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NINA Report

Ecosystem-based management: Miracle or Mirage?

Mapping and rapid evidence assessment of international and Nordic research literature on ecosystem-based management

Øystein Aas, Marthe Indset, Christian Prip, Froukje Maria Platjouw & Frode Thomassen Singsaas



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Abstract

Aas, Ø., Indset, M., Prip, C., Platjouw, F.M. & Singaas, F.T. 2020. Ecosystem-based management: Miracle or Mirage? Mapping and rapid evidence assessment of international and Nordic research literature on ecosystem-based management. NINA Report 1802. Norwegian Institute for Nature Research.

Objective: This report reviews international research literature from the period 2005 to mid-2019 of relevance for “ecosystem-based management and governance” (EBM).

Method and structure of report: We used a systematic, quantitative review combining systematic mapping and rapid evidence assessment. A search (full search string in Appendix 1) in Web of Sciences and Scopus gave a total of 11 755 unique publications published from January 2005 to May 2019 in English and Scandinavian languages. After excluding those not meeting predefined criteria and not considered relevant, 1071 publications in English language remained for analysis. Analyses were quantitative (Ch 4); and more in-depth for Nordic (Ch 5), review studies (Ch 6) and implementation studies (Ch 7).

Findings: Ecosystem-based management is an ambiguous concept, yet there is growing agreement on its meaning and content (chapter 2). Mapping the 1071 publications reveals publication rates have tripled from 2005-2019. A majority deal with marine and freshwater ecosystems, while only a few concern mountain and rangeland ecosystems. Studies from North America, Australia, UK and Germany dominate. A relatively limited number of scientific journals publish a significant share of the relevant papers. The most common research design is case studies at the regional scale. As for the specific management processes studied, most publications examine aspects related to planning, the knowledge phase, participatory challenges or ecosystem services. Decision-making processes and measures implementation are less studied, which indicate a future research potential. In the Nordic countries, studies from Sweden and Norway were most common. Forest studies in Sweden and marine and coastal studies in Norway are dominating. There are also studies of the WFD in all Nordic countries to whom the Directive applies. Review studies are frequent and useful, especially for providing overviews and outlining research needs. They also underline the need for stronger theoretical foundations to achieve more valid understandings of the challenges related to successful implementation of EBM. Overall, the in-depth review reveals that sector-organization and fragmented governance structures serve as significant obstacles against EBM. EBM cannot be achieved just by providing additional natural sciences knowledge and decision-support systems. More insight into challenges of fragmented administrations and sectoral barriers, policy processes, policy change and power relations and leadership are frequently mentioned as under-researched.

Research and management recommendations: There is a need for more critical studies and monitoring studies addressing the (lack of) improvement and change of decision-making processes in sectoral policy integration. The form, role and impact of both institutional and regulatory reforms can be a starting point for the evaluation of EBM interventions. More studies of the development and application of indicators should be transdisciplinary. “Good” indicators should ideally link ecosystem states and management measures better, and at the same time be cost-effective and easy to understand. Direct implications for environmental management include the implementation of; empirical and transparent decision-support systems such as MCDA; actively linking general development of EBM with more traditional measures in environmental management such as protected area networks and restoration programs, and strengthening the formal status of area plans at the regional level, corresponding to relevant ecosystems.

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Sammendrag

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Formål: Denne rapporten gjennomgår internasjonal forskningslitteratur for perioden 2005 – mai 2019 som belyser forskning relevant for gjennomføring av mer økosystem-basert forvaltning og styring (ØBF).

Metode: Vi brukte en systematisk tilnærming til gjennomgang av eksisterende forskning. En overordna kvantitativ kartlegging samt en såkalt rask vurdering av evidens ble gjennomført. Søkestrengen som ble brukt er gjengitt i Appendix 1, og søkene ble gjort i Web of Science og Scopus. Søket resulterte i 11 755 unike publikasjoner offentliggjort mellom januar 2005 og mai 2019. Etter å ha screenet arbeidene etter fastsatte kriterier og relevans, satt vi igjen med 1071 publikasjoner for nærmere analyse og klassifisering, alle skrevet på engelsk.

Sentrale funn: ØBF som begrep er ikke entydig definert og kan ha ulike betydninger. Likevel er det økende enighet om begrepets innhold. Antall relevante publikasjoner per år har tredoblet seg fra 2005 til 2019. En stor andel av litteraturen tar for seg ØBF i marine og ferskvannøkosystemer. Svært få arbeider ser på ØBF i fjell/alpine økosystem og åpne landskap (rangelands). Flest studier er fra Nord-Amerika, Europa som helhet, Australia, Storbritannia og Tyskland. Et relativt lite antall vitenskapelige journaler står for en stor andel av de relevante studiene. Case studier på regionalt nivå/skala dominerer når vi ser på forskningsdesign. Videre kartla vi hvilken hovedprosess innen forvaltning som dominerte i arbeidene. Vanligst var arbeider som handlet om planlegging, kunnskapsgrunnlaget for ØBF, deltagende prosesser og økosystemtjenester. Studier av beslutninger og tiltak og virkemidler for å oppnå ØBF var det færre av. I Sverige dominerte studier av ØBF i skog, mens i Norge var studier i marine økosystem vanligst. Alle nordiske land hadde studier om innføring av EUs vanddirektiv. I gjennomgangen av tidligere review-studier ga mye relevant informasjon, særlig for å gi oversikt over forskningsfeltene og om forskningsbehov. Mange av disse arbeidene etterlyste sterkere teorigrunnlag for studier av implementering av ØBF. Samlet sett er litteraturen tydelig på at sterk sektororganisering og fragmentert forvaltning er en viktig barrierer for ØBF. Det er ikke tilstrekkelig for å lykkes med å innføre ØBF å bare fortsette med ytterligere styrking av (det naturfaglige) kunnskapsgrunnlaget og produksjon av beslutningsstøtte verktøy. Først og fremst etterlyses mer kunnskap om utfordringene med fragmentert forvaltning, sektorbarrierer, politikk og maktforhold.

Forskningsbehov og forvaltningsmessige implikasjoner: Mer kritiske studier av årsaker til manglende framskritt i implementering av ØBF i mer integrert og tverrsektoriell forvaltning mangler og bør prioriteres. Formen, rollen til og betydningen av både organisatoriske og juridiske reformer kan være et godt utgangspunkt for nye studier av forsøk på ØBF, på ulike nivå. Forskning som styrker utviklingen av indikatorbasert styring for ØBF ytterligere trengs også, og denne må være tverrfaglig og tilstrebe at økologiske tilstandsindikatorer er relevante i en operativ forvaltningssammenheng. De mer direkte forvaltningsmessige anbefalingene som kan vurderes innført i norsk miljøforvaltning er blant annet å innføre mer empirisk baserte og åpne (transparente) beslutningsstøtte-systemer, i første rekke såkalte multikriterie-analyser. Det er også viktig å lage aktive koblinger mellom utvikling av ØBF på generell basis for alle hoved-økosystemene i Norge med de tradisjonelle sektorbaserte virkemidlene som nettverk av verneområder, adaptiv artsforvaltning og restaurering. Å styrke den formelle statusen til regionale planer vil også styrke ØBF.

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Foreword

In 2018, the Norwegian Research Council called for a one-year project that should aim to summarize the international knowledge status about approaches to achieve ecosystem-based management (EBM). A consortium organized around CIENS - Oslo Centre for Interdisciplinary Environmental and Social Research lead by NINA, was granted the project. This report represents the main written deliverable from the project.

The overall objective of this report is to provide a stronger knowledge base for future development of relevant ecosystem-based management approaches, and to provide input to a Norwegian research agenda. The focus has been on legal, economic, administrative and other policy-change relevant studies.

This report is the main printed deliverable from the project, conducted among several cooperating institutions, gathered under the CIENS - umbrella; NINA; OsloMet-NIBR; Fridtjof Nansen Institute, NIVA, CICERO, NIKU, University of Oslo – Faculty of Law and the Norwegian University for Life Sciences NMBU.

Early on, we decided that we wanted to apply a systematic, quantitative approach to the literature review, despite the wide and open scope of the project. This proved to be a demanding but lesson-rich approach. We thank librarians Inga Lena Grønland at OsloMet and Solveig Isabel Taylor (retired, NTNU) for their initial very useful and substantial guidance and advice on this task. We recommend strongly that future, more specific reviews use similar systematic approaches to secure transparent and unbiased reviews. In addition to the authors and the librarians mentioned above, Sofie K. Selvaag, K. Margrethe Tingstad and Line Camilla Wold at NINA provided expedite help in screening, sorting and classifying identified literature in a critical phase.

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Lillehammer/Oslo, March 2020

Øystein Aas, NINA
Project leader

1 Introduction

1.1 Background

Deterioration of ecosystems and loss of biodiversity is a major growing global concern (IPBES 2018, IPCC 2019, United Nations Environment Programme 2013). The reasons for loss and deterioration and why humans and their institutions struggle to manage and mitigate ecosystems are demanding and multiple. Firstly, ecosystems are complex, interrelated and adaptable systems hard to manage. The complex and stochastic nature of ecosystems also can lead to unexpected impacts and responses from management and regulatory actions (Berkes et al. 2003, Doremus et al. 2012, Ostrom 2009). Secondly, we have limited knowledge of the services provided by ecosystems to humans, or they represent values not tradeable in traditional markets. Even if services are valued, society lacks institutions and systems where ecosystem services are paid for in full. These challenges and paradoxes were the objectives for the process 'The Economics of Ecosystems and Biodiversity' (Kumar 2010). Thirdly, deterioration of ecosystems is a consequence of the insufficiencies of public administration and management. Kidd et al. (2011) concluded that:

"[f]ragmented administrative structures in which policy and operational responsibilities are divided between a disparate array of organizations, narrow sectoral decision-making systems with competing and contradictory objectives, a disconnection between national, regional and local level activities and between natural and administrative boundaries are typical features of governance in countries all over the world" (p. 4).

Ecosystem-based management and governance [we generally use the abbreviation EBM in this report] is an emerging, integrated approach to environmental management, considered instrumental to reach the Sustainability goals of the United Nations. EBM has no absolute, unified or distinct definition (more on this in Chapter 2), but can be interpreted to represent holistic, integrated approaches across sectors and levels, aiming to support decision-making relevant to sustain ecosystems and their carrying capacity. Such approaches also address the role of scientific knowledge, scientific uncertainties, and the incorporation of new knowledge within adaptive management models. However, existing concepts lack clarity on how to address challenges related to balancing use and conservation, obtaining social equality and how to define or agree on what is an ecosystem with sufficient "good" status.

A major challenge with EBM is that it is at odds with several established principles for public administration; such as stability and predictability versus adaptability; strict rules versus new knowledge; and new logics in cost-benefit assessments. A dominant trend in public administration in western democracies during the last decades is increasing specialization, across sectors (horizontal specialization) and administrative levels (vertical specialization), which overall leads to more fragmented public management and administration (Christensen & Lægreid 2007, Roness & Sætren 2009). The drivers behind this development are 1) general growth and expansion, 2) delegation and devolution and 3) increasing severity of goal conflicts and growing need for compromises (Christensen & Lægreid 2007, Greve et al. 2016). The growing interest in EBM must be seen as a response to this fragmentation of public administration. Another trend is the increase in governance approaches that mix public and private approaches, e.g. through combining legal and voluntary measures.

Research on public administration more generally points out that different reforms seldom replace existing frameworks but acts as supplementary and corrective approaches. This often results in further complexity as well as trials, temporal or permanent "mixed models" (Christensen & Lægreid 2007, Pollitt 2003). This has further implications for EBM.

Economic measures also play a role in supporting EBM. Typical approaches are for instance regulatory pricing signals such as taxes and subsidies, voluntary pricing signals such as certification systems, compensating measures such as off-setting, payment for ecosystem services (PES) and cap-and-trade mechanisms. Estimates of the values of different ecosystem services is not in itself something that can be classified as EBM. It needs to be transferred to decisions and behaviour, such as in the context of PES (Gomez-Baggethun & Muradian 2015, Martin-Ortega & Waylen 2018, Wunder 2015).

To summarize, ecosystem-based management and governance can cover a range of approaches, policies and measures, within and across sectors, being voluntary or formally more strict. Authorities and lawmakers can prioritize different combinations of elements dependent on type of ecosystem, identified challenges, ownership, dependent on local (national) socio-political and administrative systems and traditions. Partly due to this, it is unclear what EBM might imply, especially regarding how to balance goals for utilization versus goals for conservation, and how to handle issues of equality. More importantly, it is complicated to identify which political, administrative, juridical or economic “takes” on EBM that works best under which settings. There is also a need to shed light on when and how different approaches are implemented, as a corrective to, or supplement to existing, sector-dominated policies and administrations (Bugge 2013).

1.2 Purpose and structure of report

This report aims to give a comprehensive overview of the existing international research literature on “ecosystem-based management and governance” (EBM). The study will be based on literature reviews, and the project defined the following more specific research questions to aid the overall objective for the review:

1. Operationalization of EBM: Which terms and conditions have been identified as instrumental to establish effective EMB?
2. Which aspects of EBM have been subject to research, which have a significant volume and which have not?
3. Which key obstacles and barriers against the implementation of EBM have been identified in existing research?
4. Centralized or sectorial responsibility for EBM: To what extent can research identify which organizational models work or not?
5. To what extent has environmental quality standards been implemented in EBM and to what extent can research assess its effectiveness in an EBM context?
6. To what extent has the operationalization and implementation of cumulative impacts been part of implementation of EBM?
7. What differences can be identified between the implementation of EBM in Denmark, Sweden and Norway and how does research assess the strengths and weaknesses of these implementations?

It should be underlined that with the resources available, the systematic search for publications were designed to primarily answer RQs 1-3. More detailed and specific searches could/should be conducted to more systematically answer the other RQs. However, we discuss RQs 4-7 based on relevant findings in this review.

Chapter 2 presents and discusses the concept of EBM and related concepts, Chapter 3 presents the method used in the systematic mapping and rapid assessment of relevant publications, Chapter 4 give a quantitative overview of the included publication. Then, chapters 5-7 conduct more detailed and qualitative assessments of Nordic (5), Review publications (6) and Implementation research (7). Chapter 8 summarises the study, discusses the seven RQs and present research needs and management implications.

2 Ecosystem-based management – definitions and related concepts

2.1 The emergence of the concept

The understanding of the need for a more holistic approach to management of nature and natural resources and the integrity of ecosystems has evolved gradually. This has influenced the definition and interpretations of EBM. Already the 1972 Stockholm Declaration on the Human Environment, adopted at the first UN Conference on the Environment, acknowledged that *'The natural resources of the earth, including the air, water, land, flora and fauna and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate'* (Sohn 1973).

The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), adopted in 1980 and viewed as a pioneering treaty in many aspects, recognises *'.. the importance of safeguarding the environment and protecting the integrity of the ecosystem of the seas surrounding Antarctica (CAMLR 1980, preamble)*. This instrument also includes the following principle of conservation: *'maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources (CAMLR 1980, article II, article II, article II, article II)*.

Another important early instrument was the 1982 World Charter for Nature (WCN) that called upon states to manage ecosystems and organisms in such a way as not to endanger the integrity of those other ecosystems or species with which they coexist (UN General Assembly 1982).

The 1992 United Nations Conference on Environment and Development (UNCED), Earth Summit in Rio de Janeiro, adopted the Rio Declaration stating in Principle 7 that *"States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem...."*

The Earth Summit was also where the UN Convention on Biological Diversity (CBD) was endorsed and opened for signature, the global instrument most closely associated with EBM. Negotiations of the CBD started on the basis of texts with a traditional nature protection approach of conserving threatened species and habitats favoured by developed countries, but it soon became clear that the biodiversity-rich developing countries were not prepared to consider conservation only in a strict sense. The scope was gradually broadened throughout the negotiations leading to a comprehensive, socio-economic oriented convention encompassing such issues as sustainable use of biological resources, access to genetic resources and the sharing of benefits from their use (Glowka et al. 1994). *'The Convention sets a new context for considering biological diversity which recognises the causes of biodiversity are complex and multi-faceted and that action to address the loss must therefore reached beyond traditional approaches'* (Platjouw 2016). EBM is not referred to explicitly in the CBD, but through its cross-sectoral approach and by having sustainable use as an overall objective alongside conservation, as well as by including provisions on the protection and rehabilitation of ecosystems, it encompasses many of the EBM features. The CBD also provides a definition of an ecosystem (Convention on biological diversity 2020).

Two years after its entry into force in 1995, the CDB adopted the Ecosystem Approach (EA) as the primary framework for action under the Convention (Convention on biological diversity 1995). In the following years, further descriptions were elaborated in the CBD context. A special landmark event was the convening of a workshop in Malawi in 1998 that elaborated the *'Malawi Principles'* which were later endorsed by the CBD Conference of the Parties (COP) (Convention on biological diversity 2000) and which is widely referred to in the literature reviewed as a basis

for understanding and later articulation of the EBM concept. The establishment of the EA can be seen as a further elaboration of the paradigm shift that the CBD already in itself represented in conservation philosophy: Away from the focus on threatened, charismatic species and towards a focus on entire ecosystems.

The Malawi Principles on the Ecosystem Approach (EA)

1. The objectives of management of land, water and living resources are a matter of societal choices.
2. Management should be decentralized to the lowest appropriate level.
3. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
4. Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context.
5. Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.
6. Ecosystems must be managed within the limits of their functioning.
7. The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.
8. Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.
9. Management must recognize that change is inevitable.
10. The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
11. The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
12. The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

In the understanding of the CBD Malawi Principles, the EA combines a range of different features such as governance, decentralisation, temporal and spatial scales, ecosystem integrity, ecosystem services, conservation and sustainable use, knowledge pluralism and the engagement of stakeholders. Features that are generally considered to be consensus elements of the otherwise not very precise concept of EBM. A common denominator is integration. The principles can be seen as an attempt to facilitate the removal of artificial barriers between economics, social science and ecology, and place human needs firmly within the ecosystem model.

After the endorsement of the Malawi Principles, the CBD conducted work on how to apply the EA to work programmes on different types of ecosystems and economic sectors. At the same time, the EBM concept was recognised and integrated into several international instruments addressing environmental protection, sustainable development, or natural resources management. The approach has also been consistently endorsed by high-level policy instruments adopted by consensus in the international community.

