they both include capacity building, increasing trust, knowledge input and increasing quality.

In general, engagement with stakeholders is slow relative to the life of a project, as relationships are built, trust is established and respect is developed. Once engagement is established it is important to maintain it into the future to ensure that the developments made during the project come to fruition.

5 Options for socio-economic capacity building

ToR c) develop options for ICES in respect to the possibility of having capacity for socio-economic advice in respect to bioeconomic management strategy evaluation, economic impact assessment and socio-cultural impact assessment. Including a description of what specific kinds of capacity would be needed and various models of how that capacity could be developed and supported.

We address this ToR by beginning with presenting three possible options for ICES options on the question of capacity building for socio-economic advice, and the pros and cons for each. The options are 1) to decline to develop such capacity, 2) to contract requests to existing social science institutes and 3) to integrate social scientists into the ICES network.

To set these options in a background perspective, the descriptions of options are followed by several sections on relevant issues. These contain parts of the ICES science plan and CFP on the need for bio-socio-economic advice, some examples of what ICES already does and what ICES may be asked to do within this area, a description of the general lack of socio-economic capacity, schematic options on structures and ICES roles in relation to socio-economic advice and, finally, a couple of examples on how such advice is structured outside EU.

The last part consists of the summaries of the presentations given at the working group meeting. These were a mixture of recommendations on bio-socio-economic topics and frameworks, examples from bioeconomic research, a workshop announcement and ICES' role and capacity building for socio-economic advice. We chose to integrate Doug Wilson's presentation in the discussion text as it directly addressed ToR c.

5.1 Options for ICES in respect to Socio-economic Advice

There are three main options that ICES can choose from in respect to developing the capacity for social science advice. The first is to decline to become involved in providing socio-economic advice. The second is to act essentially as a broker passing on requests for socio-economic advice to existing fisheries social science institutions in the form of contracts then concatenating the products with the natural science advice. The third is to integrate social scientists and their institutes into the ICES network, including the review and advisory processes, and seek to produce integrated advice.

These options should be seen as "ideal types" that ICES can use to consider possible strategies. While they are certainly different they are not mutually exclusive in the sense that case-by-case decisions can always be made about specific requests; although taking such an approach already implies that the second option is the dominant one.

Perhaps the most important long-term consideration is that the provision of any kind of scientific advice depends on the institutional framework of fisheries management and that institutional framework is in flux. The Green Paper on CFP reform is calling for the implementation of results based management and a reversed burden of proof. This implies changes as well in the kinds of science being produced and the ways that science is being paid for.

5.1.1 Option One: To Decline to Develop Social Science Capacity

The first thing that ICES must consider as it is confronted with demands for providing socio-economic advice is whether or not this is an appropriate role for ICES at all. Indeed, it may not be an appropriate role for any kind of publically funded science as the application of socio-economic information to fisheries may be more to the benefit of fishing firms and fishing communities than to anyone else, and therefore should be organized and paid for by the fishing industry.

The disadvantage of this approach is that it may disappoint clients who would like to draw their marine policy advice from a single source in order to reduce their transaction costs. It would also mean that ICES would lose the ability to review and/or otherwise influence scientific advice related to policy questions relevant to ICES mission.

However, there are a number of considerations that would make declining to be involved in social science advice an attractive option:

First, ICES has no experience or institutional memory to draw on in the provision of social science advice.

This lack of experience arises first of all in respect to how such advice is going to be used. ICES feeds its advice into a political system where there are always temptations to misuse. ICES is constantly wrestling with the problem of making sure that its natural science advice is used appropriately. ICES has no experience in dealing with these complex issues as they arise and may find itself on a very steep learning curve. Potential abuses of socio-economic advice are of a different nature.

For one thing there may be temptations by managers to use socio-economic advice as an inappropriate substitute for stakeholder consultations; pretending that the ICES social scientists are speaking for the stakeholders in order to avoid the much higher transaction costs involved in actual stakeholder consultations. Such a situation would place ICES between the managers and the stakeholders as a kind of translator which would quickly undermine ICES scientific legitimacy.

Another potential misuse of ICES socio-economic advice would arise from inconsistencies between the natural and social science advice in respect to policy-making. ICES current advice very commonly involves recommending cuts in fish catches and curtailing other fishing practices in accordance with the precautionary approach. Social science advice linked to this advice would usually involve a mixture of very long term and uncertain forecasts of increased gains for "society" in general, along with much less uncertain forecasts of serious problems for existing fishing fleets and communities. It is fishing fleets, not "society" that managers and politicians must address in their day-to-day work. The long-term gains for society are already written in to the precautionary conservation of fish stocks. The short-term forecasts, on the other hand, will often point toward policies that are not consistent with the policies indicated by the biological advice. Again this problem is very dependent on how management is being structured. If a results-based approach is in force then it would be fairly easy to separate the natural science advice about the limits of impacts on the environment from the socio-economic advice about how to make a profit while staying within those limits. Under the current management set up in Europe, however, this will present a very real problem.

Second, quality control is very difficult in the social sciences and draws on a depth of experience that ICES does not have. Socio-economic advice is very different from the natural science advice. Much more that natural science, social science develops in schools and traditions that are geared more toward providing helpful insights than developing cumulative knowledge or providing fast answers. All social science is fraught with value-laden assumptions that are reflected in the ways that various traditions define their basic concepts. This is certainly true in the sociology and anthropology that is used for generating socio-cultural advice. It is even true of the most quantitative applications of fisheries economics, as evidenced by a recent debate in Fisheries (Bromley 2009) in which the way that fisheries economics has traditionally used the basic concept of resource rent was profoundly challenged by a prominent economist. These challenges were mainly on the basis of the normative assumptions about the role of management that are built into the various approaches to resource rent.

ICES relies heavily on the formal review of science that is produced for advice. Peer review in the social sciences is similar in form to natural science review. However, doing it effectively requires a broad knowledge of the traditions being drawn upon including the normative implications of the various basic assumptions they are built on. This kind of social science review is critical to developing credible and salient advice. The implication is that ICES cannot simply commission a study or a working group here and there to provide social science advice. It would also need to invest heavily in developing a balanced and informed review process.

5.1.2 Option Two: Contracting requests for Socio-economic advice to existing Fisheries Social Science Institutes

The second approach that ICES should consider is dealing with requests for socio-economic advice through developing contractual relationships with existing social science networks and institutions. The advantage of this approach is that it would provide ICES with the existing expertise in a way that may satisfy client requests while leaving ICES at arm's length from the socio-economic advice itself. The socio-economic advice would be concatenated with the natural science advice while ICES made clear that it is helping to provide the advice as a service but does not claim to have the review capability to back the advice with ICES full scientific credibility.

The major challenge that ICES would find here is that the current organization of fisheries social science, as described below in Section 5.5.2 is very fragmented. This is true from the perspective of the different kinds of institutes they are working for and the sources of funding are depending on. It is also true of the way that they approach fisheries and marine issues in terms of their own scientific interests. Most of them work in academic environments and are interested in fisheries as an example of a type of social organization, economic problem or environmental policy question rather than in fisheries per se. University economists and social scientists who see themselves as mainly working to improve fisheries management are few, and are already very busy. Commercially consulting companies are available, but they employ mainly economists, and they are stretched very thin by the current plethora of EU and national research tender contracts.

If ICES pursues this second option it will find itself competing for their attention and time. It will also likely find that structures for review will have to be put together on a case-by-case basis across the same fragmented landscape and this implies considerable transaction costs.

5.1.3 Option Three: To Integrate Social Scientists and their Institutes into the ICES Network

The third option involves taking social science into ICES as a part of the ICES network. The advantage of this approach is the possibility of integrated biological and socio-economic advice that has been effectively reviewed and has sufficient quality to be seen as official ICES advice. Such advice might prove very useful to managers, especially if an institutional structure is in place for management, such as results-based management, that clearly separates the role of natural science advice from that of socio-economic advice. Such an approach would provide an institutional rationale for how advice could be integrated. One possibility for moving this way would involve greater cooperation with the European Association of Fisheries Economists, who are described in Section 5.3.

Because this option is in direct contrast with Option One, many of the disadvantages of the third option are outlined in the advantages section under the first option. Here we will just point out that the current fragmented structures of fisheries social science will also make this a practical challenge for ICES. Those fisheries social scientists that are interested in providing advice, which is currently a group made up mainly of economists, are already very busy. Attracting other social scientists into the ICES network will mean finding incentives for them.

