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Monitoring and evaluation of spatially managed areas: A generic framework for implementation of ecosystem based marine management and its application

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ABSTRACT

This study introduces a framework for the monitoring and evaluation of spatially managed areas (SMAs), which is currently being tested by nine European case studies. The framework provides guidance on the selection, mapping, and assessment of ecosystem components and human pressures, the evaluation of management effectiveness and potential adaptations to management. Moreover, it provides a structured approach with advice on spatially explicit tools for practical tasks like the assessment of cumulative impacts of human pressures or pressure-state relationships. The case studies revealed emerging challenges, such as the lack of operational objectives within SMAs, particularly for transnational cases, data access, and stakeholder involvement. Furthermore, the emerging challenges of integrating the framework assessment using scientific information with a structured governance research analysis based mainly on qualitative information are addressed. The lessons learned will provide a better insight into the full range of methods and approaches required to support the implementation of the ecosystem approach to marine spatial management in Europe and elsewhere.

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1. Introduction

Across the globe increasing human pressures on coastal and offshore waters have resulted in complex conflicts between different human activities (which are often competing for space) and interactions between human activities and the marine environment [1]. Hence, system specific management options are required, which satisfy current and future sectoral needs. They must therefore integrate multiple objectives, including those concerned with marine conservation. Such an integrated management approach is inherent in the widely accepted concept of ecosystem based management (EBM). EBM embodies adaptive and flexible governance and management systems that require suitable and effective information-providing mechanisms which rely on appropriate monitoring programs and integrated assessments. More precisely, EBM aims to maintain an ecosystem in a healthy, productive and resilient condition so that it can continue to provide the services humans want and need [2]. A number of policies at the global scale (e.g., Convention on Biological Diversity, 1992; Food and Agriculture Organisation (FAO), Code of Conduct for Fisheries, 1995) or regional scale (e.g., Marine Strategy Framework Directive; MSFD [3] or Habitats Directive; HD [4]), recognise the need to consider human pressures in the marine environment through EBM [5]. To date, rendering EBM effective has been hampered by a number of factors, including the lack of governance structures, complexity of biological and socioeconomic processes, lack of knowledge on the dynamics and resilience of marine ecosystems, implementation costs and the need for practical tools [6,7].

The concept of EBM is closely linked to monitoring, evaluation, reporting and adaptive management, which are the essential components for effective marine management [8]. The fundamental principles for monitoring include identifying the objectives, monitoring options, scale, costs and benefits. In recent years, the formulation of operational objectives and operational deliveries has been proposed in the wider context of an ecosystem based approach to marine management. A recent study [9] presented a hierarchical monitoring framework that incorporates objectives and delivery statements of ecological, social and economic sectors. Another example is a GOIS (Goal–Objective–Indicator–Success Criteria) framework, which was used to assess the management performance of marine protected areas (MPAs) [10]. Ultimately, the monitoring and evaluation of management performance should (i) demonstrate the extent to which the objectives have been achieved; (ii) provide evidence-based feedback about what's working and what's not; and (iii) reveal interactions between ecological components, human pressures and management efforts.

Tools facilitating the implementation and assessment of EBM in marine ecosystems are the Organization for Economic Cooperation and Development's (OECD), Pressure–State–Response (PSR) framework (OECD, 1993), and the Drivers-, Pressures–State–Impact–Response (DPSIR) framework adopted by the European Environment Agency in 1995 (EEA, 1995) (see also [11]). Integrated ecosystem assessments (IEA) (see [12] and references therein) are promoted as they do not only incorporate biotic and abiotic components, but also socio-economic factors as well as an analysis of how these factors interact. A recent example of an IEA framework [13] encompassed five key steps that enhance the likelihood of a successful implementation of EBM: scoping, indicator development, risk analysis, assessment of ecosystem status relative to EBM goals, and management strategy evaluation. This IEA was later extended to seven steps, together with more practical guidance on methods and strategies to promote an inclusive and transparent process [14].

Operationalisation of EBM needs a spatially explicit management strategy to cope with fragmented decision-making processes across

different economic sectors and ecosystem components [15]. Thus, place-based or spatial management approaches, such as marine spatial planning (MSP), facilitate the implementation of EBM [16]. MSP is a public process of analysing and allocating the spatial and temporal distribution of human activities to achieve ecological, economic, and social objectives that usually have been specified through a political process [17,18]. The UNESCO has recently launched step by step guidance on how to operationalise MSP, based on examples of MSP at different stages of development from all around the world [19]. Further the European Commission published some guiding principles for MSP [20], recognising that the sustainable management of marine regions depends on the condition of the respective ecosystems. EBM is thus the overarching principle for an ecosystem based MSP which is defined as an integrated planning framework that informs the spatial distribution of activities in and on the ocean in order to support current as well as future uses of ocean ecosystems [21]. Hence, an ecosystem based MSP aims to maintain the delivery of valuable ecosystem services for future generations in a way that meets ecological, economic and social objectives.

There is an increasing demand for practical and interdisciplinary approaches, accounting for the overarching principles of EBM, to monitor, evaluate and implement Spatially Managed Areas (SMAs) in coastal and offshore waters [14,21,22]. The project Monitoring and Evaluation of Spatially Managed Areas (MESMA; www.mesma.org) addresses this demand by developing an integrated management tool box for SMAs. SMAs are defined as discrete spatial entities with different spatial extensions where a spatial management framework such as MSP is in place, under development, or considered. The tool box is developed and tested with the help of nine MESMA case studies, at different stages of MSP implementation, spanning the various geographical regions of the European marine waters (North Sea, Orkney Islands, Barents Sea, Celtic Sea, Basque Country, Strait of Sicily, Ionian Archipelago, Baltic Sea and Black Sea), and having a range of human pressures and representative habitats. The central tool developed by MESMA is a generic and flexible framework which, through a framework manual, gives guidance on the assessment of SMA effectiveness by means of structured practical tasks and associated methods and analysis. This framework builds on the lessons learned [23] and proposes an iterative process comprising the key elements of scoping, performance measures, assessment, evaluation and adjustment. Methods and technical tools, including a geodata portal, are being developed to support the implementation of the framework. A parallel governance analysis is conducted in the different case studies. Thus the ultimate aim of the MESMA tool box is to facilitate an integrated and transparent process to support the implementation of an ecosystem based spatial management.

This paper provides a comprehensive report on the proposed framework steps, together with state-of-the-art methods and tools for its practical application. Methods relate to the mapping of human activities and the assessment of their cumulative impacts on sensitive ecosystem components. Furthermore, the difficulties identified in the first implementation of the framework in each of the nine case studies are synthesized. Finally, the emerging challenges for the practical integration of the assessment framework with the governance research analysis are described.

2. Requirements for a SMA assessment

The key requirement for practical guidance on the monitoring and evaluation of SMAs is to be generally applicable at any spatial scale, independent from the major natural and socioeconomic

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