Best Practices for Provision of Scientific Advice to Sub-national Fisheries Management

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Best Practices for Provision of Scientific Advice to Sub-national Fisheries Management

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Introduction to the SAFMAMS project

The objective of SAFMAMS is to draw insights from existing research projects and management processes on the most useful forms of scientific advice for marine environmental management and to communicate those insights to scientists and decision-makers.

The research is carried out on different levels to address the important issue of geographical scale in scientific advice and its translation into management. The SAFMAMS project is looking at the use of scientific advice at the European level, the level of shared seas (i.e. in the work of the Regional Advisory Councils) and the sub-national level in relation to cooperative "co-management" programs.

The subject of scale is the key to the SAFMAMS project. It is assumed that the geographical scale of the environmental management problem is the most important variable in determining what kind of advice that will be most efficient (Degnbol, 2003). The two main reasons for this is that the larger the scale the more aggregated data must be used to create a picture of the condition of the natural systems; and that the larger the scale the more social interests and political jurisdictions are involved in decision making.

Scale in marine science:

The scales used in marine science have traditionally been based on single species perspectives. Local data collected was aggregated and generalised to give information on the general condition for the species. Even though the ecosystem approach is now lifted, there is still a tendency to focus on single species, and there is confusion on how to define the ecosystem. The knowledge produced is aggregated from the local, specific to the generalised, higher level (from local samplings to create an estimate of entire species – often shared seas level).

Scale in management:

Management, on the other hand, is based on the human structures in society. Local management is based on local socio cultural and economic structures (community-based). The knowledge needed at this level is specific: understanding changes in the local ecosystem – not entire species, but the interplay between human activity and local ecosystem factors. The advice needed at this level is highly local and should allow for quick adaptations to change (flexibility, response to change).

The end product will be an outline of the various forms that such advice can take and a description of the circumstances under which these various forms are the most useful and cost effective.

The sub-national level

Initially, a review of the role of scientific advice in local fisheries management was produced. It provided an overview of the different kinds of scientific knowledge used to produce advice; the scale of the research; the types of advice produced; the methods used for disseminating the results; the intended users; and the implications of these factors on sub-national fisheries co-management.

The review also served as the point of departure for discussions between project scientists in SAFMAMS and local stakeholders on some of the main themes:

What types of scientific advice is helpful in local co-management?

What are the possibilities and problems in interfaces between scientific and experience-based knowledge?

How can scientific advice be improved to be of better use in local management?

The local input of experiences and examples was needed in order to evaluate the main findings in the review, but more importantly: *to understand the implications of scientific knowledge on local management efforts and how the production and communication of scientific advice for the local level can be improved to facilitate better management.*

Three areas had been selected at the conception stage to inform and guide the work: the Wash in north Norfolk, UK; the Koster-Väderö fiord on the Swedish west coast; and Pärnu Bay in Estonia. These local study areas were picked out to represent and exemplify areas where marine co-management is needed and/or used to mitigate the diverse interests in the area.

The SAFMAMS process has included two workshops with representatives from each area. At the first workshop, stakeholders involved in co-management in the three areas were asked to offer their reactions and comments to the draft review, as well as to share their experiences of the local management situation and the use of scientific knowledge. During the second workshop, the stakeholders were asked to design the forms of advice that they find the most useful for addressing their management situation. Eventually, this will conclude in a Best Practices for Provision of Scientific Advice to Sub-national Fisheries Co-Management.

Review of European research projects

During the collation phase for the review, a total of 188 research projects were analysed for their implications on local fisheries management. Also, a large number of research reports and literature was studied to collect information on the use of scientific knowledge at a local scale.

The projects involve many different universities and institutions in Northern Europe and are funded through a range of funding sources: multi-national, European, national or private. The projects analysed are/were running between 2000 and 2008.

Project descriptions (containing objectives, partners, methods, type of scientific advice produced, dissemination method and project outlines) were sorted using a number of categories *designed to provide insights as to what kinds of scientific advice are produced by whom, how and for what ends.* The categories were:

- Research objective: basic science or applied science
- Type of scientific knowledge used in the project: natural science, social science or uni- multi- or interdisciplinary.
- Scale of research project: EU, regional or local

Key findings in the review

The forms and communication of scientific advice were explored, with the main findings being that: there is a spatial disjunction between local management and quantified science and modelling, which can provoke conflict; specific knowledge of changes in the local ecosystem is needed; science can be inaccessible, especially to stakeholders; and, there is very little knowledge exchange between co-management contexts.

Some priority actions were identified. These included: increasing open co-management; developing methods, such as indicators, to evaluate local ecosystem change; increasing knowledge integration; evaluating local management efforts; increasing knowledge-exchange on local co-management; increasing take-home of knowledge from research projects and more general scientific advice; incorporating local experiential knowledge in the scientific process.

Use of experience-based knowledge

Experience-based knowledge (EBK) is local, non-scientific knowledge. This kind of lay knowledge is well documented and studied in several social science disciplines (Bicker *et al.*, 2004), but very rarely studied in interaction with scientific knowledge.

In scientific research, EBK is sometimes used at some stage of the process. Until now, however, EBK has primarily been seen as a socio-cultural complement to scientific knowledge and has primarily focused on non-technical aspects. Local stakeholders have played other roles in scientific research, for example collecting data, testing new gear or technology, or contributing to evaluations or presentations of results.

Parallels can be drawn between stakeholder involvement in co-management and in scientific research. In a study of a range of co-management implementations in Africa and Asia (Raakjaer Nilsen *et al*., 2003), various management forms could be distinguished based on the type of user participation.

In *'Modern co-management'* authorities control all levels of the management process (definition of objectives, production of knowledge, implementation and evaluation).

In *'Instrumental co-management'* stakeholders are included in the implementation process.

In *'Empowering co-management'* stakeholders participate at all levels of the management process.

Similar categories can be used to define stakeholder involvement in scientific research, as follows:

'Traditional research' does not involve stakeholders or EBK in any shape or form. If human activity is considered, it is objectified and made quantifiable.

'Instrumental research' uses stakeholders or EBK as a means for collecting data (either the stakeholders are instructed to collect information using scientific methods; or stakeholder information is 'translated' into scientific knowledge using statistics or other quantifiable methods).

'Participatory research' uses stakeholder knowledge but it is seen as separate and parallel to scientific knowledge.

'Interwoven research' involves stakeholders as equal partners in all aspects of the research (from description of project objectives and production of knowledge to implementation, dissemination and evaluation).

Research objectives

The majority of the research projects investigated (60 %) fall into the category "basic research". This is especially the case for projects with a natural scientific emphasis funded through EU, the Nordic Council of Ministers and the national research institutions. The most common research objectives among these projects are:

To acquire more knowledge on species and ecosystem interaction (development of new methods)

To develop an understanding of correlation between factors (development of modeling tools and methods)

Synthesizing knowledge (databases used primarily by scientists)

The remaining projects are mainly doing applied research, these included all the social science projects, as well as th majority of the projects co-funded by NGOs, regional efforts, HELCOM and to some extent MISTRA[1].

In projects carried out in new and aspiring Member States, there is also a bias towards applied research such as mapping, synthesis, monitoring and educational efforts that would otherwise be financed by the state.

The most common research objectives among the applied research projects are:

To develop models, indicators or systems that will help assessing the status of ecosystems and predict changes and risks (help forecasting ecological and economical consequences of different scenarios or management tools).

To develop systems for dissemination of scientific results (networks, databases and educational material) to stakeholders at different levels.

It should be noted, that in most cases there is no analysis of the recipients/stakeholders when creating systems for dissemination of scientific knowledge, just as no efforts are made to include non-scientific, experience-based knowledge. The stakeholders mentioned are most often other scientists, decision makers (EU or national level) and/or managers at different levels. Only rarely are local stakeholders (fishers, greens and other marine resource users) involved and then mainly in projects dealing with technological improvements to gear, local management efforts and/or networking activities.

The main objectives found in social-science projects are:

To assess economic effects of ecosystem and management changes

To model stakeholder behaviour using economic models

To understand stakeholder interaction processes in management and/or conflicts

To develop methods for co-management at a regional and local level.

The review showed that the vast majority of research projects relevant to the local level uses natural science knowledge exclusively. However, the natural science projects include a broad variety of research fields, such as marine biology, zoology, limnology, microbiology and systems ecology. Computer-science and space technology is also increasingly used, specifically for creating models and interpretation of satellite data. An increased focus on ecosystem-perspectives is evident not only in the project descriptions, but also in the efforts to bring together experts from different natural science areas. Overall, the level of integration between different disciplines within the natural science realm appears to be relatively high.

Of the natural science projects evaluated, about 20 per cent contain a social science element. The socioeconomic research is always clearly separated from the main research, and the socioeconomic objective is mainly to assess effects of ecological or economical changes or management efforts. It seems that the term “socioeconomic” is mainly used to describe economic research andh analysis. Sociology is primarily used in conflict analysis and to some extent in knowledge and management analysis, but other related social scientific disciplines are not represented. Integration between the natural and social scientific knowledge was very limited and can only be described as multidisciplinary.

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[1] Bonus 2005 indicates a 50/50 allocation of funds for basic and applied research.

