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.
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
factors. In practice, SMAs can have different stages in the development of spatial management plans and consequently, the application of a standardised assessment framework will lead to different types of assessment outputs. These outputs can fluctuate from a performance assessment of an implemented marine spatial plan or an assessment of the process used to develop a spatial management plan, to an IEA leading to a set of qualitative recommendations to support EBM within an SMA context. A first characterisation of the SMAs and a relative positioning of the expected assessment outcomes can be conducted with the conceptual flow diagram presented in Fig. 1. The expected outcomes can vary from detailed quantitative assessments to qualitative recommendations, depending not only on the stage of the spatial management in place but also on the data available for the assessment. Therefore, an assessment of a SMA with an implemented MSP can also result in a purely qualitative description of issues and recommendations when data are absent. This highlights the need for an SMA assessment to include a data-driven element in order to produce a set of quantitative results.

3. A generic framework to monitor and evaluate SMAs

Building on the experience of existing frameworks and approaches, it can be concluded that practical steps to monitor and evaluate SMAs should reflect the principles of an adaptive environmental management cycle [8,23]. Moreover, to support the implementation of an ecosystem based marine spatial management, a framework for monitoring and evaluating SMAs must explicitly consider interactions between ecosystem components, management sectors, institutions and key actors, as well as the cumulative impacts of human activities. The presented framework accounts for those components and describes seven key steps to evaluate and monitor SMAs (Fig. 2(a)). The steps involve the definition of desired outcomes and management objectives, mapping of relevant ecosystem components, identification of performance indicators, monitoring and risk assessment, assessment of findings in relation to objectives, and evaluation of current management and recommendations for adaption. This stepwise process can be conducted iteratively and therefore it can be completed for any SMA with different sets of defined objectives. Furthermore, the feasibility of any newly proposed management measures can subsequently be assessed by a further iteration of the framework.

As previously described, the output of any practical assessment using the proposed framework depends on both the characterisation of the SMA (as described in Fig. 1) and the data availability. In turn, data availability is further linked to the requirements for specific analyses or the use of certain tools such as GIS. The framework reflects a structured analysis of mostly scientific information which is closely linked to an in depth governance analysis to provide a comprehensive SMA assessment (Fig. 2(b)). In MESMA a key focus of the governance research is to explore how different governance approaches and incentives can be combined to achieve strategic objectives in an effective and equitable manner, including opportunities for stakeholder participation (see Table 1). Thus a ‘two-stream’ and interdisciplinary approach is currently tested in the case studies, where a structured governance analysis is conducted in parallel to the assessment framework (Fig. 3). Whilst the application of the framework will assess the management effectiveness of a SMA through a prescribed and generic scientific process, the governance stream will focus on the complex institutional and geo-political reality, within which the SMA is embedded. Such an interdisciplinary approach enables the combination of the strengths of both social and natural sciences in a comprehensive and robust assessment of SMAs. However, a detailed description of the governance analysis is beyond the scope of this paper. Instead, this discussion focuses on the step by step guidance, the links between the assessment of scientific data and the detailed governance analysis as well as the challenges in integrating the two streams of research.

4. Step by step guidance on the implementation of the framework

4.1. Step 1 — Context setting

The aim of step 1 is to set the spatial and temporal context for the evaluation (step 1a) and to define the goals and operational objectives (1b). Both steps should be carried out in conjunction and together they should set the context for the physical area involved as well as the overarching aims of the SMA.

Temporal and spatial boundaries for the SMA assessment (1a) — In cases where a spatial management plan is in place or in preparation, the boundaries are defined in the management plan. In other cases, potential administrative, ecological, economic or social boundaries should be considered. This step includes identification and mapping of boundaries and timeframes in existing management plans, spatial management initiatives, other SMA activities and the institutional landscape. This step is important because the application of the SMA evaluation process (and therefore outcomes of the assessment) relate to the defined

![Fig. 1. Conceptual flow diagram which relates the context of a spatially managed area (SMA) together with the available data to expected SMA assessment outcomes.](image-url)
Goals and operational objectives for SMA (1b) — Any spatial planning or management process is driven either implicitly or explicitly by goals. Goals are high-level outcomes that a planning process or management aims to achieve through the implementation of measures. High-level goals are based on societal or cultural values, whilst the associated criteria, attributes and indicators are developed in the scientific domain and decided upon in the political domain [24]. High-level goals need to be translated into operational objectives to allow the elaboration of specific targets, limits and measures. In general, operational objectives are defined as those for which specific, measureable, achievable, realistic and time limited (SMART) targets can be set, such that management measures can be fitted and performance can be evaluated. Thus developing a set of operational objectives also includes the identification of the minimum necessary set of environmental objectives that require explicit consideration by managers.

For a SMA with an existing or already proposed spatial plan high-level goals and related operational objectives should have
Table 1
Structured and systematic guidelines for governance research comprising seven sections that have been developed for implementation in each case study.