Experience in the WGFS highlights this problem. This working group was been the main ICES expert group bringing in social scientists and only a very small group of them has participated on a regular basis. This has partly been because of problems with funding participation, social scientists cannot draw on national funds to support their participation and rely on project funding. It is also, however, because the group that has come is particularly interested in the science-management link and hence in ICES as an institution.

If ICES is serious about engaging social scientists as part of the network then national sources of funds would need to be found to support their participation in expert groups. This might include developing memoranda of understanding with social science institutes or even entering into framework contracts with them to help develop joint advice.

ICES would need to take advantage of recent advances in gathering economic data on fisheries by incorporating such data in its overall data management and make this available to economists who wish to work with ICES. Furthermore, expert groups would need to be organized that hold their interest. A suggestive list of such expert groups might include a group looking at methods for socio-economic advice, a group looking at fishing communities, a group looking at bioeconomic modelling or a group looking at stakeholder collaboration. The creation of such groups would begin to bring in a larger group of economists and social scientists who could begin to be engaged in relevant research, review and advice.

5.2 Background reflections on ICES and Socio-economic advice

ICES' mission and socio-economic advice

The mission of ICES is "to advance the scientific capacity to give advice on human activities affecting, and affected by, marine ecosystems". The ICES strategic plan *A vision worth sharing*[4] lists six themes, each with specified, measurable goals: science, collaboration, advice, data, communication, and service support. The first two themes, science and collaboration, are further developed in the *ICES Science Plan (2009–2013)*[5]. One of the 16 high priority research topics specified in the Science Plan is "contributions to socio-economic understanding of ecosystem goods and services, and forecasting of the impact of human activities." This is an area where ICES currently has limited capacity.

Several recent initiatives within ICES address issues concerning how clients' current and future need for integrated advice can be met. The WGFS is aware of the ongoing work of the SSGSC (SCICOM Study Group on Scientific Cooperation), for example SGMIXMAN has incorporated bioeconomic simulations.

While socio-economic integration has not yet been identified as a priority for ICES, there has been experience with integrating science with stakeholder concerns and the

4 http://www.ices.dk/iceswork/AVisionWorthSharing2008.pdf

5 http://www.ices.dk/assets/ssi/text/WhatsnewScience/ICES_Science_Plan__2009-2013.pdf

scientific facilitation of management plan creation. The agreed management plan for Western horse mackerel represents one of these successful scientist-stakeholder collaborations. The perhaps easiest and most direct way for ICES to integrate with stakeholders is through dialogue and collaboration with the EU Regional Advisory Councils (RACs). MIRAC (REF TO REPORT) has had 2 meetings already which have been fruitful to air ideas on how ICES-RAC collaboration has and should take place. MIRAC 2009 recognized that the collaborative development of Management Plans (MPs) is a priority for both ICES (needing stakeholder dialogue and participation) and the RACs (needing scientific facilitation of MP data/parameter identification/calibration and MP simulations). Regional MP development and testing done in an ICES-RAC collaboration (collaborative research, see other sections in this report) would most certainly be welcome by the EU Commission. WGFS is further aware that topics related to integration of socio-economic and ecosystem aspects in advice will be discussed at the October 2009 meeting of the Council.

The legal basis of Social science advice in the EU

The EU's formulation of objectives in the CFP is stated in Article 2 of the Council Regulation (EC) No 2371/2002 in 2002[6] (highlighting not in the original):

"The Common Fisheries Policy shall ensure exploitation of living aquatic resources that provides sustainable economic, environmental and social conditions. For this purpose, the Community shall apply the precautionary approach in taking measures designed to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimize the impact of fishing activities on marine ecosystems. It shall aim at a progressive implementation of an ecosystem approach to fisheries management. It shall aim to contribute to efficient fishing activities within an economically viable and competitive fisheries and aquaculture industry, providing a fair standard of living for those who depend on fishing activities and taking into account the interests of consumers.

The Common Fisheries Policy shall be guided by the following principles of good governance:

a) clear definition of responsibilities at the Community, national and local levels;

b) a decision-making process based on sound scientific advice which delivers timely results;

c) broad involvement of stakeholders at all stages of the policy from conception to implementation;

d) consistency with other Community policies, in particular with environmental, social, regional, development, health and consumer protection policies."

Thus the EU had already set up the objectives for a social, economic and ecological sustainable use of the living marine resources within the CFP in 2002. The EU also has set clear obligations to the Commission and to the Member States with respect to the implementation and control of the CFP.

The EU has also realized that a regional approach is necessary as the general framework of the CFP regulations not necessarily fit to specific regional needs. Thus the EU

6 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:358:0059:0080:EN:PDF

has set up the Regional Advisory Councils to contribute to achieve the objectives of Article 2(1) already within the same regulation (Article 31).

5.2.1 Practical Examples of Socio-economic Advice

Current examples from ICES

Within the last three examples ICES did not directly facilitated a socio-economic advice. An integration of bio-socio-economic advice has been done by the Study Group on Mixed Fisheries Management (SGMIXMAN, ICES 2008d) and within the workshop on mixed fisheries advice for the North Sea (WKMIXFISH, ICES 2009b). They presented a model (Fcube) where economic data were directly used to assess mixed fisheries management.

Because ICES' currently has no capacity for the facilitation of social science we present some ideas on potential options for building socio-economic capacity within ICES, as well as how this capacity may be developed and supported. ICES, the EU Commission and the RACs have identified management plans as the future format for biological and socio-economic advice and already developed some as stated above. However, there will be a transitional period for many stocks and we may think of some plausible hypothetical requests to ICES for specific advice. We would like to stress that we assume ICES may consider building capacity to provide bio-socio-economic advice if the purpose is to include socio-economic aspects into strategic advice, like HCRs and LTMPs, while ICES would not be interested in adding socio-economic aspects to tactical advice (like annual based advice).

Advice on a Technical Measure

For example, the EU Commission may ask ICES for a bio-socio-economic analysis of applying a 50mm increase on trawls in the Dutch North Sea demersal fishery. Clearly, such a management regulation change would have some biological and ecosystem consequences, but also consequences on fishing effort leading to potentially different socio-economic outcomes. Alternatively, if the revised EU Common Fishery Policy (CFP) is to initiate Results-based Management applicable to EU fisheries, ICES may be commissioned by the RACs to assist in a collaborative bio-socio-economic analysis on which gear modifications would be most efficient in harvesting the yearly TAC dictated by the EU.

Advice on Economic Management Instruments

For example, rights-based Management (RBM) arises as a big issue in the Green Paper on the reform of the CFP as a potential model for the solution to the problem of overcapacity in EU fisheries. Many social issues emerge from a broader application of RBM in EU fisheries (currently some countries in EU have RBM systems in operation such as Spain, the Netherlands and the UK) due to loss of rights from certain fleet sectors and fishing communities. The impact of applying RBM thus demands to be evaluated. It is hard, however, to request to a biologically focused institution such as ICES to respond to questions of such socio-economic impacts. In other countries where comprehensive RBM has been introduced, such as New Zealand, there has been little evaluation of the impact of RBM because government considers that the market (of rights) has to guide the evolution of the fishery. Indeed, very few data collection and research is being carried out for assessing capacity levels, for example, because investments in capacity are considered to be up to the industry. Research on socio-economic impact of the New Zealand Quota Management Systems (QMS) has been carried out by universities on their own but little is requested from the government. Government hires scientific advice to National Institute of Water and Atmosphere (NIWA) but on subjects such as resource status and other biologically oriented studies. Of course, the case is very different in EU where such comprehensive market base systems are unlikely to operate. Research on RBM may provide European managers with solutions on how to counterbalance the outcomes from a RBM approach and what flexible mechanisms can be incorporated to RBM approaches chosen (e.g. ITQs, TURFs and IVQs), for a given fishery, to counteract the potential negative outcomes from a RBM application. The big question is: Is ICES prepared to provide this kind of advice? This is something STECF would be more likely to be asked to answer, not ICES, most likely due to the European-exclusive participation in STECF in isolation of North America, Norway and Russia.

Compliance with management measures

A successful management plan is clearly one that is implemented concurrently with the social-economic situation and the inherent political constraints. The overriding problem in EU fisheries is control of the catches, which strongly brings in the socio-economic perspective. One may ask why there is sometimes no political will to control catches. This becomes a question for social scientists. This also underscores a potential avenue for social science integration in the development of successful management plans.