Some projects (23 of the 188 investigated) can be considered to be based primarily on socio-economic knowledge. A majority of them focus on either economic analysis of the fishery sector or the development of tools to assess the economic value of marine ecosystem goods and services. The remaining are either concentrating on conflict interaction, investigating different management options or studying behaviour, interaction and interests amongst stakeholders or one specific stakeholder group (for instance women in fisheries).

Use of experience based knowledge (EBK) in research projects:

Local stakeholders are generally not very visible in the scientific projects that were analysed. Stakeholders were/are not mentioned as anything but possible benefactors of the results in any of the natural science projects producing basic science[2].

In the applied research, on the other hand, stakeholders are more often involved in certain stages of the testing and developing of gear or technology (for instance in development of seal-safe gear, acoustic deterrents, etc.). This is the one area where cooperation between scientists and user groups occurs systematically and frequently. In the technical projects, the interface between scientific and experience based knowledge is even instrumental.

A few of the social science projects study stakeholder behaviour and interaction in fisheries management or conflict. Here the stakeholders are the objects of research, and EBK is used to shed light on different stakeholder perspectives. It is not questioned whether or not EBK is valid or not in these projects, rather the knowledge is used to understand stakeholder perspectives and dynamics, and subsequently, EBK is objectified rather than integrated.

In general, the natural science projects can be categorised as either ‘traditional research’ or ‘instrumental research’, while some of the multi-disciplinary projects and most social science projects are doing ‘instrumental’ or ‘participatory research’.

Scale, form and intended users of scientific advice

Whereas geographical scale is intimately related to the *form of advice* needed and the *method used to produce the advice*, knowledge on local ecosystem conditions is needed for successful local co-management. However, scientific knowledge is driven by the need for methodological validity, and the use of quantifiable data has often determined the scale of the research. For example, the natural science projects doing basic research focus on quantifiable data collected from several local areas (for instance using research vessel surveys) that allow for generalisations on a higher ecosystem level (for instance the Baltic Sea).

In addition, the results produced in the basic research projects are primarily aimed at a scientific audience. They are mostly presented and disseminated in one of the traditional scientific forms: scientific reports, scientific models, methods for modelling or databases for scientists.

Even though some of this scientific advice might be helpful in local management processes, the strict scientific form and dissemination methods make local application difficult and the results less accessible to outside users. It requires that stakeholders:

Know about the project and the results

Have a basic scientific knowledge that allows them to penetrate the scientific results

[2] Some of these projects might actually use data collected by local fishers etc., but if so it is not mentioned in the project methods, description or objectives.

Have an ability to translate the basic scientific results into applicable forms

In the review as well as in the interviews and workshops, we found that this puts rather high strains on local stakeholder groups as the mere task of going through all of the results to assess local applicability is a very time-consuming task requiring appropriate knowledge and training. Therefore the stakeholders will most often have to rely on applied research or good contacts within the scientific community to gain access to the relevant knowledge and findings.

There are several forms and dissemination methods in applied science, spanning from the traditional mentioned above to somewhat more user-friendly and participatory scientific forms such as databases, management plans, workshops, networks and educational materials.

In the review, the aim of several projects in the applied research category was to create networks and/or databases. This is even more common in projects with participants from countries that are new or accessing to the EU, and where there may be a greater need for establishing better contacts within the European scientific community as well as integrating knowledge systems (particularly in the Baltic Sea area).

The majority of the databases studied were either attempting to compile the same type of international or European data or bring together previously unrelated data to investigate connections. Again, the intended users were primarily scientists and managers.

The networking activities described in the projects often brought together same-field scientists on an international, European or shared seas level. Networks involving scientists and stakeholders from the relevant marine industries were represented, as well as broader networks bringing together scientists and higher-level managers (EU and national). Networking on sub-national level is mostly funded through national or regional efforts.

It is evident that there is a great interest in developing new methods for assessing effects of change within ecosystems and economy using models. Today, there are several types of models that bring together multi-species data with ecological, economical and/or managerial factors to investigate impacts (on a single species or on inter-related factors and species within the ecosystem). The models and modelling tools are commonly presented at workshops or network activities for a selected number of scientists, decision-makers and managers.

Models that identify precautionary thresholds – most commonly used in natural-science projects dealing with risk assessment.

Trend assessment methods – increasingly used to assess the effects of ecosystem change on one or several species.

Models that predict specific risks or phenomena – uses fuzzy logic to identify critical locations and periods that are susceptible to, for instance, harmful algal bloom.

Models that assess economic and ecologic consequences of different management options and ecosystem changes – mostly used in research on economical impacts of different management options.

Methods to identify ecological indicators that can be used at local and regional levels to assess the ecosystem status. Less common than the others, but attempts to use indicators or key factors to assess local and/or regional stocks or to predict ecosystem alternation at a local ecosystem level are being made.

Looking at the models and methods above from a local management perspective takes us back to the problem of scale. Models rely on data that is quantifiable (aggravated and generalised). Ecosystems fluctuate and change and are interconnected to other ecosystem levels, as well as climate and anthropogenic factors. It is therefore difficult to balance generalisations with local specifics to enable assessment or prediction at a local level. Local management is specific, whereas the quantifiable research is general (Degnbol, 2003). The risk of conflict between scientific research, advice and local management needs increases if the research methods used are not adapted to the management level.

The increased focus on ecosystem perspective and regional management will call for cost-effective methods for use at local and regional levels; the identification of indicators and key-factors are examples of efforts in this direction.

But currently, research results are primarily directed toward scientists, decision-makers or managers at European, national and regional levels. In projects with more practical technical objectives (development of new modelling methods; new gear-types; methods for restoring coral reefs) the results are commonly presented to members of the relevant industries or stakeholders.

Today, results and a project evaluation will often be combined in a workshop or networking activity, pulling together scientists and intended users. The absolute majority of projects studied here (with the exception of about 40–50 projects that use a varying degree of more intensive stakeholder participation methods) only meet the user-groups in these final stages of the project, and then often in the form of advisory boards and/or regional representatives. There is a risk that the same representatives are used in many projects; making the representatives "professional stakeholder experts" and that the advice is not trickled down to the local stakeholders at a practical level (Piriz, 2004).

Management plans, advice and conflict resolution

Research projects producing management advice (in the form of results to be used as a basis for decision makers; or as management plans and conflict resolution schemes) are well represented in the evaluated projects. Government agencies (Board of Fisheries, Environmental Protection Agency) often fund efforts that can be fed into the development of management plans or resource evaluations at a national and regional level. This type of management advice is often presented in forms that can easily be fed into the political and bureaucratic systems – reports are relatively brief and concise. There is a clear over-representation of natural science projects; only in the areas "integrated coastal zone management" (ICZM), fisheries co-management, and conflict management are social-scientific research used in this way form.

The management advice is often based on single species, ecosystem perspectives or shared seas level. Still, management is indeed determined by human infrastructure: international, European, regional, national and sub-national levels of organisation, policies and commitments.

Social-science advice on the other hand, will often be based on human infrastructure and institutions – making it easier to feed into the management system. Problems often arise in interfaces between natural and social science knowledge forms, as the pre-conceived scales are not the same.

Development of new technology and gear

Concrete research that focus on development of gear and technology that is useful in specific settings to solve a technical problems (for instance development of seal-safe gear; pingers that repel porpoise; or probe systems that allow for measuring change in shallow waters).

The techniques are responding to local or regional needs – the focus is more on adapting technology to fishery method or ecosystem characteristics than on generalising data. Here the research is often very local, and the gear is tested by local user-groups. The results are presented in stakeholder workshops or by the national or regional fishery administrations. It seems that the technical aspect of the research leaves more room for local stakeholder participation as well as for local adaptation of technology.

Lessons learnt from the review

The review concluded that the majority of the projects were natural scientific, and that the objective in these was roughly 50-50% basic and applied science. There was a tendency for the projects to follow in traditional footsteps and base the scientific advice on generalised data at an ecosystem level (or shared seas level) that is not as specific as the local management areas. A broad variety of projects were represented, ranging from databases, models, stock estimates and ecosystem studies to gear development. The scientific advice was primarily addressed to the scientific community in scientific reports or as methodological tools (for modelling etc.), and to the national and regional stakeholders presented in workshops and popular versions of the scientific report.

The scientific knowledge integration between disciplines was high within the natural scientific realm, where disciplines complement each other. There was a social scientific aspect to some 20 per cent of the natural scientific projects, but in this respect social science was most often only represented by economics. It seems that social scientific disciplines that use qualitative methods, (such as sociology, anthropology, psychology or human ecology) are rarely used in combination with natural science in the fisheries research. When natural science and one of the social scientific disciplines mentioned above are combined, the disciplines are rather doing parallel research (multi-disciplinarily) than attempting deeper knowledge integration.

In the second part of the review, results from interviews with stakeholders from three local study areas were brought together. Similar management conflicts were reported back from all three areas. There are protected areas within both of the areas the Wash and Koster-Väderö and the conflict situations mainly evolve around nature protection versus fishery. In Pärnu Bay, on the other hand, conflicts concentrate on anthropogenic resource use and the need for more efficient system for fishery control.