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<thead>
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<th>Section</th>
<th>Contents</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>Context: description of the socio-economic and political context, and the regional policy framework (e.g., regional sea management plans)</td>
</tr>
<tr>
<td>II</td>
<td>Objectives and management measures: identification of a priority objective and secondary objectives for the evaluation of governance approaches, and the associated legal and policy framework.</td>
</tr>
<tr>
<td>III</td>
<td>Conflicts: description of conflicts between environmental conservation and resources use, as well as between sectors or resource users</td>
</tr>
<tr>
<td>IV</td>
<td>Governance approach and effectiveness: description of the main governance approach employed (top-down, decentralised, bottom-up, or market-based), and its effectiveness in achieving the priority objective and addressing related conflicts</td>
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<td>V</td>
<td>Incentives: description of the incentives implemented to encourage behavioural changes to fulfil the priority objective and to address related conflicts, as well as a discussion of the incentives needed to improve governance</td>
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<td>VI</td>
<td>Cross-cutting themes: discussion of five cross-cutting themes representing wider-scale institutional or structural issues that may underpin the effectiveness of individual incentives and/or the overall governance approach: (a) combining top-down role of state and bottom-up participative approaches; (b) cross-border issues between different countries; (c) environmental and social justice issues and related rights of appeal; (d) influence of different knowledges and of uncertainty in decision-making</td>
</tr>
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<td>Conclusion</td>
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Fig. 1. An interdisciplinary approach that combines the strengths of social and natural sciences in assessing the management effectiveness of a SMA.

Fig. 4. An example of a state indicator is presented from the Barents Sea case study showing population trends (apparently occupied nest sites) of Atlantic Puffins at Hennyken (Røst archipelago, Nordland), Anda (Vesterålen, Nordland), Gjesvær (Finnmark), and Hornøy (Finnmark) as percentages of the mean for all years. The y-axis is logarithmic. The mean is defined as 100% such that 2 represents a population twice the mean, 3 a population three times the mean, 0.5 half of the mean etc. [60].

Fig. 5. An example of a pressure indicator is presented from the Inner Ionian Archipelago–Patraikos and Korinthiakos Gulfs case study showing the relationship between hake MSY, estimated by the Schaefer model (red line), and the relative landings hake per year (2003–2008). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)
been defined early in the design process to improve communication and to standardise expectations of stakeholder groups [25]. In general, a 'bottom up' approach to management would entail the development of objectives by a wide range of stakeholders. In practice this requires the establishment of focused guidelines regarding process and goals to underpin productive consultations [26].

Where there are no predefined goals and operational objectives, numerous marine policies may apply from the international to the local level. The high-level goals can be taken from these policies and operational objectives can then be derived. For instance, in Europe any SMA assessment has overarching regional objectives such as those defined by the MSFD or the Common Fisheries Policy (CFP; [27]). Hence, in the absence of predefined SMA objectives, a suite of MSFD operational objectives may be used instead; guidance on their practical assessment is available [28,29]. As an example, listed in Table 2 are a number of policies at global and regional scale together with their high-level goals and operational objectives. Given that existing overarching policy goals are in place, step (1b) can be conducted in a first instance without formal stakeholder consultation. However, the validity of high-level policy goals, the assessment results and proposed management recommendations, derived from the application of the framework, should be communicated to and evaluated by different stakeholders throughout the governance analysis. The results from the governance research will feed into the process in steps 6 and 7 to allow an inter-disciplinary assessment of the management effectiveness of a SMA and the feasibility of implementing recommended management measures (see Fig. 2(b)).

4.2. Step 2—Existing information, collation and mapping

Information on relevant ecosystem components needs to be gathered and mapped in order to assess potential spatial overlaps
Fig. 7. Location of the nine SMA case studies testing the framework: (1) southern North Sea, (2) Pentland Firth and Orkney Waters, (3) Barents Sea area, (4) Celtic Sea, (5) Basque country continental shelf (SE Bay of Biscay), (6) Strait of Sicily, (7) Inner Ionian Archipelago and adjacent gulfs, (8) Black Sea, and (9) Baltic Sea with showing different levels spatial management plan implementations (yes, no, and in progress).

Table 2
Examples of conventions and directives that apply in the study area, with their high-level and operational objectives.

<table>
<thead>
<tr>
<th>Convention/Directive</th>
<th>High-level objectives</th>
<th>Operational objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Convention on Biological Diversity (1992).</td>
<td>To conserve biodiversity, promote the sustainable use of the components of biodiversity, and the fair and equitable use of genetic resources.</td>
<td>To achieve by 2010, a significant reduction on the current rate of biodiversity loss at the global, regional and local scale.</td>
</tr>
<tr>
<td>European Marine Strategy Framework Directive (2008).</td>
<td>To protect, conserve and, where possible, restore the marine environment in order to maintain biodiversity and provide diverse and dynamic oceans and seas which are clean, healthy and productive</td>
<td>To achieve ‘good environmental status’ in Europe’s regional seas by 2020, according to a set of 11 descriptors and a relevant list of indicators.</td>
</tr>
<tr>
<td>European Habitats Directive (1992)</td>
<td>‘To promote the maintenance of biodiversity’, and to contribute to the general objective of sustainable development.</td>
<td>To maintain or restore the natural habitats and the populations of species of wild flora and fauna at a favourable conservation status, according to a specific set of criteria.</td>
</tr>
<tr>
<td>European Common Fisheries Policy (2009)</td>
<td>The protection of fish stocks in European waters against overfishing; a guaranteed income for fishermen; a steady supply at reasonable prices for consumers and the processing sector; and the sustainable biological, environmental, and economic exploitation of living aquatic resources.</td>
<td>Integrating environmental concerns into fisheries management to ensure the sustainability of fisheries, and using the principle of maximum sustainable yield (MSY) for stock management. Increasing stakeholder involvement and compliance through the establishment of Regional Advisory Councils.</td>
</tr>
<tr>
<td>European Water Framework Directive (2000)</td>
<td>The protection and enhancement of aquatic systems; the promotion sustainable water use; the progressive reduction and full elimination of discharges and emissions of harmful substances and pollution into aquatic resources; and the mitigation of the effects of floods and droughts.</td>
<td>To achieve by 2015 ‘Good ecological and chemical status’ in all surface and groundwater bodies.</td>
</tr>
<tr>
<td>European Birds Directive (2009)</td>
<td>To conserve and protect birds which naturally occur in the Union and their habitats.</td>
<td>Maintain the population levels of bird species which correspond to ecological, scientific and cultural requirements. The establishment of a coherent network of Special Protection Areas comprising all relevant and suitable territories of bird species which naturally occur in the Union.</td>
</tr>
</tbody>
</table>
and impacts. In this framework, ecosystem components comprise natural and socio-economic features. Natural ecosystem components encompass, for example, the occurrence of species groups, functions or processes describing the ecosystem. In contrast, socio-economic components comprise different (existing and potential) human uses and sectors.