5.3 The Current Situation in Fisheries Social Science in the ICES Area

There are a number of practical issues to make note of if ICES decides to incorporate socio-economics in its advice. The most difficult of these arise from the fragmented situation of social and economic expertise in the ICES area. ICES must find ways in which social scientists and economists (preferably ones that already have experience/knowledge of fisheries, but this shouldn't be a requirement as it could be an unnecessary limiting factor) can help supply advice. WGFS specifies that interdisciplinary work should occur at the beginning of a collaborative WG or project, and not in an ad-hoc way. This said, multidisciplinary integration can occur in two ways: 1) in the existing ICES framework, perhaps at the Expert Group level, or 2) in the early stages of a management plan/harvest control rule development, or an EU-funded scientific project.

Fisheries social science in the ICES area does not have any network capacity that is equivalent to what ICES does in the natural sciences. Economists and other social scientists interested in fisheries issues are scattered through a number of different kinds of institutions, including individual consultants and consulting companies, small independent research units, marine laboratories and universities. The largest group is found in universities and this group can be further divided into individual or small groups of scholars with fisheries interests working in academic units with other missions and a somewhat larger group found in academic units dedicated specifically to fisheries and, increasingly, integrated marine policy. Not only are there large differences in types of institutions, European fisheries social scientists' interests vary widely and interests in fisheries are often a subset of a broader academic interest such as environmental economics, economic development, environmental policy, community studies, migration or human ecology.

The numbers are also quite small compared to the natural science infrastructure. Salz *et al.* (2007) combining both economic and non-economic social sciences identified 12 research institutes within the area where ICES provides advice where there is a primary focus on fisheries social science. These institutes had a total scientific staff of 151, with 72 of them being at the now dispersed Fisheries College at the University of Tromsø. They also identified 22 other institutes where social scientists with an interest in fisheries could be found. They included in this list organizations that had contributed to three or more fisheries-related research projects. In addition they identified 12 consulting companies with an important focus on fisheries social science and eight others with some fisheries social science capacity (Salz *et al.*, 2007).

European level networking for fisheries social scientists is also much less organized than what is found for natural science. European fisheries social scientists mainly attend four regular conferences, three of which represent active membership organizations. Two conferences are mainly for economists and two of which are mainly for non-economists, although these lines are increasingly being crossed with increased interest in multidisciplinary approaches. Fisheries social scientists regularly attend the People and the Sea Conference which is hosted every two years by the MARE Centre and the University of Amsterdam. This is a very popular conference and has probably become over the last several years the most important meeting for this group. There is no membership organization associated with this conference. Several European fisheries social scientists are active members of the International Association for the Study of Commons (IASC), which holds a biennial conference. On a global level, fisheries economists regularly attend the meetings of the International Institute for Fisheries Economics and Trade (IIFET). Both IASC and IIFET are basically academic organizations with no structures for advice provision.

The only group that has expressed interest in providing fisheries management advice is the European Association of Fisheries Economists (EAFE). EAFE holds an annual conference with a good deal of attention to management issues. It is also seeking to develop an advisory capacity and their recent strategy has involved becoming active in the Regional Advisory Councils partly because their leadership does not believe they are yet in a position to provide "joint advice" (EAFE 2005).

On the whole European fisheries socio-economics is carried out in a very fragmented institutional context. The funding structure is both fragmented and uncertain, and very heavily dependent of EU sources. Salz *et al.* (2007) found that only eight institutes have sufficient research mass to guarantee continuity of research programming. The academic groups depend mainly on Framework contracts and keep their fisheries-related research alive by moving from project to project. The wide range of interests among these scientists means that only a subgroup of these projects will involve fisheries, and still less will be relevant to fisheries-related advice. Those economists and social scientists that do provide advisory services are stretched very thin. Most of the advisory work carried out through tender contracts is done by a small group of no more than eight consulting companies (Salz *et al.*, 2007).

5.3.1 Further options for socio-economic capacity building

If ICES decides to go in the direction of options as described in Section One, there are a number of potential models for what this would look like. Figure 5.1 and Figure 5.2 and 5.3 illustrate five alternative ways of providing socio-economic advice in the landscape within which ICES is an actor. Figure 5.1a illustrates the situation as it is today. The European Commission (EC) is used as an illustration of ICES clients. ICES do not have the capacity to deliver socio-economic advice. The STECF and the RACs provide the EC with socio-economic input. The disciplinary competence of ICES Expert Groups (EG) reflects the competence of the National Fisheries Institutes (NFIs). There are currently very few social scientists and economists represented in the EGs.

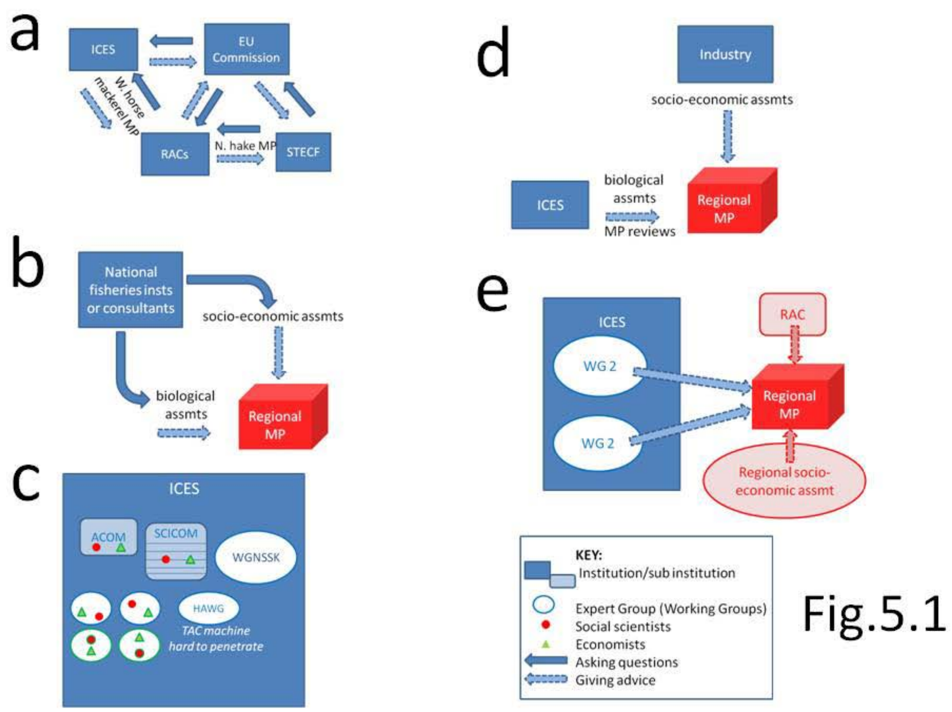

Figure 5.1. a) The situation today, b) A situation without ICES, c) Socio-economic competence integrated in the ICES structure, d) A results-based management scenario, e) Regional socio-economic advice given outside ICES.

Figure 5.2b is the "world without ICES" scheme where NFIs and outside consultant are asked to provide the necessary assessments for regional management plans. An example of this can be seen in Dankel *et al.* (2009) where scientists got together to outline a bio-socio-economic assessment of the effects of different trawl types in the Georges Bank mixed fishery.

Figure 5.1c illustrates a situation where competence from social and economic disciplines is included in basically the same structure as described above. Social scientists and economists would be an integrated part of ICES. They would participate in EGs and also be represented in ACOM and SCICOM. This development could come as an evolution of NFIs; as some NFIs employ scientists from various disciplines this would give ICES a resource base of such competence. Alternatively, such competence would have to be recruited to the EGs on an ad-hoc basis, raising the issue of funding for participation. Synergies from collaboration with large international and well funded research projects is one possibility, arranging EG meetings in collaboration with scheduled research project activities. Some EGs are likely to have more multidisciplinary representation than others. The stock assessment EGs are less likely to include competences from disciplines outside fisheries science, at least in the short term.

Figure 5.1d illustrates a model for producing input to advice in a results-based management setting. The industry appears as an important actor, producing their own socio-economic assessments.

Figure 5.1e illustrates a scenario where the socio-economic advice is generated outside the current ICES structure. A regional body coordinates input from various actors. ICES EG/WGs still contribute with biological assessments.

Under the scheme illustrated in Figure 5.2, ICES would have to set up regional groups on biological and socio-economic topics (combine existing groups or put them under a regional umbrella and set up new ones if necessary).