A central subject in the review has been the subject of scale. The scales used in marine science have traditionally been based on single species perspectives. Local data collected have been aggregated and generalised to give information on the general condition for the species. Even though the ecosystem approach is now lifted, there is still a tendency to focus on single species, and there is confusion on how to define the ecosystem. The knowledge produced is aggregated from the local, specific to the generalised higher level (from local samplings to create an estimate of entire species – often shared seas level). Management, on the other hand, is based on the human structures in society. Local management is based on local socio cultural and economic structures (community-based). The knowledge needed at this level is specific; there is a need to understand changes in the local ecosystem – not entire species but the interplay between human activity and local ecosystem factors.

There is a general problem with translating scientific advice produced in research projects to the local management level. In all three study areas, stakeholders report that it is difficult to

Find scientific advice that is relevant to the local management situation. There are no resources at the local level to monitor and sort all scientific advice produced in international research projects for relevant knowledge to be used in local co-management.

Translate scientific advice produced within research projects at a higher level (shared seas or larger ecosystem levels) to the local ecosystem. To take on suck translation and adaptation of scientific advice, scientific resources are needed at the local level. The scientific officers working at the local level are not able to take on such tasks, as they are busy collecting and interpreting data from the local area.

Compare experiences from other local management areas. Though there might be important lessens to be learned from other local management projects, it is difficult to find the time and resources to extract knowledge that can be transferred from one area to another. More cooperation between local-level management groups and institutions is wanted by the stakeholders. Research projects that entail such knowledge (by comparing local cases or developing tools for knowledge transferral) are in high demand.

The majority of the stakeholders interviewed for the review have a natural scientific background. This reflects the traditional natural scientific focus in fisheries research, with marine biology as the central discipline. There is a tendency amongst the interviewed stakeholders to chalk down social scientific knowledge to “common sense”. It seems that the lack of social scientific human resources at a local level is even hindering adaptation of social scientific advice in co-management. Obviously, natural science is needed to understand the ecosystem status and change. But the ecosystem is met by human action based in society – therefore there is even a need for social scientific knowledge to account for human behaviour and guide towards successful co-management. Increased cooperation between natural and social science would be very fruitful at all levels to understand the interfaces between human society and marine resources.

The fishers and managers in the three study areas prefer scientific advice and management methods that allow for quick adaptation to ecosystem changes; and they are particularly interested in forecasting, monitoring and understanding the local ecosystem and its changes.

The fishers and industry are rarely involved in planning the scientific research (examples VI and VII are exceptions from this general trend). The fishers would like that their experiences could be integrated more in scientific research and that they could be more involved in data collection etc. The Eastern Sea Fisheries Joint Committee has succeeded in building trust from the fishermen during the last decade (see example III, V and VI). The Co-management initiative in Koster builds on an organization of stakeholders that has developed out of conflicts in the area. As part of the Co-management initiative courses are held for fishers in marine biology. The goal is to build trust between fishers and scientists, and to inform fishers of the methods used in research dealing with fisheries.

Nature conservation representatives, on the other hand, prefer scientific advice that has a precautionary quality. In their perspectives, ecosystem changes need to be monitored and evaluated over a longer time-period to be sure that it is valid. Here the need for pragmatic management and precaution collide – there is clearly a need for scientific and managerial methods for producing scientific knowledge at the local level for management purposes.

This need is not met by the research reviewed in the first part of this review.

The central question for future fisheries research should be: How do we create scientific advice that is scientifically valid, has a precautionary perspective and allows for adaptation to ecosystem changes?

Based on the review, it can be concluded that funding resources should be directed towards efforts that will support and develop local management initiatives. This includes

Developing methods and systems to evaluate ecosystem change at the local management level. This entails research that will support quick response to local ecosystem changes (indicators or other ecosystem evaluators) while at the same time taking into account precautionary aspects.

Developing methods for local co-management. (This includes pilot-projects as well as evaluation of existing projects as well as comparison of different methods.)

Research that evaluates local management efforts. How are natural protection interests balanced with marine resource use? What can be done to improve local co-management?

Developing methods and forum for knowledge exchange on local co-management. What lessons can be transferred from one local management situation to another?

Developing methods for local stakeholders to gain access to scientific advice produced in research projects. Funding authorities should encourage local application of scientific advice by adding applicability at the local level as a priority. Further resources can be directed to help translate scientific results to the local management level.

Finally, the subject of scale should be highlighted in all research projects, and further research is needed to analyse and support knowledge integration.

Developing methods to analyse experience based knowledge as well as ways to incorporate this local knowledge in scientific advice.

The local study areas

The local study areas in the SAFMAMS project have been picked out to represent and exemplify areas where marine co-management is needed and/or used to mitigate the diverse interests in the area. The local study areas are:

The Wash, UK

Pärnu Bay, Estonia

Koster-Väderö Fjord, Sweden

Process

The SAFMAMS process has included two workshops with representatives from each area. At the first workshop, stakeholders involved in co-management in the three areas were asked to offer their reactions and comments to the draft review, as well as to share their experiences of the local management situation and the use of scientific knowledge. During the second workshop, the stakeholders were asked to describe the forms of advice that they find most useful for addressing their management situation. Finally, a joint workshop was held gathering stakeholders from all three areas to discuss best practices, share experiences and lessons learnt and to facilitate international contacts at the local level. The conclusions of this process are set out in this paper on Best Practices for Provision of Scientific Advice to Sub-national Fisheries Co-Management.

Representation

Local representatives from three stakeholder groups were selected in each area. The representatives were considered to be key-informants due to their role in the management efforts, their knowledge and experience in the area, and/or their role as representatives for a specific group of stakeholders. In each area, 8-9 stakeholders were interviewed during the first phase and a similar number participated in the local workshops. It was not always possible to get the same stakeholders to participate in both events, but a similar representation was strived for.

The three main stakeholder groups were:

Scientists and local managers

Fishermen

Local nature protection representatives (governmental or NGO), i.e. “greens”.

Interview methods and exploration of best practices

In the first phase of the local component of SAFMAMS, interviews were carried out following a “practical interview guide”, structuring the main interview themes and designed to shed light on findings of the draft review of the role of science in cooperative fisheries management. The interviews were carried out in the three local languages: English, Estonian and Swedish.

The purpose of the second workshops was to learn more about best scientific practice in the local marine co-management context. In advance of the workshop, participants were provided with three documents: The Workshop Agenda; SAFMAMS Deliverable 3: ‘Review of the Role of Science in Cooperative Fisheries Management’; and an Executive Summary of the D3 report.

The objectives of the workshops were threefold. First, to obtain valuable feedback on SAFMAMS Deliverable 3: 'Review of the Role of Science in Co-operative Fisheries Management'. Interviews with the workshop participants had contributed to the Review paper, and the workshops provided a good opportunity to report findings and check facts. The second workshop objective was to gather examples from participants of their experiences of best practice in the provision of scientific advice to support fisheries at the local co-management level. Third, the workshop was intended to improve SAFMAMS understanding of how different stakeholders feel that scientific advice can be used better in the management of the fisheries and conservation efforts.

These objectives were achieved in three stages. First, an overview of the Review paper was presented to participants. This was followed by a discussion of the findings. Second, each participant was asked to think of an example of where they thought good scientific practice had been used to support fisheries co-management. Each of these examples was briefly discussed by the group. Third, participants were invited to discuss ideal characteristics of science to support fisheries co-management and strategies for developing those characteristics.

During the final joint workshop, representatives from each area provided presentations of the characteristics of the fisheries and nature conservation values, as well as the management systems in place. This was followed by joint discussions on particular themes. Practices were also explored through a fishing trip and a tour around some of the research facilitites at Tjärnö, Sweden, where the meeting was held.

Brief introductions to the study areas

Several similarities between the three study areas were found regarding the use of scientific advice in local co-management. They all contain nature protection sites. In the Wash and Koster-Väderö fiord, there has been some serious conflicts between resource users (fishermen) and nature conservationists (nature protection agencies and NGOs). In Pärnu Bay, on the other hand, there is less stakeholders representation for nature conservation. The Ministry of Environment is responsible for incorporating nature protection in management decisions. The conflicts in Pärnu have been evolving more around competition over resources between recreational and professional fishermen.

Some other differences were also noted: while management in the Wash seems to be more participatory and open to local stakeholders, the Swedish co-management pilot initiatives are aiming for that broad local participation and Estonian local management is largely coloured by a more centralised management culture.

The Wash, United Kingdom

Management structure

The Eastern Sea Fisheries Joint Committee (ESFJC) (www.esfjc.co.uk) is one of 12 Sea Fisheries Committees, which have inshore fisheries and environmental management responsibilities within the 6-mile limit around the coasts of England and Wales. The main offices of the Committee are in King's Lynn, Norfolk.

The Committee was formed in 1894 to protect inshore fish stocks along the East Anglian coast for the benefit of local fishing communities that relied on those fish stocks for their livelihoods. The Committee is now recognized as a leader in the field for its commitment to protecting the local fish stocks and the marine environment that they are dependent upon and for its approach to conservation for the benefit of the fishing industry generally.

