Theme session F

Integrated ecosystem assessment and decision support to advance ecosystem-based fisheries management

Conveners: John Pope (UK), Lena Bergström (Sweden), Melania Borit (SAF21 ETN project, Norway)

Rapporteurs: Charlotte T. Weber (SAF21 ETN project, Norway), David Reid, (Ireland)

Synopsis

The session aimed to bring together practitioners and stakeholders in integrated ecosystem assessment and ecosystem based fisheries management, both within and beyond ICES, to exchange views, knowledge and skills. It also aimed to allow stakeholders to see how the EBFM approaches work, and to compare and contrast them for their own purposes. The session welcomed all aspects of making an ecosystem based management operational, from data assembly to knowledge, choices of human activities, pressures and ecosystem component, pros and cons of different approaches. The session also aimed to highlight what stakeholders want from an ecosystem based fisheries management and what they can provide.

The session gathered a diverse audience, which successfully reflected the session's direction on integrative science. The presenters and audience represented social scientists, fisheries scientists, model developers, ecologists and managers and they also covered different generations, so that overall the session was a team effort for integrative science

The session was organised into four sub-themes, each followed by discussions that invited all session participants to contribute to answering discussion points on the topic. The first session introduced overarching concepts and current issues, whereas the three other sessions focused on the key sub-themes; Stakeholder involvement in decision support, integrated ecosystem analysis and models to support ecosystem based management. The topics covered mainly centered around governance, information flow from scientists to decision makers, finding new tools to assess fisheries more holistically, integrated ways to collect data, toolboxes for decision support, ways to assess state of ecosystems and ways to monitor it, how to include stakeholders, what stakeholders to include. A great range of ecosystem models for assessment, decision support and to test management scenarios were presented and discussed. These also helped identify the areas and aspects where more research is needed.

Conclusions

EBFM emphasises the human dimension to ecosystem management and it is vital to 1) include this dimension in modelling efforts, drawing on expertise from various domains (e.g. economics, mathematics, biology, social sciences, psychology) and approaches (e.g. quantitative, qualitative); 2) include stakeholders at all stages of the process and 3) identify key aspects to be considered so that the question is addressed is a way that is comprehensive enough but not too complex to be useful. There is an ongoing task of

building trust and collaboration between researchers coming from different domains, and between stakeholders and practitioners and managers. This means learning each other's rather different concepts and concerns and ways of expressing these concerns. It also means being prepared to provide solutions that stakeholders need and clarifying science without dumbing it down.

The usefulness of the session's conclusions to the ICES Science and/or Advisory function

The topics covered by this session are in line with ICES Goals 1 and 2 as detailed in the ICES Strategic Plan 2014-2018. The outcome is highly useful for implementation of these goals, and includes proposals for how to operationalise and develop further ecosystem-based management advice.

Main scientific results

Theme 1: Governance frameworks for the ecosystem approach

Several human activities depend on the marine environment and influence on it. Key activities at sea include fishing, mineral extraction, aquaculture, harbor development etc., but many activities on land also affect the marine ecosystem. A systematic evaluation of drivers on the ecosystem and the needs and visions of different stakeholder groups is required for building a governance framework to support the ecosystem approach. Cases were also shown when sufficient knowledge may be available but the governance framework to support an ecosystem approach could be missing. The session also considered how the framework of socio-ecological complex adaptive systems can support management to become more holistic, exploring how the fisheries could be put into this context, as explored by the SAF21 project (www.saf21.org). Another key process that was highlighted was to understand the pathways and roles of scientific information, in order to understand how it contributes to the decision making process, and identify potential critical barriers to information flow. Including the stakeholders as active partners in collecting information was proposed as a key part of the process to develop an ecosystem approach and support active co-management of the fishery.

The session particularly discussed the **pros and cons of studying fisheries as socio-ecological complex adaptive systems (SECAS, as opposed to studying them as only ecological systems, or non-complex system).** It was stated that this cannot be avoided in reality, as the system is in fact complex, but it was also questioned if an even broader context is needed and what sectors should be additionally considered. A disadvantage of studying complex systems is that it is less predictive and that uncertainty may also increase with increased complexity. However, developing the SECAS approach for fisheries would have the opportunity to learn from other domains of expertise to evolve in terms of complexity and managing chaos. It was also questioned if this would increase costs in the management and decision process even further.