One example could be to keep the existing groups, and establish regional groups corresponding to the RACs to take the information of all existing groups and use these groups to assist in setting up the RFMPs (Figure 5.3). It would closely assist the RACs in setting up Regional Fisheries Management Plans (RFMP) and will be able to give tactical advice on "day-to-day" questions of the RACs:

ICES will give strategically advice to the EU Commission.

STECF will get capacity to evaluate the RFMPs.

RFMPs will be set up for, e.g. 5 years.

ICES will deliver ecological and socio-economic indicators on a yearly basis which allows the system to react on sudden changes.

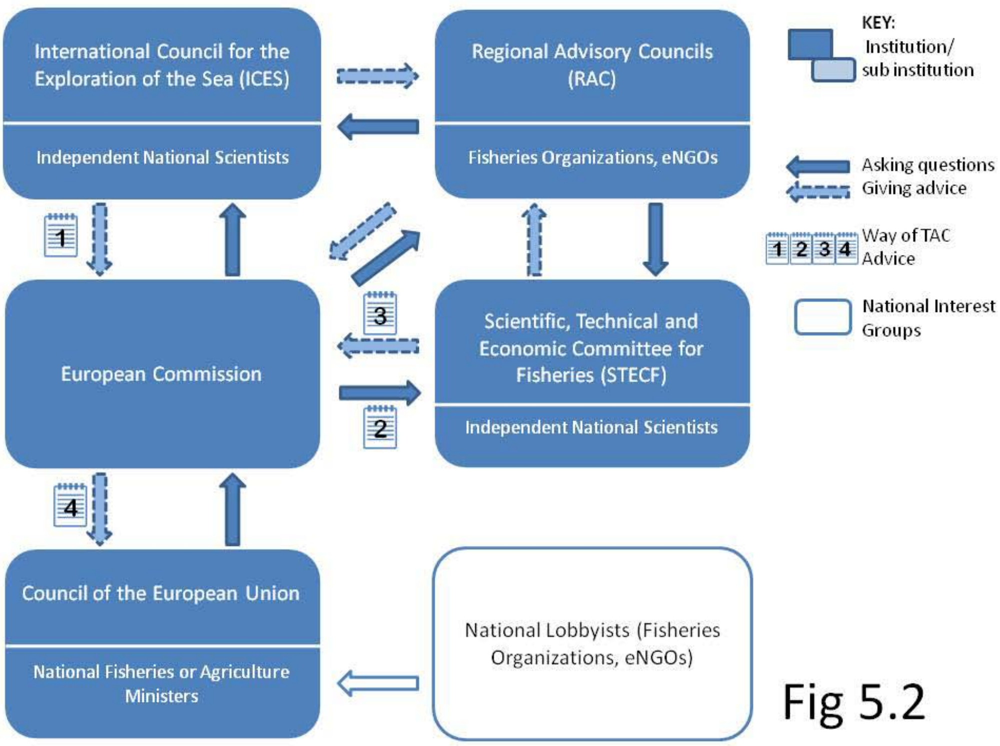

Figure 5.2. A scenario where ICES has regional groups on biological and socio-economic topics.

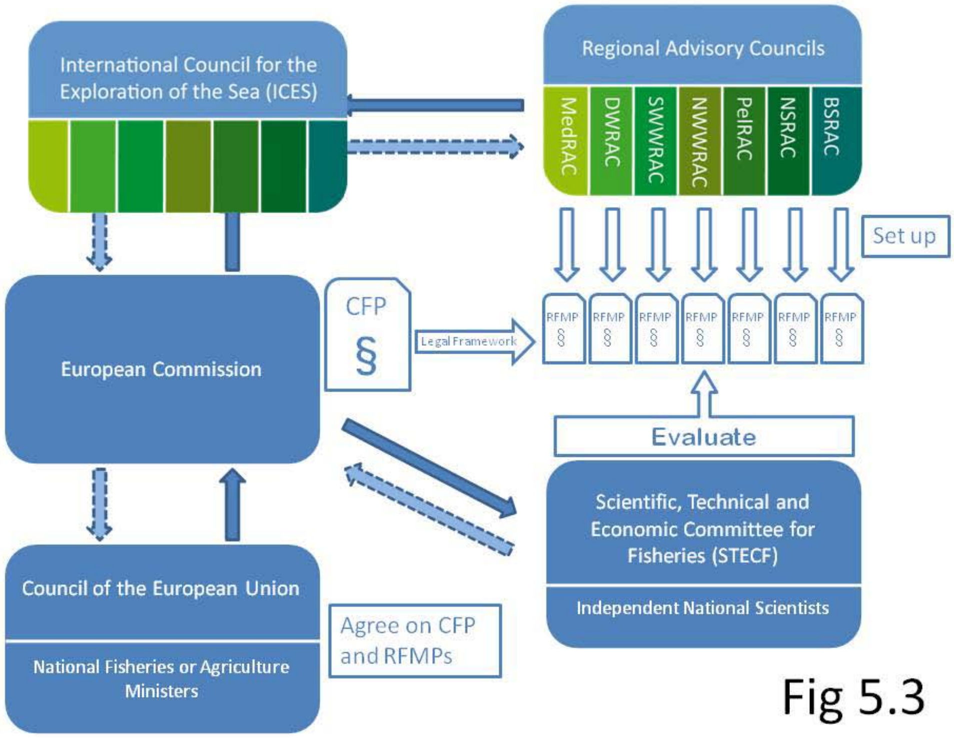

Figure 5.3. A scenario where ICES has regional groups corresponding to the RACs and RFMPs.

Socio-economic advice to the European Commission related to the CFP

STECF (Scientific, Technical and Economic Committee for Fisheries) .The STECF was established in 2002 as an advisory body to the European Commission (CEC 2002). STECF is required to address the following issues in its annual report; "(a) the situation as regards fishery resources relevant to the European Community; (b) the economic implications of the situation of those fishery resources; (c) the developments in fishing activities, with reference to biological, ecological, technical and economic factors; and (d) other economic factors affecting fisheries" (CEC 2002, p.2.).

5.3.2 Socio-economic advice to ICES Member Countries outside the CFP area

Norway

In Norway, a clear distinction between responsibilities for scientific advice related to stock assessment and responsibilities for socio-economic aspects of fisheries is evident. Research feeding into the ICES stock assessments is carried out by the Institute of Marine Research (IMR). Economic data collection and analysis of profitability of fishing fleets are carried out by the Directorate of Fisheries (DoF). Stakeholder consultations are considered part of the political process. In a recent study based on interviews with key informants, it was found that "IMR purposely does not include social scientists (although they do take part in some multidisciplinary research projects) and the DoF does not recommend that social scientists study the impact of fisheries decisions be part of ICES" (Baltic Sea 2020, 2009. p. 72).

United States

In the US, socio-economic data related to marine fisheries are collected via observer programs administrated by NOAA's National Marine Fisheries Services (NMFS).

Collaborative research projects involving fishers are also part of socio-economic data generation (Baltic Sea 2020, 2009. p. 82).

Canada

In Canada, regional variations are evident in collection of fisheries related socio-economic data (Baltic Sea 2020, 2009. p. 90).

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5.4 Examples of approaches to socio-economic advice

The following contains summaries of presentations given at the working group meeting.

5.4.1 Bio-Socio-Economic management advice using influence diagrams: The role of ICES?

Samu Mäntyniemi, Sakke Kuikka and Päivi Haapasaari

Introduction

The purpose of this presentation is to suggest a unified framework for quantitative evaluation of the socio-economic impacts of management actions while accounting for uncertainty in a conceptually consistent way. We also pinpoint the areas of expertise needed to implement such a decision support system.

Our suggestion is to build the advisory process on the theory of making optimal decisions under uncertainty (Raiffa, 1968). Uncertainty is inherently an object that does not physically exist, but is a state of mind of a person or a group of persons (de Finetti 1975 (Ramsey 1926, Nau 2001). The same is true for the valuation (utility) of the outcomes of the system to be managed: the desired bio-socio-economic state of nature is a human choice. The theory of subjective expected utility (Raiffa 1968, Ramsey 1926, Savage 1954) provides a consistent framework for advising rational behavior under uncertainty. The theory is based on the following principles:

- The uncertain knowledge of the system must be formulated as probability statements. The probability is the degree of belief on a particular hypothesis being true
- The valuation of outcomes must be expressed quantitatively at least on a relative scale
- Each alternative decision changes the probability distribution of the outcomes
- Expected utility of a decision is the weighted average of the valuations of the outcomes, calculated using the probabilities of the outcomes as weights
- Decisions can be ranked based on their expected utility, the optimal decision is the one with the highest expected utility

Influence diagram

Influence diagrams are graphical models that are designed to work according to the theory of subjective expected utility (Pearl 1988). Variables relevant to the system are denoted as nodes in the graph. Uncertain variables, decision variables and utility variables are denoted by ovals, rectangles and diamonds, respectively. Causal relationships between the nodes are denoted by arrows pointing from the cause to the effect. Thus, an influence diagram provides a useful graphical way of illustrating the structure of the system to be managed.