The Committee is composed of 20 members, consisting of four County Councillors from Norfolk and three each from Lincolnshire and Suffolk. Nine members are appointed by the Fisheries Minister, as being persons acquainted with the needs and opinions of the fishing interests, or having knowledge of, or expertise in, marine environmental matters of the district. The Environment Agency appoints the final member.

The Joint Committee is an autonomous Local Authority in its own right, but does not receive any funding from central government. Funding of the Committee is totally provided by a direct levy upon its three Constituent County Councils, Lincolnshire, Norfolk and Suffolk, with their contribution being in proportion to their membership, i.e. Norfolk 40%, Lincolnshire and Suffolk 30% each. The annual budget is approximately £1.3 million.

The Committee appoints Officers to undertake its duties. In 2005 there were 21 members of staff and 2 patrol vessels and 1 research vessel. Further information on the organizations aims and objectives can be found on their website.

As a result of the increased export of shrimp, mussel and cockles for the continental market, pressure has increased on the stocks, especially the sedentary mussels and cockles. Both these species are managed through the provisions of the Wash Fishery Order that came into force on 4th January 1993.

Under the terms of this Order the Committee, working in close co-operation with the industry itself, can close shellfish beds, allocate areas of intertidal flats to individual fishermen for the cultivation of shellfish, impose quotas and limit the number of vessels licensed to work the beds. Therefore the Committee must be considered to be the primary tool for co-management in the area.

Main marine resources in the area

Fishermen within the Wash devote most of their time to fishing for cockles, mussels and shrimps (brown and pink) although the large double-beam trawl shrimp vessels range throughout the District as stocks dictate. Demand for all three species, mainly for Continental markets, has increased rapidly in recent years leading to heavy investment in vessels and sophisticated equipment both afloat and ashore.

The Wash & North Norfolk Coast are rich and varied wildlife areas, accommodating national and internationally important assemblages or migratory, breeding and non breeding bird species e.g. 163,000 waders and 51,000 wildfowl use the Wash including dark-bellied brent geese, knot, dunlin, bar-tailed godwit, sanderling, oystercatcher, wigeon, curlews, scoter, etc.

The North Norfolk Coast supports 4,500 pairs of Sandwhich Tern (c. 33% of the British population) 400 breeding pairs of Little Tern, 1000 pairs of Common Tern, c. 30% of the British population of Marsh Harrier, as well as Ringed and Grey Plover, Avocet, Shelduck, Pintail, Oystercatcher etc. A breeding colony of common seals, which accounts for c. 9% of the total UK population, is resident within the Wash.

Marine communities that are of international importance (e.g. Peacock and Ross Worms, dense Brittle Star and extensive Razor beds, Lug and Sand Mason Worms etc.) are also found here.

In addition, the North Norfolk Coast offers the only classic British example of a barrier beach system; extensive areas of saltmarsh and creek patterns that have developed behind sand and shingle bars and with clean mobile sand in exposed areas. Here, habitats range from the estuarine to those more suited to exposed coastal areas salt meadow and saltmarsh scrub.

On account of the unique environmental traits, the area carries several environmental designations:

3 Sites of Special Scientific Interest (SSSI), 6 National Nature Reserves (NNR), a Special Area of Conservation (SAC) and three Special Protection Areas (SPA) for its wild birds. The SPA sites are also Ramsar sites.

Pärnu Bay, Estonia

Management structure

Fish resources in Estonian waters belong to the Estonian state and management is the responsibility of the Ministry of Environment. The Department of Fish Resources manages and co-ordinates research, assessment, exploitation, stocking and protection of fish resources. The Estonian Marine Institute is the main academic institution involved in interdisciplinary marine science in Estonia; it was established in 1992. The role of Environmental Inspectorate is to control performance of fishery legal acts, inspect fishing harbours and fishing vessels in Estonian waters and make proposals to the minister on fishing restrictions and closures if fish resources are endangered.

Main marine resources in the area

Pärnu Bay is considered the most important fishing ground for Estonian coastal fisheries. Commercially, the key species is Baltic herring (*Clupea harengus membras*). Herring catches in Pärnu Bay have varied between 7,000 and 10,000 tonnes in the past decade. Other important fish species are perch (*Perca fluviatilis*) with catches around 300-400 tonnes; vimba (*Vimba vimba*) with catches around 100 tonnes; roach (*Rutilus rutilus*); and whitebream (*Blicca bjoerkna*) with catches around 100-200 tonnes. Formerly, stocks of pike perch (*Sander lucioperca*), with catches of over 400 tonnes, and smelt (*Osmerus eperlanus*), with catches of over 1,000 tonnes, were also abundant (IFM, 2006). Pikeperch used to be the second most important commercial fish (after herring), but catches decreased sharply after 1997 and the pikeperch fishery was closed in 2000 (EMI, 2004).

Pärnu Bay is a mixed fishery involving different fishing gears (e.g. gillnets, fykenets, pound nets) and exploiting a number of different species. In the herring fishery, pound nets are often used. In 2005, 175 pound-net licenses were issued (IFM, 2006). Both commercial and recreational fishermen exploit fishery resources. The number of fishers (excluding recreational fishermen) has been fluctuating during the last decade from 600 to over 700.

Recreational winter fishing on ice is an important feature of the Pärnu Bay fisheries. The estimated mean number of recreational fishermen fishing on ice for the winter 2001/2002 was 800-1,200 per day (up from 400-600 the winter before). This activity puts a high pressure on perch: it has been estimated that the mean catch during the 2001/2002 winter was 4.5 kg per fisher per day. Thus, the estimated total catch by recreational fishers is about the same as from the commercial fishery.

Koster-Väderö fiord, Sweden

Management structure

Since the 1970s, there have been ongoing controversies on various management levels in the area. In 2000, a conflict between conservation and fisheries interests was high-lighted when Swedish National authorities proposed to make a Marine Protected Area of the Koster-Väderö trench. Researchers and conservationists opposed trawling, while coastal fishermen were afraid that the proposed reserve would threaten their interests. A number of planning processes and projects were carried out to address the conflict and local participation has played a central role for finding solutions. For example a "Koster Board" representing various stakeholders was created.

Another recent step toward marine co-management is the Swedish Fisheries Co-management Initiative (SFCI). The SFCI is an experimental program that started in January 2005, involving five different areas in Sweden – one of them Koster-Väderö. It brings together stakeholders such as commercial and recreational fishers, local and regional authorities, researchers, water owners and other local stakeholder groups. The aim is to discuss methods for co-management and solutions to local management issues. The initiative has some similarities to the RAC and contains elements of Integrated Coastal Zone Management (ICZM). In the Koster-Väderö area, the Co-management Initiative builds heavily on the already existing local management structures mentioned above.

Main marine resources in the area

The Koster-Väderö area is situated in the northern part of the Swedish west-coast. The islands in the area have around 300 permanent inhabitants and an additional 3,000-4,000 people in the Summer.

The Koster fiord (which is a marine trench) is the richest sea-area in Sweden from a biodiversity perspective. The trench is rich in shrimp, but also in deep-water species unusual for the rest of Skagerrak due to its depth, saline water and low water temperatures, such as deep-sea corals. About 200 species of animals and 9 algae are unique to the Koster area and the total number is estimated to be some 4,000 species.

Within the Koster fiord all trawling is forbidden (FIFS 1993:30). Still, local trawling for north sea-shrimp, being a traditional activity that has taken place for more than 100 years, has been excluded from this rule. However, the fishery is regulated. For example, trawling is not allowed above 60 m depth and there are restrictions on the size and weight of the trawls and boards. The shrimp fishing is also limited in time (only three fishing-days a week) and in space (sensitive reef areas are excluded).

The annual catch of shrimp is around 200 tonnes and the fishery employs around 50 people. To this supporting activities should be added, such as fish auctions, boat maintenance, and processing. Around 30 trawlers are fishing partly or solely in the area (County Administrative Board, 2000). Access to the fishery is divided among the fisherfolks informally, within the limits of the total allowable catch.

The Koster shrimp fishery is the only fishery in Sweden that is certified to use an organic label (certified by Swedish KRAV). NGO's such as Swedish WWF and Swedish Nature Conservation Association consider the Koster shrimp fishery a good example of sustainable small-scale fishery.

Koster is presently under protection by conservation-ordinances and the Koster fiord is a Natura 2000 area. Since 2005, a new process is under way aiming to turn the area into a national marine park.

Use of scientific knowledge and advice in study areas

The scientific knowledge produced in most of the research projects encountered during the review is very rarely used in the everyday management in the study areas. Instead, science officers closer to home supply the main sources of scientific information and advice.

In the Wash, management information is provided by the staff at ESFJC (yearly stock and catch assessments; information on general ecosystem changes; landing information). Natural England (former English Nature; the English equivalent to a Nature Protection Agency) also carries out research in the area to monitor ecosystem changes, map wetland species and provide risk assessment for management purposes. It has also formulated conservation objectives for the natural values in the area, which have recently been agreed with the wider stakeholder groups.