In terms of economic sectors, the recognition of EBM as a new overall approach has been most evident for instruments on fisheries and marine management with several initiatives building on the provisions of the Law of the Sea Convention and its implementing Fish Stock Agreement. Prominent examples are the 1995 FAO Code of Conduct for Responsible Fisheries, the 2001 Reykjavik Declaration on Responsible Fisheries, and the 2003 FAO Technical Guidelines on Ecosystem Approach to Fisheries.

Similarly, EBM was endorsed by regional instruments and institutions including the EU. EBM is incorporated in the European Common Fisheries Policy and a number of other policies, and in EU legislation such as the 2000 Water Framework Directive, the 2008 Marine Strategy Framework Directive and the 2014 Maritime Spatial Planning Directive.

2.2 Definitions

With the comprehensive adherence to the EA and EBM by international institutions and instruments as outlined above, one could expect that the concept has a common definition and that its implications for management are clear. This is, however, not the case. The concept has provoked an ample academic and practical debate on its understanding and use reflected in numerous pieces of literature published over the last 30 years (Engler 2015).

As discussed above, the CBD Malawi Principles as one of the first expressions of the EA/EBM has served as a role model or point of departure for further development of the concept. The accompanying COP decision to the Malawi Principles provides the following description (rather than definition) of the EA:

'The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way (Convention on biological diversity 2000, p. 6).

This vague description underlines that the EA does not possess a legally binding character. As a 'strategy' it rather serves as a guiding policy orientation (De Lucia 2015). This non-doctrinal approach is further underlined in the CBD decision underlining that *'[t]he ecosystem approach does not preclude other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes, as well as other approaches carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations. There is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions. Indeed, there are many ways in which ecosystem approaches may be used as the framework for delivering the objectives of the Convention in practice (Convention on biological diversity 2000, p. 6).'*

An abundance of other attempts to define and describe the EA and EBM have been provided. Below are some examples:

An early and well-known understanding was proposed by Grumbine (1994). After analysing a series of existing definitions, he concluded that ecosystem-based management was understood as management that *'integrates scientific knowledge of ecological relationships within a complex*

socio-political and values framework toward the general goal of protecting native ecosystem integrity over the long term (Grumbine 1994).'

A straightforward definition when it comes to covering what many now consider to be the most important elements of EBM was provided by group of American scientists and policy experts who delivered a scientific consensus on marine EBM. They defined ecosystem-based management as *'an integrated approach to management that considers the entire ecosystem, including humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive, and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity, or concern; it considers the cumulative impacts of different sectors (Engler 2015, p. 290).'*

The two above definitions reflects a trend over time from a more eco-centric approach (e.g. 'protecting native ecosystems integrity over the long time') to a more anthropocentric approach with a focus on ecosystem services (exemplified in statements such as: 'so that it can provide the services humans want and need').

In terms of policy and legal institutional definitions, the two regional regimes, the OSPAR Commission and the Commission of the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention) jointly have developed the perhaps most tangible and useful definition 'for the ecosystem approach to the management of human activities': *the comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity.* Noticeable is its careful balance between eco-centric and anthropocentric approaches. The definition was copied by the Arctic Council with the only change that the basis shall not only be best scientific knowledge but also traditional knowledge (Arctic Council 2013).

Whereas the examples of descriptions and definitions provided above have related to area-based EBM, the approach can also be sectoral (Engler 2015). This has mainly been articulated by the fishery sector, but to some extent also in forestry and wildlife management. FAO defines the Ecosystem Approach to Fisheries as follows:

'The purpose of an ecosystem approach to fisheries is to plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems (Attwood et al. 2005).'

Concluding remarks

EBM has no universally agreed definition or delimitation. It is an extensive concept with many different research-related themes and approaches, both disciplinary, epistemologically and methodologically.

Still, there are some commonly recognized denominators in the reviewed literature:

- The overall feature of EBM is a focus on the structure and functioning of entire ecosystem in contrast to single species or within administrative borders that are not coherent with the spatial units of ecosystems (Platjouw 2016).
- Thereby, it involves coherence and coordination and the integration of relevant sectors and levels of management (Watson & Albon 2011).
- Stakeholder participation is also a key element (Franzen et al. 2015).
- EBM is knowledge-based and adaptive to changes in the socio-ecological system.
- It often incorporates the precautionary principle and cumulative effects (Convention on biological diversity 1998, Convention on biological diversity 2000, Curtin & Prellezo 2010, Frohlich et al. 2018).

2.3 Related concepts

As we have discussed above, the concept of EBM has been around for at least 30 years and has been extensively discussed, elaborated and developed. Several of other expressions used interchangeably exist such as ecosystem management, the ecosystem approach, the ecosystem approach to management. The number of expressions reflects the confusion around the exact meaning of the concept and its implication for management and governance, as discussed above. This uncertainty is compounded by different understandings of other concepts that underlie EBM such as ecosystem services, ecosystem health, ecosystem integrity, and even ecosystem itself (Engler 2015).

Moreover, the approach is closely associated with several other integrated approaches and frameworks. The following provides some examples of these:

Sustainable development

The concept of sustainable development has been elaborated in parallel with EBM (and EA), and EBM is often described as a key tool to achieve sustainable development (De Lucia 2015). An example is by the International Council for the Exploration of the Sea stating that *'[t]he EA is embedded in the concept of sustainable development, which requires that the needs of future generations are not compromised by the actions of people today. EA puts emphasis on a management regime that maintains the health of the ecosystem alongside appropriate human use of the marine environment, for the benefit of current and future generations'* (Rice 2005).

Ecosystem services

The 2005 UN Millennium Ecosystem Assessment identified ecosystem services as the benefits people obtain from ecosystems and divided such services into four categories:

1. Provisioning services: products obtained from ecosystems, such as food, fresh water, fuel-wood, fiber, biochemical and genetic resources.
2. Regulating services: benefits obtained from regulation of ecosystem processes, such as regulation of floods, drought, disease, land degradation and water purification.
3. Supporting services: services necessary for the production of all other ecosystem services, such as soil formation, nutrient cycling and primary production.
4. Cultural services: non-material benefits from ecosystems, such as aesthetic enjoyment, recreation and tourism, inspiration for culture art and design, and spiritual experience.

While some scholars have argued that EBM should remain purely eco-centric, contesting the ecosystem services approach as 'commodification of nature', ecosystem services are encompassed in the vast majority of EBM understandings (Prip 2018). Already the CBD Malawi principles from 2000 stated that maintenance of ecosystem services, should be a priority target of the ecosystem approach. (Principle 5). The importance of ecosystem services for EBM was further emphasised by the Millennium Ecosystem Assessment from 2005 and the follow-up initiative launched in 2007 'The Economics of Ecosystems and Biodiversity' (TEEB 2008).

Adaptive management

There are different understandings and expressions of adaptive management, but its overarching aim is towards an iterative consideration within management whereby learning takes place and management strategies are adjusted accordingly (Wehn et al. 2018). It is generally acknowledged that adaptive management is an important element of EBM. As stated by the CBD in relation to adopting the Ecosystem Approach as the overarching framework for action under the Convention: *The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Ecosystem processes are often non-linear, and the outcome of such processes often shows time lags. The result is discontinuities, leading to surprise and uncertainty. Management must be adaptive in order to be able to respond to such uncertainties and contain elements of 'learning by doing' or research feedback. Measures may need to be taken even*

when some cause-and-effect relationships are not yet fully established scientifically' (Convention on biological diversity 2000 section A).

Social-ecological system (SES) framework

The social-ecological systems framework is a comprehensive conceptual framework for diagnosing interactions and outcomes in social-ecological systems. While EBM has its roots in natural science, the SES framework has been developed in social sciences and economics. It is based on the idea that all resource use is rooted in complex social-ecological systems. The main idea of the framework is to assess why some systems are sustainable while others collapse through the identification and analysis of relationships at multiple levels of the systems across appropriate spatial and temporal scales (Ostrom 2009).

The planetary boundaries approach

This approach could be viewed as EBM for the entire global ecosystem. It defines *'a safe operating space for human societies to develop and thrive, based on our evolving understanding of the functioning and resilience of the Earth system (Steffen et al. 2015).*

In addition a number of other concepts, frameworks and approaches to natural resource management, planning and decision-making have similarities and can be seen as related to EBM. Some examples are Integrated coastal zone management, sustainable use of forests/multiple use of forests, Wise use of wetlands and Green infrastructure planning.

3 Methods and process

3.1 Quantitative reviews

Scientists are generally well trained to conduct literature reviews. These are often based on the existing interests and overview one or a group of scientists possess – they take their point of departure in the sources and studies that these scientists have found interesting and worked on before. However, by basing reviews on selected sources, literature reviews can be liable to significant biases, represent subjective views, and often lack transparency. This has led to increased interest in the use of more systematic approaches to assessing research findings and evidence, through the application of different types of systematic reviews (SRs).

While systematic, quantitative reviews are highly useful, conducting them with rigour and transparency is time- and resource consuming. Such detailed, systematic and quantitative reviews are also dependent on a concrete Research Question, typical for medicine or biology. The so-called PICO approach where the Population (“patient”), Intervention (treatment), Comparison (control group/alternative treatment) and Outcome (effect) can be specified, defined or measured, is generally needed to conduct systematic reviews following the “gold standard” (Collins et al. 2015).

For wider objectives, for social scientific themes and applied needs with limited budgets, simpler reviews, that still follow some of the principles from systematic, quantitative reviews are needed. Rapid evidence assessments, quick scoping reviews and systematic mapping are examples of such “lighter” or less stringent approaches (Figure 1), but still aiming to avoid biases and foster transparency.

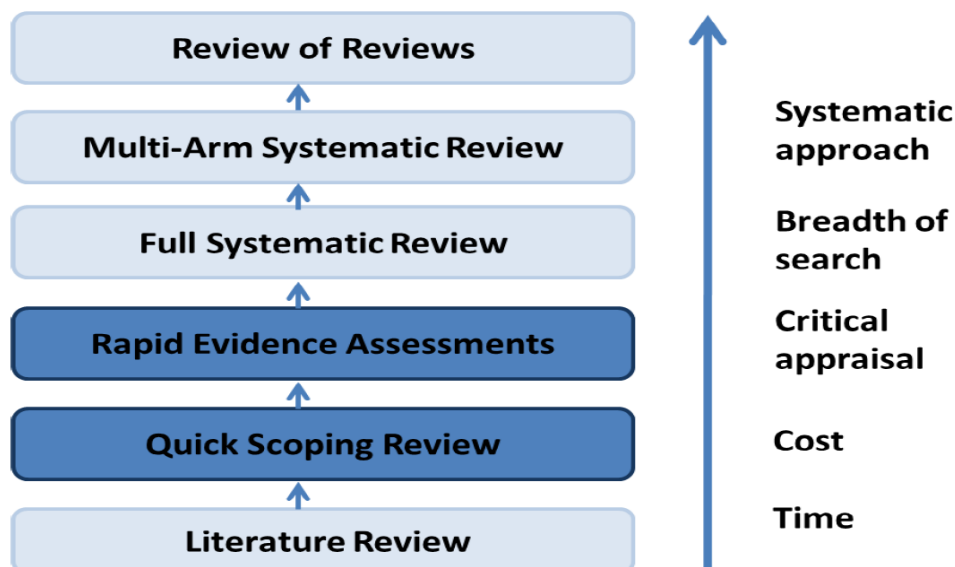


Figure 1. Quick Scoping Reviews and Rapid Evidence Assessments in the hierarchy of evidence reviews. From Collins et al. (2015).

The application of systematic reviews within environmental sciences has grown fast and is now well established (Sutherland & Wordley 2018). Within the Nordic countries, the Swedish EVIEM group, now based at FORMAS, is maybe the most ambitious and concrete example of how to build competence within systematic reviews in environmental sciences. Also, within applied, mul-

tidisciplinary environmental sciences, well-defined and concrete questions are needed to conduct systematic, quantitative reviews. Within subareas such as pollution sciences this is easier than in other areas. However, clear frames and well-defined questions can be formulated , e.g.

“Can biomanipulation improve water quality in eutrophic lakes?” or “How is the management of roadsides affect spreading of non-native species?” (Bernes et al. 2017). However, also more open-ended questions can be formulated such as: “Which legal barriers can be identified for implementation of adaptive management of socio-economic-systems” (Frohlich et al. 2018)?

Systematic reviews, either rigorous, quantitative investigations of precise and well-framed questions to less detailed and rigorous, yet systematic scoping reviews are recommended to follow a certain, stepwise process with the following main stages (Collins et al. 2015):

1. Planning

- Set up review team
- Refine research questions
- Develop protocol for searches, including deciding in which databases languages and countries searches shall be conducted

2. Literature search and analysis

- Record results in database
- Screening, according to criteria from protocol
- Each screening step should be described

Extract the relevant evidence/literature

3. Summary and recommendations

- Describe volume and key characteristics of the relevant literature
- Use literature to answer all research questions
- Identify key research gaps

The different stages and steps can contain several difficult questions for consideration. Examples of such questions are how to treat so-called “grey literature” (e.g. reports from different knowledge-producing institutions and consulting companies, white-papers), and what languages to include.

When the searches are conducted a key task starts: the screening of the resulting literature base. A well-designed search will often include lots of literature not relevant for the research questions. The screening normally is conducted in several stages. In the first stage, the team typically assesses only the title of the work. In the next stage, the abstract is considered. Finally, the full work is taken into account. The screening process often reduce the initial, gross search result with 80 – 90 %.

The research questions and objectives for this study are wide and open-ended. EBM cover a range of interventions (treatments) leading to outcomes affecting policies, people and society, as well as (or ultimately) ecosystems including the integrity, quality and productivity of habitats, species and populations. It is also possible that several interventions can lead to the same outcomes. As such, the objectives of this study are not suitable for systematic quantitative reviews. Despite of this, we have aimed to work as systematic, transparent and quantitative with the search for relevant knowledge.

3.1.1 Procedure

To assist the demanding and rather wide topic for the review, we organised a core-review group, as well as a wider expert/reference group. While the output primarily is the result of the work of the core review group, an important part of the process was two extensive workshops, one in April 2019, and the other in December 2019. The purpose of the first was to plan, present and discuss disciplinary approaches to EBM, e.g. from law studies, economics, planning and political sciences, and how to frame and clarify the research objectives better. The second workshop focused on presenting and discussing preliminary findings and the final report outline. Participants in the workshops are mentioned in the foreword.

We conducted a systematic search in two databases; Web of Science (WoS) and Scopus. Initial criteria for exclusion/inclusion were:

- Only publications from year 2005 and later were included.
- Publication categories (to be selected in the databases) included were: Article, Review, Editorial material, Book, Book Chapter.
- Languages: Publications in English and Scandinavian languages
- Geography: We selected primarily studies from “western democracies”, however exceptions from this have been done if a publication looks highly relevant.

We did a series of search trials, especially in terms of how to develop terms, keywords and their combination through the use of Boolean operators AND or OR. In addition, we applied so-called proximity operators.

Since the scope and research questions of our study were so wide and open, we faced a significant challenge with large number of publications from our searches. After several trial searches with hundreds of thousands of publications identified, we decided to include certain qualifier terms within many of the separate searches. This is a bit unconventional, and by doing this we faced the risk of excluding material that otherwise would have been included. It was however a necessary adjustment to achieve a manageable amount of publications.

Another adjustment we made was replacing the Boolean operator AND (within the single searches) with a proximity operator. By doing this, we reduced the amount of irrelevant material significantly.

The final search organised search terms in three groups; 1: Ecosystem type integrated with the terms “integrated” OR “management” OR “governance”; 2: Key policy processes with relevance to EBM, and; 3: Terms related to EBM management approaches and measures (Table 1). The search terms within each group were combined using the operator OR, and eventually the results from the three groups were combined with the operator AND.

The full search string is presented in Appendix 1.

Two similar searches according to the keywords and combinations presented in Table 1 gave a total number of 7732 items in WoS, and 10166 in in Scopus. After checking and correcting for duplicates, a total of 11755 publications was imported to an Endnote-database subject to further analyses.

Table 1. Overview of the search. Figure showing output from SCOPUS search, and the application of the Boolean operators OR and AND, which result in a total number of 10166 items taking into account the exclusion criteria. Search conducted 24th June 2019.

Ecosystem type		Key policy processes with relevance to EBM		Terms related to EBF management approaches and measures	
Column 1		Column 2		Column 3	
Forest W/5 (integrated OR management OR governance)	41519	ecosystem*	412108	resilience OR resilient	114713
Range* W/5 (integrated OR management OR governance)	18025	Biodiversity	160162	integrated W/3 (management OR regulatory OR legislation) AND (ecosystem*)	48401
coast* W/5 (integrated OR management OR governance)	16140	environment* W/3 (management OR governance)	92453	(Law OR legal OR regulation OR regulatory OR legislation) AND (ecosystem*)	25022
river* W/5 (integrated OR management OR governance)	13060	"water framework directive" OR "2000/60/EC"	5655	adaptive W/3 (law OR management OR governance)	24697
Basin W/5 (integrated OR management OR governance)	8894	"natura 2000"	2192	decision-making W/3 (management OR governance OR ecosystem*)	14255
urban AND (integrated OR management OR governance) AND ecosystem*	7515	ramsar OR "Convention on Wetlands"	1981	"Policy change"	16011
marine W/5 (integrated OR management OR governance)	7291	"Convention on Biological Diversity"	1777	Management W/3 Ecosystem*	15940
lake* W/5 (integrated OR management OR governance)	5059	unclos OR "United Nations Convention on the Law of the Sea" OR Losc OR "law of the sea convention"	1686	stakeholder* W/3 (involvement* OR engagement OR participat*)	14387
wetland* W/5 (integrated OR management OR governance)	4975	"Habitats Directive" OR "Directive 92/43/EEC"	1601	"Policy implementation"	14292
ocean* W/5 (integrated OR management OR governance)	4593	"Marine strategy framework directive" OR "Directive 2008/56/EC"	722	decision-making W/3 (management OR governance OR ecosystem*)	14255
Wood* W/5 (integrated OR management OR governance)	3597	"Convention for the Protection of the Marine Environment of the North-East Atlantic" OR OSPAR	465	"spatial planning"	7989
(pasture OR pastoral) W/5 (integrated OR management OR governance)	3329	"birds directive" OR "Directive 2009/147/EC"	276	"policy strateg**"	5807
grassland* W/5 (integrated OR management OR governance)	3281	"berne convention" OR "bern convention" OR "Convention on the Conservation of European Wildlife"	269	politic* AND ecosystem*	5674
mountain* W/5 (integrated OR management OR governance)	1761	"maritime spatial planning directive" OR "Directive 2014/89/EU"	23	"system* transform**"	3668
terrestrial W/5 (integrated OR management OR governance)	1475			holistic W/3 (management OR governance)	2884
freshwater* W/5 (integrated OR management OR governance)	1330			"govern* strateg**"	2749
shore* W/5 (integrated OR management OR governance)	1114			multisector*	2370
Meadow W/5 (integrated OR management OR governance)	455			"Multi-level governance" OR "multi level governance" OR "multilevel governance"	2056
				"government administrat**"	1187
				"administrative boundaries"	1023
				("policy-making" OR policymaking OR "policy making") W/3 (management OR governance OR ecosystem*)	1161
				governance W/3 Ecosystem*	449
				"govern* transform**"	319
				"govern* coordination"	190
				"area-based management" OR "area based management"	61
	129302		609712		306318
Column 1 AND column 2 AND column 3			14305		
C1, C2 & C3, published 2005 and later			11794		
C1, C2 & C3, published 2005 and later, limited to 5 publication types (Article, Review, Editorial material, book, book chapter)			10725		
C1, C2 & C3, published 2005 and later, limited to 5 publication types, and only english and scandinavian languages			10166		

Screening

Screening was conducted in three stages. We utilized the screening software Rayyan QCRI in the first two rounds (Ouzzani et al. 2016).

