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Steps to unlocking ecosystem based fisheries management: Towards displaying the N dimensional potato

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ABSTRACT

Any ecosystem based fisheries management system is necessarily faced with the problem of multiple objectives that trade-off against one another. Typically, objectives such as the maximization of yield, employment or profit or minimizing environmental impacts will be optimized in different parts of the decision space, which is formed of the fishing mortality rates that can be applied to the various species, given the constraints imposed by the mixed species nature of many fishing fleets. Since objectives cannot be simultaneously achieved, managers need to consider how such objectives trade-off against one another in order to choose a balanced strategy. Normally, they also have to consider the views of different groupings of stakeholders, who often favour widely different and conflicting objectives. This is particularly difficult if stakeholders are reluctant to expose their negotiating positions. This article explores two possible approaches to developing a Decision Support Framework for the North Sea. The first is a classic Multi- Criteria Analysis (MCA) approach that was developed in cooperation with North Sea stakeholders. The implementation went smoothly for the definition of suitable scenarios, decision trees and criteria, but failed in facilitating consensus on how to set priorities at the stakeholder level. However, it remains a possible approach for higher level management to adopt. Consequently, to aid effective decision-making a simpler approach was designed to visualise stakeholders concerns both to themselves and to the managers in charge of actual decision-making. Rather than trying to achieve some joint optima of the objectives that stakeholders wish to achieve this approach seeks to avoid the solutions various stakeholder groups resent the most. This 'N dimensional potato approach' proposed here treats the decision space as analogous to a partially rotten potato that has to be prepared for the table: each group of stakeholders cut away those parts of the decision space that they consider unacceptable. Ideally, this would leave a decision space where somewhat acceptable compromise solutions exist. But, if no decision space is left after all have made their cuts, this approach will still inform managers about the consequences of different solutions in terms of which group will be disappointed and by how much. Making this approach operational requires both uncovering various stakeholders' views of the unacceptable areas, and also displaying these areas in a convenient fashion together with areas of stakeholder consent. The article describes the steps taken to address these two tasks by the North Sea case study of the MareFrame research project.

1. Introduction

The European Union (EU) has committed itself to implement an ecosystem based fisheries management (EBFM) approach (Dolan et al., 2016; Link and Browman, 2014; Ramírez-Monsalve et al., 2016a,b) to be applied (EC, 2013). Overall progress has been achieved for example through the introduction of multi-annual, multispecies fisheries management plans or through a better articulation of the environmental and social dimensions in the fisheries policy although in a rather piecemeal fashion. A central problem in pursuing EBFM is the need for the fisheries management system to strike a balance between diverse objectives. This is difficult because EBFM must ultimately address the

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interactions of fishing on all ecosystem components as well as how the various fisheries best use the system. In fisheries systems human impact is typically applied by a wide range of fishing fleets that target and produce by-catch on different species and these species will often interact through predation processes.

The task is rendered even more difficult because in applying EBFM managers also need to consider the views of diverse groups of stakeholders who characteristically have widely different and conflicting objectives. Thus, the favoured objective of a particular group of fishers might relate to yield maximization while others favour maximizing employment or profit. Moreover, even if different groups of fishers favour the same type of objective they may still be in conflict as to how it should be pursued for different fleets that fish different species. Meanwhile environmental NGOs will be concerned with reducing or avoiding environmental impacts. Such diverse objectives will necessarily be optimized in different parts of the decision space formed of either the fishing mortality rates that can be applied to the various species or to the fishing effort of the different fishing fleets. The complexities involved rule out simpler decision making approaches such as the traditional nostrum of managing each fish stock to achieve its single species maximum sustainable yield (MSY). This is in part because maximum yield for all species is not jointly feasible in an interactive species system (ICES, 2013) nor typically in a mixed catch system (ICES, 2017). Moreover, an MSY approach does not address the real objectives of fishing such as profit or employment even for single species management (Larkin, 1977).

In response to the limited advances in implementing EBFM, in 2014 the EU funded a large research project (MareFrame) to remove the barriers that prevent a more widespread use of the EBFM in Europe. The MareFrame project developed decision support frameworks for seven case studies covering all the EU sea basins. Each case study involved a scoping exercise and the use of the outputs of ecosystem-models to support structured decision-making (using Bayesian Influence Diagrams or multi-criteria analysis, MCA) in an iterative stakeholder engagement process.

