

Selecting indicators for operational assessment of marine ecosystem services

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Summary

Coastal zones are the theatre of many human activities and multiple stakes compete in marine ecosystem management. While taking into account complexity of socio-ecological processes, the ecosystem services (ES) approach offers numerous ecological, social and economic indicators to decision-makers. Common theoretical frameworks, typologies of marine ES and indicators have already been developed. However, to improve ES approach contribution to integrated assessments, it is still needed to better understand where efforts - from monitoring to indicator computation - should focus on.

A framework is developed to implement ES approach for assessing marine and coastal areas in support of operational management. This methodology combines a synthesis of available knowledge on marine ES and selection of a core set of indicators by experts and stakeholders. Indicators are selected according to aims and scope of assessment, ability of indicators to enlighten practical management objectives and decisions, feasibility of indicator computation and intelligibility to multiple end-users. This participatory approach was applied and discussed in a case study: kelp forest management in Western Brittany. Our results support that ES approach could provide new insights to management debate, when looking for trade-offs between exploitation and conservation issues. Finally, perspectives of this work include integration of such a core set of indicators into spatial explicit ES modeling to test impacts of different management scenarios on Kelp forest ES.

Introduction

Beyond a framework to apprehend links between ecosystems and human actions, ecosystem services (ES) concept provides a common language that facilitate trade-offs between ecosystems and economic management objectives for decision-making (Braat and de Groot, 2012; MEA, 2005). Despite this, ES approach has rarely been included effectively in integrated assessments for marine management (Laurans et al., 2013). Spatially explicit ES assessment tools have indeed proved to be time and cost consuming when fully implemented (Bagstad et al., 2013). Therefore, understanding where efforts should be focused on and what we need to measure to make the best use of limited resources is a true challenge in building decision tools for marine operational management.

This paper presents an original methodology to select relevant indicators for operational assessment of ES. Through the case study of kelp forests in Western Brittany, it gives feedback about application of ES approach to natural resources management and marine spatial planning.

Materials and methods

The Molène archipelago is part of the Iroise Sea Marine Natural Park (PNMI). It is the largest exploited kelp forests of the French coast and hosts commercial species, remarkable species of marine mammals and birds, traditional fishing activities and an extremely varied cultural heritage.

A primordial point in selecting indicators for operational assessment of marine ES is to identify which ES should be assessed as a priority to inform current management decisions. Firstly, an exhaustive list

of kelp forest ecological functions and ES was built from scientific literature and expert knowledge. This list was then subjected to the triage approach suggested by Pendleton et al. (*in prep.*). This framework helps delimiting the scope of assessment with regard to social demand by answering the following questions: *Who for? What for? Where efforts should be focused on?* Kelp ES were then ranked with respect to their potential for changes and potential influence of local management intervention. To compute indicators, data relating to environmental, biological and socio-economic features, as well as spatiotemporal patterns of human activities in the Molène archipelago were compiled (e.g. Bajjouk, *pers. comm.*; PNMI, 2010; Ifremer, FIS, "Fisheries Information System"). Finally, relevant indicators were selected according to their ability to enlighten practical management objectives and decisions, their computation feasibility and intelligibility to multiple end-users. Local stakeholders, experts and scientists were involved throughout the whole process.

Results and Discussion

Kelps are harvested for alginate production and, as engineer-species and primary producer, maintain an ecosystem that delivers many other services related to associated biodiversity and its contribution to local human activities and cultural heritage. Thirty-two ES were identified for Molène kelp forests and 12 were retained by the triage procedure, including 4 provisioning services, 5 support and regulation services and 3 cultural services. These ES are expected to be potentially impacted by two factors of changes (intensification of kelp harvesting and more frequent storms in relation to climate change) and to be responsive to local management interventions (e.g. no-take zones, harvesting rotation and harvesting capacity and effort management). Finally, 24 indicators were selected to assess kelp forest ES and were discussed regarding their relevance to assess Molène kelp forest status.

The core set of indicators was computed and gave an initial ES assessment of Molène kelp forests. These results could serve as a base-line to evaluate future evolutions of Molène kelp forests and compare efficiency of kelp harvesting management measures. Lessons learned from this case study concerned both technical aspects of indicators selection and computation and ways of leading ES assessment, sharing knowledge and involving local stakeholders to accomplish an efficient and operational integrated assessment of ES. Our results support that ES approach could provide new insights to management debate, when looking for trade-offs between exploitation and conservation issues.

References

- Bagstad, K. J., Semmens, D. J., Waage, S., and Winthrop, R. 2013. A comparative assessment of decision-support tools for ecosystem services quantification and valuation. *Ecosystem Services*, 5:27-39.
- Braat, L. C., and de Groot, R. 2012. The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy. *Ecosystem Services*, 1(1): 4–15.
- Laurans, Y., Rankovic, A., Billé, R., Pirard, R., & Mermet, L. 2013. Use of ecosystem services economic valuation for decision making: Questioning a literature blindspot. *Journal of environmental management*, 119:208-219.
- MEA - Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Wellbeing, Synthesis*. Island Press, Washington D.C., U.S.A.
- Pendleton, L., Charles, M. and Mongruel, R. A Triage Approach to Determine Ecosystem Services Valuation Needs for Marine Management. *In preparation*
- PNMI, 2010. Management plan 2010-2025, summary. Agence des Aires Marines Protégées, Parc Naturel Marin d'Iroise, Le Conquet, 42 pp.