4.2.1. Ecosystem components (2a)

An important part of the scoping process is the definition of ecosystem components which correspond to the defined set of operational objectives. Under step 2a GIS should be used to allow for the collation, visualisation and analysis of spatial information. The scale at which the components are mapped depends on both the scale of the operational objectives and the availability of data in the SMA. For instance, some human activities such as fishing or shipping require larger spatial mapping, whilst geodata on habitats may be only available at the local scale. Moreover, if information on ecosystem characteristics is available at the relevant scales more detailed maps can be produced in the form of marine landscapes or seascapes (see e.g., [30–35]). In contrast, where data availability is poor in relation to the spatial scale and the operational objectives of the SMA, the relevant ecosystem components may be mapped on a very broad scale using descriptive variables or interpretations based on expert judgement (e.g., www.finding-sanctuary.org and [36]). Further, the spatial claims of future human uses can be described by their specific requirements and restrictions for instance, by minimum or maximum water depth, grain-size, density of target organisms or wave dynamics.

4.2.2. Pressures and impacts (2b)

This step requires analysis of the spatial and temporal overlap of the distribution pattern of the identified natural ecosystem components and current and future human activities (including the spatial overlap of human activities). This implies the identification of existing or potential conflicts between different users, or between users and natural ecosystem components. A useful tool to assess interactions between human activities is an interaction matrix indicating the potential conflicts and compatibilities between human activities (see e.g., www.plancoast.eu/files/handbook_web.pdf). Such an interaction matrix can be combined with a GIS to map areas of potential conflicts and prioritise spatial management requirements within a SMA.

Where a spatial and/or temporal overlap between current and future human activities and ecosystem components can be identified, a detailed analysis on the pressures exerted by those activities and their combined impacts on ecosystem components should be performed. In general, the assessment of an impact of a human activity on an ecosystem component requires both a method for translating human activities into ecosystem-specific pressures, and a measure of sensitivity of ecosystem components to those pressures [37]. Thus after having defined the relevant activities, these should be classified into generic pressure and impact categories.

As an example, Annex III of the MSFD contains a list of human pressures and impacts which should be carried out for each indicator using a set of criteria relevant to the objectives, for example the abundance of a certain species, a measure of diversity or the surface area covered by a certain habitat. Indicators are required to measure the status of attributes of the ecosystem components and criteria related to the operational objectives, should follow a structured and objective process [47]. Thus after having selected the candidate indicators a viability analysis should be carried out for each indicator using a set of criteria [50]. Indicators should follow a structured and objective process [50–52]. Scientifically they should be easy to measure, interpretable, grounded on scientific theory, sensitive and response specific. From a management perspective they should be cost effective, concrete, relevant to the objectives.
linked to the outcome being monitored, developed inclusively and part of the management process [50]. However, the multidimensionality and complexity of natural ecosystems and human impacts indicates that all environmental variables cannot be monitored and incorporated, with several indicators needed to delineate relationships with each management objective [53].

Another important part of step 3 is the definition of thresholds or reference points against which the status of the indicators can be assessed in step 4. Thresholds or reference points should ideally reflect high level goals, such as sustainable use or development [54]. There is a large body of literature on methods and approaches to set reference points for ecological indicators [55]. For instance, for exploited species, many science advisory and management agencies such as the International Council of Exploration of the Sea (ICES) use limit and precautionary or buffer reference points as core tools [56]. Further examples described a quantitative method to define thresholds for the level of human pressure for ecosystem components [57] and reviewed the methods to define reference points [58]. However, in some cases where a threshold cannot be established the assessment of reference directions, that is, desirable or undesirable trends in indicators, may be sufficient [14].

4.4. Step 4 — State assessment or risk analysis

State assessment evaluates whether or not the management goals and operational objectives of an already implemented management plan have been met. Risk analysis in contrast estimates the probability of not meeting defined management objectives, based on the predicted result of suggested management measures (i.e., management plan existing, not yet implemented). In other words, the state assessment evaluates the performance of a current management through monitoring and auditing, while a risk analysis evaluates the predicted effectiveness of proposed management scenarios. Whether a state assessment or risk analysis is carried out will depend on the characteristics of a given SMA (i.e., spatial management plan implemented or in planning phase).

Where a spatial management plan is already in place, the state assessment will assess if the selected indicators are in an undesirable state in relation to the defined thresholds, taking into account different levels of uncertainty. In this context, the framework specifies the appraisal of the relationship between state and pressure indicators. This comprises also a quantitative or qualitative assessment on how state indicators are generally affected by human pressures or natural processes. Ideally, state indicators have been clearly defined in the monitoring and audit process of an existing spatial management plan. In practice, however, there are cases where the monitoring (including the state indicators) is not specified. If this is the case, the assessment should be based on state and pressure indicators which are in line with both the SMA objectives and implemented management measures. Ultimately, this step allows for an evaluation of existing management measures implemented in the SMA.

