Marine Policy 55 (2015) 23–32

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Identifying marine pelagic ecosystem management objectives and indicators

Verena M. Trenkel [a,*], Niels T. Hintzen [b], Keith D. Farnsworth [c], Christian Olesen [d], David Reid [e], Anna Rindorf [f], Samuel Shephard [c], Mark Dickey-Collas [g]

[a] Ifremer, rue de l'île d'Yeu, BP21105, 44311 Nantes Cedex 3, France
[b] IMARES, Part of Wageningen UR, Institute for Marine Resources and Ecosystem Studies, PO Box 68, IJmuiden 1970 AB, The Netherlands
[c] School of Biological Sciences, Queen's University Belfast, 97 Lisburn Road, Belfast BT9 7BL, UK
[d] Danish Pelagic Producers Organisation, H.C. Andersens Boulevard 37, 1553 Copenhagen, Denmark
[e] Irish Marine Institute, Galway, Republic of Ireland
[f] National Institute of Aquatic Resources, Technical University of Denmark, Jægersborg Allé 1, 2920 Charlottenlund, Denmark
[g] ICES, H.C. Andersens Boulevard 44-46, 1553 Copenhagen, Denmark

ARTICLE INFO

Article history:
Received 5 September 2014
Received in revised form
5 January 2015
Accepted 5 January 2015

Keywords:
Ecosystem-based management
Marine pelagic community
Management objective
MSFD
CFP

ABSTRACT

International policy frameworks such as the Common Fisheries Policy and the European Marine Strategy Framework Directive define high-level strategic goals for marine ecosystems. Strategic goals are addressed via general and operational management objectives. To add credibility and legitimacy to the development of objectives, for this study stakeholders explored intermediate level ecological, economic and social management objectives for Northeast Atlantic pelagic ecosystems. Stakeholder workshops were undertaken with participants being free to identify objectives based on their own insights and needs. Overall 26 objectives were proposed, with 58% agreement in proposed objectives between two workshops. Based on published evidence for pressure-state links, examples of operational objectives and suitable indicators for each of the 26 objectives were then selected. It is argued that given the strong species-specific links of pelagic species with the environment and the large geographic scale of their life cycles, which contrast to demersal systems, pelagic indicators are needed at the level of species (or stocks) independent of legislative region. Pelagic community indicators may be set at regional scale in some cases. In the evidence-based approach used in this study, the selection of species or region specific operational objectives and indicators was based on demonstrated pressure-state links. Hence observed changes in indicators can reliably inform on appropriate management measures.

1. Introduction

High-level strategic goals for marine ecosystems and fisheries are determined by international policy frameworks such as the European Common Fisheries Policy (CFP) and Marine Strategy Framework Directive for Europe (MSFD) [26]. The CFP is a set of regulations stating that fish stocks should be exploited below or at MSY (maximum sustainable yield) taking ecosystem considerations into account and ensuring that exploitation actions are precautionary, while the MSFD is an EU Environmental Directive, expected to be implemented for fisheries through the CFP as part of an 'Ecosystem Based Fisheries Management' (EBFM) framework. The MSFD groups broad ecosystem objectives into categories called descriptors, for which the objective is to reach 'Good Environmental Status' (GES). Ecosystem state in relation to management objectives (e.g., GES) is determined using indicators. In fisheries management under the MSFD and the CFP, indicators have two roles: providing (a) triggers for management measures ("control" function) and (b) evidence for management performance reporting ("audit" or "assessing" function) [75]. Indicators are thus considered essential for an ecosystem approach to monitoring and managing human pressures on marine ecosystems [18,74].

The hierarchy of high-level policy driven strategic goals, intermediate general ecological, economic and social objectives, and lower level operational objectives, needs to be defined before choosing suitable indicators [40,43]. In this study the hierarchical framework (Fig. 1) was applied to Northeast Atlantic pelagic ecosystems. Pelagic communities have a pivotal role in the

* Corresponding author. Tel.: +33 240374000.
E-mail address: verena.trenkel@ifremer.fr (V.M. Trenkel).

http://dx.doi.org/10.1016/j.marpol.2015.01.002
0308-597X/

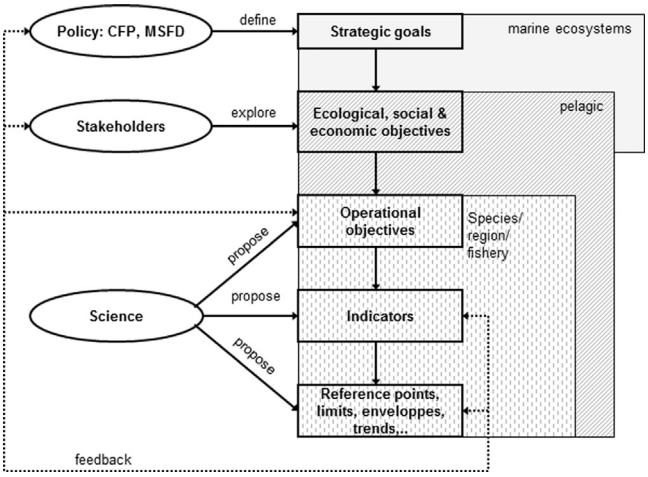

Fig. 1. Framework linking strategic goals, ecological, social and economic management objectives, operational objectives and indicators for Northeast Atlantic pelagic ecosystems. Feedback processes may occur but were not addressed in this study (dashed lines).

function of many large marine ecosystems, but have received much less attention in the scientific literature than demersal systems with respect to which general and which operational objectives might be relevant. However, specifying objectives for the pelagic is equally important for effective implementation of the MSFD.

