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Can we develop an integrated ecosystem assessment without using reference points?

Marie-Joëlle Rochet, Verena Trenkel, Pascal Lorance, and Pascal Laffargue
Ifremer, France. Contact author: Marie-Joëlle Rochet, Ifremer, B.P. 21105, 44311 Nantes Cedex 03, France ; Tel +33 2 40 37 41 21 ; Fax +33 2 40 37 40 75 ; email mjrochet@ifremer.fr

Introduction

Ecosystem based management (EBM) creates the need for Integrated Ecosystem Assessments (IEA). EBM takes an ecosystem-scale perspective and operates under multiple objectives, associated with multiple uses of and activities in the marine ecosystem. Therefore IEA needs to integrate – incorporate an evaluation of ecoystem components and their uses into a whole. Assessment, or evaluation, implies that IEA is not just a description, but also states whether the ecosystem state and dynamics are satisfactory. That is, IEA requires the application of normative standards (Freyfogle and Newton, 2002). This means that science, which aims at description (stating or predicting facts), cannot deliver an IEA on its own – the IEA needs to be an interactive process with the clients who set the norms.

Reference points (RPs) have been extensively used as a convenient way of operationalizing environmental norms. They are also considered a cornerstone of integrated assessments because they enable to standardize non-commensurate indicators. Various spatial, historical, and functional categories of approaches are used to define RPs. Related challenges include availability of knowledge and data, the difficulty to translate broad management goals into numbers, and the non-interchangeability between areas or time periods. Moreover, when a suite of indicators is used, there is no reason to expect that RPs determined independently for each indicator would be consistent. To set consistent RPs across multiple pressures and components, a fully parameterized quantitative mechanistic ecosystem model would be necessary. There is growing consensus though, that ecosystem models are to be used in a strategic rather than tactic manner – that is, not to make accurate estimates or predictions of future states (such as RPs), but to improve our comprehensive understanding of how the system works (Link et al., 2012).

Besides, the normative dimension of RPs implies that limit and target levels for any given criterion or indicator will vary widely across and even within stakeholder groups. Multiple objectives and complex, non-linear dynamics unavoidably generate conflicts. Taking an ecosystem approach to management implies to take account of side-effects on multiple objectives of a management decision made to meet one objective.

Single use environmental assessment usually asks three kinds of questions. (1) Does current state meet the management objective? (2) If not, what can be done to move the system closer to the objective? (3) What are the risks (probability of undesirable consequences) of the management options? Moving to IEA adds many more questions (4) Are the objectives compatible? (5) If not, what can be done to reconcile them? It is obvious from simple combinatorics that a small increase in the number of objectives results in a steep increase in the number of questions, even if objectives are only taken pair by pair. Moreover, because an ecosystem is a dynamic system, the ability to reconcile two non-compatible objectives depends not just on the objectives, but also on the current ecosystem state and dynamics. Identifying issues and conflicts, not to talk about RPs, by an analytical approach in this context is daunting; stakeholder input might be as adequate.

Approach

EBM will mostly consist in resolving conflicts of objectives. Management bodies will have to create the necessary institutions and mechanisms to arbitrate these conflicts. The science needed to support these arbitrations describes the trade-offs associated with the conflicts of objectives.

We propose that science contribution to an IEA might involve a combination of three kinds of tools and approaches: (1) Integrated Ecosystem Description (IED); (2) methods to assess whether current state meets the management objectives in broad terms, and whether current dynamics move the system towards or away from the objectives; and (3) methods to describe and quantify trade-offs.

1. Integrated Ecosystem Description includes a synthetic inventory – a list of the important ecosystem components, activities, boundaries and institutions; and a "value-free" description of current levels and trends in drivers, pressures and states. IED relies on published science with the necessary peer-review delay – which also permits to take the necessary step back. IED is met, for ICES, by the Ecosystem Overviews that are being prepared by a number of Expert Groups.
2. To assess whether current state meets the management objectives, we propose to use a hypothesis testing framework. For example, in the case of the European Union (EU) Marine Strategy Framework Directive (MSFD), the general working hypotheses might be H_0 (state): The ecosystem is currently in Good Environmental Status (GES), and H_0 (dynamics): The ecosystem is not moving away from GES. Most complaints (by stakeholders, administrations, management bodies…) could be framed as challenges to these hypotheses. Whenever the hypothesis is rejected, actions need to be taken.
3. To analyse a trade-off we need to understand the links between the components and activities involved in the trade-off, and to quantify the amount of downside to be traded against upside of a particular decision.

Application

As an example of the proposed analyses, this framework is applied to the Bay of Biscay.

Objectives: The EU Common Fisheries Policy (CFP) aims at environmental sustainability; economic, social and employment benefits; and availability of food supplies. The EU MSFD aims at Good Environmental Status, which includes (D1) maintained biological diversity; (D2) non-indigenous species at non-adverse levels; (D3) healthy stocks; and (D5) eutrophication adverse effects minimised.

IED: In the Bay of Biscay in the early 1990s, fishing appeared to be the only activity exerting widespread impacts on several ecosystem components. Terrestrial activities had some widespread impacts. With the exception of marine transport impacting seabirds at the regional scale through oil pollution, other activities had only local impacts, mostly nearshore (Lorance et al., 2009).

State and dynamics: Since the 1990s the Bay of Biscay ecosystem productivity has been increasing and fishing pressure decreasing (Rochet et al., 2010); these simultaneous variations in pressures have counteracted each other (Rochet et al., 2013); resource dynamics and economics cannot be demonstrated to have influenced fleet dynamics, which seem to have been mostly determined by the vessel buyback programme (Rochet et al., 2012). Overall the system does not seem to be moving away from the CFP objectives.

Trade-offs: Economic benefits *vs* MSFD D3: mariculture industry is negatively impacted by the healthy stock of blackspot seabream, which feed on cultivated mussels. CFP *vs* CFP: decreasing *Nephrops* discards by the *Nephrops* trawler fleet in the BoB might increase catches of bycatch species and potentially compromise stock status.

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