The second discussion point was about **the pros and cons of using citizen science for collecting fisheries data.** The discussion centered round the aspects cost-efficiency and reliability in data. It was suggested that the collection of extra data would bring extra costs, but that the added value could be even higher, since the relative costs is probably low compared to dedicated sampling programs. With respect to reliability of the data, it was highlighted that the purpose of collecting the data needs to be clear so that one knows what

the data will be used for. There needs to be a survey sampling design, so we know what sort of data we are collecting and what quality the data is going to have. Collaboration between scientists and citizens is needed for the collection to be successful and fruitful.

Theme 2. Stakeholder involvement in decision support

In the past, decision makers have often been supported by separate disciplinary advice streams on the consequences of the management decision they must reach. This can often emphasize complications rather than provide a simple, useable overview. In turn, this makes it difficult for managers and stakeholders to form a clear view of the trade-offs between their objectives.

Integrated Decision Support seeks to simplify and unify advice streams to help address this problem. Managing human activities in this context is always going to be complex and difficult. We need to build trust and agreement between the parties involved, and we need to avoid regulation that leads to unexpected or even the opposite outcomes to those we hoped for. Under these circumstances, an integrated understanding of the fine mechanisms governing fishers' behaviour in relation to the regulative processes is needed, to the benefit of decision makers, fishing industry and the environment alike.

The presentations under the sub-theme identified and clarified the key roles of stakeholders in the decision making process. In a presentation from the MAREFRAME project Stakeholders are identified as the core for the ecosystem approach to management, to make the science and models socially robust, and that the recommendations are being heard. Stakeholders also have a key role in identifying priorities. In this decision support framework, the role of science was identified to help identify trade-offs through strategy choices and develop processes for involving stakeholders. It was highlighted that involving stakeholders from the very beginning is essential for a successful ecosystem based management. Further, examples on a participatory planning process and decision support for the West coast of Scotland mixed fisheries showed the role of stakeholder to identify alternative and desirable management objectives and to evaluate different management alternatives. Finally, an approach for measuring good fisheries governance using indicators was presented, which would make it possible to measure governance on in a way that is easy to use and can be applied in many areas

The sub-session discussed **how stakeholders' participation can be enhanced within the current policy context,** and considered "**who are the stakeholders".** The session participants shared experiences that it often is difficult to reach out to stakeholders and get them involved and attend meetings to support method development. The definition of stakeholder was also raised – could there be stakeholders out there who are not aware that they are stakeholders, or are we already creating more stakeholders than needed? It was suggested that including a wide range of stakeholders does not automatically improve the decision making process but that it is important how the process is being run. It was proposed that it could be helpful in each case to narrow down the scope by asking additionally: what aspects are at stake and what are their relative degrees of risk? It was discussed if it one could rank stakeholders importance based on effects and impacts on the ecosystem. These issues were seen as important for having a good quality in the decision making process, but also that there is a risk that some tools may not be ever be used in practice if the decision makers find them too difficult and complex. This may also in the end reflect on stakeholder motivation to participate in development projects. The participants

proposed that if we want to make EBFM operational, it is important to have a credible body that enables stakeholders and the other different groups to come together.

Theme 3: Integrated assessment approaches

Integrated ecosystem assessment (IEA) is now one of the cornerstones of the ICES strategic plan. IEAs can take many forms, including *inter alia*:

- Integrated Trend Analysis (ITA) using time series across an ecosystem to identify common patterns and key variables. These have the advantage of working with good empirical time series, but are limited by data availability.
- Approaches that include qualitative information where we are less restricted by data variability but require the use of expert judgment which can reduce the credibility of the analysis.
- Approaches like Bayesian Belief Networks which can use both types of information but are computationally expensive and probably only include a limited number of components.

Any approach has its pros and cons and arguably the best practice is to utilize several in a complimentary fashion. They should also be able to support advice that allows operational decisions to be made by local, national, and international authorities as well as a wide range of stakeholder groups.

This sub-session focused on recent developments and ways to improve integrated ecosystem analyses, including examples of applications from different geographic regions. The integrated analyses make it possible to assess status and trends in the whole ecosystem and evaluate links and commonalities among variables. By identifying deviations, abrupt changes and common patterns, focal areas for further management and examination are identified. They also provide overviews to helps identify the areas of science where research has to be done. The presentations showed example of ecosystem-level redundancy analyses to inform the indicator selection process and analyses to identifying leading indicators of shifts in marine ecosystems, to identify and propose focal areas for management. Different approaches and methods for Integrated Ecosystem Assessments are used in ICES within the working groups for integrated assessment. Currently, a method evaluation is ongoing where working group experts are asked to evaluate approaches that they are familiar with using an analysis of strengths, weaknesses, opportunities and threats (SWOT), and the results will be used as a basis for the further development of IEA in ICES.