The first screening was done based on the title of the work, supplemented with other short information such as keywords. This was done individually, where each member of the core review team assessed approximately 2900 publications. Key exclusion criteria were country (excluding studies not conducted in “western democracies”), and studies with no direct management or governance relevance, typically ecological studies without a clear and direct relevance for EBM. After the first screening, 2226 publications remained, representing 19 % of the original volume.

The second round organized the remaining publications in two databases, considered by the reviewers in pair utilizing the “blind” function in Rayyan. In this stage, inclusion or exclusion was decided on based on the relevance of the study for the objectives for this analysis. Many publications were “borderline” in their relevance (typically those dealing with the knowledge base for EBM). When the two reviewers coded similarly, that the publication should be included or excluded from further analyses, no further action was needed. Publications where the two reviewers disagreed, the two reviewers met, discussed and decided whether to include or exclude the publication from further analyses. Both pairs of reviewers initially disagreed about approximately 20 % of the publications, which also illustrate the amount of “borderline” relevant publications. The result after screening 2 included 1094 publications, representing approximately 9 % of the initial search result. The third stage consisted of a quality check of these publications, and a limited number of publications were excluded for being duplicates or after closer inspection did not fulfil previously set exclusion criteria. This quality control left us with a total of 1071 publications.

After a joint discussion in the review team it was concluded that – given the broad scope of the task, a quantitative analysis of these publications would be needed to answer the first, overarching research objectives (1-3).

To get a meaningful overview of the outcome, a more detailed classification of the content of the publications was conducted. This included most often an assessment of the full publication. Each publication was coded according to the following variables:

1. Year of publication (2005-2019)
2. Country where study was conducted (Country, countries, Europe, EU, n/a (not relevant or not applicable))
3. Scale: Whether the publication conducted a study at a local, regional, national or international scale.
4. Journal: Name of journal for publication.
5. Research Method: Qualitative, Quantitative, Document study, Review/Synthesis, Case study, Mixed.
6. Sector: Agriculture, Fisheries, Forestry, Ocean, Environment, Energy, Cross/multi sectoral.
7. Process: The coding of the process variable is described in chapter 4.1.
8. Theme: The coding of the theme variable is described in chapter 4.1.

A file giving the detailed overview of the characteristics of all included publications is presented in an electronic attachment to the report.

3.2 Supplementary qualitative reviews

Separate searches in databases such as Oria (www.oria.no) was conducted to identify highly relevant literature in the Scandinavian languages, since the main WoS and Scopus search provided little in these languages. In addition, the workshops with the reference group provided some direct input regarding other highly relevant literature.

4 Results I: Quantitative review

4.1 Quantitative content analyses of EBM research

This chapter presents the results of a quantitative mapping of 1071 academic publications concerning (aspects of) ecosystem-based management (EBM). The 1071 publications constitute the outcome of the three-staged screening approach described in chapter 3. The screening and quantitative mapping of existing research on EBM is particularly relevant for illuminating the second research question of this report: Which aspects of EBM have been addressed in the academic literature and which are less studied? Quantitative content analyses may help extracting a general, yet somewhat simplified overview of characteristics, patterns and trends in the academic literature on ecosystem-based management. A quantitative mapping and overview also offer a basis for selecting and exploring into more demarcated issues, in turn addressing the other research questions regarding cumulative impacts, economic, institutional and legal EBM obstacles and achievements.

The 1071 publications were classified by means of nine main variables: publication title, name of journal/book, year of publication, main ecosystem type, research method, studied countries, scale, main management process and topics.

While publication title, year and name of journal/book is fairly straightforward, the analytic thinking behind some of the other categories deserves some explanation. Rather quickly, we got the impression that research on EBM was conducted on distinct ecosystem types. We thus mapped publications by means of the main ecosystem types put forward (Nybø & Evju 2017). Furthermore, we mapped publications according to scale, i.e. variation in size and distribution of the geographical area under study. Applying local, regional, national, European and global scales, allows for including the formal governance levels of public policy. Simultaneously, the small-to-large gradient allows for other geographical scalar spaces. In this report, the term “scale” thus refers to spatial constructs along differing sizes and landscapes (Jordhus-Lier & Stokke 2017: 53). They are constructs because they involve some degree of coordination between authorities and actors belonging to that area. Thus, scale denotes a geographical-administrative area that is studied in relation to EBM. A scale can be small and local, referring to a single river basin or demarcated coastline, municipality etc. The regional scale is a bit more elusive, comprising the traditional meso-level of government such as the German Länder, the Nordic counties, or river basin districts. However, it may not be situated within the borders of a single state but crossing national borders such as marine areas like the Baltic Sea or Bay of Biscay. The point is, regional scales vary in size. They constitute a distinct and joint geographical shared space in need for coordination. The national scale refers to the jurisdiction of the territorial state. The European scale refers to the jurisdiction of the EU, while the global scale refers to global processes or phenomena, for instance in relation to the UN. Of course, some studies did not address the issue of scale, and so the term n/a refers to “not available”.

Further, we coded publications according to the *main work process* under study. Applying differing *work processes* as a variable in the content analysis is related to the acknowledgement that governance takes place in more or less organized settings. According to the classic organization theorists Lutherford Gulick (1937: 22 & 24), budgeting, planning and law are examples of major work processes that are distinct in terms of their techniques, methods and approaches.

Although EBM may be ascribed somewhat differently in the literature, it is commonly argued that EBM relies on certain work procedures, or management processes, defining *how* work should be done (Howarth 2009). Certainly, EBM is about safeguarding good ecological status, biodiversity and sustainable development, i.e. substantial objectives. Substantive rules such as reference conditions, threshold values and parameters also serve as significant ingredients in addressing the environmental status of ecosystems. Simultaneously, as stated through the Malawi

principles, EBM approaches imply addressing the particular ecosystem as the base line, i.e. decentralization to the lowest appropriate level, where all forms of relevant information should be considered, as well as effects of activities on that particular ecosystem. Thus, the first step of the EBM approach involves generating a coherent *knowledge base* of the relevant ecosystem. How to achieve *knowledge-based* management has triggered a vast research literature on scientific characterization, monitoring, impact assessments, cumulative impacts, GIS tools, the development and monitoring of indicators and so forth. Moreover, the Malawi principles identify conflicts between short-term gains and the need for long-term maintenance, as well as how ecosystem functioning is affected by complexities, uncertainties and temporary, unpredictable conditions, which delineate a role for adaptive governance and *planning* as a central ingredient. Thus, in the mapping, publications that address planning as a central aspect of examination, are registered with 'planning' as the main process.

Related to planning is also stakeholder involvement and public participation. The Malawi principles emphasize that the EBM approach should involve all relevant sectors and consider all forms of relevant information. Thus, "participation" is included as a main management process. The principles further recognize the need to understand and manage the ecosystem in an economic context, meaning that those who generate environmental costs (e.g. pollution, distortion) should pay. This also involves valuing nature in terms of its economic benefits.

Whereas ecosystem services have gained a lot of research interest in the literature, we label those publications with a distinct "ES" label. These contributions make it possible to single out the key work processes associated with EBM. Knowledge- and data gathering is one, which has triggered a vast research literature on scientific characterization, monitoring, impact assessments, cumulative impacts, GIS tools etc. Planning is a second sub-process. In addition, participation, economy, ES, legal aspects, decision-making and measures implementation all address distinct procedures from a public management perspective and regarded central in the EBM approach.

In summary, publications are thus sorted by means of the following key words and main processes (Table 2).

Table 2. Key words for main process and related topics used in classification of relevant literature.

Key word	Related topics
Knowledge base	Characterization, cumulative impact, impact assessments, decision support systems (DSS)
Economy	Budgeting, decision support systems (DSS)
ES (ecosystem services)	Valuation
Planning	Spatial planning, watershed planning, regional planning, urban planning
Participation	Public participation, community participation, stakeholder involvement
Decision-making	
Measures implementation	Restoration, programme of measures
Protection/conservation	Protected areas,
EBM (Ecosystem-Based Management)	Watershed management, implementation of ...

The main management and governance processes put forward in table 2 above are not mutually exclusive. Two or more processes may appear as equally central in a publication. In addition, several publications focus on the entire ecosystem management and governance process without decomposing it or selecting a specific sub-process. Hence, it was necessary to include “EBM” as a distinct label, referring to publications that focus on EBM in general, or on two or several of the main management processes presented in table 2 above.

4.2 When and where? Publications across time and space

The screening reveals that there has been a growing body of research on EBM in the period between 2005 and mid-2019 (Figure 2). Whereas 37 selected publications were released in 2005, there has been a steady increase and tripling towards 2018. The apparent drop of publications in 2019 has to do with the screening period, which ended in May 2019. Thus, the publication rates of 2019 only represent the first part of that year. Nevertheless, the overall impression is a significant increase during the period, showing a significant increase in research relevant for implementation of (more) ecosystem-based management and governance approaches.

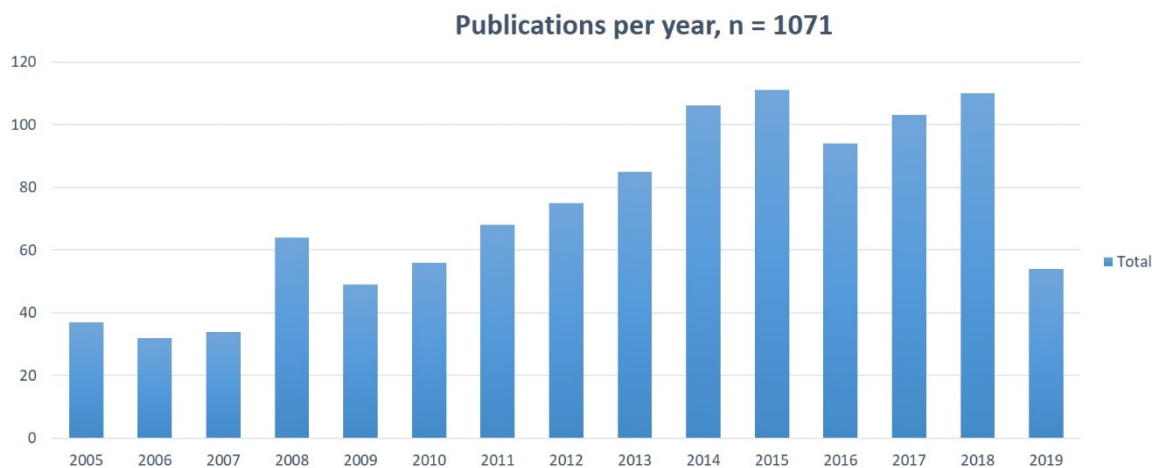


Figure 2. Number of publications per year, 2005 – 2019. N=1071

The screening also reveals that EBM is by large studied within specific ecosystems. Table 3 to the right displays that research on marine ecosystems has triggered most publications, followed by publications on freshwater and coastal ecosystems. Few relevant publications were identified for mountain and rangeland ecosystems. It is worth noting that the exact distinction between marine and coastal ecosystems may be somewhat inaccurate. Generally, publications classified as coastal ecosystem studies deal with near-shore or land-sea interfaces. Marine ecosystems are always fully marine.

Marine ecosystems	388
Freshwater ecosystems	230
Coastal ecosystems	156
Forest ecosystems	132
Urban ecosystems	58
Wetland	38
Rangelands	17
Mountain ecosystems	9
Unspecified /general EBM	43
Total	1071

Some publications classified as coastal could (also) have been classified as marine. As will be presented later, there are distinct differences across the identified literature in the two ecosystems.

Looking at the volume of research across ecosystem types throughout the time-period of 2005-2019 reveals some interesting patterns. Figure 3 below shows the distribution of publications per year and ecosystem type, revealing how publication rates are increasing for most of the ecosystem types. Research on marine ecosystems dominates as the most published during the period, although publication rates peak in 2014 and then drop. Publication rates are increasing for most of the other ecosystem types until 2018, particularly academic papers on freshwater, urban ecosystems, wetland and forest ecosystems.

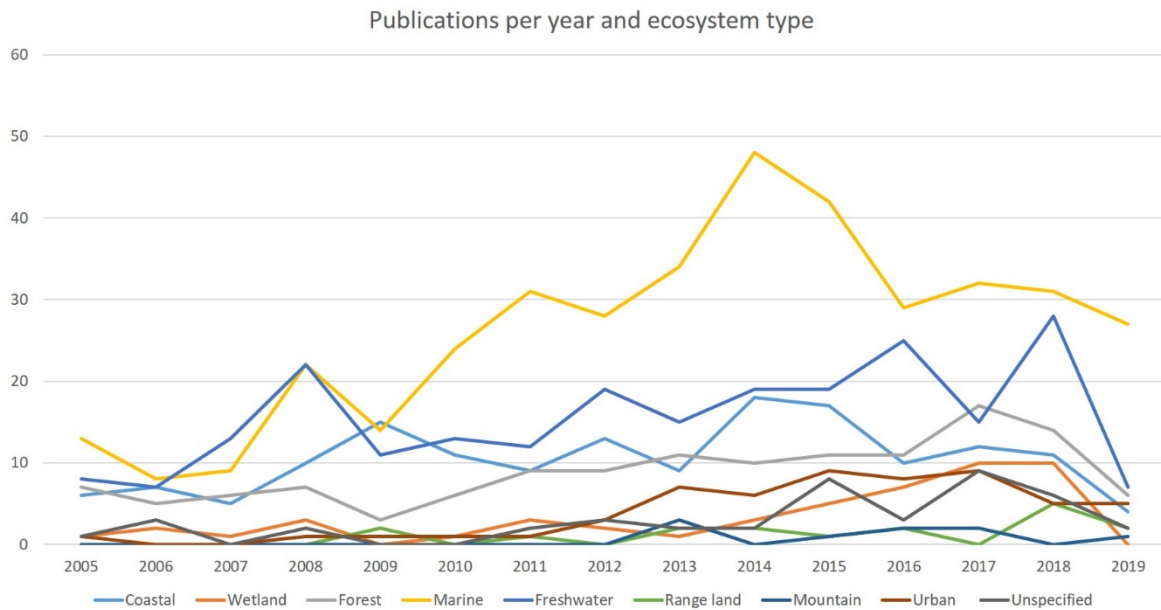


Figure 3. Number of publications identified across main ecosystems 2005 – May 2019. N=1071

The propensity to study EBM within specific ecosystem types has led to a varied spectre of academic journals publishing articles on the topic. Still, a somewhat restricted number of journals appear as key outlets (Figure 4). For marine and coastal studies, Marine Policy is very dominant, but seconded with Ocean and Coastal Management. Also, forest and urban ecosystems publications are dominated by ecosystem-specific journals exemplified with Forest Policy and Economics and Urban Ecosystems. However, for freshwater, several more general environmental management research journals come out as the most used. Environmental Management, Ecology and Society, Environmental Science and Policy and Science of the Total Environment are ranked the four most used. Some of these, especially Ecology and Society are used for all ecosystems.