The quantitative part of the diagram includes probability statements about the causal relationships and potential values of the variables and statements of valuation of the outcomes. Software packages that implement influence diagrams are typically able to provide interactive decision analysis, where the decision-maker can immediately identify the optimal decision and also compare the expected utilities of other potential decisions.

Influence diagram software, such as Hugin Expert (http://www.hugin.com/), can also perform the analysis of the value of information (VoI) (Mantyniemi *et al.*, 2009, Groot Koerkamp *et al.*, 2008, Yokota, Thompson, 2004). VoI analysis reveals the variables to which the rank of the decisions is the most sensitive to. The VoI itself provides a measure of the rational maximum price that could be paid for gaining access to better information prior to making the decision. The currency of the price is the same that is used in the valuation of the management outcomes.

In practice, the influence diagram can be built incrementally, guided by the analysis of VoI. In the first phase, the diagram could be constructed based on existing knowledge possessed by trusted experts. Then the decisions can be made in any point of time based on the best knowledge available at the time of decision-making. The diagram can be improved on each time-step by gathering more expertise and data on the variables identified most important by the analysis of VoI.

Bio-Socio-Economic influence diagram

In order to give bio-socio-economic advice using influence diagrams, it is clear that expertise on all three domains is needed to construct such a diagram. The expert team could consist of scientists, but it could also include stakeholders to be able to utilize their knowledge.

The role of the biologists would be to formulate, for example, how the fish stock would react to different levels of fishing effort in terms of the surviving population and also in terms of the amount of the catch. This is clearly what ICES is doing at the moment. Therefore the expertise needed for this part of the influence diagram is already present in the ICES community. However, the stock assessment should be conducted by using Bayesian statistics to ensure that the output is conceptually compatible with the decision theory. To our knowledge, this requirement is currently satisfied only by the working group for Baltic salmon and sea trout (WGBAST).

The economists would create a model for the profits gained by different levels of fishing effort based on the knowledge of the costs and, e.g. based on the knowledge of the elasticity of the price of the fish. ICES working groups do not typically manage and analyse economic data nor do they include fishery economists. To gain capacity for economic advice, the working groups would have to include experts in Bayesian econometrics and start gathering economic data.

The role of social scientists would be to model the beginning and the end of the causal chain from the decision to the utility of the outcome. The beginning of the causal chain is the human reaction to the management decision, which then affects the realized fishing effort. Actors in the system may commit themselves differently to different kinds of management decisions, which should be formulated in terms of probability statements within the influence diagram. The last end of the causal chain is the overall valuation of the management outcome, the “social utility”. Social utility could be seen as a (potentially complex) combination of valuations of different outcomes of the management. For example, the social utility could be a weighted average of utilities of profit, employment and biological status of the fish stock. While the actual valuation and weighting should match the one possessed by the decision-maker, the methods of social science could potentially help in quantifying the utility perceived by the society. At will, decision-maker may or may not adopt this view. Social scientists have not traditionally been involved in ICES advisory process. Therefore the (holistic) assessment groups should include social scientist in their work. To ensure that the results of the modelling of the human behaviour can be seamlessly integrated into the influence diagram, the output of the analysis should be presented using Bayesian probabilities. As an example of such an analysis, see (Haapasaari, Karjalainen, 2009)

The alternative management actions, for which the expected utilities are going to be calculated, must be defined by the managers. It could be the responsibility of the manager to ensure that the proposed alternatives can be legally implemented. Alternatively ICES would need experts on international and national law to assess whether the actions proposed by managers can be implemented.

Quantitative analysis of the entire fishery system, as suggested here, requires also a considerable amount of theoretical and technical knowledge of the decision theory and its implementation using influence diagrams. Such knowledge may be part of the training of, e.g. system analysts, statisticians or artificial intelligence engineers or computer scientist, depending on the institute. At least one such person would be needed in each working group to supervise the process of constructing and using the diagram. More detailed help in constructing the diagram could be provided by professional facilitators (O'Hagan *et al.,* 2006), whose role is to help to convert the knowledge of the domain experts into probability statements needed in the model.

Summary

To be able to give quantitative bio-socio-economic management advice under uncertainty, ICES would have to considerably expand its expertise outside from the traditional fishery science. Domain experts and experts in decision analysis should be incorporated in ICES work to ensure that all areas of expertise can be integrated and that the overall uncertainty becomes correctly analysed and consequently acknowledged in the advice. ICES has started to build this capacity by offering training in Bayesian stock assessment as part of the training program, but heavier investments in training and reformation of the assessment groups is clearly needed.

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5.4.3 Towards integrated ICES advice: biology and socio-economics - *ICES scientific advice: science-policy co-production*

Robert Aps

It is important to note that the regulatory and academic sciences are different. Regulatory science is expected to generate information needed to meet regulatory requirements and to provide reliable information for decision-makers. The goal of the regulatory science is conflict resolution via public debate over competing interests and values, and it often has social and economic implications.

The role of uncertainty is also different. Predictive certainty of regulatory science is required by the political process and by legal requirements while uncertainty is expected and "embraced" by academic science. Scientific advice developed by ICES is largely based on the results of regulatory science, and much less on the results of academic studies

ICES advice could be seen a boundary function between science and management and it is driven by management/policy. For example, ICES - EC arrangement (1987) states "The Commission of the European Communities.... shall have the right to ask the International Council for the Exploration of the Sea ....for scientific advice on fisheries resources management and related matters, which the Council shall to the extent possible provide". "Memorandum of Understanding" and "Letter of Agreement" is the formal basis for the ICES regulatory science-policy co-production process.

On the science side, ICES advisory process claims to be based on the best available regulatory science, the advice is generated in accordance to working arrangements, working relationships and cooperation that have been in place on all levels of the ICES network because its inauguration and were taken as integral part of ICES' regular work.

However, ICES advisory science is limited to consideration of the impact on the marine ecosystem while socio-economic considerations are outside ICES remit. This division was discussed already in 1976. The ICES *ad hoc* working group on the biological basis for fisheries management (Charlottenlund, January 1976) stated: „Because biologically based objectives such as highest physical yield from a resource has been thought to represent a more generally acceptable aims of fishery management than for instance economic objectives, fishery scientists have played a primary role in formulating and promoting objectives for resource management".

Scientific advice requires internal consistency and must refer to well-defined targets. As these targets are rarely if ever defined explicitly by the political system, fisheries science has taken upon itself beyond the remits of classical science to define such targets starting with the political texts. Political texts are often imprecise on how to balance conflicting objectives. Therefore, step taken by fisheries science is significant as <u>it defines fisheries science as a regulatory science</u> rather than academic science.

Maximum Sustainable Yield (MSY) and Precautionary Approach

This concept focuses on maintaining the reproductive capacity of a stock through keeping the spawning stock above a reference point (Bpa). While the MSY model in principle advises on the best option in the form of a set of fishing mortalities the precautionary approach defines upper boundaries on the fishing mortality (Fpa) and lower boundaries on the spawning-stock biomass (Bpa). When outside these limits management is expected to introduce actions that will bring the stock back inside precautionary limits.