In cases where no spatial management is implemented, a first application of the iterative framework will only require a risk analysis. Such a risk analysis should comprise a sensitivity analysis of suggested management measures, which corresponds to a formal management strategy evaluation (MSE). More precisely, this requires a comprehensive assessment of how a set of proposed management measures or management scenarios are likely to affect the performance of chosen indicators. There are a few tools, such as the ecosystem model Atlantis (http://www.cmar.csiro.au/research/mse/atlantis.htm), which allow assessing management options in the course of a risk analysis (see review of tools in [14]). Another promising approach is the use of Bayesian belief Networks (BNs) together with GIS to enable the spatially explicit assessment of risks for certain ecosystem components under different spatial management scenarios [61].

4.5. Step 5 — Assessment of findings against operational objectives

This step reflects a technical summary of the risk analysis or state assessment. It comprises an interpretation of these results in terms of the extent to which the operational objectives have been achieved or have failed. For each operational objective defined in step 1b, the results for the indicator assessment should be summarised. This summary may contain a table with objectives—indicators matrices or a description of the findings. For instance the traffic light method facilitates decision-making through integration of several criteria [62]. At this stage lessons learned and gaps identified, in relation to the selection of the operational objectives and associated indicators, should be extracted and transferred in a structured way to the next framework steps (Table 3).

4.6. Step 6 — Evaluation of management effectiveness

At first, the management effectiveness in achieving the operational objectives of a SMA should be evaluated, accounting for the key pressures from particular human activities. Under step 6, a synthesis of the findings should identify any mismatch in management measures, i.e., why something does or does not work. Here the sources of uncertainty in the assessment results should be reflected and a description of how those uncertainties accumulated in the overall assessment should be provided [63–65]. This also includes some guidance on how to deal with uncertainty or unforeseen consequences in time and space. A comprehensive synthesis should also link to both a description of the level of stakeholder satisfaction and acceptance, and an assessment of the overall balance between high-level policy objectives and local objectives. A detailed governance research analysis will complement such an evaluation. This is because it provides an understanding of the social and political context, the effectiveness of

<table>
<thead>
<tr>
<th>Locality</th>
<th>Time period</th>
<th>Years of data</th>
<th>Change per year(%)</th>
<th>Trend</th>
<th>Significance</th>
<th>Trend over last 5 years</th>
<th>Breeding success last 3 years</th>
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<tbody>
<tr>
<td>Hernyken</td>
<td>1979–2010</td>
<td>32</td>
<td>−3.4</td>
<td>***</td>
<td>n.s.</td>
<td>−7</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>2000–2010</td>
<td>11</td>
<td>−0.7</td>
<td>O(−)</td>
<td>n.s.</td>
<td>−7</td>
<td>0.0</td>
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<tr>
<td></td>
<td>1981–2010</td>
<td>10</td>
<td>−0.5</td>
<td>(−)</td>
<td>n.s.</td>
<td>−7</td>
<td>0.0</td>
</tr>
<tr>
<td>Andøya</td>
<td>2000–2010</td>
<td>8</td>
<td>−3.2</td>
<td>±</td>
<td>n.s.</td>
<td>−7</td>
<td>0.0</td>
</tr>
<tr>
<td>Gjesvær</td>
<td>1997–2010</td>
<td>14</td>
<td>−1.8</td>
<td>(−)</td>
<td>n.s.</td>
<td>−7</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>1980–2010</td>
<td>28</td>
<td>2.2</td>
<td>+</td>
<td>n.s.</td>
<td>−7</td>
<td>0.0</td>
</tr>
<tr>
<td>Hornøy</td>
<td>2000–2010</td>
<td>10</td>
<td>−0.5</td>
<td>0(−)</td>
<td>n.s.</td>
<td>−7</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Population trends in Norwegian Puffin colonies in the Barents Sea Management area. The table shows population trends per year (%), trend (+/−/0) and significance level for the estimated trend (Monte Carlo simulations, ***p < 0.01, **p < 0.05, *p < 0.1, n.s.—not significant. Trends over last 5 years and breeding success last three years marked with grey are under the threshold (pers. com. Svein-Håkon Lorentsen).
existing governance approaches and incentives in achieving goals and objectives as well as related issues such as equity, justice and the balance between top-down and bottom-up governance approaches.

4.7. Step 7 — Adaptations to current management

The results of the assessments in steps 5 and 6 will be used to decide if adjustments to the current spatial management of the area should be recommended. If this is the case, the recommendations should comprise alternative sets of operational objectives, management measures or even an evaluation of the appropriateness of the geographical delimitation of the SMA. Ideally, costs and benefits of alternative management scenarios should be described in monetary terms [66]. If this is not possible a qualitative description should be provided as a minimum. Any alternative scenarios should be realistic (i.e., based on main drivers for change [43]) and linked to the respective policy drivers.