Academic journals

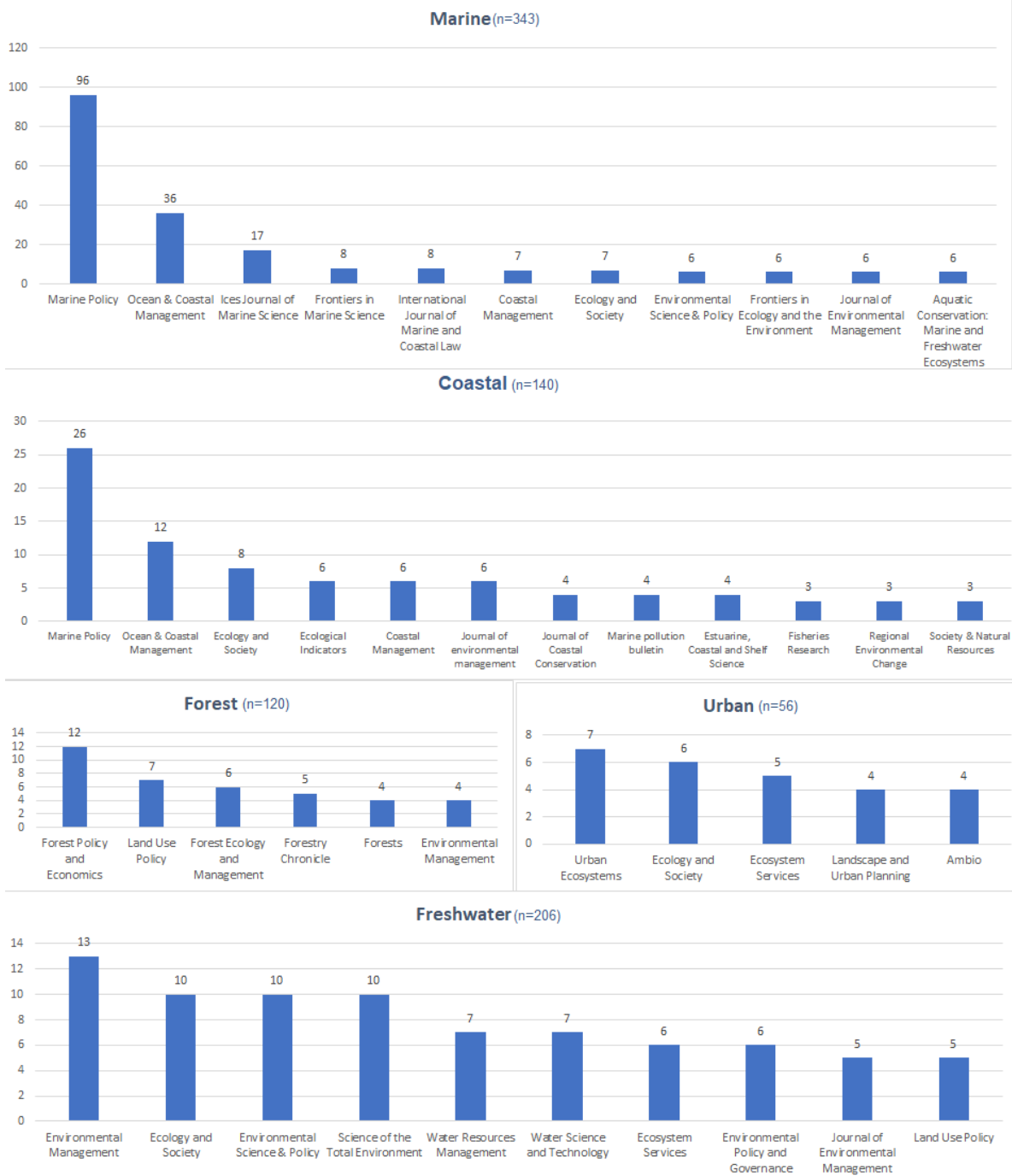


Figure 4. The most used journals across ecosystems. Some journals are listed in several ecosystem categories, like Ecology and Society, Coastal Management, Marine Policy, Environmental Management, and Ecosystem Services. Smaller sample size (N=865) as books and book sections are kept out.

In terms of research design, the mapping reveals a strong dominance of case studies (393), followed by reviews (264) of existing research, and then documents studies (Figure 5). We also see that there are relatively few comparative large n studies registered in our sample (18), while quantitative research like surveys are more common but still modest.

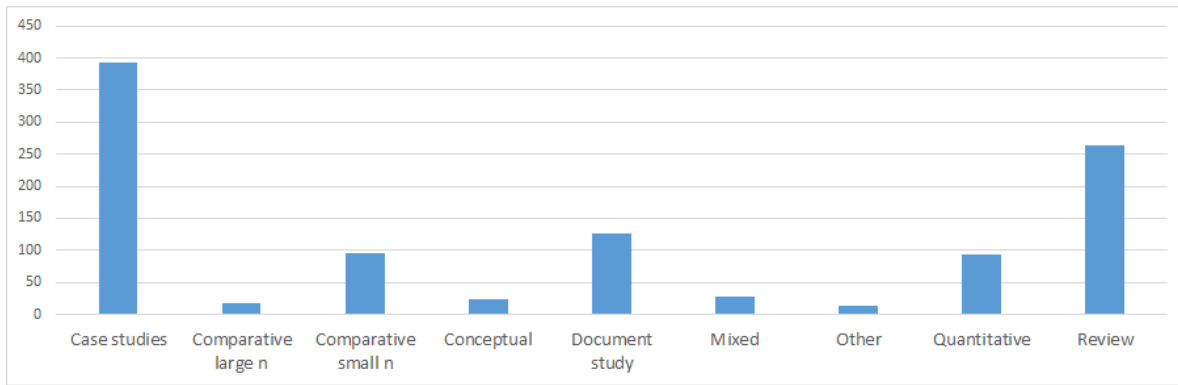


Figure 5. Overview of research design applied in publications. N = 1071.

4.3 Content: Countries, scales, processes and themes

Research on EBM is not a western phenomenon but conducted at all continents. This mapping however, has only included research conducted in European countries, Australia and North America. This is done for the sake of comparability. Despite perhaps relevant for understanding EBM, studies in other regions and countries were excluded during the screening. The reason for applying geographical exclusion criteria was to arrive at a volume of publications that is manageable for more qualitative purposes, as well as being relevant in a Norwegian policy context.

Table 4.

USA
European countries

UK

Australia

Canada

Sweden

Germany

Norway

Spain

Netherlands

Ireland

Portugal

Finland

France

Greece

Italy

Poland

Studies of, or within the USA and large-n studies of European countries (the darkest rows in Table 4) appear as the most applied countries, identified in well over 100 publications each.

The UK, Australia and Canada serve as the second group, covered in between 50 and 100 publications, either as single unit studies or as small-n comparative studies. This is not surprising, given their position as marine nations.

There are several countries that appear in 20-50 publications, as single unit studies or small-n comparative studies. Sweden, Germany, Norway Spain, the Netherlands, Ireland, Portugal, France and Finland occur in this third most common group, with Germany, Sweden and Norway with the highest numbers.

Greece, Italy, Poland, as well as several eastern European countries seem to be less represented in publications, which might indicate a research potential.

EBM may challenge existing administrative borders by accentuating the role of ecosystem landscapes as the frame or organising principle for public and private governance. Sorting publications by means of which scale they comprise enables an overview of which administrative spaces that

have gained attention in existing studies on EBM. Publications by means of their scale point at some interesting patterns as seen in figure 6 below.

We see from figure 6 that over half (52 %) of the publications study EBM at regional scales. Marine fisheries, regional governance models in ocean management, integrated coastal zone management, mountain regions, river basin districts, regional forest programs etc., are examples of studies that put regional management under scrutiny. Studies of EBM at local scales make up the second largest category. This means that about 66 %, two-thirds of the publications, study EBM as local or regional governance processes. Only 9 % of the publications deal with EBM at a national scale, for instance in studying national forest policies and national legal frameworks. About 11 % of the publications study EBM from a cross-scale (multilevel or multiscale) governance perspective. This generates the impression that EBM has regionalized research on management and governance, while (so far) put less emphasis on the role of national processes.

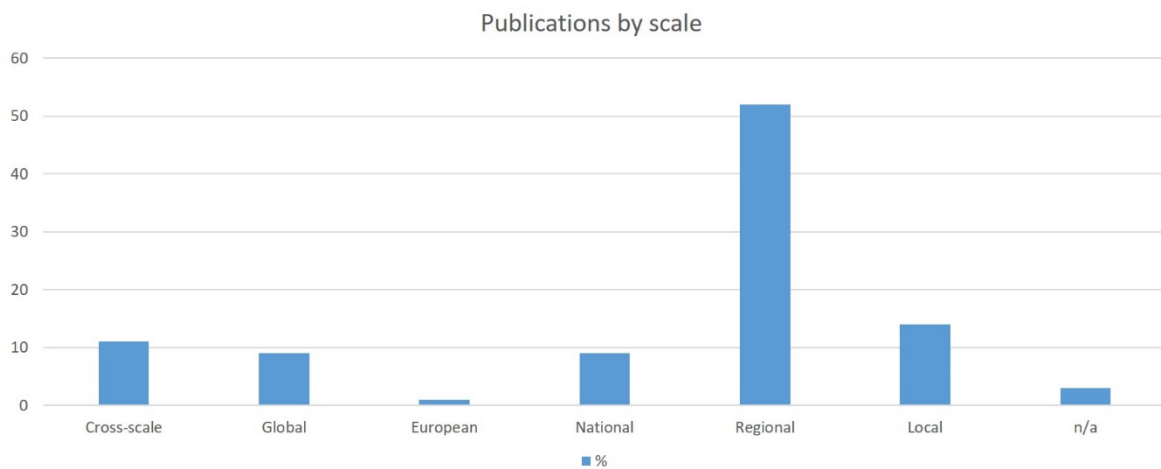


Figure 6. Spatial scale applied in the selected publications. N=1071.

The focus on regional scales is fairly robust across ecosystem types, except for studies of urban ecosystems that primarily deals with local studies (Figure 7). Having kept differences in publication rates between the ecosystem types constant, we see fairly similar patterns regarding scales. However, freshwater publications have a higher share studying the “European” scale, which most likely has to do with the EU and the WFD.

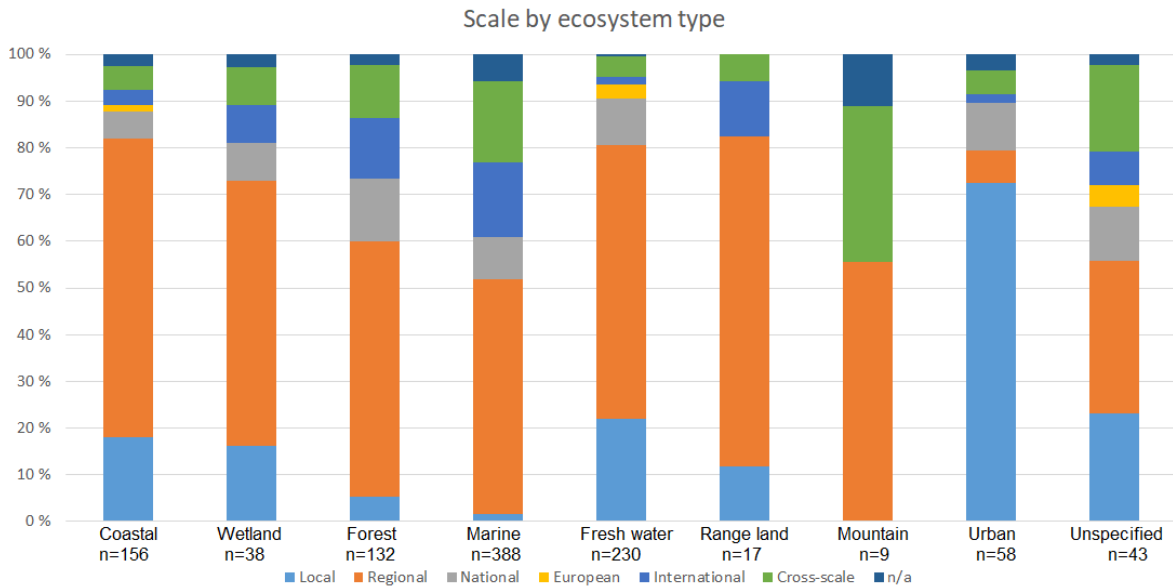


Figure 7. Publications across different scales and ecosystem types.

In the academic literature, it is argued that EBM involves an enhanced focus on administrative procedures and processes (Howarth 2009). Thus, to get an overview of the research endeavours and topics, the mapping was organized around the main management and governance processes that can be linked to EBM: Issues related to knowledge building, legal issues, economy and ecosystem services (ES), planning, participation, decision-making, measures implementation and protection/conservation. Publications dealing with several of the processes or the more general concept of ecosystem-based management, were categorised as a separate class and marked with “EBM”. This category spanned wide and it is difficult to describe it short except that these were relevant studies that did not fit into any of the other main processes.

Firstly, the mapping exercise confirmed that most of the selected articles actually addressed one or more of these management processes. Secondly, the results indicate that research on EBM has been dominated by studies on planning, the knowledge base and ecosystem services (ES), see figure 8 below.

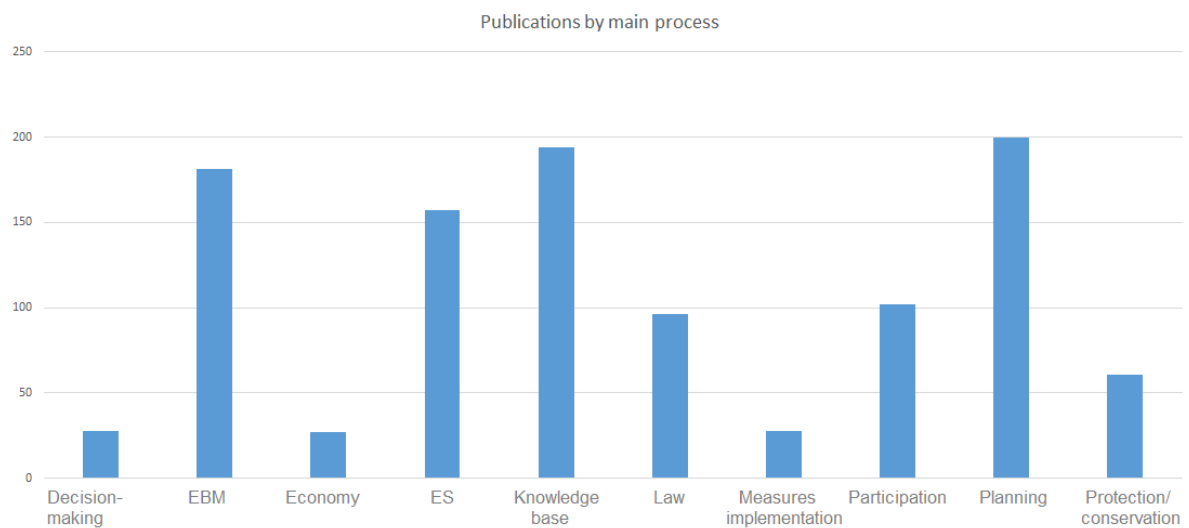


Figure 8. The main public management process dealt with in publications (n= 1071).

Planning studies have mushroomed in connection to EBM research. Figure 8 shows that about 19% of the publications address planning as the main management process. Frequent planning themes are adaptive management and how to accommodate for vertical and horizontal coordination, as well as sectoral policy integration. Decision support systems, adaptive governance and stakeholder involvement are also studied in relation to planning. About the same share of publications (18%) address issues related to the knowledge building phase: characterization and classification of environmental status and human impact, impact assessments, cumulative impacts, monitoring, risk management, as well as decision support systems are frequent topics related to the knowledge phase. Also, ecosystem services (ES) have gained a lot of scholarly attention: 15% of the publications have focused on ES, often related to the development of decision support systems, valuation and impact assessment.

Among the less studied management processes are decision-making and measures implementation. Only 2-3 % of the publications study decision-making processes and measures implementation, issues that are decisive if EBM is to work. Moreover, despite significant research on ecosystem services, other economic issues such as sustainable budgeting and taxing, as well as trials in PES-approaches¹, are not well studied. These low rates thus identify a future research potential.

Recognizing that many publications do not deal with a single management and governance process only, but include two or more, it should be noted that having assigned the management process to a publication simply means that the paper is devoted *mainly* to a particular process, not entirely.

Are all management processes equally studied across ecosystem types, or do publications of the varying ecosystem types favour particular processes? Figure 9 below displays the distribution of research on management processes. The pattern leaves the main impression that the number of studied management processes is likely to increase with publication rates. For instance, marine ecosystems have the highest number of publications followed by fresh water, coastal waters and forests. All these ecosystems comprise publications on every management and governance process. The exception is coastal ecosystems which does not comprise any publications on decision-making. Moreover, figure 9 shows how marine, coastal and freshwater ecosystems have few publications on ecosystem services relative to their volume of publications.

The tables also reveal how research on ecosystem services has dominated within urban ecosystems, while freshwater research has devoted a lot of attention to planning studies and participation, which may be explained by the dominance of the WFD.

¹It should however be noted that we often excluded literature studying REDD+ and similar international PES initiatives aimed to reduce deforestation in tropical forests due to our focus on studies conducted in "western democracies". Some key findings from this literature are, however, presented in Chapter 6.

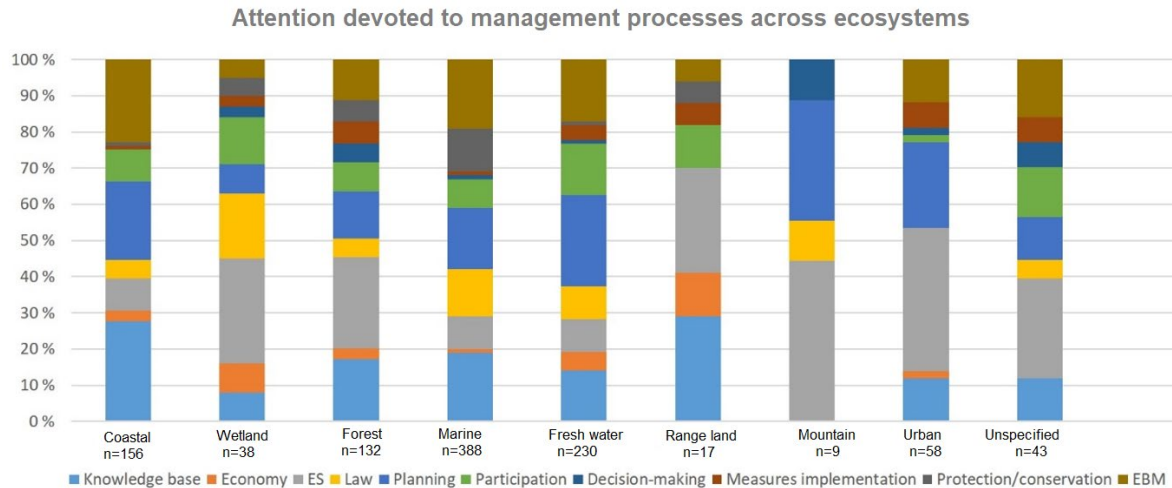


Figure 9. Number of publications classified after the main management and governance process, across ecosystems. N=1071.

4.4 Summary

The mapping of 1071 publications displays how research on EBM has increased, both across time, journals and space. While research on marine ecosystems have had the highest publication rates for several years, research on other types is now expanding, such as freshwater, urban and wetland ecosystems.

As for the quantitative content analysis, an overall impression is that the “mainstream” EBM research comprises regional studies on planning and participation, the knowledge base or ecosystem services. Western European countries with long coastlines tend to be more studied than eastern or central European countries. Adding to this general pattern, the mapping further identifies a research gap between the relatively limited research on EBM within urban ecosystems, and the high impact that urban areas have on their ecosystems: only 5% of the publications in our sample dealt with urban ecosystems. It is definitely water that has attracted most EBM research: Marine, coastal and freshwater ecosystems display the highest publications rates, while research on terrestrial ecosystems are lagging. Although forest ecosystems are relatively well studied, the limited number of studies on wetlands is puzzling, given the attention to planning in the academic literature as well as wetlands’ important function as carbon storages. The increased pressure on land-use planning would indicate more research on wetlands. In addition to urban areas, studies on range land and mountain ecosystems are few. Thus, the current mapping indicate an imbalance in the research on eco system types.