Research from national or international levels is very rarely used in ESFJC management, as the information needed to manage fisheries in the area is *specific and local* and the scientific advice produced in research projects that could be relevant for local management of the Wash is rarely easily accessible. ´

In Pärnu Bay, management information is provided by the Estonian Marine Institute (EMI) (stock assessment; environmental impact assessment; catch forecasts and management advice). EMI also supplies information for the Department of Fish Resources (DFR) at the Ministry of Environment as a basis for national management decisions. The Estonian Marine Institute is the main Estonian academic authority on fishery and marine ecology and has the competence to put local research into an international scientific context, and *vice versa*. However, this is not a high enough priority and due to a lack of resources this is not being done on a regular basis.

In Koster-Väderö fiord, management information is mainly provided by the Laboratory for Coastal Fishery (Kustfiskelaboratoriet), the Laboratory for Offshore Fisheries (Havsfiskelaboratoriet) and the Tjärnö Marine Biological Laboratory. The Laboratories for Offshore Fisheries and Coastal Fisheries are both research sections under the Swedish Board of Fisheries, whereas Tjärnö Marine Biological Laboratory is a coastal and marine research centre linked to the universities in Gothenburg and Stockholm.

The close cooperation with universities and the national Board of Fisheries, facilitates the integration of relevant information from national and international research projects into the local management advice, as well as dissemination to relevant local stakeholders involved in the co-management initiative, but there are still issues concerning relevance and access. The regional administration (the County Administrative Board of Västra Götaland) is responsible for monitoring changes in the marine ecosystem, but has limited resources and scientific competence for more in-depth research.

A number of issues surrounding scientific advice came up in all of the areas to some extent:

- Resource users often sceptical about scientific advice and its neutrality
- Need for increased openness and stakeholder involvement in management
- Lack of integration between management of fisheries and conservation efforts

- Limited use of experience-based knowledge and social science
- Importance of distributing scientific advice to local stakeholders
- Insufficient provision of information tailored to local needs and interests

No change toward sustainable marine resource use can be carried out without the direct and open cooperation with stakeholders at all levels. Local stakeholders are the most important partners in this future work. Researchers should open up their understanding of ecosystems to include human influence and resource use. The understanding of human behavior in marine resource use includes bringing together natural scientific and social scientific perspectives; while at the same time incorporating experience based knowledge in scientific advice.

The challenges facing science and funding authorities are indeed demanding. The marine resources are at stake. Still stakeholders at all levels, particularly at the local level, direct their efforts to find new methods for sustainable marine co-management. The scientific task is to monitor and support such sustainable development.

Best Practice – what works well and why

The Wash

Participants were invited, after some time for thinking, to each share an example, drawn from their own experience, of best scientific practice in local fisheries and nature conservation co-management in the Wash. This section reports these examples. Several of the participants referred to the very recent case of cockle-dredging management, and the information included in this example is therefore fairly detailed. This is followed by a discussion of best practice lessons for the use of science in local scale co-management of fisheries and nature conservation.

Best practice examples

ESFJC Stock assessments ESFJC conduct stock management in the Wash. They assess what stock is available, and the management system allows fishermen to take a third, the birds take approximately a third and the remainder is left for growing on. This process requires regular research into the beds and their recruitment and it is important that findings are regularly and openly conveyed to fishermen by ESFJC.

Eider Ducks A public inquiry ruled against fishermen who had applied to use bird scarers in the Wash. This process was regarded as inappropriate to address this kind of issue. It had high costs associated with it in time and money and it provoked significant acrimony between different actors within Wash co-management. This legalistic approach to problems also runs contrary to the kind of adaptive management approach that is being seen elsewhere in the Wash. However, it has encouraged all parties to work together more on adaptive approaches to addressing other issues, such as the cockle fishery.

The cockle dredging fishery The cockle fishery, whose prosecution was distributed over several key cockle grounds, was suffering from low recruitment and high discard rates. The fishermen and ESFJC worked successfully together using shared knowledge to address this problem. They agreed that: first, the bar spaces on riddles and dredge-heads needed to be made smaller; and, second that all the cockles should be taken out of just one area, rather spreading the fishery over all the cockle grounds. In addition, only beds with large cockles on them are opened. A similar approach to management has now been used in the mussel fishery – the results of this have yet to be assessed. However, in this case, there are concerns that a warm winter will have prevented spat settlement and that Natural England will attribute the absence of spat to overfishing.

The cockle fishery decision was partly driven by research conduced by CEFAS, commissioned by Natural England, on the potential impacts of dredging on muddy vs. sandy sediments. Fishermen expressed concerns that they were excluded from the research process in this case, although it was a desktop, rather than a survey-based, study. This study found that invertebrate communities in muddy sediments are more likely to be negatively impacted by dredging than those in sandy sediments, as the latter are more accustomed to disturbance.

Fishermen could see that they could do something to address this issue and it was also compatible with ideas they had for improving recruitment in the fishery. As a result of the changes, there is now high recruitment on the area that was high targeted, providing a good basis for next summer's fishery, discarding has been reduced to a very low level, and nature conservation responsibilities are also being met. Although at the moment suction dredging for cockles takes place in the sandiest areas, if the stock distribution alters more information will need to be gathered in the future about the different sediment types and their location. This is being addressed by new sediment survey work by ESFJC.

The new scientific knowledge regarding sediments has resulted in a change in the view of nature conservationists who now recognise that suction dredging is a sustainable fishing technique, as long as it is used on the appropriate sediment type – areas where the seabed is sandy, rather than muddy. This has changed the environmental view of suction dredging and it is now regarded as a viable and sustainable way of fishing the cockle fishery. This changed view has improved the nature conservation perspective of the overall status of the Wash SAC.

Other scientific work within the cockle fishery includes breakage rate assessments and measures to reduce both breakages and discards of cockles. Over several years, applied collaborative research by industry and ESFJC has been successful in addressing this issue.

Sabellaria reef protection *Sabellaria* reefs are a key environmental feature in the Wash, which form part of the Special Area of Conservation (SAC) designation. As the main fishery that impacts the *sabellaria* is bottom-trawling for brown shrimp in the Wash and pink shrimp in the deeper water, which is licensed by the UK Department for Environment, Food and Rural Affairs (Defra), ESFJC had the option of asking Defra to manage the feature at the national scale. However, ESFJC decided to manage *sabellaria* locally to make the most of their good communicative links with the local fishermen and Natural England officers. This is a significant resource – finance and staffing – burden.

ESFJC are working with Natural England and Newcastle University to define clearly what 'reef' looks like, and what is more of a 'crust', so that scientists can map the *sabellaria* reefs. Once that knowledge has been obtained, a bylaw will be introduced to prohibit bottom-trawling in those areas. This will be advantageous to fishermen, to help them avoid damage to fishing gear, and it will protect a feature that is of genuine environmental importance. Thus, there are mutual benefits to this process. It is important to base this regulation on clear science, rather than to introduce a vague regulation that could have significant and unnecessary fishery impacts.

Sediment change on cockle beds One the western shore of the Wash, an area of cockles was covered several years ago with approximately three or four metres of sediment and it was linked to beach recharge. There was existing scientific knowledge of the sediment in that area, which had been collected for other reasons. Scientific work was undertaken to investigate and the sediment couldn't be directly attributed to the beach recharge, but it was possible to verify the fishermen's claims that there was a deep amount of sediment over certain parts of the cockle bed. This was an early example of fishermen's observations being used as the basis for scientific investigation, rather than fishermen's views being ignored or distrusted.

Fishermen's knowledge A principle factor in this review is the review of conservation objectives, to which all management measures need to be oriented. Natural England are responsible for this process and have reviewed the available science of the current status of the designated features within the site in order to underpin draft conservation objectives. These are subject to some informal consultation, and then will be disseminated to all members of the SAC management group and the advisory groups that support it. In this way they will be considered and discussed by people who live and work in the site and who have lay knowledge of the site, before final objectives are set. This will hopefully help to broker the credibility gap between marine science and experience-based knowledge by grounding the science in the real world and ensuring that conservation objectives are viable. Management measures will then be reset to ensure that favourable condition of designated features will be achieved in the future.

In the advisory groups there is an 'anecdotal change' process, which recognises that the experience of fishermen is fundamental to ensuring that environmental management schemes are appropriate. The process gives fishermen the opportunity to feed any information on changes they notice to the advisory groups. This information is then passed to the management group and to Natural England who can take the information on board and consider the information alongside changes that are being noted from scientific work in the Wash. This grounds the science, which can have a 'snapshot' quality, and does not necessarily carry with it the depth and length of experience that a fisherman can offer. Anecdotal experience has value and can contribute to science and to adaptive management.

Discussion of best practice – Some lessons

Participants were asked to comment on the reasons why the examples they gave of good uses of science worked well for fisheries and/or nature conservation management. This discussion section reports and explores those reasons. Key lessons relating to best practice are included.

Science-based management The importance of having good science for fisheries and nature conservation management is generally recognised in the Wash, where extensive survey work and many ad hoc studies are carried out. All workshop participants would prefer fisheries management measures to be grounded in scientific knowledge. It is also important that this knowledge is regarded as valid by all interests – particularly, fishermen, nature conservation interests and inshore managers. A number of key lessons can be learned:

- To ensure the credibility of findings, scientific studies should be conducted by independent experts, who have no vested interest in the fishery or nature conservation features. Scientific work done by ESFJC is regarded as highly credible. As stock managers they have no vested interest, on either the nature conservation or fishery sides, and they are unbiased.
- Fishermen have multiple roles to play in science. These include observing and reporting change, proposing research questions and assisting with research processes.
- Science needs to have a broad scope, taking in a range of influences on the marine environment, alongside fisheries.
- All parties need to be open to investigating new management options and scientific questions.