Scenarios are collections of quantitative and qualitative stories (lines of reasoning) that hypothesize alternative futures that an eco-social system might face in the near future. Data and stories represent the drivers for change and therefore an assessment of the potential impacts of these drivers on both the ecosystem and the social system (spatial functions) calls for alternative policy objectives and measures to preserve or improve the current state of affairs. Potential costs and benefits of alternative scenarios can be qualitatively assessed in collaboration with key stakeholders. Through assessing the data and stories that hypothesize alternative policies from different perspectives, their feasibility as well as the robust components can be evaluated. If key stakeholders identify similar components (objectives, measures) as feasible and desirable, these can be accepted as baseline for the alternative policy scenario. Furthermore, any alternative set of objectives may require recommendations on the monitoring programs to allow for the performance assessment of the respective indicators. The defined alternative set of operational objectives can be used for a new application of the framework. Finally, a general evaluation of the level of implementation of the EBM in the area of concern should be provided. This can be done by relating the objectives to the criteria of EBM [6]. Potential restrictions on particular human activities, which lead to pressures that are undermining achievement of goals and objectives, are recommended from a scientific perspective through the application of the framework and can range from informal arrangements to temporal and spatial restrictions and complete bans. In this step the synthesis of the assessment results should be aligned with the results of the detailed governance analyses in order to evaluate the validity and feasibility of alternative objectives and measures (Boxes 1 and 2).

5. Selection and challenges of MESMA case studies

With the help of standardised criteria, the SMA test cases were selected which (i) range in scale from a local to a transnational approach (ii) do not have strictly sectoral interests; (iii) cover the European encompassing regions of the North East Atlantic, Mediterranean, Baltic Sea and Black Sea; and (iv) allow for a comparison between case studies. In total, nine case studies were selected showing different stages of the development of spatial management plans (Table 4; Fig. 7). Currently, these SMA case studies are testing the assessment framework, supported by a detailed “user manual” that provides practical guidance on its implementation. Below is a brief description of each case study.

### Barents Sea case study

The puffin population size is a “state” indicator for several of the objectives in the Barents Sea Management Plan such as the preservation of ecosystem state and productivity, preservation of viable levels of threatened and vulnerable species, and existence of viable populations of naturally occurring species where genetic diversity is maintained [59]. The reference level for the puffin indicator is based on the mean for the last 10 years and on historical data. The threshold is defined as a viable population based on simulations of population parameters and population size, 20% decline in population over more than 5 years, or unsuccessful breeding three years in a row. As an example, the threshold of 20% decline is reached if the population shows a decrease in the last 5 years from 1 to 0.8. (Fig. 4) [60].

### Inner Ionian Archipelago case study

Hake (*Merluccius merluccius*) landings are used as a “pressure” indicator to evaluate the achievement of the operational objective of a sustainable exploitation of the resource in the Inner Ionian Archipelago. Hake landings (kg) were compared with the Maximum Sustainable Yield (MSY). The latter threshold value was estimated using the Schaefer Model, with fishery dependent data from the period 2003–2008. Results showed that landings were generally below MSY for the studied years, which possibly indicates sustainable harvesting of the hake stock in the case study area (Fig. 5).

### Southern North Sea case study

An example for scenarios based on qualitative stories is the development of renewable energy in the southern North Sea. General scenarios for Europe’s development were described by two key uncertainties (CPB, 2003): a strong role for the public sector versus private responsibility, and successful international cooperation versus an emphasis on national sovereignty. It seems that realisation of the ambitions of the offshore wind energy industry mainly depend on international agreements, societal demands and oil prices. The levels of subsidies by (national) authorities highly influence investments in, and therefore the spatial demand of, wind farms at sea. The way in which (planned) wind farms are combined with other activities differs between countries. For example, in UK waters they may have an overlap with Natura 2000 sites, whereas they are excluded in other North Sea countries. It is, therefore, not clear how wind farms are to be combined with other activities, such as Natura 2000 sites, in the future. Hence scenarios for adaptations to current management may include the support or discouragement of the development (rate) of offshore wind farms and facilitation or obstruction of their spatial combination with other activities.

### Inner Ionian Archipelago case study

Here a quantitative scenario is presented identifying candidate areas for a network of coastal and off-shore MPAs in the Inner Ionian Archipelago. This network aims to expand the already existing Natura 2000 network for the conservation of...
specific habitat types and species, according to the requirements of the EU Habitat Directive. The final selection of priority areas was based on minimizing the conflicts with economic activities such as fishing and tourism. The ultimate goal was to communicate the site selection approach to key stakeholders, and in cases when consensus was reached, sites were proposed as MPAs. The GIS based decision support tool Marxan was used to identify conservation priority areas by integrating socioeconomic and biophysical data. In Marxan, the user sets a target for the conservation features of interest, which in this case was expressed as the percentage of the feature’s spatial extent [24]. Conservation features were subjected into the categories “high priority”, encompassing e.g., seagrass meadows (Posidonia oceanica), Mediterranean monk seal (Monachus monachus), loggerhead turtle (Caretta caretta), and “low priority”, including other important components of the case study area such as marine mammals, nursery areas for European hake (Merluccius merluccius) or migratory seabirds (Phalacrocorax aristotelis, Calonectris diomedea). For all species and habitats, presence-absence data were used, with the exception of sea grass meadows, where values on percentage coverage were available. EU directives, expert judgment, and current literature were used to define three scenarios with low, medium and high conservation expectations. The following targets for high and low priority features were used: (a) 60% and 20%, (b) 70% and 40%, (c) 80% and 60% [67]. The socioeconomic factors incorporated in the analysis were fishing (trawlers, purse seiners and small-scale coastal fisheries with nets or longlines) and tourism. Existing or developing areas of tourism were implemented in Marxan as the cost metric based on the General Framework Plan for Sustainable Tourism Spatial Planning in Greece (YPEKA, 2009). The underlying rationale was that massive tourism has conflicts with conservation plans whereas alternative “green” tourism is environmental friendly. Biodiversity hotspots were identified by compiling the available spatial distribution data of the conservation features. For illustration purposes the low (60% and 20%) and medium target (70 and 40%) scenarios are presented herein. For the low target scenario the best solution accounted for 32% (4879 km²) of the study region (Fig. 6(a)), whereas for the medium target scenario the best solution accounted for 44.5% (8385 km²) of the total study area (Fig. 6(b)). A full description of the approach is provided in [68].

with some reflection on the respective challenges and obstacles each case study faced whilst testing the framework.