Arguably, ecosystem-based management and governance is characterised by its reliance on procedural, rather than substantive, administrative approaches. In procedural approaches, work follows specific work procedures, not substantive quality outcomes. Alternatively, work may be directed towards particular standards, objectives, for instance fixed emissions. However in EBM, such targets are not fixed, but something that materializes based on a fixed set of procedures such as knowledge gathering, participation, planning etc. As mentioned above, the current mapping reveals that planning, knowledge gathering and decision-support procedures, as well as ecosystem services are the most studied management processes. Other processes such as decision-making, measures implementation and economic procedures such as budgeting, are represented in few studies.

5 Results II: Nordic studies

5.1 Introduction

The project team conducted a specific review of Nordic EBM literature. In total, 122 publications were reviewed of which the large majority are academic articles mainly written in English. The remaining publications are reports and other types of grey literature mainly written in Danish, Norwegian or Swedish. This chapter focuses mainly on the Scandinavian countries, Sweden, Norway and Denmark, from which a majority of the Nordic research came from. These three countries have much in common being unitary state systems where national parliaments have supreme legislative power and with relatively similar systems of democratically elected decision-making institutions at state, regional and local levels.

However, there are also interesting differences relevant for EBM that cut across sectors and public authorities both horizontally and vertically. The Norwegian and Danish political-administrative system builds on the principle of ministerial responsibility according to which each individual minister is constitutionally responsible for decision-making within the ministerial policy area and accountable towards the Parliament. In Sweden, the government formally takes decisions collectively and subordinate agencies are accountable to the government as a whole. Moreover, as a very special characteristic, Sweden has a dual administration with clear separation between the policy-preparing ministries and executive agencies (Tallberg 2010).

Another Swedish speciality, not found in the other countries, is a system of environmental courts consisting of five regional and one superior appeal court.

Denmark's institutional governance structure differs from the 2 other countries by not having the decentralised state institutions at regional level which have been given important roles related to environmental management in Sweden and Norway (Indset 2018). Besides, the popularly elected regional councils in Denmark have quite limited authority in terms of ecosystem and environmental management. Municipal cooperation and collaboration are therefore the means for EBM when ecosystems transcend municipalities.

Both Sweden and Norway have provisions in their constitutions in support of EBM. Chapter 1, Article 2, of the Swedish Instrument of Government states: *'The public institutions shall promote sustainable development leading to a good environment for present and future generations.'* According to Article 112 of the Norwegian Constitution *'Every person has a right to an environment that is conducive to health and to a natural environment whose productivity and diversity are maintained.'* Denmark does not have similar provisions in its constitution.

The following will provide an overview of the distribution of literature among Nordic countries and some examples of topics addressed in relation to both different types of ecosystems and cross-cutting themes. The publications referred to should also be viewed as examples. They do not provide full coverage of publications related to the different matters described.

5.2 Distribution of literature among Nordic countries

Most of the publications have Swedish authors followed by Norwegian authored publications while less literature is Danish. Even less represented are studies from Finland and Iceland. This distribution may be an overall reflection of the attention devoted to the EBM concept – also politically. In both Norway and Sweden, the governments have commissioned expert reviews and policy advice on an important component of EBM: valuation of ecosystem services (NOU 2013:10 2013, SOU 2013:68 2013).

The distribution of articles on different ecosystems reflects the commonality of ecosystems in the different Nordic countries: Forest ecosystems have attracted the most attention in the Swedish literature followed by freshwater/river basin ecosystems. Unlike the other Nordic countries, Sweden also has a comprehensive coverage of EBM in relation to urban ecosystems. More than the other countries, Swedish literature addresses EBM in relation to ecosystem services. There is relatively little coverage in Swedish literature of the EBM concept as such. For Norway, the main part of the EBM literature is on marine and coastal ecosystems and very much with a spatial planning perspective. For Finland, the main focus is forest ecosystems and for Denmark freshwater/river basin ecosystems. Icelandic literature is mainly about marine ecosystems. Given the large areas of mountains in Norway, Sweden and Iceland, it is interesting to note that EBM of mountain and alpine ecosystems are very scarce.

5.3 Studies from different ecosystems

A large majority of the Nordic literature deals with EBM in relation to specific types of ecosystems. Three ecosystem types receive almost equal attention in the reviewed literature: forest, the sea and freshwater/watershed (in the understanding of the EU Water Framework Directive). Less literature addresses coastal and urban ecosystems and very limited amount covers agricultural (including rangeland and pastoral land) and mountain ecosystems.

Forest ecosystems

A common theme of the literature on forest ecosystems is how sustainable forest management can contribute to build more resilient ecosystems and landscapes in the face of climate change and other pressures. This includes the promotion of forest biodiversity (Sotirov & Storch 2018) and the integration of forest and water management (Eriksson et al. 2018, Futter et al. 2011, Keskitalo & Pettersson 2012). Another theme is the role of forest certification for sustainable forest management which deal with e.g. comparisons of different types of certification schemes (Gulbrandsen 2005) and the importance for biodiversity of certification (Johansson et al. 2013). Other literature is about public participation in developing forest planning and programmes (further referred to below) (Saarikoski et al. 2010). Effects of the international forest regime on domestic forest governance are also addressed (Lindstad 2015).

Marine ecosystems

Regarding marine ecosystems, marine spatial planning as a tool for EBM is addressed by many publications typically including discussions on stakeholder involvement in the planning process and with comparisons of planning processes of different countries (Karlsson 2019, Olsen et al. 2014, Platjouw 2018, Rodriguez 2017). Another important theme is the interface between science and policy with a particular focus on monitoring a mapping of marine ecosystems as a basis for EBM (Knol 2011, Knol 2013). A third key theme is the sectoral application of EBM to fisheries (Sainsbury et al. 2014, Sigurjónsson 2007, Stål et al. 2008). Also, in relation to marine ecosystems, there is literature about EBM as a tool to adaptation to climate change and promotion of resilience, here in the context of adaptive capacity in fisheries management: (Harsem & Hoel 2013). Most literature on marine EBM has a national or regional approach, but there are also examples taking a global approach (De Lucia 2019).

Freshwater/watershed ecosystems

Most articles on this type of ecosystems are based in the implementation of the EU WFD, a piece of legislation built around EBM and to which the non-EU Member State, Norway, is also bound. Many take a local case study approach with a focus on local public participation and local building of institutions in the development and implementation of River Basin Management Plans, the primary instrument for implementation of the WFD (Andersson et al. 2012). Another cluster of mainly Norwegian publications take a national policy and governance approach. This literature discusses the challenges of implementing the WFD through institutional changes from a fragmented sectoral basis to a 'whole of government' approach across the sectoral lines (Indset & Stokke 2015). Also, the legal challenges of WFD implementation in Norway is addressed

(Andersen 2013). One article compares WFD implementation in Norway and Sweden, two countries with fairly similar administrative and political systems, but with different ways of implementation of the administrative requirements. While Sweden has delegated decision-making power to novel regional-level bodies, Norway has established networked, interdependent structures for coordination, but with no decision-making power (Indset 2018). Important in this context is the comprehensive 'grey' report from the research project 'Water Pollution Abatement in a System of Multi-level Governance: A study of Norway's implementation of EUs Water Framework Directive (WAPABAT) (Hanssen et al. 2017).

One article also deals with the relationship between integrated water resources management and integrated coastal zone management (Rasch et al. 2005)

In parallel to literature on other ecosystems, there also exists literature on the science-policy interface in EBM (Jørgensen et al. 2008), as well as on adaptive management (here in the context of flood control, Johannessen & Granit 2015).

Urban ecosystems

The limited amount of EBM related literature on urban ecosystems mostly addresses ways to the safeguarding of ecosystem services in urban planning (Kaczorowska et al. 2016, Kati & Jari 2016).

5.4 Cross-cutting themes

Local, participatory approaches to EBM

Across the different ecosystems, there is considerably attention in the Nordic literature to EBM at local level and the involvement of local stakeholders (including indigenous communities) in EBM planning processes. This underlines the significance with which this topic is generally considered for successful EBM. Besides the extensive literature on local approaches to the implementation of the Water Framework Directive referred to above, this theme is also addressed in relation to EBM management of forests (Nordstrom et al. 2011), coastal zones (Oen et al. 2016), rangelands and pastoral ecosystems (Petursdottir et al. 2013, Ulvevadet & Hausner 2011), mountains (Filyushkina et al. 2016, Hahn et al. 2006, Overvag et al. 2016) and wetlands (Hahn et al. 2006).

Comparative studies

Comparative studies of different countries' approaches to EBM is a common methodology in many of the Nordic publications reviewed. They mostly cover West European countries and typically include the Nordic country of the author(s). The interest in comparison is justified both in gaining experience from different countries' implementation of EBM and in the need for compatibility in the case of cross-border ecosystems. Comparative studies are found in literature on both forests, marine areas freshwater/river basins (Jager et al. 2016), and coastal areas (Portman et al. 2012).

Ecosystem services

Increasingly, EBM has been viewed in the context of ecosystem services, the benefits people obtain from ecosystems. This is also evident in the Nordic EBM literature. Most of the literature on individual types of ecosystems deals with the importance of EBM for securing ecosystem services - implicitly or explicitly. Not surprisingly, this is especially true for urban ecosystems with some articles on considerations for ecosystem services in urban planning as referred to above.] Some articles address the ecosystem services approach in general. This includes how ecosystem services can be integrated into environmental impact assessments (Karjalainen et al. 2013), payments for ecosystem services (Matthies et al. 2016) and ecosystem services in legal terms (Prip 2018).

A part of the reviewed grey literature deals with valuation of ecosystem services including reports of expert panels commissioned by the Swedish and Norwegian governments respectively (NOU 2013:10 2013, SOU 2013:68 2013). Some literature addresses non-monetary ecosystem services (Filyushkina et al. 2016).

EBM as a general concept

Nordic literature on EBM, more specifically, is limited. The literature reviewed deals with the development of an analytical framework for EBM (Borgstrom et al. 2015) and EBM in a legal context (De Lucia 2018).

Sectoral approaches to EBM

Perceptions of, and responsibilities for EBM by the economic sectors utilising natural resources for production have received relatively little attention in the reviewed literature. The forestry sector has been addressed mainly through the literature on forest certification referred to above while a few articles address ecosystem-based fisheries management as also referred to above. Recently, Norwegian literature has addressed marine aquaculture in an EBM context (Fauchald 2020) including challenges in harmonising the WFD with the aquaculture legislation and management systems (Stokke & Indset 2012).

Agriculture is the subject of only one article reviewed (Velten et al. 2018), and no literature was found addressing the extraction industries.

5.5 Terms and conditions that have been identified as instrumental and as obstacles to establish effective EBM

Stakeholder involvement, trust building and buy-in, in particular from local stakeholders, is widely highlighted as an important element in EBM and with that institutional development that provides for such involvement (Franzen et al. 2015). Also highlighted in the literature is the value and necessity of a close working relationship between science, management and stakeholders (Gullestad et al. 2017). 'This calls for appropriate tools such as models to support management of technical and social aspects of different phases of the implementation (Jørgensen et al. 2008).

Trade-offs for coexistence of users in multiple use management of the same land/seascapes through political and institutional support, is considered to be an important factor for EBM (Horstkotte et al. 2016). For this, effective legal and institutional frameworks for spatial planning are seen as suitable tools both for larger ecosystems like the sea (Platjouw 2018) and smaller like ecosystems in urban areas (Kaczorowska et al. 2016).

Clear directions from the international instruments that have adopted EBM as a framework for natural resources management have also been highlighted as instrumental (Lindstad & Solberg 2010).

It follows that the lack of these conducive terms and conditions constitute barriers to EBM. More generally, Nordic literature, like the reviewed literature overall, touches upon fragmented sectoral government systems and the lack of 'whole-of government' approaches as a key obstacle (Sander 2018c). Management across spatial scales in combination with 'social scales' is seen as a particular challenge. 'A core problem of multi-scale coastal management is the difficulty in identifying adequate spatial scales for the management of natural resources that can coordinate both ecological knowledge and the management of social resource use practices. Indeed, ecological and social scales of management may be incompatible' (Bruckmeier 2014).

In a Norwegian context, economic interests of a big business sector and for society as a whole has been seen as a main obstacle for applying EBM to the aquaculture sector (Fauchald 2020).

5.6 Environmental quality indicators

Quality indicators or norms have been addressed mainly in the context of implementing the Water Framework Directive (WFD) where these constitute an essential element.

Besides, the 'traffic light' system for marine aquaculture in Norway has been addressed as a new type of quality norm system. In order to regulate growth in Norway's aquaculture industry a colour coding scheme – green, yellow and red - is used to identify regions whether expansion can take place using sea lice pressure on the farmed fish as an environmental indicator (Olausen 2018).

Commissioned by the Norwegian Ministry for Climate and Environment an Expert Committee issued a report with recommendations for a system for the determination of good ecological condition in both marine and terrestrial ecosystems based on indicators (Nybø & Evju 2017).

5.7 Key lessons

Nordic literature appears to be well represented in the overall picture of literature about EBM emphasizing that the Nordic countries have generally been strong supporters of this approach. This is particularly the case for Sweden and Norway with a large majority of EBM related literature compared to the other Nordic countries. Reflecting the natural characteristics of the Nordic countries, the primary focus of the literature is on forest, marine and freshwater/river basin ecosystems.

Nordic literature seems to have more focus on addressing practical experiences and the lessons learned of opportunities and constraints in the application of EBM and less on theory, models and analytical frameworks for EBM than the reviewed literature in general. Still, like EBM literature in general, the Nordic literature leaves an impression of countries being at very early stages of the transformative change that EBM represents. In this context, the EU WFD has been an important reference as a legal framework pursuing a clear but challenging paradigm shift towards EBM.

Nordic literature has a strong focus on local implementation with the participation of local stakeholders. Especially Norwegian literature also focusses on policy and governance from a national perspective. Also, Nordic literature reflects a development of EBM from focussing mainly on biodiversity and ecological integrity to ecosystem services. Especially in Norway and Sweden, research on ecosystem services have been addressed as holding potential for being a strong incentive for EBM.

6 Results III: Reviews and syntheses

6.1 Introduction

Around 200 of the publications identified in the quantitative search were labelled as reviews. However, the “reviews” range from a few systematic, quantitative syntheses, to assessment of legal texts and more qualitative assessments and research needs related to EBM. The relevance of the different “reviews” to this project therefore varies and we did not have resources to present a thorough, systematic assessment of all 200 “review” publications. Instead, we review the publications that we found most relevant to EBM and its objectives. Below, we present some key findings and recommendations from qualitatively selected publications, organised primarily by ecosystem type, but also under some more general headings.

6.2 Key findings from highlighted reviews

6.2.1 Forests

The forest review literature, as forest literature in general, is dominated by economic approaches, recently often applying the ecosystem services concept. The traditional forestry literature with its focus on timber production is gradually expanded to take into account also other services, including those not traded in regular markets. In a Norwegian context, this is also the ecosystem type where the use of private approaches has been most used, especially certification (Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification (PEFC), (Johansson et al. 2013)). However, as Filyushkina et al. (2016) points out, this expansion is so far primarily restricted to cultural services (typical recreation) and biodiversity. Less research has addressed regulating services, despite some of the international efforts to save rainforests addresses these services as well (however there is more international research on REDD+ and PES that has been omitted in this review, see Chapter 3). Nevertheless, there is little doubt that there is significant unclarity and/or disagreement regarding how different services should be priced.

Adhikari & Baral (2018) and Sayer & Collins (2012) review different forest governance models, labelled hierarchical, scientific-technical, adaptive-participatory and strategic approaches. The essence in these reviews is that no approach is superior to others, and that place-based adaptations generally are needed. This is due to differences in ownership, governance structures, forest ecology and not the least the continuous and growing dynamics inherent in forest ecosystems.

In a Nordic review, Johansson et al. (2013) contrasts two approaches to achieve EBM of boreal forests; conservation (understood as a mix of protected areas and maximised commercial use of non-protected areas) vs. sustainable use. It is concluded that both approaches have limitations. The study also concludes that combining FSC certification and Swedish forestry laws together is not sufficient to achieve existing objectives for the conservation of biodiversity in Swedish forests.

The economic/ecosystem services approaches often taken in EBM of forests highlight some challenges with the payment for ecosystem services-approach. These relate to some basic principles for any trade. First of all, the goods/service that is traded must be well defined. Secondly, the goods/service should be accountable (E.g.: Is the service delivered in full? When?). In a situation where one party pay another for a range of more or less well-defined and well-understood ecosystem services from a forest, such simple premises for trade agreements might be difficult to achieve. A good example of the challenges of implementing such PES mechanisms are the ambitious REDD+ programs, aiming to reduce deforestation in developing countries by internalizing climate-related, regulating ecosystem services from forests (Gupta & Haug 2013).

While we omit a detailed review of REDD+ research, some of the key challenges should be presented, as they are relevant for other PES initiatives. According to these agreements, developed countries should stimulate developing countries to achieve reduced deforestation, and if they succeed, they will be compensated economically. REDD+ was launched in 2008, but research suggests that success so far has been limited (Angelsen et al. 2017). Some identified reasons for lack of success include issues related to rights, and challenges in achieving social equality and distribution of compensation to those directly affected by, and involved in, forest management and use. These experiences highlight that such agreements come at a cost – that transaction costs are significant and often higher than expected and planned for in the first place. PES approaches hold potential to weight and balance different ecosystem services better, and also make decision processes more transparent (Brink 2011). As long as many ecosystem services are still produced and utilized in the absence of established market transactions, they tend to be underestimated or even ignored in decision-making processes with major impacts on ecosystems.

6.2.2 Freshwater/watersheds and research specifically addressing implementation of EU's water framework directive

In this project, a significant body of literature regarding ecosystem-based management of freshwater units and watersheds have been identified, especially research assessing several aspects of the implementation of EU WFD. This is also true for publications categorised as “reviews”. Since Norway also has transposed this directive (opposed to the habitat directive and other environmental directives), this body of research is also of special interest in this project.