The precautionary approach focuses on the stock–recruitment relation and postulates that above some limit spawning-stock biomass recruitment is not influenced by the amount of spawn but is controlled by the carrying capacity of ecosystem in which the fish live. While the MSY includes the fishing mortality as the direct control this is indirect in the precautionary approach model. The associated decision models for MSY and Precautionary Approach are illustrated in Figure 5.4

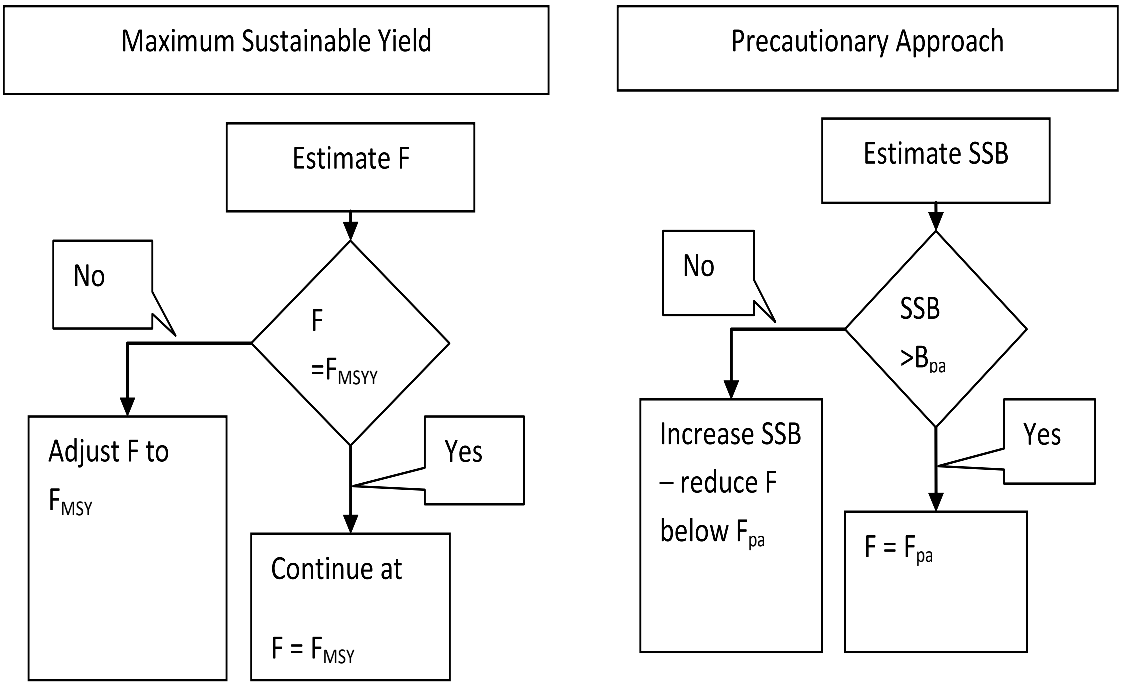

Figure 5.4. Decision models for MSY and Precautionary Approach - F is the estimated fishing mortality and SSB the estimated spawning-stock biomass (Aps and Lassen, 2009).

Precautionary Approach shifts the burden of proof: fishing is only permitted when it is proved that the activity will not cause undue harm to fish stocks or the marine ecosystem rather than the present situation when fishing restrictions are only accepted if the fishing activities are proved harmful. In this case the burden of proof should be placed with the fishing industry while the public science would audit such claims. The real challenge for the science-policy co-production is now to develop the scientifically justified procedures for such a reversal of burden of proof process. This probably would move the boundaries between the public science, industry and management and introduce a science compartment in the industry box.

Poor data – uncertain science – uncertain policy

European Court of Auditors conclusion (2007): incompleteness and unreliability of catch data prevent the TAC and quota system, which is a cornerstone in the management of Community fisheries resources, from functioning properly while the regulatory framework and the procedures in force guarantee neither the exhaustiveness of data collection, nor the detection of inconsistencies during validation.

Fisheries economics: research topics

Fisheries economics is considering the resource rent (economic rent) as a key concept in fisheries management being the driving force behind the widespread overexploitation of fishery resources and, at the same time, determining the potential economic and social benefits that may be derived from well-managed fisheries. If the costs cover all elements used to produce a given level of exploitation in a fishery including an acceptable level of return on capital then the resource rent is any revenue received in excess of this amount.

Economic objective is to maximize net economic benefits (sustainable rents) flowing from the fishery while efficiency of fisheries may be measured as the difference between maximum rents obtainable from the fisheries and the actual rents currently obtained. Rent dissipation could be used as an efficient (inverse) metric both of the economic and biological health of the fishery concerned.

<u>Important research topics</u> include: 1) studies on future development of property and use right systems while such systems will have major implications both for the generation of resource rent and for its sharing between different stakeholders, 2) studies in support of developing policy on how to design management arrangements that prevent resource rent from being dissipated.

Socio-economic advice, would ICES decide to move in this direction will require, among other qualifications the capacity:

1) to understand the concept of resource rent in general and the concept of Maximum Economic Yield (MEY) in particular
2) to calculate the maximum rents obtainable from the fisheries and the actual rents currently obtained
3) to use rent dissipation an inverse metric both of the economic and biological health of the fishery concerned
4) to understand property and use right systems while such systems have major implications both for the generation of resource rent and for its sharing between different stakeholders
5) the understand reasons to collect resource rent (sometimes called 'super-normal profit' or 'super-profit'), rent collection mechanisms and associated traditional cultural and societal values.

Assessment of socio-economic consequences associated with changes caused by CFP reform

It would be necessary to assess the socio-economic consequences related to:

1) reduction the EU fishing fleet overcapacity (better economic performance, less employment),
2) introduction of a system of transferable fishing rights (concentration of business, less employment, cost of public control),
3) managing the fisheries based on MSY concept, and setting up in addition to biological objective also clear economic (Maximum Economic Yield, resource rent, resource fee) and social objectives (employment),
4) regionalization of the fisheries management (win – win or who are the expected winners and losers),
5) giving more responsibility to industry (cost of self-management and the public control, culture of compliance),

6) changing / removing the principle of relative stability (win – win, expected winners and losers, redistribution of the fishing possibilities),

7) integrating CFP into the broader maritime policy context (EU Integrated Maritime Policy, marine spatial planning, reallocation of marine space, alleviation of socio-economic impact of reducing capacity in the catching sector).

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5.4.5 Integrated Modelling of Socio-Ecological Systems in Australia

Richard Little

Human response to management decisions is a great source of uncertainty in natural resource management, and understanding human behaviour and decision-making is an important step in sustainable management of fisheries and marine systems, particularly under changing environmental conditions. We have worked on developing a wide range of models involving human behaviour that help us to better understand and evaluate strategies for managing natural resources. This work covers the development of vessel dynamics models of fishing behaviour on the Great Barrier Reef (GBR), including models of individual quota trading, and information sharing among vessels in social networks. Our work also includes the development of a large integrated agent-based model of a marine ecosystem and economy on the northwest shelf of Australia.

For the Reef Line Fishery on the Great Barrier Reef of Australia, vessel dynamics models have been developed to accurately simulate the spatial distribution of effort across the reef system, as well as the temporal distribution of effort that has developed with the recent implementation of an Individual Transferable Quota (ITQ) management system. These models are agent-based. The behaviour of the vessel agents associated with spatially allocating effort across the roughly 4000 reefs of the GBR has been parameterized based on discrete choice random utility models. Agent behaviour associated with buying and selling quota is based on their initial quota allocation, seasonal fish prices as well as the individual variable costs, fishing efficiency, fishing experience and spatial constraints of vessel port range. With the objective to maximize profit, vessels either purchase or sell quota of either species, if it is in their best interest to do so.

For the northwest shelf of Australia, we have developed a large integrated agent-based modelling framework to evaluate prospective multiple-use management strategies. The framework, called *InVitro*, allows us to represent the biophysical and socio-economic components of the region as either individual agents, or as a broader scale analytical model, all in a single agent based modelling structure.

Agent representations of the biophysical environment include benthic habitats, fish species and their potential dependence on benthic habitat, and large megafauna. Representation of human use of the marine environment include commercial trawl and trap fishers, recreational fishing, shipping, and land-based industries that produce outfalls. In this virtual world, we also simulate the management and procedures that occur in the marine environment including fisheries stock assessments and decision procedures, outfall monitoring and mitigation as well as an agency integrated conservation management procedure.

Results are shown to illustrate some of the effects of modelling the human dynamics on the environment, and how we use these models to compare and evaluate the potential effectiveness of management strategies in achieving the goals and objectives of managing the fisheries and the marine environment.