5.1. Southern North Sea (SNS)

The SNS case study is transnational and shows a high level of complexity due to the great variation of habitats, species, processes, human activities, regulations and governance arrangements. There is no overarching spatial management plan for the whole region, but numerous sectoral and geographically defined plans exist, including the Wadden Sea Plan 2010 (CWSS 2010), the sea use management in the Belgian part of the North Sea and the maritime spatial plans of the German and Dutch Economic Exclusive Zones (EEZs). Thus the assessment framework is tested and evaluated at different spatial scales, nested within the higher hierarchical scale of the SNS. This allows to determine how priorities change when shifting scale, how the transition from one level to another works and what the implications are for marine spatial management. A first challenge at the SNS scale was the definition of common operational objectives which are related to the objectives of the existing spatial management plans. In the North Sea, there have been initiatives to assess multiple management objectives for conservation areas [69] but the SNS case study has made the first attempt to assess multiple objectives on this larger spatial scale. By contrast, the governance analysis is conducted in a ‘bottom-up’ manner, starting from smaller-scale spatial management initiatives with clear objectives and conflicts; these will form the basis for discussions of regional-scale governance issues.

5.2. Pentland Firth and Orkney Waters (PFOW)

This case study covers a compact and busy coastal area in the far north of Scotland, where the deployment of large scale marine energy and the associated construction operations and infrastructure have started. An intense effort by the Scottish government and others to complete a non-statutory pilot marine spatial plan (PFOW MSP) for the area is in progress in advance of a later statutory plan to be developed under new legislation [Marine (Scotland) Act 2010]. Objectives for the plan are listed in Table 4. The framework is being used to assess the emerging process for the PFOW MSP in a rapidly changing situation as wave and tidal energy devices are tested and deployed in what has become the leading area internationally for wet renewables development. Very little is known so far about the interactions of these devices with the environment and other marine activities; the government has adopted a policy of ‘deploy and monitor’ because of the urgency attached to the activity for reasons of energy demand, the economy and climate change. Two stakeholder workshops have been held to research attitudes first to environmental monitoring and second to the new governance arrangements which are encompassed in legislation but not yet implemented. The first run of the framework in the PFOW area endorses the need for MSP and exposes key issues of governance to which solutions are sought such as (i) defining ‘material interference’ with public rights in marine space and dealing with the consequences; (ii) building an accountable planning regime with a negotiating platform and right of appeal; (iii) researching interactions and setting baselines and (iv) deciding how to share the wealth created from the marine commons. Future work under the MESMA program will complete a governance analysis for the PFOW area and develop alternative governance scenarios to the centralised arrangements currently set out in legislation.

5.3. Barents Sea

This case study concerns a heavily used area with a management plan in place; the “Barents Sea Management Plan” (BSMP; see details on its objectives in Table 4). Following international guidelines for EBM, the plan provides an overall framework for managing all human activities (oil and gas industry, fishing, and shipping) in the area, to ensure the continued health, production, and function of the Barents Sea ecosystem. Extensive information on seabed conditions, habitats and biodiversity was provided by MAREANO (Marine Areal Database for the Norwegian Coastal and Ocean Areas) program during the plan's development (and revision). One focus of this case study is to compare the proposed assessment framework to the BSMP process and assess its usefulness for a sustainability appraisal or audit of the BSMP. The framework was used both to scrutinize the process related to the Barents Sea management plan (development, implementation and revision) and at the same time test the usefulness of the framework in the particular setting of the Barents Sea. The revision of the management plan in 2010/11 was based on a state assessment that included new information gained in the period 2005–2009 and delivered in reports from the involved management forums. First results revealed, not surprisingly, that the process leading up to the Barents Sea Management Plan, its implementation, and revision did not follow exactly the same
impacted by different human activities and a detailed understanding of the effects these activities would have on the different ecosystem components. Even though this analysis is an important part of area based management, the detailed analysis of impact (including cumulative impact) presupposes scientific knowledge that is presently lacking. It does, however, point towards a very important field where more knowledge is urgently needed. First insights from the parallel governance research analysis showed that three government groups were set up to implement and follow up the BSMP on a yearly basis: the management forum, the monitoring group, and the risk forum, where government institutions and agencies participated. Further key issues could be identified such as (i) the importance of stakeholder power in decision-making, which is particularly relevant for the Barents Sea case where the interests of strong sectors and stakeholders such as fisheries and oil and gas industry are involved, (ii) the cross-border cooperation between Norway and Russia, which is a particularly timely topic due to a newly agreed upon border between the two nations in the Barents Sea, and (iii) the use of scientific knowledge and issues relating to scientific uncertainty in the mapping and implementation of valuable and vulnerable areas identified in the BSMP.

5.4. Celtic Sea

The Celtic Sea case study is a transnational area that has several management plans under development. There has been increasing competition for ocean space in the Celtic Sea due to the designation of MPAs (Marine Conservation Zones and European Marine Sites) and the planned development of wind farms as part of the UK government’s commitment to install 25 GW of offshore wind capacity by 2020. Preliminary observations at workshops and meetings indicate that there is a feeling amongst fishermen that they are increasingly being displaced from fishing grounds in the Celtic Sea, due to the allocation of ocean space for nature conservation and offshore renewable energy development. There are, therefore, growing conflicts between the different sectors that use the Celtic Sea. Thus the assessment framework is used to observe the ongoing process. More specifically, the case study follows a nested approach and looks at several on-going initiatives in the case study area, together with the conflicts, challenges and good practices of MSP that emerged from these initiatives.