MareFrame deployed a co-creation approach to generate knowledge that has scientific acceptability (credibility), policy relevance (salience) and social robustness (legitimacy) (See Ballesteros et al., 2018). This approach is established as being relevant for transdisciplinary and problem oriented research. Tress et al. (2004), define transdisciplinary research "…as projects that involve academic researchers from different unrelated disciplines as well as non-academic participants, such as land managers, user groups and the general public, to create new knowledge and theory and research a common question". Facing similar challenges, an equivalent definition of transdisciplinary research is as pertinent to EBFM as it is in a landscape ecological context.

Essentially, the co-creation approach ensured that stakeholders were involved in the entire research process, which following Mauser et al. (2013) may be divided into the three stages of co-design, co-production and (co-) dissemination of results, in a continuous and iterative process to improve outcomes. The co-design phase involved cooperating with stakeholders to frame the problem focus, and to outline the general research approach to be deployed, while considering the practical constraints given by the project tasks committed to, and the availability of expertise, time and resources. Existing policy objectives (notably a requirement to satisfy Maximum Sustainable Yield (MSY) targets in terms of F and SSB for commercial fish stocks) represented another important constraint, as a failure to take such objectives into account would undermine the relevance of the research. Policy relevance is one of the aforementioned criteria of the co-creation approach. In the North Sea case study co-design was first addressed at a meeting held in London in May 2014 with a wide range of stakeholders who were asked to bring their most pressing problems to the table and to prioritize them. It was further focused by discussing the evolving solutions with them at their own meetings. In the co-production phase, the project researchers had the main responsibility of performing the main scientific work related to developing a decision support framework of relevance for the identified problem focus. The involvement and impact of stakeholders was less intense in this phase compared to the previous stage but was nevertheless important to enhance the quality of preliminary outcomes and to provide feed-back on prototypes of the decision support tools to allow necessary adaptations. The final dissemination phase involved stakeholders testing the developed decision support tools and providing feedback about their utility and potential for further development and use. Co-creation has proven to lead to benefits beyond what could be achieved through traditional research (Ballesteros et al., 2018) channelling scientific findings as usable and accessible for decision-makers to support adaptive fisheries governance (see Cvitanovic et al., 2015).

The North Sea fisheries system is a dominant component for the EU's EBFM implementation, with many fish species, many different fishing fleets and multi-level governance settings. For the North Sea, the most relevant stakeholders (various groups of fisheries interests and environmental NGOs) were involved by including as project partners the two EU advisory councils whose mandates include the North Sea: the North Sea Advisory Council (NSAC) and the Pelagic Advisory Council (PELAC). The North Sea is managed jointly by the EU and Norway; since the project is focused in the EU policy context, stakeholders from third countries operating in the area were not involved in the work presented here.

The task to be addressed was to provide a decision support framework for a North Sea EBFM. The MAREFRAME agreed approach to providing decision support frameworks for all areas was to use either multi-criteria analysis (MCA) or where possible Bayesian Influence Diagrams (BID) to gain understanding about their merits and weaknesses in participatory modelling. So for consistency the initial approach to a North Sea decision support framework was to develop a MCA for the area. This decision to use MCA was taken at a MAREFRAME wide workshop rather than in consultation with stakeholders but they were closely involved in the subsequent implementation. MCA (Janssen, 2001; Kowalski et al., 2009; Sheppard and Meitner, 2005) jointly considers the utility relating to criteria, which in turn are associated with objectives such as value, profit, job creation, catch or good environmental status (GES) outcomes of the system. In the context of EBFM, this approach presupposes that well-established model(s) can predict the consequences of different management decisions. Given such models, MCA provides one possible though discrete solution: the model(s) estimate the outcomes of various alternative management scenarios, and then – through the MCA – the various objectives are weighted so that the 'best' scenario (optimal trade-offs) can be identified. This is a viable approach in situations where decision-makers agree on the overall problem structure, on the relevant objectives when evaluating alternatives, and on the shape of the utility functions for each indicator. Clearly, the outcomes of an evaluation with an MCA will be more acceptable to the involved decision-makers if they agree broadly on how the different criteria are weighted.

The Minimum Sustainable Whinge of Pope (1983) provides an alternative but potentially complementary approach to decision support to MCA. This approach identifies those parts of the decision space that avoid regions where any stakeholder grouping would be incensed. Thus, the strategy is not to seek for the *optima* but to avoid the multiple *pessima* of the system as seen by the different stakeholders. This area of possible compromise between stakeholders is the so-called "minimum sustainable whinge region". However, Pope (1983), for the sake of simplicity, restricted the criteria to long-term profit, jobs, and catch for a very simple single species system, and he considered only the opinions