- Finding common ground and identifying mutually satisfactory solutions for fisheries and nature conservation represents a very effective means of managing problems.
- Where relevant, lessons can be learned from outside the local area and external scientists can bring new knowledge and perspectives on existing problems.

Relevance of science to management In view of the high costs associated with scientific research, it is also important that it is relevant to the management process. In the case of the Wash, for example, this means that scientific analysis needs to be appropriate to fishery and conservation objectives. With this in mind, it is important that:

- Fishery and conservation objectives are clearly understood.
- The basis of the management system needs to be clearly defined. For example, whether an adaptive approach or a system of quantitative thresholds is in place, all parties need to understand the implications. And the relationship between science, policy intentions, management regulations and the 'favourable status' of the site also needs to be transparent.
- All parties understand the benefits and objectives of scientific research. This provides an incentive to participate in the science process.
- Scientific demands do not become too onerous or relationships between different actors in the co-management process in the Wash may be undermined.

Communication about science Open and continuous communication about science between all interests is very important. It is advantageous to take the time to convey and discuss scientific ideas, studies, findings and their management implications, as it can reduce the amount of misinformation in the management process. This process must include fishermen, scientists, managers and nature conservation agency staff. Experience in Wash indicates several ways of ensuring effective communication:

Regular meetings need to take place between fishermen, nature conservation interests and fisheries and marine site managers. These should discuss positive news, as well as problems. Inshore managers can act as mediators between different interest groups.

A commitment to openness by all parties is helpful, and can reduce the possibility of surprises and the development of resentment or a blame culture. Regular communication also presents opportunities to share knowledge, to learn collectively and to improve the understanding of participants of each others' points of view. This can reduce conflict.

Experience-based knowledge can be gathered for scientific purposes via this type of communicative network. Participants can also share their knowledge of bad practice in science and co-management.

Discussion of future actions

Workshop participants were divided into two breakout groups to discuss, first, what the ideal characteristics of science for co-management are; and, second, what practical strategies can be adopted to achieve those characteristics. In this section, we report on the ideas expressed during the breakout groups. Table 1 provides a summary of characteristics and associated strategies.

Ideal characteristics of science to support co-management

Having been asked to produce 3-5 characteristics of science, participants discussed what the ideal scientific setup would be to support local co-management of fisheries and nature conservation in the Wash. These characteristics are described below and are divided into three broad categories: scientific content, scientific process and communication of science. The subsequent section explores potential strategies for achieving them.

Scientific content Participants outlined several aspects relating to scientific content. Both groups proposed that science for co-management must include resource users' anecdotal information, especially when planning research. It was also suggested that science should include reference to historical context; that the scale of research needs to be considered; and that wider environmental factors affecting fish and shellfish stocks and nature conservation features need to be considered, for example rising temperatures.

Scientific process Participants also referred to characteristics of the science process. They proposed that the process needs to be inclusive of all relevant interested individuals, groups and organisations; that the science must be accepted as credible by these different actors; and that it needs to retain a measure of independence.

Communication of science Finally, participants focused on characteristics of scientific communication. They took the view that scientific ideas, findings and implications need to be effectively conveyed to a range of interested parties and that strategies should be adopted to ensure that information is clear and understandable, rather than being open to misinterpretation.

Strategies for achieving ideal characteristics

Having identified ideal characteristics of science, participants were asked to discuss what could be done to ensure that they are present in the science supporting local co-management? This section describes the sixteen strategies that participants identified to address the 'ideal' characteristics outlined above. They are divided into the three categories of scientific content, process and communication.

Scientific content A mechanism needs to be devised to record and incorporate experience-based knowledge in scientific research. Fishermen's knowledge can also be used to propose and design research questions and projects.

Information gathered by scientists, using traditional science methods, can be 'ground-truthed' by inviting stakeholders to comment on the science before any decisions are made on the basis of its conclusions.

A fishing industry representative could be included in research steering groups, alongside scientists, and stakeholders should be involved in the practical design of research.

Established European Marine Site working groups could take on the responsibility to ensure that, where relevant, a broad range of factors, not just fisheries, are considered in the science process, and that information sources are equally broad.

There is not a great deal of historical information available. A system could be developed to record information about interesting 'incidents', so that they can be investigated or understood at some time in the future, when their relevance may become obvious.

More scientific work needs to be conducted at the local scale as national scale research is often not directly transferable to the local context.

Some external research is relevant and managers, industry, scientists and nature conservation interests should all remain open to what is happening elsewhere in the UK and the rest of the world in similar situations. Inter-site communication would be useful to share information between Natura 2000 sites in Europe. A network could be established to achieve this. Symposia on common issues could also be useful to facilitate exchange of ideas.

Scientific process. An independent mediator could be mandated by all interests to be responsible for commissioning research. A shortlist of candidates would have to be drawn up and voted on. It is important that somebody does not just assume the role, as this would lack legitimacy. However, it is likely that, in the Wash, ESFJC would be best placed to take on this role. Ad hoc mediators may also have to agreed upon to deal with particular conflict issues. These should be people with a local connection.

Regular meetings between scientists, industry and all other parties are needed to exchange information and reduce suspicion.

Time must be allowed in the science process for interested parties to express their views and stakeholder comments should be reflected in scientific reports. For example, in meetings, presenting science is not enough; scientists should allow much more time for discussion.

Scientific communication Scientists should make communication of their work a high priority. This would improve the general awareness and understanding of science among lay people. One way of achieving this would be for scientists to explicitly commit to 'communication of results' in project proposals and that this needs to be a requirement of funding.

Scientists need to improve the way they communicate science. They have to think about their audience and use appropriate language that conveys findings in accurate and simple ways.

Scientists need to be explicit about uncertainty in their findings. They need to be both honest about not having all the answers and open to suggestions from resource users and other interested groups. This honesty and openness needs to be reciprocated.

Focusing on just a few key points can be an effective way of communicating scientific findings and encouraging discussion, so that communication is not just one-way.

Written reports should include straightforward executive summaries, written in layman's terns.

The key data on which decisions are based needs to be effectively and quickly communicated to all parties, so that rapid decisions can be made.

Conclusions

The Wash represents a unique combination of a strong fishing tradition and an unusually high number of nature conservation designations. A co-management structure is being used to address these two sets of demands and to find ways to enable the needs of each to be met as far as possible. General management of both fisheries and nature conservation sites, and, specifically, attempts to find common ground, have significant science requirements. The examples discussed in section 4 – stock assessments, cockle recruitment, bird, habitat and fauna protection – illustrate the diversity of these requirements. However, they also illustrate the potential to use science to find broadly acceptable solutions to fishery and conservation problems.

As section 5 reports, there are several key characteristics of science for co-management of fisheries and nature conservation. First, science needs to be credible. The independence of scientists and the existence of an unbiased and transparent science process are both important factors contributing to credibility. Second, without compromising its independence, science needs to collaborative. Those who live and work in the Wash region carry with them a vast bank of knowledge and experience about fisheries and about the marine environment. For example, fishermen are best placed to notice at an early stage any changes taking place within that environment that may require scientific investigation.

To make this most of the knowledge and experience available, science needs to be innovative. Only by being open to new ideas and questions can science fulfil its role of supporting the constantly changing needs of fisheries and nature conservation co-management. Finally, the science process must be underpinned by regular communication about ideas, studies, findings and their management implications between all parties – fishermen, managers and nature conservation interests. This communication needs to be straight-forward, understandable and relevant.

Participants proposed a variety of strategies for developing ideal science characteristics relating to content, process and communication. An overview of these is provided in Table 1. Initiating and maintaining these strategies will require all parties – industry, managers, nature conservation staff and scientists – to be committed, open, honest, communicative and innovative. They are designed to ensure that maximum value can be gained from available resources, such as knowledge, experience, finance and time.

Table 1 – ideal characteristics of science for co-management in the Wash and strategies for achieving them

Category	Characteristic	Strategy (no.)
Scientific content	The use of resource users' anecdotal knowledge	Bottom-up stakeholder-led initiatives, such as fishermen identifying research questions and assisting in research design (1)
		Develop a mechanism to record and incorporate anecdotal information in the science process (1)
		'Ground-truth' scientific results using anecdotal knowledge (2)
		Fishing industry representative on research steering groups (3)
	Reference to historical context	Systematically record information about atypical events for future reference (5)
	Sensitivity to scale of knowledge	Conduct more local-scale science (6)
		Improve awareness of research elsewhere by networking (7)
	Consideration of non-fisheries factors	Established European Marine Site working groups can highlight environmental factors and knowledge (4)
Scientific process	Inclusiveness	Regular meetings between all parties (9)
	Credibility	Discussion between scientists and interested individuals and groups (10)
	Independence	Mediators for commissioning research and resolving conflict (8)
Scientific communication	Understandability and Clarity	Scientists need to find ways to communicate science inaccurate but simple ways (12)
		Focus on key points (14)
		Encourage discussion (14)
		Executive summaries in layman's terms for written reports (15)
	Honesty	Openness on all sides about uncertainty (13)
	Speed	Quick reporting of key findings can support rapid decision-making (16)
	Regular and consistent	Commitment by scientists to communication with stakeholders at all stages of the science process (11)

Overall co-management in the Wash for fisheries and nature conservation was regarded by participants as being quite advanced. However, during the workshop they identified key means by which the situation can be improved still further. Science, and its content, process and communication, will play a key role in this process, offering the opportunity to improve knowledge and reduce conflict. There was broad interest from participants in the Swedish and Estonian local cases investigated by SAFMAMS. It is hoped that the final SAFMAMS workshop will offer an opportunity for participants from each of the locations to meet together, share practice and build links with each other.