5.5. Basque Country (SE Bay of Biscay)

Human pressures on the Basque continental shelf are intense and diverse including some specific economic activities such as red seaweed extraction [70]. Currently, there is no spatial plan or management implemented. There are only scattered spatial management initiatives in place such as the “Territorial Sectoral Plan for the Protection and Ordination of the Basque country littoral zone”, expanding 500 m from the inner edge of the seashore [71]. The main goal of the plan is to achieve greater environmental and ecological protection of the natural heritage by managing the human activities causing adverse effects. It also aims to optimise the coordination of coastal and terrestrial planning actions between governments, so as to guarantee the maximum efficiency for environmental protection and restoration. New activities are foreseen to be developed such as a wave energy converter which may involve conflicting interests [72]. Therefore, there is a need for integrative analysis approaches to select the most suitable locations for those activities. The
framework is being used to assess the current management and to develop a spatial management plan, on the basis of the MSFD and the preservation of ecosystem functions and services [73,74]. The structured governance analysis will be used to observe the ongoing process on the implementation of renewable energy platform building, including interest conflicts between stakeholders and the management measures taken to resolve them.

5.6. Strait of Sicily

This is a transnational case study including Italian and Maltese waters as well as international waters (high seas). There is no overarching management plan for the whole region, but there are sectoral and geographically defined plans. The most important human uses are fishing, aquaculture, conservation, shipping, gas pipelines and tourism. Other important uses for which only limited information exists are oil drilling and extraction, deployment of gas pipelines and communication cables, construction of wind-mill farms. Although information is often limited to the mere presence, or the location of planned future development zones for such facilities, they are of strategic importance and may impact other activities in the relevant areas. The framework is being used to assess the potential for the implementation of a spatial management plan in the Strait of Sicily in order to minimise conflicts between users. For the assessment high-level objectives such as maintaining ecosystem health, which are in line with the MSFD goals, are used. The first challenges for the application of the framework to this case study, related to accessing relevant data and stakeholder engagement.

5.7. Inner Ionian Archipelago and Adjacent Gulfs

The case study area, including the Inner Ionian Archipelagos and the Patraikos and Korinthiakos gulfs, has no MSP for the whole region. There are, however, sectoral and geographically scattered spatial management plans in place or under development, such as thematic national (Greek) management plans for touristic and urban development or master plans for fisheries and aquaculture. In the coastal zone the main human activities include fisheries, urbanization, heavy industry, tourism, aquaculture, and shipping, whilst in offshore waters the main pressures come from fisheries and shipping. Growing conflicts exist among human uses like commercial fisheries and tourism, but also between human uses and nature conservation. The area is also susceptible to different types of geohazards. For the application of the framework high-level objectives comprise the protection of biodiversity, sustainable management, and the goals of the MSFD, the Habitats and Bird’s Directives, and the Water Framework Directive (WFD; [75]). The framework is being used to evaluate existing sectoral plans, identify data and knowledge gaps and recommend appropriate initiatives (for the development of relevant and meaningful MSP scenarios) to be presented to key stakeholders, whose involvement was foreseen while setting up the governance analysis. As yet, results showed that the whole process, although there is a high uncertainty in certain outcomes due to data gaps, is rather informative for both scientists and managers and could provide potential guidelines and recommendations for adaptation to support an ecosystem based management.

5.8. Black Sea

This is a transnational case study with EU and non-EU countries. The Black Sea region is increasingly becoming a priority in the international agenda [76]. Regional spatial management is under development, as the actors involved understand that common problems need to be addressed jointly in order to find effective solutions. The political set up is, however, different in EU and non-EU countries [77] and national legislations are also variable, e.g., until 2007 Turkey did not have any legal provisions for establishing MPAs. The latest Strategic Action Plan for the Black Sea [78] recommends only the increase of the number and surface area of MPAs. Common interest, cross boarder issues and potential conflicts are all present in the Black Sea region between the major sectors (see Table 4). The framework is applied with a focus on the implementation of marine conservation areas (Nature 2000 areas) in Bulgaria, supporting the development of the national marine strategy, followed by a governance analysis for the entire Black Sea region. The main challenges identified for the application of the framework are the complexity of the organization of responsibilities for environmental monitoring and protection in Bulgaria, which is divided between different ministries and intra-ministerial organizations, and the data acquisition for the larger geographical scale.

5.9. Baltic Sea

The case study is nested in relation to spatial scale and the framework is applied to the HELCOM Baltic Sea Action Plan (BSAP) at the Baltic Sea level, Östergötland County in Sweden, and Puck Bay in Poland. The BSAP has clearly defined goals, initial operational objectives with associated indicators and has involved stakeholders. At the sub-case study level, Östergötland County has several parallel spatial management plans by various management bodies, for various geographical scales, at various stages of development. Stakeholder conflicts exist among traditional users of the archipelago, developing industries and nature conservation. In contrast, in Puck Bay there is no spatial management plan and conflicts occur between fisheries, nature conservation and tourism. Thus a pilot plan and a Strategic Environmental Assessment (SEA) have been developed. The plan has neither been implemented nor includes clearly defined operational objectives and indicators. The framework is being used to evaluate strengths and weaknesses of the BSAP, to compare and evaluate the current situation and existing management measures in the two sub-case studies, and develop recommendations for adaptations of the management. The challenge for the Baltic Sea case study has been to compile and evaluate the large amount of information available as a result of the development and implementation of the BSAP. For Östergötland County, the first challenge was to select a primary management plan and investigate how that interacts with the others; for Puck Bay, the challenges were to involve stakeholders and to select suitable operational objectives.