The WFD has been regarded as 'the most ambitious and complex piece of legislation on environment ever enacted in the EU' and has been considered as a potential template and pilot for future environmental regulations in other ecosystem types (Prieto 2009, as cited in Voulvoulis et al. 2017). The Directive has a major objective in that all EU waters should reach “good ecological status” by 2015, not including those water bodies with legal exceptions. The framework is built around a set of indicators developed from biological, physio-chemical and hydro-morphological characteristics essential across different water bodies. The Directive also has ambitious objectives and demands regarding multi-disciplinary, transparency, public participation and social and economic sustainability. A keystone in WFD is the development of River basin management plans (RBMP), involving all relevant sectors. In short, the WFD can be considered one of the most ambitious efforts in establishing an EU-wide water legislation as well as achieving EBM in aquatic and coastal ecosystems.

Despite - or maybe because of - the major ambitions for the WFD, the implementation has been much slower and more demanding than expected, and there is a large body of research investigating many aspects of EBM, including some highly interesting reviews, also useful for the implementation of EBM in general.

Giakoumis & Voulvoulis (2018) conducted a thorough review of the policy implementation, as part of the formal review by the EU in 2019. They assessed the initial objectives, their interpretations, and summarised identified challenges and barriers against successful implementation of the WFD. They conclude that

“Findings reveal that different interpretations on the Directive’s objectives and exemptions left unresolved since its negotiation, ambiguity and compromises observed by its Common Implementation Strategy and lack of real support for the policy shift required have all been barriers to the harmonised transposition of the IRBM [Integrated river basin management] paradigm, the key to delivering good ecological status.”

Their review also collated identified implementation problems from EU's fourth (2015) implementation report of the WFD, which grouped a wide set of problems into five major areas; Monitoring

and assessment; Pressures; Integration of policies; Gap analysis and Exemptions. Under these headings a number of more detailed barriers to progress was identified, see Figure 10.

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Table 1 A summary of the implementation problems for the Member States based on the Fourth implementation report (European Commission 2015)

Implementation progress	Number of Member States (27 in total)
<i>Monitoring and assessment</i>	
• Gaps and delays in the implementation of monitoring and RBMPs	18
• Improve methodologies for status assessments	17
• Determine and finalise the reference conditions	8
• Revise, improve and make transparent the designation process of the heavily modified and artificial water bodies	10
<i>Pressures</i>	
• Improve pressure analysis	11
• Weak pressures and impacts analysis	14
• Establishing clear links between pressures and measures (improving the pressures and impact analysis for developing PoMs)	21
• Apportion pressures to relevant sources and sectors and drivers (including the need for quantitative methods)	15
<i>Integration of policies</i>	
• Need for better integration of other EU Directives and other legislative drivers in implementing the WFD	20
<i>Gap analysis</i>	
• Assess the gaps and effectiveness of basic measures	9
• Justify and set out clearly the need for supplementary measures	13
• Improved gap analysis to inform the PoMs for the achievement of objectives	23
• Providing more information regarding the scope of the measure (extent, cost of measures and expected impact on water bodies)	9
<i>Exemptions</i>	
• Improve the approaches in the application of exemptions in RBMPs	9
• Ensure that exemptions for not achieving objectives are adequately justified	20

Figure 10. A summary table of implementation problems for the WFD. From Giakoumis & Voulvoulis (2018).

In a slightly older work, Boef & Fritsch (2016) conducted a systematic quantitative review of research assessing the implementation of the WFD in Europe. Their analysis identified 89 articles, which were classified by year of publication, country of origin (author, case), scale, topic, disciplinary approach, method and theoretical approach. They found that the research is dominated by studies in the large countries of UK, Germany and Netherlands. Multidisciplinary, applied studies with poor theoretical foundation dominate. When classifying the studies thematically, they found a strong domination of studies of the participatory aspects and objectives, while many important themes were clearly understudied, especially policy integration [across sectors].

6.2.3 Wetlands and land/sea interfaces

Pittman & Armitage (2016) conducted a systematic review of 151 publications considering “governance of land-sea interface”. They make up the status for research on this wide theme, identified dominating governance approaches, look at how governance is conceptualised and identified challenges and successes. The existing research is dominated by studies from USA, Canada, UK and Australia. They identify three dominating approaches to governance; Integrated management; Ecosystem-based management and Conservation planning. They define EBM as clearly more ambitious than IM. They identify a range of challenges and label the main issues: Boundaries; Scale; Negotiating trade-offs; and; Incentives to sustainable use. They also identify some successes, especially how strong science-policy integration can make a difference in

achieving sustainable governance, and when functional fit exists between ecosystems and managerial system. They end their review by asking for more research into linkages between the social contexts where problems occur and functional ecological scales. Besides, they also call for the application of richer conceptual frameworks to study governance at such interfaces.

Velez, Garcia & Tenorio (2018) conducted a systematic review of global coastal wetland protection policies. They identified 259 publications which were thematically grouped in Development and impacts; Territory; Local populations; Governance; and Management. For the themes of this report, it is especially studies related to Governance and Management that are relevant. Literature on these themes is mostly from western countries, while the themes Development and Local populations are most common in developing countries. While they identify a growing number of studies concerning coastal wetland protection, the challenges are multiple, and partly vary between developed and developing countries. The paper has a rather grim conclusion:

“...that development policies are affecting coastal wetlands by promoting or allowing urban and economic activities to grow out of control; territorial planning is mismatched with ecological dynamics and influenced by economic interests; the government must build adaptation and a collaborative, multilevel, and decentralized system to achieve the integration of local population in decision-making” (p. 272).

In short, they point out that at a global scale, there is a long way to achieve ecosystem-based management of coastal wetlands.

6.2.4 Marine ecosystems

Marine ecosystems are those with the largest body of research covering aspects of EBM. Not surprisingly we have also identified a high number of reviews related to marine EBM. Generally, reviews of marine EBF can be differentiated into four subcategories along two variables:

- 1) Those dealing with international/transnational marine EBM, typically in marine ecosystems outside national jurisdictions, and those studying this within a nation’s territory, and;
- 2) Those dealing with EBM of marine fisheries and those dealing with cross-sectoral EBM. The international studies generally tend to take on a less stringent approach to EBM than the latter (Grip 2017).

Several review publications identify similar trends in the scientific literature on marine EBM:

- The body of literature has generally grown (Kelley & Sherman 2018, Sander 2018b).
- There is a dominance of fish and fishery related studies (Haas et al. 2019, Kelley & Sherman 2018).
- Research needs to move from the “What’s, why’s and when’s to the how’s” in implementing EBM (Link & Browman 2017).
- Some scholars also call for more studies of socio-economic aspects and ecosystem-services of marine EBM (Kelley & Sherman 2018).

While we do not have the capacity to assess all relevant reviews, there are some that we consider especially useful across the challenges of implementing EBM in all ecosystems deserves to be highlighted.

Engler (2015) did a very thorough review of “the ecosystem approach to oceans management”. She goes through relevant and competing concepts, implementation paradigms (space-based vs. Sectoral implementation), Indicators, ecosystem approach in international law including practical implementation at the regional level. She concludes that:

“...developments over the last 40 years have installed the ecosystem approach as a central, necessary and feasible paradigm...[and for]developing policy and research agendas and priorities. However, the jury is still out in relation to its capacity to influence human behavior through

direct management actions. Many factors concur to this limitation, but two stand out: the inadequacy of traditional regulatory frameworks and institutional arrangements to capture the complexity, uncertainty, and variability of ecosystems; and the reluctance of the international community to embrace a global, comprehensive, and substantive international obligation that effectively protects the ecological systems on which life on Earth depends.” (p. 288).

Grip (2017) conducted a review of international marine environmental governance aiming for EBM. He described three major scientific approaches to EBM; namely;

- Research programmes designed to improve our knowledge and understanding of the physical, chemical and biological processes that form the basis for maintenance and functioning of marine ecosystems, including social and economic developments and interactions with the atmosphere and the land;
- Monitoring and assessment programmes designed to monitor the status of the marine environment, including its resources and the changes taking place in the environment owing to natural and anthropogenic causes; and
- Management programmes designed to ensure the rational management and use of the seas and their resources.

He points out that most research so far has dealt with the two first bullet points. Also, he concludes rather grim on the last point regarding international oceans EBM that:

“However, the success has been limited. The weaknesses of international organizations depend fundamentally on problems at the national level. The international organizations are no stronger than their Contracting Parties allow them to be.” (p. 413).

Kelly, Ellis & Flannery (2018) conducted an analysis of research of “sustainable marine governance” by viewing it through the lenses of “transition management”. They used some of the most-cited publications on holistic, integrated marine management as the empirical basis for the review. This conceptual review takes a critical perspective and argues that the literature omit or lack empirical investigations of the key institutional and administrative barriers to succeed with more holistic, integrated and ecosystem-based marine governance efforts. Further, Kelly et al. (2018) identify the key institutional barriers as incumbency, path dependency and policy layering. The study ends with a recommendation that future studies should be theoretically stronger, utilising e.g. theories of change and transition to gain a better understanding of the challenges with implementing EBM.

6.2.5 Urban ecosystems

Most of the reviews on urban EBM focus on understanding and measuring ecosystem-services in urban and near-urban environments (O’Brien et al. 2017, Pulighe et al. 2016) and we do not go further into these.

However, Ordonez et al. (2019) recently published a systematic review of studies on the perspectives of municipal urban forestry managers. They found that the studies were dominated by North American cases, and that they tended to focus on operational and budgetary issues, and to some extent on coordination. They recommended that future studies should engage more with management processes.

6.2.6 Decision support systems and analytical frameworks

For different forms of integrated management, a decision-support system is often needed or at least useful, especially to weight different interests and concerns against each other. Decision Support Systems (DSS) are often understood as an interactive system, usually based on a computer system, that processes unstructured input data into structured data. Data from a DSS becomes information when it is relevant and utilised by decision makers. And not every DSS is

based on computer-systems. A DSS may also (using computerised systems or not) consider approaches of dealing with expert opinions, involve graphic presentation methods, and use of secondary data.

Several reviews summarize the application of decision-support systems in different forms of integrated management, including EBM. Much of these studies centre on different types of, and the application of, Multi-criteria decision analysis (MCDA), its technical and procedural improvements, across many ecosystems and jurisdictions. In general, there seem to be clear consensus that this is the most appropriate DSS approach (Acosta & Corral 2017, Estevez & Gelcich 2015, Uhde et al. 2015). It has the ability to combine different types of data and assessments (e.g. quantitative and qualitative, market- and non-market values, primary and secondary), and clearly foster transparency and participation. It also is highly suitable to combine with GIS or other spatial tools. It is worth noting that in Norway, MCDA has mostly received academic interest, and so far relatively little attention from decisionmakers for the eventual strict implementation in practical public administrative processes e.g. related to Impact assessments and cumulative impacts.

6.2.7 Environmental quality standards and indicators

Indicators, ecological or others, are relevant for several purposes in EBM. In general, they are used to provide a simplified overview of complex socio-ecological systems. They often relate to reference points (limits or targets) and can be instrumental to assess progress in different aspects of EMB, and towards achieving objectives on several different areas, not only regarding ecosystems or key species, but also socio-economic conditions and governance. A “good” indicator is often considered an indicator that relates to management objectives, is scientific valid, concrete, respond to management responses, and is cost-effective and easily understood (Engler 2015). Reference points relate to a baseline, often set against conditions in a previous time period, or in a comparable “control”-area. The setting (or selection of) a reference point is a highly critical task, and it is important to underline that it is “as much as a political process as it is a scientific one.” (Engler 2015 p. 306).

In general, there is a limited number of reviews assessing environmental quality indicators in EBM. However, some highly useful exemptions were found.

Engler’s (2015) excellent review goes through the many approaches and roles of indicators, but also the challenges and pitfalls. Ideally, assessment of indicators and reference points are placed within a context identifying pressures (e.g. harvest or pollution), states (change in e.g. occurrence of an indicator species) and responses (e.g. managerial actions to reduce pressure and improve state). The framework DPSIR (Drivers – Pressures – States – Impacts – Responses), that have expanded the pressure-state-response framework with Drivers and Impacts - is the analytic framework that seem to have received most academic interest in terms of a framework that is useful to understand challenges for sustainable management of ecosystems and natural resources (Gari et al. 2015, Patricio et al. 2016) and in which indicators and reference points best can be placed. Even if indicators can assess all elements in complex systems, e.g. within the DPSIR framework, most indicators assess ecosystem states (Nybø & Evju 2017). Ecological indicators can be simple, typical indicator species, or more complex ones, e.g. assessing diversity measures, productivity, trophic structure and physiochemical factors.

Several authors have stressed the challenges of linking the state(s) of ecosystems as measured through indicators, and management or policy measures. In this vein, some scholars to distinguish between types of indicators. One simple way is to separate between state indicators and management indicators. The state indicator give information on the overall condition, also factors that managers cannot control, while management indicators reflect indicators that humans can have at least some control over. Related to this, another classification talks about conceptual, legitimizing and instrumental indicators. The first two types mostly have a role in raising awareness and affecting policy development and research agendas, while the latter – instrumental

indicators – can have a direct relationship with specific policy- or management action, it works as a control rule. Some reviews suggest that very few are used instrumentally (Bell et al. 2012 & de Sherbinin et al. 2013, as cited in Engler 2015).

Along these lines, in a very thorough and sobering review, evaluating EU's WFD, Wuijts et al. (2018) highlight how the meeting of three different scholarly traditions, namely ecology, social and economic sciences and law, governance and decision-making differs, in a way that challenges linkages (causal) between governance measures and water quality. They highlight that while ecology looks upon water quality as something complex, demanding and uncertain, social and economic research tend to focus on processes, while law is concerned with stability and predictability, and that these differences challenges the setting of ecological objectives. They conclude that WFD research so far have focused more on planning as opposed to implementation, and that there is a striking lack of research investigating if policies and measures affect (improve) the ecological status (e.g. water quality, biodiversity) as expected. They also recommend that existing frameworks used to analyse good water governance should be improved by "connecting the individual elements to the contribution they each make to water quality improvement, in a preferably (semi) quantitative way.."(p. 13).

Samhuri et al. (2012) also discussed EBM and the development of meaningful indicators to link ecological status/states with management goals and measures. They underline that:

"A fundamental challenge with assessing ocean health and ecosystem services is that we lack a scientific framework for expressing ecosystem conditions quantitatively in relation to management goals."

They discuss the use of different approaches to identify indicators and reference conditions and the problems associated with how to measure distances between current states and reference conditions² (objectives). Based on this, Samhuri et al. (2012) argue against reference point-based objectives resulting from negotiated processes, and instead recommend objectives set by transparent science-based framework processes.

We also identified other papers that raised concern over linkages between observed states, defined reference points in the environment and policies and measures (Rossberg et al. 2017). Rhetoric questions such as "Can this measure reasonably well affect the monitored state?" and "What other factors and drivers can affect the indicator and eventually blur, overshadow or exceed the effect of the measure?" can be examples of such concerns. However, it is important to note different types of indicators and their varying roles in the development of (more) EBM-oriented governance.

6.2.8 Other relevant review studies

A relative recent and very substantial review investigates and reviews literature dealing with "the relationship between adaptive management of social-ecological systems and law" (Frohlich et al. 2018). Since adaptive management is a key aspect of how we have defined EBM, and that legal approaches is also important in this study, this systematic review deserves cautious attention.

The outset for the review is the fact that adaptive management is considered "valuable" for successful management of dynamic and complex socio-ecological systems. The authors then point to findings that failure of implementing adaptive management might relate to the "conservative"

² Some differences also exist in how the term "reference condition" is used, adding further to the confusion about interpretation of key terminology. See Nybø & Evju (2017) p. 177 for a discussion of the different meaning and use of "reference condition" in EU's WF and MSF Directives.

structures embedded in institutions, norms and regulations and social values. Specifically, the authors argue that there is a need to study more closely the impacts of legal frameworks on adaptive management implementation.

Their quantitative search in Scopus combining Adaptive management AND law OR legal OR legislation resulted in a total of 327 publications. After screening and closer examination these were reduced to 80 publications considered relevant. They found that the body of relevant literature grew steadily during the period 2006 – 2016. The law values that could hinder design and implementation of adaptive management were Stationarity; Certainty and Finality. Stationarity was defined as objectives aiming to protect status quo (e.g. through restoration back to former situations) instead of adaptation and resilience. Examples of stationarity was identified in environmental laws from Australia, South Africa and USA. Certainty reflects the tendency to make decisions at the start of a process building on the assumption that all environmental and social consequences could be predicted. This tendency also relates to finality; that authorities from the start do all they can to justify their decisions, to avoid reopening of decisions made. Finality can be seen as a principal conflict between law and empirical science. As such, finality actively oppose the iterative and flexible nature needed in adaptive management.

The paper ends with a discussion of ways law better can accommodate the needs embedded in complex social-ecological systems, e.g. through legislative standards for adaptive management and flexibility. More concrete approaches could include systematic review mechanisms, enhanced public participation and multi-jurisdictional arrangements.

Roillard et al. (2018) assessed to what extent the major EU environmental directives (WFD, MFSD, Birds and Habitat Directive) support major policy-principles for EBM. The policy relevant principles identified were:

- that EBM should take into account ecological integrity and the full set of ecosystem services; that they operate at the right scale, apply transdisciplinary and varied knowledge;
- involve stakeholders and is transparent; support cross-sectoral and cross-scale/level coordination; and
- implement adaptive management.

In general, they find that the Directives are in line with, and support the main principles. However, a range of obstacles and challenges in the Directives were identified. These were;

- Lack of guidance for how to handle sectorial conflicts
- Rules for exemptions were unclear
- Weak guidelines for implementation of local knowledge
- Weak on how to handle challenges over time (what timespans are relevant for goal formulations) and space

Morrison et al. (2017) conducted a conceptual review of the role of power in so-called polycentric systems. Polycentric systems, defined as cooperation among multiple autonomous actors and decisionmakers at different scales, can be both a consequence of, and a measure supporting efforts aiming to achieve more ecosystem-based governance, and is considered as a promising governance approach to better combat global environmental and climate change. They define polycentrism as a model of governance that actively steers local, regional, national, and international actors and instigates learning from experience across multiple actors, levels of decision-making, and temporal scales. It is considered as a promising approach to reach common objectives through cooperation and conflict resolution. Yet, recent critiques have highlighted several inherent contradictions and limitations of polycentrism, pointing to the role that power may play in undermining the potential advantages of polycentrism over other forms of governance. Highlighting how three specific elements of power—power by design, pragmatic power, and framing power—imbue different levels of actors and arrangements with the authority to realize collective goals in polycentric governance systems, the authors stresses a number of challenges and research needs. First, they find that it is important to be clear and specific on what makes polycentric governance distinctive, and to identify how embedded and prevalent it is in all governance

structures. Second, they argue that it can be useful to track how power dynamics within polycentric governance systems change over time. They end by stating that “the heart of this scientific debate is the issue of whether interactions between different actors in polycentric systems actually improve the prospects of dealing with the dilemmas of climate change.” (p. 12).