Pärnu Bay

Each participant was asked to think and also write down positive experience(s) they know and then explain why it had worked well and what was the role of science in it. The summary below aggregates responses from two separate discussion groups. It must be noted here that not all the comments were made solely on the best practices and often criticism was expressed. As these messages contain important and valuable information by enabling to better understand the situation and the lessons learned, all thoughts from the workshop participants were included into the following section. The two break-up groups were chaired by Taavi Nuum and Henn Ojaveer.

Pärnu region has historically had substantial differences compared to other regions of the country. In Pärnu, there was a strong union of professional fishermen, strong and efficient scientific knowledge both in terms of fundamental and applied aspects and which is essentially important for the recent 15 years, increase of fishers has been lower than in other regions. All this has resulted in remarkably better condition of commercial fishery resources, although some very valuable fish stocks showed clear declining tendencies.

In general, it was mentioned that increasingly better communication has been achieved between different stakeholder groups (incl. scientists, managers, administrators, fishers) and aslo between different disciplines (biology, ecology, sociology and economy) when making fisheries managament decisions. Fish stocks have been largely managed on the basis of scientific advice.

One of a few definite success-stories is management of local fish stocks is management of the Gulf of Riga herring population. Gulf of Riga is inhabited by a distinct herring population and this stock is assessed and managed as a separate unit at international level. The basis for this is scientific achievemnts that were able to show that the gulf herring populations in the Baltic Sea behave differently from the open sea population(s). The annual management advice is provided by the International Council for the Exploration of the Sea (ICES). Pärnu fishers exploit the Gulfof Riga herring stock by poundnets in spawning grounds which is considered more sustainable than trawl fishery. Herring consitutes far the largest share of catches for local fisherem and therefore play essential role in their incomes. It was mentioned that during bilateral negotiations between Latvia and Estonia, location of herring trawling grounds were agreed, as well as implementation of one-month fishing ban in spring to protect spawners. Although the stock has shown some decreasing tendency during past years, it is still in a relatively stable condition, in full reproductive capacity and fished sustainably.

Pikeperch has been for a long time one of the most valuable commercial fish in Pärnu Bay. In order to secure higher recruitment, every year artificial spawning substrata were placed to the sea. This has happened already since 1980’s, as a joint activity of local fishers and scientists. Unfortunately, due to unsustainable fishery – still over 50% of the commercial catch constitutes of undersized fish – this stock has almost lost its commercial importance since the late 1990s.

It was stressed that annual temporal restrictions posed by the Minister of Environment for coastal fisheries have been softened in recent years, after quite strong and strict restictions previously which have resulted in some positive signs in developments of fish stocks. The number of professional fisherem has continuously decreased in recent years. This has happened due both to strict fishing restictions and therefore limited access resources, but also due to declines of some valuable fish stocks.

After switch from the planned to market economy, fishing was seen as an easy and rapid way of wealthiness. Therefore, the number of resource users (professional fishermen) has increased. One of the important preconditions for this was implementation of the ultra-liberal fisheries policy, practically failure of the firsyt Fisheries Act in the 1990s and also relative weakness of the fisheries inspection.

It was also mentioned and discussed that the capability of the fishing control of the Environmental Inspection of the Ministry of Environment has steadily and substantially increased. This enables closer inspection and control of the declarations of fish trade both within the region but also for export. Furthermore, strengthening of the control has resulted in the decrease of the share of illegal fishing. It was discussed that fishermen with long fisheries familiy traditions are essentially involved in the fisheries sector currently. In addition, so called category of ’enthusiasts’ was mentioned as having survived the very strict regulatory times.

One of the clearly positive developments mentioned during the workshop was that both knowledge, experience and capability of fisheries authorities of the country has continuously increased. Therefore, the management decisions are currently being made on the basis of better information and in the situation of enhanced competence of fisheries authorities.

One additional factor that was suggested to be in favour of fish stocks was recent substantial problems for export of fish and fish products to Russia. These problems hamper fish export and although creating socio-economic problems and resulting even in banckrupcy of some fishing industries in other parts of Estonia, were still seen as having noteworthy positive impact to some selected fish stocks.

Compliance of fishermen to fishing rules in relation to potential sanctions from EU was also discussed. It was mentioned that EU might wish to implement more strict fishing regulations when large proportions of undeclared fish catches might show that there is less and less fish available in the sea.

It was also mentioned that one of the major drawback is lack of communication between scientists and fishing industry: fishermen don’t want or haven’t had possibilities during the former Soviet times to communicate with the fishing industry. This was mentioned in the context that in some regions there is an excessive fish processing potential pointing therefore for an urgent need for detailed economic analysis and follow-up actions.

One important field where improvement is needed is outreach to wider public. Local fisheries scientists have provided contributions to local fisheries newspaper and have often been interviewed by local newspaper correspondents. However, although the situation has been improved in recent years, it was still considered insufficient and there is therefore a need (and interest for people) for scientific results to be converted into the form which is understandable for ordinary people.

Although directly independent for fisheries science, there are continuously more initiatives towards developing of united actions within fishers communities. These were lacking during the former soviet times and have started to evolve only recently. The reason for this is that the product for fishers is insufficiently valued and the only way out of this situation is undertaking united actions within the sector.

- Identifying future research priorities
- Integrated approach to development of the resource management system by involving all relevant science disciplines
- Public outreach
- Involvement of socio-economic sciences in management decisions
- Innovative approach approaches to develop new and more sustainable goods and services
- Identifying blocks

After agreeing on the common research priorities both groups were given two goals and asked for each goal to name the 2-5 biggest problems that stand in the way of realizing this goal or consensus about this goal. Each named problem was classified as a constraint (the institutions represented here do not have the power to change this) or a block (if we focus we can fix this) was. The groups were asked to report on plenary only blocks. After identifying the blocks, participants of the workshop were asked to choose categories of four the most important blocks that where removing them would get us farthest down the road toward improving science for the CFP.

Agreed common blocks:

- Lack and/or insuffiency of competence
- Rigid finance system
- Data insufficiency and quality
- Mismatch between the importance of the sector and attentiaon by wider community

Proposing strategies

Each group has then been assigned one block to build a strategy for removing on concrete actions and events to take place over the next five years. The blocks were ’Data insufficiency and quality’ and ‘Lack and/or insufficient of competence’. Results of the group work is shown in the following two tables.

Table 1

Name of block assigned to your group: **Data insufficiency and quality**		
Action or event	When this should happen	Who should do it
Modification of the fisheries information system to more user-friendly and amendment with some data	2007-2008	Ministry of Agriculture
Systematization of fisheries biology data	2007-2008	Estonian Marine Institute (EMI)

Composition of the data collection guidelines and ensuring quality of the data	2007	EMI and government agency
Surveillance and check of the existing data	2007	Ministry of Environment

Table 2

Name of block assigned to your group: **Lack and/or insufficient competence**		
Action or event	When this should happen	Who should do it
Make schoolchildren continuously acquainted with the general subject	As soon as possible	Ministry of education and research
Preparation of textbooks and learning materials in the national language	As soon as possible; continuous	Ministry of education and research; universities
Further education of administrators/managers /specialists in Estonia and inviting quest lecturers	2007	Tartu University, University of Life Sciences

Koster-Väderö fiord

This section is based on the participating stakeholders' experience of best practice in the Koster-Värderö fiord area. However, the participants felt that it was to some extent premature to ask them about best practice for the provision of scientific advice for the local management efforts, since this was something that was just starting to develop. As a result the session reported to a large extent on best practice in the relationship and interaction between fishermen and researchers (and managers) at the local level.

Following this discussion, the participants were given five minutes to think of and write down their best example of useful interaction between scientific advice and the local management efforts. They were then asked to share this and discuss it with the other participants. In the last session of the workshop, the participants were split in two groups and were asked to think of what the perfect setup for provision of scientific advice for the local area would be and what would be needed to secure better scientific advice and communication of this.