6. Challenges in integrating the assessment framework and governance analysis

There are some important differences between the applications of the above introduced assessment framework and a structured governance analysis; the former relies mainly on quantitative methods and the latter on qualitative methods (see Fig. 3). It was, therefore, decided that a ‘two-stream’ and inter-disciplinary approach would be followed in the MESMA case study research, in which the two streams of research run in parallel and complement each other in the evaluation of SMAs. However, the alignment of a generic framework using primarily scientific information with a specific and in-depth governance analysis raises important challenges, which are examined below:

6.1. Mismatch in scope

The generic framework was designed for the monitoring and evaluation of SMAs as well as to provide guidance on the
development of management scenarios and initiatives (e.g., the Strait of Sicily). In contrast, the governance analysis in all case studies is focused on evaluating real initiatives, which can be an overarching management plan or a sectoral plan with spatial elements, if there is no overarching management plan in place. Though, it is not possible to conduct an in-depth governance analysis on management scenarios without a reality base.

6.2. Mismatch in scale

A number of case studies applied the assessment framework to assess multiple objectives and indicators at a regional scale, encompassing different countries (e.g., southern North Sea, Strait of Sicily, Baltic Sea and Black Sea). It is difficult to conduct a detailed governance analysis at such a geographical scale, due to the heterogeneous policy and legal frameworks that exist at regional, national and local levels. Consequently there are different priorities, objectives and complex interactions between actors representing the interests of different countries and sectors. Hence in these cases, the governance analysis should follow a nested approach, in which the regional policy frameworks and governance settings are briefly examined as part of the context, whilst the focus is maintained on specific examples of spatial planning and management at a much smaller scale (e.g., networks of MPAs).

6.3. Difficulties in selecting a common objective

Due to the mismatches in terms of scope and scale a few case studies found it difficult to identify a common objective from which to begin application of the framework or governance analysis. Preliminary findings from governance research in MESMA case studies indicated that decisions relating to objectives and priorities in real MSP initiatives are primarily shaped by political and economic factors, which are context specific and often do not follow scientific rationale. In the case studies, the governance analysis should focus on a single priority objective, as it is very difficult to assess the balance between different objectives and priorities through any generic guidance (see Table 1). In practice, the integration of the framework and governance analysis is facilitated by focusing on an objective that is shared by both approaches and appropriate to the specific context of a case study. The governance analysis subsequently addresses the conflicts between this priority objective and other objectives.

7. Conclusions

Here a standardised and generic framework for the monitoring and evaluation of SMAs is proposed, together with practical guidance on its application. The suggested stepwise process is based on existing concepts of adaptive management and considers a number of practical examples [14]. Although the testing of the framework in the SMA case studies is at an early stage, some challenges could already be summarised. Due to the definition of SMAs, the case studies represent very different situations which to begin application of the framework or governance exercise. A framework and the expected output has shown to be a very useful difficulty in identifying common operational objectives. This was particularly evident in transnational case studies as differences between countries had to be taken into consideration when defining a specific operational objective that is applicable to all countries that have jurisdiction in the SMA. In some case studies the stakeholder engagement process was aligned to the step-wise assessment process and could therefore provide input for the objective setting. In MESMA the stakeholder engagement process is part of the structured governance research analysis which is treated as a parallel activity when following the step-wise process. On the practical side, the alignment of the framework assessment using primarily scientific information with a governance analysis proved to be demanding. Hence a number of key issues and challenges have been already derived from the case study experiences with respect to integration of the two streams of research comprising the (i) divergence of the assessment and research scope, (ii) mismatch in scale and (iii) difficulties in selecting a common objective. It can be concluded that the integration of the framework and governance analysis can only be facilitated by focusing on one carefully selected priority objective, appropriate to the specific context of a case study. Most case studies did not yet fully implement the assessment of multiple objectives and/or the interdisciplinary ‘two-stream’ assessment approach. Hence final conclusions on a successful integration can only be drawn after completed tests by the case studies.

Some more general challenges for the framework application can be derived from the literature. On the one hand, the spatial scale defined for the SMA and its assessment is important; ecological processes and functions are scale dependent and any boundaries defined may be arbitrary making the detection of response and changes difficult [13]. On the other hand, the temporal scale is an important factor influencing assessment outputs. An example might include the response of indicators to implemented management measures [51]. Moreover, information is not always available at the relevant spatial or temporal scale for management. This mismatch of scales makes it difficult for managers to account for the coupled human-natural systems of tomorrow and to incorporate those into their planning processes [79]. In addition, spatial management measures need to be aligned in such a way that they address objectives from local to regional scales. At a regional scale, a successful example of such amalgamation is the Great Barrier Reef marine park where MPAs are integrated in a wider spatial zoning plan [80].

In summary, there are many challenges in the monitoring and evaluation of SMAs and a standardised framework with detailed practical guidance has been lacking. Ultimately, MESMA aims to integrate the framework with its “user manual”, the structured governance analysis guidance together with technical tools and a geodata infrastructure, into a tool box which will drive the practical guidance on spatial management forward. In the future the comparison of the lessons learned across case studies will provide further insight into the suite of methods and approaches required to support the implementation of the ecosystem approach to marine spatial management.

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