5.4.6 Options for bio-socio-economic modelling for advice support: *Examples from USA and Norway*

Dorothy J. Dankel

This presentation focused on two papers and techniques used to incorporate more holistic evaluations of management strategies for decision-makers. The first paper was initiated by stakeholders' lack of knowledge of the consequences of incorporating new gear technology in the Georges Bank groundfishery (Northeast USA) and the scientific challenge of integrating a simple bio-socio-economic assessment of the effects of three different groundfishery trawls (the otter trawl, the Separator trawl and the Ruhle trawl) (Dankel, Jacobson *et al.*, 2009). The main objective was to create a toolbox to enlighten managers and stakeholders on the potential unforeseen biological (yield and spawning-stock biomasses of 7 groundfishery stocks) as well as socio-economic consequences (employment hours per year and producer surpluses) that result from exclusive use of each of the three trawls. This was done by coupling a mixed-stock yield model with a socio-economic model that included an employment-effort relationship, catchability coefficients of the three trawls for each of seven groundfish species, costs and species-specific catch revenues. The results show a menu of management options for decision-makers, so depending on the management objectives, the best number of days at sea (the fishery currently runs under effort-based management) per year may be determined. Perhaps the main result is that indeed integrated bio-socio-economic assessments can be made when an interdisciplinary team of scientists can gather and integrate their data in a meaningful way for managers and stakeholders.

The second paper (Dankel, Jacobson *et al.*, 2009) takes a more theoretical look at how integrated biological and socio-economic assessments affect unique stakeholder utility function. The main objective here was to be able to quantify Hilborn's qualitative notion of a "zone of new consensus" between heterogeneous stakeholder groups (Hilborn 2007). To do this, Dankel *et al.* (Dankel, Heino *et al.*, 2009) introduce a framework (Figure 5.5) of assessing stakeholder satisfaction and zoning in on management strategies that bring the greatest benefit for all stakeholders, also known as Ralwsian utility (Rawls 1971; Rawls 1974). The bio-socio-economic model was calibrated separately for the cod and capelin fisheries in the Barents Sea. Only through the development of a bio-socio-economic modelling framework can the holistic quantification of stakeholder desires be undertaken. The results show that when two management regulations (harvest rate and minimum harvest size) are taken into consideration, the capelin stakeholders are able to achieve 76% of joint stakeholder satisfaction whereas the cod stakeholders realize 97% joint satisfaction. Thus, quantification of the most important utilities of a fishery (yield, spawning-stock biomass, employment and profit) can lead to clarification of management strategies robust to stakeholder desires.

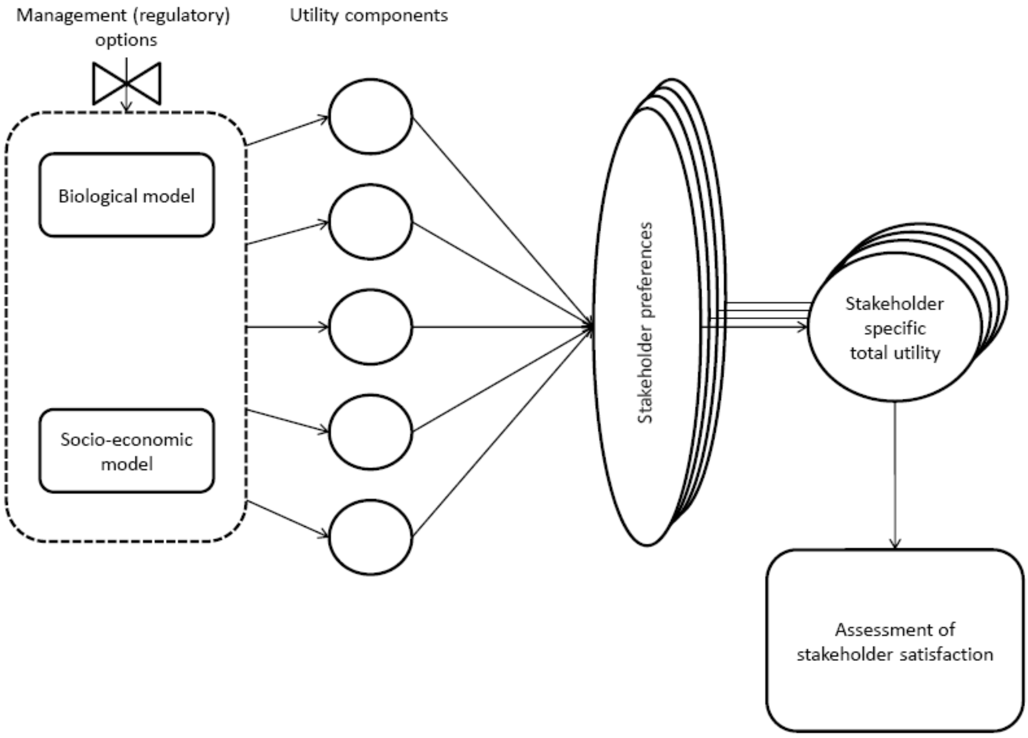

Figure 5.5. A schematic representation of the framework introduced by Dankel *et al.* (Dankel, Heino *et al.*, 2009).

5.4.7 References

Dankel, D. J., M. Heino, *et al.* 2009. "Can integrated assessments reconcile stakeholder conflicts of interest in marine fisheries management?" in prep.

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5.4.8 Workshop on Introducing coupled ecological – economic modelling and risk assessment into management tools

Jörn Schmidt

During the session on TOR (c) a workshop was advertised which will take place from 16–18 June 2010 in Kiel, Germany. The workshop will concentrate on methodological approaches regarding integrated economic and ecological modelling and risk assessment in a regional scope. Regarding the terms of reference, the workshop aims on reviewing regional scale model framework examples, to identify necessary data, to identify ways to use these frameworks in management, and to identify ways to evaluate risk assessment scenarios. A lot of work with respect to relevant economic modelling has been performed, but not fully used in the current work of ICES. Thus, the workshop explicitly wants to invite expertise from outside ICES to fully explore the possibilities on future cooperation with the economic discipline. It will build upon the experience of several EU projects, e.g. EFIMAS as well as a recent EU-tender reporting on bioeconomic modelling, and reflect on work already done within ICES expert groups like SGMIXFISH or WGFS.

The workshop was proposed during the work of the Working Group on Integrated Assessments of the Baltic Sea (WGIAB) and, thus, one case study area will be the Baltic Sea. However, cross-case study comparisons are highly welcome, e.g. North Sea and outside ICES examples.

The outcome of the workshop will be complementary to the work done within WGFS and a close communication between the groups is necessary to maximize the value of the products.

5.4.9 The SMAST Decision Support System for Fisheries Science

Azure Dee Westwood

The School for Marine Science and Technology (SMAST) is the marine science research arm of the University of MA at Dartmouth, located near the large fishing port of New Bedford on the east coast of the USA. SMAST does a lot of advanced technology work in fisheries and undersea research. Much of this work involves close collaboration with the fishing industry, earning SMAST a good reputation and status of trust with industry which poises us to expand our research endeavours. Some of the projects we're involved with include sea scallop surveys, ecosystem modelling, habitat conservation, lobster surveys, and groundfish tagging.

In early 2009, collaboration between SMAST researchers and the University of Massachusetts at Dartmouth Department of Engineering developed into a 17-member team dedicated to developing a Systems Approach to fishery science and management in New England. The team has defined its mission to: "…establish a research team to apply a systems approach to fishery science and management for utilization of fish resources while sustaining and enhancing the existing population."

Since February 2009, there have been seven systems team meetings, a dedicated brainstorming session, and a half-day workshop by an outside systems dynamacist. The meetings have included professors, stock assessment biologists, graduate students, fishery scientists and post-doctorate researchers. Over this period, the team has been successful in defining the current fishery science and management system in New England which includes a 'road map' outlining the different subsystems that make up the fishery complex.

In keeping with the intentions of a systematic approach to research, the systems team drafted a complete Strategic Plan including detailed objectives, plans of action, and goals for the next two years. Using the strategic plan for the team, Task Forces and sub-teams have been formed to examine specific plans of action. For example, the Stakeholder Task Force, a team of four researchers, developed a comprehensive list of all individuals and businesses involved in the fishing industry in New England, including contact info. The Task Force is currently working to prioritize the extensive list using techniques from Norwegian fishery researchers. The task force will narrow the list to include those who have the most 'stake' or dependence on the fishery for later integration into the system model.

As part of the systems approach, SMAST has also developed what it is calling a Decision Support System Program (DSSP). This a tool developed by modellers at SMAST that can advise fisheries managers on what the optimum management strategy would be for a given species under certain conditions and objectives. There is a user-friendly interface that allows managers or other users to enter information such as the species under management consideration, the desired management year, the fish stock distribution, fishing effort, CPUE, habitat criteria etc. The program also allows one to define subareas for managing, to set constraints (i.e. Days at Sea, Total Allowable Catch, gear types, etc.). The program would then provide an estimate of CPUE based on historical data for the area selected and provide an output optimization of how much of that species to catch, when and where based on the areas you've defined.