Best Practice Examples

There was considerable overlap between the examples that the participants chose, which seems to indicate that there was relative agreement on what the best examples were. As mentioned in the introduction, the participants felt that it was to some extent premature to ask them about best practice for the provision of scientific advice for the local management initiative, since this was something that was just starting to develop. As a result the session reported to a large extent on best practice in the relationship and interaction between fishermen and researchers (and managers) at the local level. In the following sections we will initially look at the examples through which best practice was illustrated by the participants. Subsequently we will, on the basis of the examples as well as the discussion at the workshop, try to extract some general lessons in relation to what has allowed best practice to emerge in the Koster-Värderöfjord area and what we can learn from this in relation to best practice for the provision of scientific advice to sub-national fisheries management.

Protection of Hard-Bottom Habitats The first example of best practice, which was mentioned by the participants, was the so-called Koster-Värderö Agreement, which is a local co-management-like agreement from 2000 to protect hard-bottom habitats in the area. Scientists, fishermen and managers worked together to develop this agreement, which has been in force since, with backing from all sides.

Several things played a role in making this successful agreement possible. Firstly, it was mentioned, the fishermen in the area are historically used to cooperate. They were as such used to working together, which was a necessity in the process. Secondly, detailed three-dimensional maps of the bottom areas were used in the process to facilitate discussion between fishermen, mangers and researchers. These maps enabled the fishermen quickly to point out the areas, which was of little interest to them, either because there was little to catch and/or they were difficult to trawl. In this way it was possible to agree on much of the area to be protected relatively easy.

The Koster-Värderö Agreement process was mentioned as a best practice breakthrough because it was the first time local fishermen actually had the chance to sit down with, and experience, the authorities as real persons.

Education of Fishermen and Scientists A fine example of interaction between fishermen and scientists, which was brought forward by several participants, is the educational programme, which Tjärnö Marine Biological Laboratory is running for commercial fishermen. The programme is aimed at teaching fishermen more about broader marine-environmental concerns and why it is important to manage the marine environment in a sustainable way. Notably, the initiative to this programme was actually taken by a group of fishermen, who experienced that not all of their colleagues were living up to the Koster-Värderö Agreement (see above). This made them approach Tjärnö Marine Biological Laboratory to explore the possibility of setting up a course, which would provide fishermen with broader knowledge.

The next phase of the interaction process in terms of education is programmes where scientists are educated by fishermen and spend time onboard their vessels to learn about fishing practices etc.

These programmes were held up as examples of actions that not only broadened the scope of the involved participants but also helped to develop trust between fishermen and scientists. This is perhaps the closest to a direct example of good practice in the provision of scientific advice at the local level that the participants brought forward.

Live storage of Norwegian Lobster A common denominator of the best practice examples is not surprisingly that the fishermen (or at least the fishermen taking initiative or participating) have had an economic incentive to take part in the process – either to increase their income or to limit the negative impact of management measures. This is also the case in the example of Norwegian lobster.

The background of the example is that the ability to store live Norwegian lobster would increase the price they would get for their catches – both because the fisherman can wait and not sell the lobsters until he feels that the price is right, and because the fisherman can transport the lobsters to where he gets the most for them. Moreover it was through the research programme documented that there was little idea in releasing small lobsters as most of them died anyway. The researchers and fishermen together developed a programme where fishermen did most of the research work onboard their vessels under guidance of the researchers, which were the methodology experts.

As a result the fishers are now able to store live Norwegian lobsters and thereby maximise their revenue.

Local Shrimp Stock Research The ongoing research aimed at establishing whether the local shrimp is actually a stock of its own was also brought forward as an example of local research in benefit of local fishermen. The potential value of this programme is considered to be very great. If it turns out that it is possible to establish that it is in fact its own stock there will suddenly be much more scope for actually developing a real programme of local scientific advice. At the moment the shrimp is considered to be part of the North Sea/Skagerack/Kattegat stock, which means that there is limited scope for actually developing true local management, where the stocks are protected in favour for local fishing communities.

No-trawling areas to protect cod. The fifth and last example, which was brought forward by the participants, was the establishment of no-trawling areas to protect cod. The banning of trawling close to the coast along the Swedish west coast was a decision, which was taken centrally in Sweden. This decision could potentially have been devastating for the Norwegian lobster fishery (50 % caught in affected areas). When the decision was taken local fishermen considered boycotting the sea fisheries laboratory, which is the Swedish official body advising on fisheries issues. However, a group of local fishermen considered that the confrontational strategy was not the one that would pay off. They therefore approached the laboratory to find some way to keep trawling for lobster allowed in the area by carrying out research into the matter.

It turned out that catches of cod was not an issue in trawls with a selective panel, which then continued to be allowed in the affected areas. If the fishermen had chosen to follow the confrontational strategy it would not have been allowed to trawl in the areas today. This was presented as a good example of how good cooperation at the local level between fishermen and researchers was able to amend a (perhaps questionable) decision taken at the central level.

Best Practice Lessons

The content of this section was not directly discussed at the workshop. Rather, this section is an attempt from the SAFMAMS researchers present at the meeting to draw some general lessons in relation to the provision of scientific advice from the best practice examples reported above.

Trust Trust between the local actors seems to be one of the most important preconditions for developing best practice. It is difficult to make a recipe for how to develop this trust. However, at least it seems that it has been an advantage that there is an active and responsive *local* research institution (Tjärnö Marine Biological Laboratory). The participating fishermen expressed that they were probably still sceptical towards scientists and scientific advice but that this was not so much the case towards the local scientists, which they knew and trusted. The educational programme that Tjärnö Marine Biological Laboratory and the local fishermen are setting up at the moment could be a model to follow elsewhere to build trust and give fishermen and scientists a common ground to start their interaction from. It would also be a natural setting in which scientific advice could be channelled and directed to the local level. In general it was stressed that people needed to meet each other face-to-face to develop trust.

In terms of lessons for the best practice of providing scientific advice for local management a lesson could be that advice needs to be interpreted and communicated directly face-to-face by somebody local that enjoys the trust of those affected by the advice.

Neutral Meeting Place / Facilitating Institution The presence of the local Co-Management Initiative was also mentioned as a facilitating factor. This institution provides both a forum for discussing various topics as well as a forum where trust develops – simply because people sit down in a neutral setting and see each other in the eyes.

A lesson which could be learned is that a neutral, local institution in which interactions between scientists and researchers can take place is very useful. This will probably also be the case in relation to the presentation and communication of scientific advice.

Maps Good maps were mentioned as something that really made a positive difference, when scientists and fishermen were communicating. The presence of very detailed maps of the sea bottom of the area had made it much easier for fishermen to relate to the discussions on protecting specific areas.

It is highly likely that this could be transferred as a general lesson for provision of scientific advice. Instead of providing scientific advice in text it should whenever possible be presented visually. This would put managers, researchers and fishermen on a much more equal footing.

Discussion of Future Actions

In the final session of the workshop the participants discussed what would be the ideal set-up for research and scientific advice in support of the local management efforts, what problems that made this set-up difficult to put in place, and what could be done to achieve this considering the problems.

Goals The participants identified several goals, which they considered worth discussing further and possibly pursue in the future. Most importantly the participants considered and agreed on the following:

The local Co-Management Initiative should be made permanent and function as a forum where ideas for research projects could be taken up and discussed by researchers, fishermen or other stakeholders. The permanent local Co-Management Initiative, which should have a real secretariat, could help to identify sources of funding for carrying out (initially) pilot and (eventually) full studies.

Communication is the key issue in the interaction between researchers and fishermen. Fishermen are not a priory opposed to rules but often have difficulties understanding the point of them because they are not properly presented. It would be preferable if local researchers, who are more trusted by the local fishermen, could explain the background of rules to fishermen. This would need to be institutionalised in one way or the other.

A systematic collection of basic data at the local level should be set up. Such data should be collected in a way that would make them trustworthy and acceptable to all actors. The basic data should be collected by scientists *and* fishermen in cooperation - and the fishermen should be compensated financially for their work. In this way trust between fishers and scientists could be built.

Hinders In relation to achieving the goals above, the participants identified the following hinders, which stood in the way:

Lack of funding was mentioned as a key problem. There are not enough funds available for local research programmes. And there are not enough funds available to compensate fishermen for participating in research programmes.

Another problem was that there is still to some extent an issue of trust, which for instance means that fishermen are concerned how the data they provide are used – and whether the data could cause problems (for instance through lower quotas) for them at a later stage. Currently the fishers feel that they are “obliged” to misreport catches, since they believe that they will receive lower quotas, if they report the correct catch. However, since the fishers tend to report lower values than what is truly caught, the precautionary approach leads to lower quotas in the end.

The genetic material, which could determine whether the shrimp stock in the area is an independent stock, is still not available. If it turns out that it is indeed an independent stock, this will open a lot of new possibilities – simply because it will then not be managed under the Common Fisheries Policy but instead be considered a national stock.

Strategies The following are the measures that the participants considered could be done to advance towards the goals mentioned above – taking into consideration the hinders also mentioned above:

It was considered that it was important that researchers and managers become better at informing fishermen, so that they understood that it is in their own interest to provide accurate data. Uncertainty leads to lower quotas because of the precautionary principle - and more accurate data could lower the uncertainty.

It was furthermore considered vital that the local Co-Management Initiative be made permanent. It should have a permanent secretariat, which among other things could help solve a central problem - namely that of the lack of funding for local research. The secretariat could help apply for money for instance through the EU’s structural funds.