IEA approaches are traditionally focused on food web and ecosystem aspects but a development to include also the human dimension is desired. A Bayesian decision support model was presented, proposing to overcome some of the methodological and conceptual issues that may hinder such a development. The model is developed around case studies in the Baltic Sea and includes, in addition to food web aspects of relevance for fisheries management (salmon, herring), e.g. variables on economic importance, cultural importance and governance performance. The session also presented approaches based on participatory modelling, as a tool to adapt new goals and management strategies.

Cumulative effect assessments are applied in order to assess of impacts from multiple human activities on the ecosystem in the spatial dimension. Hence, they are also a connection point between integrated ecosystem analyses and marine spatial planning. A global review of the current state of cumulative impact assessment was presented including

a proposal for best practices and development needs. In addition, recent results from ODEMM in the Celtic Seas was presented to give an updated qualitative integrated ecosystem assessment which covered a comprehensive set of sectors, including fishing, land use, military activities, telecommunication, shipping, waste water, research, etc. The assessment identifies the risk of impact attributed to different activities, and cumulatively, in specific geographic areas to support assessment and identification of management priorities.

The participants in the theme discussed and aim to identify **the key components and features that we need to focus on in an integrated ecosystem assessment.** It was concluded that for it to be truly integrated, all the experts and stakeholders need to be involved from the very beginning, so they can develop and evolve together all along, rather than adding experts/stakeholders along the way. It is important that models can be developed further as knowledge increases in an adaptive way. As a way forward, it is proposed that approaches should not aim for being perfectionist or getting it right the first time, but rather have flexible elements so that they can gradually improve and evolve.

Theme 4. Developments and applications to support and ecosystem based management

Ecosystem-based fishery management (EBFM) is concerned with sustainable ecosystems and human activities, particularly fisheries. Ecosystems and fisheries are typically complex so fisheries administrators and stakeholders need to make difficult trade-offs between a number of possibly conflicting objectives. These require both short and long term considerations of consequences for fish stocks and the wider ecosystem they inhabit, the economic and social impacts on the fishing industry, and realistic prospects that existing and proposed regulations will lead to compliance rather than to circumvention.

Successful EBFM will ultimately require that this entire advice stream is integrated. Initially though, this integration needs to include:

- how ecosystems and their interaction with fish stocks are assessed to explain how they might respond to fishing and other anthropogenic drivers
- how the various ecological, economic, and social tradeoffs implicit in regulating human activity can be balanced
- how management can best work with the fishing industry to encourage it to be a beneficial and compliant component of the whole ecosystem

The session included presentations on the application using various levels of complexity and generalization that could already now, or soon, be available for management and for the decision-making process.

- An ecosystem-based and risk-based approach for how to assess impacts on benthic habitat communities at a regional sea scale, aiming for a common set of indicators in the OSPAR region. The indicators would reflect levels of disturbance of anthropogenic activities as well as the condition of habitats exposed to pressures.
- A practical risk management tool to integrate fisheries and hydrocarbon activities in the Lofotens and Barents Sea, Norway, aiming to assess how oil spills might affect the main fish stocks using an ecosystem-based risk assessment approach. The model is tailored for the specific purpose and designed to identify how the choice of location for an oil platforms is connected to risks for the fish community.

- An integrated ecosystem model using Atlantis was presented for Icelandic waters and is suited to simulate events at ecosystem level with high complexity, incorporating links between fisheries and ecosystem.
- A delay difference model of the North Sea Multispecies Fishery System was presented as a module for decision support to EBFM. Fleet behavior and various socio-economic aspects are included with the possibility to also add more complex aspects (e.g. compliance) and tweek that behavior in the model in order to explore the different outcomes of varying fishers' behavior. The model is proposed to be useful for stakeholders particularly due to its charming simplicity.
- An approach to broaden current single-species advice to include consideration of environmental change of relevance for short term stock forecasts, as well as of the economic state of the fishery.
- A solution to resolve conflicting MSY targets in multispecies fisheries management based on a game theoretic concept, the Nash equilibrium.
- A decision support approach for management of multi-species fishery. Different goals defined together with stakeholder groups to be used in model which explored different management scenarios; this shows the trade-offs between scenarios and which goals can be reach by what type of management; output a forecast with the model
- Management scenario evaluations taking stock of stakeholder views and opinions into a multi-criteria analysis and explore different management scenarios focusing on the gadoid fisheries of the Icelandic fleets.
- Co-creation processes to test environmental, economic, and social criteria together with stakeholders. Stakeholders were involved into the process and their opinions and views on the risks were included, and stakeholders could interact with the model output

The full list of presentations is available in the theme session timetable.