While the DSSP can be used to benefit fisheries management, it has not been tested by managers. We are working to revitalize the program into two components, one for managers and one that can be used to help the fishing industry decide optimal areas to fish in that meet management requirements while maximizing their profits. But any DSSP is highly dependent on the data contained within it; bad data will result in bad optimizations, which can lead to bad management advice and decisions. In addition, absent from the DSSP is socio-economic data. These are all things we are starting to address now and will work to improve the DSSP through several iterations of the model and our systems team process.

With that background to what we're doing at SMAST in terms of systems, one of the key elements in our road map of fisheries is socio-economic considerations. Throughout fisheries we see social and economic considerations as a major consideration – from human impacts on the system, to stakeholder input, to research involving industry-based surveys. We recognize that objectives vary in fisheries – the objectives that the government or management have is not necessarily congruous to what stakeholders like the fishing industry may have.

We plan to do several things to address socio-economic issues in our work, which may serve useful to ICES. A systems approach is helpful in identifying socio-economic data needs by presenting the fisheries system in a schematic way that clearly shows where the data needs and gaps are. Our plans for incorporating socio-economic issues are:

1) Create a database of all major fishery stakeholders in our area (name, contact details, etc.).

2) Also using methods from Mikalsen and Jentoft (2001) to develop a ranking of stakeholders in terms of their relative "stake" in the fishery process.

3) Conduct focus group discussions with the fishing industry and other participant communities to refine fishery management objectives

4) Collect feedback from fishing industry, managers, environmentalist, and other stakeholders on existing fishery management strategies. Use the stakeholder database for contacts.

5) Determine data needs of the current DSSP – identify what's missing in terms of data fields (i.e. socio-economic data).

6) Collect the missing data through existing sources. Supplement missing data by conducting SMAST surveys, focus groups, interviews, oral histories, etc. Utilize sites like HumanDimensions.gov as a resource to gather information as well as develop methods and tools to collect socio-economic data.

7) Conduct oral histories and use Atlasti text analysis software to determine themes in stakeholder concerns; also makes analysis of large volumes of

text like contained in an interview transcript, more manageable and in a timely fashion.

8) Develop an objective function that correlates socio-economic impacts with fishing strategies in terms of revenue, costs, fleet distributions, multispecies interactions, and other biological factors (4c).

9) Establish an education workshop in sustainability for fishing industry.

10) Deliver results of systems work and DSSP to industry members through formal and informal presentations around the region.

SMAST has developed a strong reputation among industry for being a scientifically rigorous partner in conducting fisheries research. Our reputation will strengthen our ability to gather socio-economic information throughout New England.

Annex 1: List of participants

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Annex 2: Agenda

Tuesday October 12th

10:00 Welcome and introduction to the tasks of the meeting

Presentations, ToR b)

10:30 ***Marion Dreyer:*** *Summary of workshop on experiences from participatory modelling.*

11:00 ***Päivi Haapasaari:*** *Participatory modelling to enhance understanding and consensus within fishery management*

11:30 ***Ewen Bell:*** Science - *stakeholder interaction with regards to North Sea Nephrops fisheries*

12:00 ***George Tserpes:*** *Participatory approach in the Mediterranean swordfish case study*

12:30 ***Rich Little:*** *Participatory Fisheries Management and Research on the Great Barrier Reef of Australia*

13:00 Lunch

14:00 ***Martin Aranda:*** *Developing a long-term management plan for Northern hake*

14:30 ***Doug Wilson:*** *Participatory modelling in Horse Mackerel*

15:00 ***Questions***

15:30 ***Coffee break and trial run, web conference***

15:45 ***Samu Mäntyniemi:*** *Bio-Socio-Economic management advice using influence diagrams: The role of ICES?*

16:15 – 18:00 Discussion on ToR b)

Wednesday 13 October

9:00 Teresa Johnson *Collaborative research*

9:30 Background and introduction to ToR c)

9:45 ***Robert Aps:*** *ICES advice – co-production of science and policy*

10:15 ***Rich Little:*** *Integrated Modelling of Socio-Ecological Systems in Australia*

10:45 ***Dorothy Dankel:*** *Options for bio-socio-economic modelling for advice support Examples from USA and Norway*

11:15 ***Coffee break***

11:30 ***Doug Wilson:*** *Why, in God's name, would ICES want to give social science advice?*

12:00 ***Jörn Schmidt:*** *Announcement: Workshop on introducing coupled ecological – economic modelling and risk assessment into management tools*

12:30 ***How to structure the discussion on ToR c)***

13:00 – 14:00 Lunch

14:00 ***What are the key questions to address at the web conference?***

14:45 ***Coffee break***

15:00 – 17:00 *Web conference on ToR c*

15:00 Azure Dee Westwood: *Developing a systems approach for fisheries in New England, USA*

15:30 – 17:00 Discussion

Thursday 14 October

9:00 Introduction to ToR a)

Group discussion/writing on ToR a), b) and c).

13:00 Lunch

14:00 – 17:00 Group discussions/writing

Friday 15 October

9:00 Plenary presentations of group discussions

12:00 -13:00 ToRs for 2010 and wrap up!

Annex 3: WGFS terms of reference for the next meeting

The **Working Group on Fishery Systems (**WGFS) chaired by K.H. Hauge, Norway, will meet 11–15 October, ICES headquarters, Copenhagen 2010 to:

a) Review and generate recommendations about the future structure of risk evaluation and management strategy research within ICES toward greater inclusiveness across the fisheries system and greater usefulness in policy advice. This includes re-evaluating the role of WGFS in light of several other ICES groups involved in risk evaluation and management strategy.

b) Evaluate the past contribution of WGFS activities on ICES as a way to inform future directions;

c) Review ongoing work in social network analysis on the science - policy boundary.

WGFS will report by 1 December 2010 (via SSGSUE) for the attention of SCICOM and ACOM.

Supporting Information

Priority	The main focus of WGFS is the fishery system and the role of scientific advice within that system. The system-based approach relates directly to priorities such as developing an ecosystem-based approach to management and the effective implementation of the precautionary approach. Consequently, these activities have a very high priority. The work of the Group is also essential if ICES is to advance the development of realistic projections of fisheries development that account for the reaction of other parts of the overall fisheries system.
Scientific justification	The Group met in 2000, 2001, 2003, and 2004 to develop a framework for case study analysis and has identified European (North Sea cod) and North American (Georges Bank mixed fisheries) case studies. Funding for the European case study had been granted from 2003 under the EU Framework V Programme; funding for the North American study was granted from 2004. This effort resulted in 7 papers that were published in the special issue of the ICES JMS based on the Symposium on Management Strategies held in Galway in 2006. The key role for the WGFS is to integrate across disciplines to develop analytical and investigative methods/approaches for studying fishery management systems. The main but not exclusive focus of these investigations of the overall fisheries system is to improve the effectiveness of scientific advice. The Group met in 2005 in conjunction with the PKFM, FEMS and EASE projects all of which dealt with organizational and institutional aspects of the production of scientific advice. The 2006 meeting placed a strong emphasis on the ecosystem-based approach and particularly the issue of spatial planning. The 2007 meeting also considered and provided specific recommendations in relation to ICES current reorganization of the advice system, especially in respect to the European Marine Strategy and the role of the Regional Advisory Council. The 2008 meeting invited experts from policy arenas outside fisheries to discuss the ways they handle uncertainty in making scientific advice. The 2009 meeting discussed experiences with participatory modelling and ICES options for socio-economic advice.
Resource requirements	Secretariat support for meeting.
Participants	These include scientists working with fisheries management, both from an economic, social and biological perspective. Participation is from ICES countries and scientists both from disciplines and scientific circles not traditionally represented at ICES.

Secretariat facilities	No additional software/hardware is anticipated beyond that which is currently available.
Financial	No financial implications.
Linkages to advisory committees	The goal for this Working Group is to better understand fishery management systems which is a central element of the work of ACOM.
Linkages to other committees or groups	Close links to SGMAS and SGRAMA who address the technical aspects of management strategies.
Linkages to other organizations	WGFS will continue to seek to widen participation for this group, including contact with relevant academic and inter-governmental organizations.