6.3 Summary

Overall, several review studies are highly useful in giving overview of the state of the art on EBM in different ecosystems. Firstly, the systematic quantitative reviews are generally in agreement on what is dominating research. Secondly, several of the reviews are highly useful in providing input to future research, both in terms of topics that are under-researched, but also highlights the need for theoretical foundations to achieve more valid understandings of the challenges related to successful implementation of EBM.

7 Results IV: Research addressing institutional change and policy integration: time to join-up government

7.1 Introduction

In chapter 4 and the quantitative mapping, we identified relatively few publications that actually studied decision-making processes, economic aspects such as budgeting and tax/compensation systems, and measures implementation – the stage of the EBM process where operational measures are to be executed. Looking into different studies addressing aspects of institutional adaptation and cross-sectoral policy integration, the evidence clearly points in the same direction.

A main finding in the reviewed research literature is that obstacles and shortcomings in existing political-administrative systems in terms of fragmentation effects and coordination challenges, are more than well-documented (Huiteima et al. 2009, Morrison et al. 2017, Newig et al. 2016: 1010). Fragmentation denotes the degree to which tasks, mandates, capacity and/or decision-making authority are separated across institutional divides, instead of gathered in the same organizational unit (Egeberg 2012, Egeberg 2016). Western public administrations are advanced and highly specialized polycentric systems, with capacity of effectively solving its own, demarcated problems. The main problem of high system specialization in relation to EBM is fragmented jurisdictional interests with policy goals that undermine each other. If system specialization is not compensated for by sufficient coordination mechanisms, specialization is centrifugal, causing further fragmentation in public administration (Bouckaert et al. 2010).

About 25 percent of the publications in the current review identify fragmented governance structures at and across administrative levels as a significant barrier against sectoral policy integration and the achievement of EBM (see for instance Alexander & Haward 2019, Bouma 2015, Morrison et al. 2017, Nanda et al. 2018).

7.2 Fragmented governance structures

Bouma (2015) finds a range of local ecosystem governance approaches that have emerged because of the failure of hierarchical public approaches to effectively manage and govern ecosystems. He sees decentralization to the local or community level as a necessary precondition, since local institutional arrangements have proven efficient in controlling free-riding behaviour and defection. Also, trust is fostered in smaller systems, which in turn has a positive effect on finding operative solutions to sustainable resource use. Hence, local agreements, followed by the development of institutional arrangements to control free-rider behaviour is essential.

A comparative analysis of the performance of specific mechanisms used to support integrated coastal zone management in eight countries (Belgium, India, Israel, Italy, Portugal, Sweden, UK, and Vietnam) illuminate how each mechanism hold differing comparative advantages and enhance specific types of integration more effectively than others (Portman et al. 2012). For instance, environmental impact assessments enhance integration between science and policy and can be useful to integrate knowledge across sectors (Portman et al. 2012). Planning hierarchies and regulatory commissions are effective mechanisms to integrate policies across government levels, with the latter also promoting public–government integration. Regulatory commissions are forums mandated by law or regulation, dedicated to integrated decision-making. They consist of representatives of government departments, agencies including local and regional authorities, and other experts working together in a collaborative and participatory process for the purpose of adopting decisions about coastal management. However, only three of the countries had regulatory commissions (UK, India, and Israel). Regulatory commissions are forums mandated by law or regulation, dedicated to integrated decision-making. They consist of representatives of government departments, agencies including local and regional authorities, and other experts

working together in a collaborative and participatory process for the purpose of adopting decisions about development, or the management of activities along the coast. However, the implementation of specific mechanisms is conditioned by differing planning systems, governance, cultures and historical trajectories, and these differences are multiplied by each state with their unique and varied coastal environments and eco-systems.

Another case study on urban governance in Rotterdam found that a digital planning tool that linked datasets was important in providing new insights and to advance integrated planning (Tillie & van der Heijden 2016). Studying wetland management in Perth, Australia which had undergone a marked reduction in water depth through time associated with climate change and urban development, Nanda et al. (2018) investigated how mismatches and barriers against EBM could be overcome. However, they found no easy fix: Short term decisions were preferred, long-term decisions required substantial reform of the institutional framework and multilevel collaboration to enable the implementation of adaptive management. There was a need for alignment of decision pathways between jurisdictional, institutional and ecosystem scales: Consensus, plan formulation and negotiation across institutional levels was required. In a survey and case studies of 8 German municipalities, all identify scattered responsibilities as a challenge and obstacle in the integration of EBM in municipal planning (Wamsler 2015). The same study finds that cities having managed to integrate cross-cutting issues such as environment and climate change mitigation in the past were more likely to have progressed in EBM, this is a finding that speaks to the above mentioned role of institutional context and trajectory.

Artioli et al. (2017) argue that forms of urban integrated management are flourishing, but with uneven effects in terms of reversed fragmentation. Efforts to counterbalance fragmentation must take place within the uneven power structures that drove the fragmentation in the first instance. In research on marine ecosystems, Pittman (2016) finds that structures that seek to align differing dimensions, such as bioregional, political-administrative etc., have contributed to expand collaborative capacities. Collaborative and network governance across the land-sea interface are emerging as specific modes of governance, which may be potentially useful in enhancing social-ecological fit (Pittman & Armitage 2016, Sandstrom et al. 2014). Additionally, boundary-spanning organizations or governance organizations that seek to reduce fragmentation through strategic collaborations can be particularly useful to improve the capacity of governance to deal with social and ecological problems in EBM (Berdej & Armitage 2016, Fischer 2015, O'Mahony & Bechky 2008).

7.3 Challenges at the EU level

The fragmentation of political-administrative systems is evident, not only within national systems but also at EU level and through regional Sea Conventions. Raakjaer et al. (2014) describes how the implementation of EBM at the regional sea level is characterized by a highly fragmented European governance system, where there is lack of coordination within the European Commission, between EU, international organisations, regional sea Conventions and the member states. The sectoral governance arrangements at the differing levels should provide measures supporting EBM (Raakjaer et al. 2014). The article develops suggestions for a nested governance system and institutional interaction. The term institutional interaction can be seen as the influence of one institution on the development and effectiveness of another. Two or more institutions may affect each other to a similar extent, or one institution may affect the other(s) but not vice-versa. Institutional interaction can have positive effects when it leads to synergies, or negative effects when it leads to disruption and fragmentation between the institutions. There is a need to reduce institutional ambiguity. Instead, interactions should be regionalised in the sense of developing a nested governance system at the level of the regional sea. The analysis of the governance situation in the four regional seas shows similarities across seas and sectors in the lack of synergetic institutional interaction between the coordinating parties. According to the article, the way forward is to foster specific forms of institutional networking and interaction for each of the regional seas to secure better policy coordination (Raakjaer et al. 2014).

7.4 Lack of proper institutional design

The challenge remains that there is no blueprint for effective institutional design. The second challenge applies to the decision-making role of specialized and powerful national regulatory agencies, keen on maintaining their political position in the system. They are often found to act as obstacles in management reforms, explaining why they often become weak. For instance, an evaluation of the Norwegian administrative reform of the aquaculture sector showed that it implied a very limited de facto transfer of decision-making authority, which can be described as the mere delegation of administrative tasks (Sandersen & Kvalvik 2014). The decision-making power of the specialized national agency remained largely unchanged and there is only a very limited degree of regional autonomy. Adding to this (Indset & Stokke 2015), found that efforts to harmonize decision-support systems were blocked already during the characterization and classification phase when implementing the WFD in Norway. This rather effectively hampered the identification of appropriate measures to improve ecosystems. The reluctance of reorganizing decision-making authority has seriously limited the spread and effectiveness of EBM approaches, which indicates an important future avenue for research.

7.5 Improvement through better involvement?

Not everything, however, is in the black. Steenberg et al. (2019) describe novelties of EBM in urban areas. The Edmonton (Canada) tree mapping project shows the importance of novel sources of data and technology, where open data, open government and crowd sourcing are ingredients. Local governments are making data regarding trees collected and used publicly available without restriction. In Edmonton, the initiative has measured and mapped over 260 000 trees on public and private property that can ultimately provide a more complete municipal tree inventory and educate and engage the public in urban forest stewardship. Such crowdsourcing have some concerns over the quality of the data collected by citizen volunteers that may not have the skills and training (e.g., species identification, risk assessment). However, such programmes are typically not replacing expert practitioners' own mapping but supplementing them. Moreover, there are educational and empowerment benefits for the participating citizens and community groups. Another project dealt with the implementation of an urban forest master plan (UFMP) in Halifax, Canada. The UFMP was initiated with a study of baseline urban forest conditions in 2007. It included a number of public and expert consultations to elicit a comprehensive list of values people associated with urban trees and forests, which were then each connected to management objectives and targets, along with indicators for future monitoring initiatives. The UFMP also included the development of a neighbourhood-scale approach to plan implementation that was preceded by a detailed neighbourhood-level assessment of current conditions and management needs. This process is based on the need for partnerships and civic engagement, especially for managing trees and forests across ownership types. The second case is the City of Toronto's prescribed burn program. The justification for the program is the maintenance of the regionally threatened black-oak in city parks heavily used by city residents and surrounded by older residential neighbourhoods. The parks are classified as Environmentally Significant Areas by the City. While urban development is no longer a major threat for these three parks, the loss of ecosystem structure and function in black-oak savannahs due to fire suppression, grass maintenance, and invasive species is an ongoing problem. Thus, annual prescribed burns have been implemented to restore and maintain the black-oak savannah ecosystems (Dinh et al. 2015, Foster & Sandberg 2004). These initiatives illustrate the importance of integrating EBM in cities, as urban forests are crucial to the long-term health and resilience of urban landscapes (Steenberg et al. 2019).

In summary, there is a clear need for critical studies and monitoring studies addressing the (lack of) improvement and change of decision-making processes in sectoral policy integration. The form, role and impact of both institutional and regulatory reforms can be a starting point for the evaluation of EBM interventions.

8 Discussion

8.1 General summary

Ecosystem-based management and governance (EBM) is an ambiguous concept. Yet, as verified in this report, there is growing agreement on its meaning and content. A total of 1071 relevant publications were identified and included in a quantitative analysis. From the Nordic countries, 122 publications were identified. Internationally, studies of marine and coastal ecosystems dominated strongly, but also studies of freshwater ecosystems are frequent. Least common were studies of mountain and alpine ecosystems. Studies from USA, Canada, Australia and the large European countries dominate. A relatively limited number of scientific journals publish a significant share of the relevant papers, but this varies between ecosystems. The most common approach is case studies at the regional scale.

It should be stressed that these conclusions and percentages are not to be understood as an unambiguous overview and representation of all existing research on EBM, but that these are conclusions based on the methodology chosen and the processes conducted for screening and sorting, with its benefits and shortcomings.

Research on the Knowledge basis, Participatory approaches and Planning are dominating while fewer studies assess implementation of and consequences of EBM. The studies identified deals with cross-sectoral and intra-sectoral approaches to EBM. This study echoes other reviews that call for more implementation studies to supplement the large body of knowledge-supporting studies and studies providing diagnoses of differing anthropogenic pressures on ecosystems.

In the Nordic countries, Swedish and Norwegian studies dominate, reflecting ecosystem types of core importance in each country, with forest studies in Sweden and marine and coastal studies in Norway being most common. Studies of aspects of the Water Framework Directive (WFD) are found in all Nordic countries to whom the Directive applies.

Review studies are highly useful in giving overview of the state of the art on EBM in different ecosystems and for outlining research needs. They also underline the need for theoretical foundations to achieve more valid understandings of the challenges related to successful decision-making and implementation of EBM.

8.2 The seven research questions

The project formulated seven specific research questions to aid the overall objective for this assessment of EBM

8.2.1 Which aspects of EBM have been subject to research, which have a significant volume and which have not?

The quantitative mapping of 1071 publications in chapter 4 displays a growing volume of research on EBM in the period from 2005 to May-2019. The increase is rather steady and the number of publications triples by 2018. The general pattern is that studies of EBM are linked to specific ecosystems: either marine, coastal, freshwater, wetlands, forest, rangeland, mountain or urban. Thus, ecosystem-oriented social science journals figure high as the most applied academic journals. Marine policy, Ocean and coastal management, Ecology and society, Environmental management, Forest policy and economics, Environmental science & policy and Ices Journal of Marine Science are examples of journals with high publication rates on EBM. The

more general public administration journals like *Public administration*, *Journal of public administration and management*, *Regulation and governance* and *Journal of European public policy* are represented, but with only a few articles.

Looking into ecosystem types, research on marine ecosystems displays the highest volume, about 36%. It is followed by freshwater (ca. 22%) and coastal ecosystems (15%). However, publication rates on marine ecosystems drop and level out from 2014. Publications on forest, wetland and freshwater ecosystems increase rather steadily throughout the period. Research on urban, rangeland and mountain ecosystems display the lowest publication rates. Arguably, the gap between the relatively limited research on EBM within urban ecosystems (5%), and the high impact that urban areas have on their ecosystems, is puzzling. It may point towards further research need. Whereas about 64% of the publications deal with water (marine, coastal and freshwater), research on terrestrial ecosystems is lagging. Although forest ecosystems are relatively well studied, figuring fourth of the ecosystem types related to EBM, the limited number of publications on wetlands is puzzling (about 3-4%), owing to wetlands' important function as carbon storages. Given the high focus on planning studies, wetlands could have been expected to attract higher research interest. In general, an increased pressure on land-use planning would indicate more research on all terrestrial eco-systems, both urban, mountain, rangelands as well as wetlands. Thus, the current mapping indicates an imbalance in the research on ecosystem types.

An overall impression is that the "mainstream" EBM publication comprises the regional scale, planning or procedures related to the knowledge phase, or ecosystem services. Western European countries with long coast lines tend to be studied over eastern or central European countries. Publications on EBM are characterized by a focus on procedural, rather than substantive, policy processes. In procedural approaches, work is organized and mandated according to specific work procedures, tasks and methods. Alternatively, when delineating management according to substantive quality outcomes, work is evaluated against particular standards and objectives, for instance fixed emissions to be obtained. Typical for EBM is that substantive targets are not fixed, but something that materialize during the knowledge gathering phases. This probably explains the high volume of publications addressing the knowledge phase related to issues such as ecosystem characterization and classification, cumulative impacts and impact assessments, knowledge-based decision support systems, etc. The current mapping also reveals that a high share of publications address planning issues and ecosystem services.

Simultaneously, there are some processes that appear as somewhat under-studied. Decision-making processes, measures implementation and budgeting have generated low publication rates, and are issues that deserve further attention.

The Norwegian Nature Diversity Act, with its cross-sectoral application, and principle on cumulative impacts and the ecosystem approach, has been an important step forward in the operationalization of EBM in Norway (Backer 2010). In practice, however, decisions may not appear sufficiently ecosystem-based yet (Jakobsen and Henriksen 2012). More research is needed on how to foster the implementation of EBM through the Nature Diversity Act.

8.2.2 Operationalization of EBM: Which terms and conditions have been identified as instrumental to establish effective EMB?

In our sample, topics related to characterization and classification of environmental and ecological status, methods for assessing cumulative impacts, impact assessments, validation of ecosystem services, etc., are fairly well documented, and found to provide fruitful tools for EBM. A bulk of studies concern how to apply and convert science-based knowledge into management procedures and Decision Support systems (DSS). There seems to be an expanding toolbox available and ready for application .

The research literature has also illuminated how this science-knowledge-management interface is included into legislative frameworks, for instance the WFD and the Marine Strategy Framework Directive (MSFD). It involves a formalization and obligation of scientific work processes as administrative procedures. Also, collaborative planning processes and stakeholder involvement are increasingly included into the tool-box of EBM. Several scholars, inter alia Howarth (2009), refer to this development as proceduralisation: “the use of mechanisms that require public administration to follow specified procedures, whilst not necessarily guaranteeing particular environmental quality outcomes” (Howarth 2009: 394).

Further, the literature devotes attention towards governance networks. As a base-line, the focus is optimistic: networks are seen as well-suited arrangements that address polycentric and bioregional problems, which are often beyond the capacity of individual organizations. Networks may serve as collaborative structures that unite stakeholders into both formal and informal arrangements. Further, networks can operate across multiple jurisdictions and geographies (i.e., be multi-scalar), have many centres of authority, and comprise local to national stakeholders and institutions. Finally, networks offer opportunities for communication and collaboration without the need for costly new organizations. Thus, they facilitate flows of information, and fulfil functions necessary for dealing with cross-boundary issues that traditional ownership-focused organizations cannot solve (Fischer 2018). However, there are obstacles in network managements related to their layered and informal character, without binding arrangements.

The non-binding character also applies to administrative procedures. In his study of the EU WFD, Howarth (2009) finds a mismatch between the level of ambition of the management procedures and the level of discretion granted to member states in implementation. This will risk undermining the achievements of the directive.

Similar findings are revealed in a comprehensive evaluation of the Norwegian Planning and Building act. The screening conducted in this project has identified significant research on planning and participation along regional scales. There seems to be a move in the legal text towards rather operative local and regional planning processes, and a range of planning tools are developed to handle today’s challenges related to the climate and biological diversity. Still, the soft and non-binding character of these tools appears unsatisfactory. Regional level planning is supposed to serve as a node of coordination between scales and levels, conflict of interests and sectoral policy goals across institutional divides. The available soft tools, however, do not sufficiently bind the differing actors to “the mast” of decision-making. If physical, regional planning is to serve as an efficient instrument in societal planning, tools need to be developed with a more binding character (Hanssen & Aarsæther 2018).

8.2.3 Which key obstacles and barriers against the implementation of EBM have been identified in existing research?

Let us start with two basic arguments derived from the general public administration literature. Firstly, institutions often change in subtle and gradual ways over time. Although not so dramatic, slow and piecemeal changes can be equally consequential for shaping substantive political outcomes (Mahoney & Thelen 2010). Secondly, national political-administrative systems serve as trajectories framing policy change and adaptation. Path dependencies, long-standing norms and doctrines, views on appropriate behaviour and power-constellations are institutional variables that should be included into the analysis (March & Olsen 1989). These factors causing inertia, are widely acknowledged basic premises for political-administrative behaviour. However, there is a tendency in the current sample of literature to fall back on a one-sided focus on active agency. Without integrating the continuous, slow and incremental variables, there is a risk that public administration research and EBM research will remain two distinct literatures.