2. Methodology

A stakeholder engagement process was undertaken to explore general ecological, economic and social management objectives for pelagic ecosystems (primarily for fish and top predators – birds and marine mammals). Examples of operational objectives, indicators and reference points were then identified for each stakeholder suggested objective based on a review of the scientific literature and expert knowledge (Fig. 1). Operational objectives and reference points apply to specific stocks, marine (sub-) regions or fisheries, while most indicators are suitable for any pelagic ecosystem with the same operational objectives.

Involvement of 'stakeholders' is considered a crucial part of EBFM [31]. All parties gain from this relationship, which stems from stakeholders having a right to decide how the marine environment is used, and an associated responsibility for sustainable use [34]. Operationally, this requires definition and representation of stakeholders. Here the stakeholder definition by Lorance et al. [49] was used: public, private/business, associations/groups/NGOs and individual stakeholders. Public stakeholders include fisheries scientists and managers (national and European). Stakeholder involvement was implemented by inviting stakeholders with interest in pelagic fisheries to two separate workshops (the first involving scientists and the second other stakeholders) to explore and list ecological, economic and social management objectives that might be suitable for the management of Northeast Atlantic pelagic ecosystems. The workshops were both organised by scientists, but selection of objectives was independent and intended to give each group the freedom to identify objectives according to their own insights and priorities for pelagic fisheries and ecosystems.

An evidence-based approach was then applied to select indicators corresponding to proposed objectives. This approach consists of specifying operational objectives for a given general management objective based on published empirical evidence for a link between manageable pressures and relevant ecosystem states. Thus, a hypothesised pressure-state link based on theory was not taken as sufficient evidence.

The evidence-based approach interprets operational objectives at species and region scale and has not previously been applied to large pelagic systems. Ecological indicator developments have focused primarily on demersal communities ([11,79,80], etc.), but see [89,87] and [84] for some pelagic examples. Pelagic fish species set distinct requirements for indicators, since they can exhibit substantial, environmentally influenced, fluctuations in abundance and wide-ranging mobility [16]. For small, and medium sized, pelagic fish species, high variability on different scales is created by schooling behaviour, environmentally driven long distance (thousands of kilometres) migrations between spawning, feeding and nursery grounds, and strong recruitment fluctuations [47]. "Small-pelagic" fish communities consist of few species, leading to the term wasp-waist food webs, though these waists are rather barrels if considered in terms of biomass [29,55]. In contrast to many demersal mixed-species fisheries, pelagic fishing generally targets single species [12], so direct pelagic fishing impacts affect single stocks, though indirect effects may cause food web perturbations [78]. Further, pelagic fisheries do not damage vulnerable benthic habitats and the fisheries exhibit low CO_2 footprints per kg of protein harvested [62] and use little fuel energy per kJ of energy harvested [88]. The strong environmental forcing of recruitment, growth and survival makes for very uncertain biomass reference-points based on the single species stock assessments used in the management of pelagic fish stocks [4,20]. The challenge is increased by the need to broaden management objectives to implement an EBFM for pelagic fisheries under EU jurisdiction [30]. Lastly, the primary anthropogenic impact on the marine ecosystem in Europe is fishing; fishing can drive shifts in pelagic fish communities [97].

3. Exploring ecological, economic and social objectives

The stakeholder workshops took place in spring 2013. For the scientist workshop, six participants in the EU-funded Myfish project (www.myfishproject.eu) were selected, based on their experience either in Northeast Atlantic pelagic fisheries, or EBFM. The scientists listed 22 potential objectives without seeking agreement on their relevance and defined a categorisation scheme grouping objectives related to societal values, food web structure and flow, fish population structure and flow, habitat quality and quantity, and fisheries yields (Table S1 in Supplementary material). For each objective, responsiveness to fisheries management was considered.

For the second (other stakeholders) workshop, individuals with active involvement in advice, debate or implementation of either management for Northeast Atlantic pelagic stocks or EBFM were invited. The invitation was accepted by eight representatives from three stakeholder categories: NGO (1), fisheries managers (3), and pelagic fishing industry (4), facilitated by three scientists. As in the first workshop participants were asked to list management objectives they considered crucial for pelagic ecosystems and fisheries, and all suggestions were again accepted without challenge by the facilitators. The facilitators asked 'clarifying' questions to define distinct objectives, encouraging a wide range of ecological concepts in relation to GES to be considered, but did not disclose the list of objectives created in the first workshop. This lead to nineteen objectives being listed (Table S1). For each objective the likelihood that fisheries management could help to reach it was discussed.

The two workshops resulted in a total of 26 objectives being suggested (Table 1). There was rather good agreement between the scientists and the other stakeholders: 58% (15) objectives were suggested in both (Table S1, Supplementary material). All 26 objectives were retained for the subsequent steps.