These insights have a significant bearing on how the science-policy interface should be studied. In the screened literature, there is a call for more effective integration of science and decision-making. However, as mentioned above, studies tend to treat these issues as an instrumental act of integrating decision-support systems into decision-making processes (Yousefpour et al. 2012). Integrating science into decision-making processes may represent one of the most difficult challenges of public administration in general and environmental management in particular. The topics that are fairly well studied in our assessment, the processes of knowledge gathering and monitoring: inter-calibrated methods in ecosystem characterization and classification, methods for assessing cumulative impacts, validation of ecosystem services, etc., are found to provide effective means towards EBM, but not necessarily implementation in decision-making. Simultaneously, there is need for more critical research on how such administrative procedures end up being practiced within differing institutional contexts, and how national public administrations impact on the practices.

For instance, a key point is that formal coordination structures of public organizations do not only change to improve functional efficiency, but also because they follow political doctrines and norms, power relations etc. (Behnken et al. 2016, Wenzel 2016). Within these systems, the role of path dependent behaviour, administrative norms and logics of appropriateness should be taken into account in order to further understand how EBM decision-making processes unfold and measures are agreed and implemented (Indset 2018). These variables are not sufficiently illuminated in the existing sample of publications. In other words, there is a need for more research on the interactive relationship between structure and agency in EBM. This is confirmed, for instance by Kelly et al. (2018), pointing out that while integrated management approaches have a normative capacity to fundamentally transform marine governance, the failure to understand the institutional dynamics that may impede effective implementation, leaves much of the research in this field naively impotent (Kelly et al. 2018). Liu et al. (2008) argue that a fruitful approach is to start with elaborating and understanding the decision context and the key political questions of interest. In this, the institutional setting and division of responsibilities are important.

A second and related obstacle is organization. This study illuminates how the existing sample of research is rather conclusive concerning the need for institutional reform. It is widely acknowledged in the literature that EBM requires coherent action towards the whole of the ecosystem, which has put cross-sectoral policy integration as well as horizontal and vertical co-ordination on the research agenda. Whereas current public administrations are often characterized by specialization and organization by the purpose (sector) principle such as energy, agriculture or transport (Gulick 1937), ecosystem based management and governance rests on spatial or geographical organization principles such as the river basin, the habitat or the forest. EBM may also be fostered through process organization, i.e. aligning work according to a specific work process such as planning, legal procedures or budgeting (Gulick 1937). Thus, current public administrative systems are pre-dominantly set up according to sectoral mandates and responsibilities. The sector-organization is identified as a coordination problem and obstacle for adaptive governance and coordination across sectoral policies. Pre-existing organizational set-ups, and fragmented law and governance arrangements, do not accommodate well for the coordination requirements of EBM. This is pointed out in a range of publications. (See for instance Indset 2018, Mitchell et al. 2015, Raakjaer et al. 2014, Soderberg 2016, Wenzel 2016, Platjouw 2016).

Moreover, there are shortcomings in the research about the implementation of measures. How and why measures are identified and their impacts on the environment, need to be better studied. While several publications end with recommending expert-based processes, the reasons why such solutions are not selected – which obstacles and solutions that explain the lack of implementation – are not thoroughly dealt with. Further, there is a need to critically test and study the apparent paradox that inclusive and participatory processes are able to define long-term ecosystem goals and objectives in a way that would reflect a greater concern for the diversity of ecosystem processes that sustain life and well-being. This proposition seems largely untested, especially when linked to decision-making and measures implementation at the national level (Layzer 2012 as cited in Engler 2015: 294).

8.2.4 Centralised or sectorial responsibility for EBM: To what extent can research identify which organizational models work or not?

A recurrent argument in the literature is that there is no one-size-fits all. While there is limited exact knowledge and specific findings, EBM needs to be critically studied within the specific political-administrative context. Morrison et al. (2017) highlight the importance of examining power dynamics in polycentric systems, including how power asymmetries differ and may affect EBM differently across settings.

For EBM to work, some degree of centralized authority and enforcement seems to be essential. For instance, having compared Canadian and Norwegian marine management plans, Sander (2018c) finds that different national policy styles and leadership affected implementation. While the Norwegian government led the process in a top-down manner and tried to apply a “whole-of-government” approach, the Canadian government delegated the responsibility to regional branches. The Norwegian political leadership also negotiated compromises in the form of package deals, while in Canada there was a reliance on collaborative planning based on consensus which lead to problems of implementation. On this basis, Sander (Sander 2018a) questions whether and how collaborative consensus-based planning may avoid pitfalls.

However, in the implementation of the WFD, the Norwegian government has taken another approach, relying on consensus-based processes and management through their silo-organized ministries with their underlying agencies. Dilemmas have been decentralized to regional governance levels and weak, networked structures which have not been able to solve conflicts (Hanssen et al. 2017, Hovik & Hanssen 2015, Indset 2018, Indset & Stokke 2015). Here, the role of the EU-level in terms of the European Commission and the EFTA Surveillance Authority, have been central for driving domestic implementation.

These findings suggest that EBM is not only context-specific, but also policy specific. Organisation is not everything, political power and legal frameworks are also very important. It has been argued, for instance, that fragmented structures of environmental law and governance, and the idea of environmental policy integration, could weaken protection of the environment and ecosystems (Bugge 2010). Decisions affecting ecosystem functioning are made under various legal and administrative frames. This makes it difficult to coordinate courses of action and ensure the maintenance of the integrity of the ecosystem as a whole (Platjouw 2016). Legal instruments differ in their geographical application and substantive scope, and public officials often have been assigned particular mandates within the frame of the applicable legislation. More research is needed on the implications of centralized and sectorial responsibility for EBM.

8.2.5 To what extent has environmental quality standards (indicators) been implemented in EBM and to what extent can research assess its effectiveness in an EBM context?

Indicators have been used both to monitor ecosystem states, but also drivers, stressors, governance and social and economic conditions as well. As Engler (2015) points out, indicators can play different roles in EBM, and she highlights several interesting distinctions: between procedural and substantive indicators; between [ecological] state and management indicators; and between conceptual, legitimizing and instrumental indicators. Procedural indicators monitor e.g. participation, decentralization, while state indicators say something about the ecosystem. Management indicators suggest that they monitor ecological states resulting from management actions or measures and is synonymous with what other scholars label instrumental indicators.

In an EBM context, indicators have been implemented in the WFD framework, in which it is also tied to legal and administrative structures of water and aquatic ecosystem management and governance.

The research points out that “good indicators” – indicators that are cost-effective, sensitive to management and easy to understand, are challenging to develop (Engler 2015, Samhuri et al. 2012, Wuijts et al. 2018). Several scholars specifically points out the importance of developing ecological state indicators that are management sensitive, but it is very challenging and rather seldomly done. Wuijts et al. (2018) and Samhuri et al. (2012) provide rather harsh critique of such non-instrumental indicators. However, again as Engler (2015) points out, conceptual and legitimizing indicators can also play an important role in EBM, if not in an instrumental way to steer and evaluate adaptive management directly. Instead they are useful to understand the complex systems surrounding human impacts on ecosystems and in raising awareness towards decisionmakers about ecological problems. An example of the development of an indicator in Norway that is not an ecosystem indicator in full, but rather based in indicator species is the so called “traffic-light system” to regulate growth in salmon aquaculture. Monitoring of sea lice infestation on wild salmonids and assessment of added mortality, legally anchored in specific regulations in the fish farming act, form the basis for political decisions for growth, stability or reduction. While an interesting and potentially promising approach, the framework is also an example of the mixing of science and stakeholder compromises, not always resulting in good indicators (Samhuri et al. 2012).

More research is needed to develop “good” and “instrumental” indicators, including indicators that link ecosystem states, management and governance initiatives, and socioeconomic states and outcomes (Engler 2015). Further work on indicators would benefit much from clarifying what type to be developed, confer the typologies presented in the first paragraph.

8.2.6 To what extent have operationalization of cumulative impacts been part of implementation of EBM?

Most of the literature we identified dealing with cumulative impacts, focused on understanding mechanisms behind how different stressors worked together, and it identified knowledge needs in this area. This research is highly dominated by natural sciences studies of consequences of multiple stressors, often on marine ecosystems or species, including issues like non-linear responses and non-additive responses. The strong natural scientific approach is also reflected in the portfolio of the Norwegian Research Council on the topic of cumulative impacts (Norwegian Research Council, 2017).

In a managerial context, cumulative impacts, in principle and (hopefully) in practice, will sometimes be addressed in approaches applying ecological indicators or environmental quality standards (8.2.5). The review by Halpern, B.S., & Fujita, R. (2013) is nevertheless useful and gives a comprehensive overview of applied research in marine cumulative impact assessments, including research needs. They point to cumulative impact mapping as a practical approach to management of cumulative impacts across sectors and types of impacts, e.g. combining impacts from harvest, pollution and habitat loss. The article also points to threshold and cumulative impact caps (a type of indicator) as meaningful ways to apply in cross sectoral management. More research might be needed though, also on the assessment of cumulative impacts in the context of environmental impact assessments and the consideration of cumulative impacts in decision-making processes.

It should be underlined that from a methodological view, better publication searches targeting studies implementing cumulative impact assessments in management and governance should be conducted.

8.2.7 What differences can be identified between the implementation of EBM in Denmark, Sweden and Norway and how do research assess the strengths and weaknesses of these implementations?

Both Sweden and Norway have produced large amounts of literature on EBM compared to the very limited amount produced by Denmark. This reflects the degree of attention EBM has received in policy and legislation in the three countries. EBM has in general been much less articulated in Denmark compared to Sweden and Norway.

Reflecting the commonality of ecosystems in the countries, forest ecosystems have attracted the most attention in the Swedish literature while the main part of the Norwegian literature is on marine and coastal ecosystems. Besides, a large amount of both Swedish and Norwegian literature has been produced on national implementation of the EU WFD. Most of the limited Danish literature is also about this. The widespread attention given to the WFD indicates the paradigm shift this directive requires away from sectoral and towards integrated or polycentric governance. While the literature on WFD reveals implementation challenges in all countries, this seems to apply to Norway in particular.

A large part of the Scandinavian – mainly Swedish - literature addresses EBM from a local and regional perspective focussing on local governance and the role of local stakeholders. Another large part - mainly Norwegian - addresses EBM in a national context often with comparative international studies of EBM governance.

Scandinavian countries have a history of spatial planning as an important management tool, and both Swedish and Norwegian literature reflects its importance also for applying EBM.

Both Sweden and Norway have relatively more literature on practical experiences and lessons learned and less on EBM theory and conceptual frameworks than the reviewed literature in general indicating that Scandinavia may have moved a step further in the transformative governance change that EBM will often require. Still, the literature leaves an impression of countries being in a “trial and error” phase and not in any way having completed implementation of EBM. The obstacles for implementation are very similar to those identified in non-Scandinavian literature not least fragmented, sectoral governance systems and the difficulty of applying ‘whole-of government’ approaches.

8.3 Research needs and steps towards the development of a research agenda in support of implementation of Ecosystem-based management and governance

In general, research in support of EBM spans a wide variety of disciplines, methods and ecosystems, including sectoral and cross-sectoral investigations. It should be underlined that EBM is an approach that is dependent on significant knowledge-input and topical expertise in management agencies as well as in research institutions.

Generally, state-of-the art is represented with large, varied bodies of literature that provide a knowledge base for giving diagnoses of ecosystems, their current states, and what causes loss of ecosystems and biodiversity. There are also much literature that addresses the following themes and topics in support of EBM:

- Challenges, opportunities and ways to achieve participatory processes within EBM
- Planning and planning processes that can support EBM
- Valuation approaches, including valuation of ecosystem services
- Development of, and discussion of the use of decision support systems, such as MCDA
- Analytical frameworks that can be used to conduct precise diagnosis of complex socio-ecological systems, such as DPSIR and SES

It is also clear that research is dominated by studies of some ecosystem-types and not of others. Studies in marine and coastal ecosystems dominate, followed by freshwater. Fewer studies deal with forests and urban ecosystems. Surprisingly few were found dealing with mountains and alpine/polar ecosystems. There is also an impression that the different strands of research of EBM stay within their own “ecosystem-silos”, with few studies actively comparing approaches taken in coastal/marine EBM with studies in freshwater EBM. An exemption from this is Voulvoulis et al. (2017) that points to the WFD framework as an obvious template for EBM in other ecosystems. This is an assessment and suggestion strongly supported by this research team.

While there is ample and voluminous publications on the knowledge base and diagnosing studies, most reviews and summary works clearly agree that the major research deficits exist on the implementation challenges of EBM. This is, in our view, where research agendas need to be developed. Below, we give some initial suggestions to a research agenda to strengthen the knowledge base for implementation of EBM in Norwegian environmental governance.

8.3.1 Strengthened theoretical and conceptual foundations for research in implementation of EBM

Several scholars have suggested that implementation research in EBM needs to be strengthened theoretically (Boeuf & Fritsch 2016, Kelly et al. 2018, Sander 2018b). Lack of theory might reduce the value of studies, leading to lack of general learning. Theories applied in policy processes and change (Orach & Schluter 2016), transitional management (Kelly et al. 2018) and implementation theory have been suggested as relevant (Winther 2012, cited in Sander 2018b). We also suggest that EBM research should be more closely linked to the public administration literature and institutional perspectives on political-administrative action and change.

8.3.2 Conditions fostering and hindering sectoral policy integration, policy change, including power aspects

Examples and cases show that there can be many ways towards (more) EBM. Despite this, strengthened sectoral policy integration and enhanced vertical and horizontal coordination are emphasized as key challenges that need to be studied within their specific political-administrative contexts.

The role of political ambitions and goal-setting as well as political decision-making processes are a second group of key aspects that is under-researched and thus point towards a promising avenue (Prieto 2009 as cited in Giakoumis & Voulvoulis 2018, Sander 2018c). Studying what conditions that spark political priority are imperative (Orach & Schluter 2016), as well as understanding power relations and political dynamics (Morrison et al. 2017).

8.3.3 Dilemmas and paradoxes in EBM: Participation, top-down vs bottom-up and stable (legal) frames vs adaptive, knowledge-based approaches

The reviewed literature points to several paradoxes within EBM, some bordering on being oxymorons. Several of these challenges need research so we better can understand them and eventually identify solutions.

One such paradox is that between participatory processes and safeguarding ecosystem and their integrity, functions and services. Participation and involvement, often organised through bottom-up processes, is a goal in itself and a key feature of EBM (see chapter 1 and 2). However, several researchers raise concern that this “more is better” approach, is blurring the challenge

that this compromise-oriented process may weaken the interest of ecosystems (Samhuri et al. 2012, Sander 2018b). These more inclusive approaches are often weakly mandated with few tools and mechanisms to actually enforce their outcomes.

Another dilemma related to the intrinsic character of EBM; that it must be adaptive, and knowledge-based, with systematic evaluations and adjustment based on achievement and new knowledge. On the other hand, successful EBM should be anchored in laws and regulations, to avoid EBM being subject to changing policies or powerful sector interests. Frolich et al. (2018) have highlighted how legal approaches to management and decision-making can act as barriers, and that this needs to be addressed in future research and management.

How to cope with scientific uncertainty in (adaptive) ecosystem-based decision-making needs to be further explored. As both the management and the regulation of ecosystems could be limited by significant gaps and uncertainties in scientific knowledge, adaptive management and regulation of human activities may require uncomfortable concessions from the traditional rule of law values, such as predictability and stability of licenses and permits to utilise marine areas and resources. Yet, scientific knowledge may also require the law to drive changes to established socio-economic practices that are environmentally harmful. Here, adaptive regulation may be problematic if the political discretion in environmental management is not sufficiently controlled by the law. The level of scientific uncertainty is closely linked to what kind of regulation is needed to achieve environmental and other policy goals. There is a need for more social sciences research on the question of how law could facilitate the adaptive management of ecosystems without overlooking important rule of law values such as predictability, stability, coherence, or accountability (Platjouw & Soinen 2020).

8.3.4 “Good” Indicators and linkages between ecosystem states and management and policy measures

Indicators have been highlighted as a relevant approach to achieve EBM across sectors and ecosystems, also capturing and taking into account cumulative impacts (Engler 2015, Halpern & Fujita 2013). However, a range of challenges in regards building EBM around indicators have been identified. These range from administrative and political rules for exemptions that sometimes can undermine their effect being too laxed or unclear (Giakoumis & Voulvoulis 2018), to scientific challenges of identifying “good” (cost-effective, relevant and sufficiently sensitive) indicators (Engler 2015).

Several scholars have called for a wider set of indicators, not only to measure ecological states and conditions, but also to develop indicators that monitor social, economic and governance aspects of EBM (Engler 2015, Samhuri et al. 2012, Wuijts et al. 2018). A specific challenge identified is to develop indicators that links ecosystem states (and their eventual improvements) and management and governance measures. Research to improve indicators, especially operative/instrumental indicators, is recommended to be transdisciplinary, as well as being clear on the role of science (where science ends) and when politics take over (Engler 2015).

Further research into indicators should also take Engler’s (2015) advice that also non-instrumental indicators can be useful, for instance to inform and raise awareness among the public and decision-makers. As such the distinction between conceptual, legitimising and instrumental indicators could be useful to better clarify the purpose of indicators in future research.

8.4 Management implications

As we have seen and documented above, to implement “true” holistic and cross-sectoral EBM, much remains to be done in regards establishing collaborative administrative structures and legal

claims that will take time and demand resources to scientific, managerial, legal and political processes.

However, this review also highlights several other measures and approaches, that might be easier, simpler and quicker to implement, within existing administrative, sectorial, legal and economic frames, primarily by the environment sector.

8.4.1 Implementation of more formal and transparent Decision-Support Systems

The literature is very clear on recommending the use of more formal decision support systems as opposed to the reigning “professional judgement/assessment” – processes that dominate in Norwegian environmental decision-making such as in EIAs and other decision-making with significant ecosystem consequences. Such systems have several advantages:

1. They are transparent for involved interests and sectors
2. They facilitate stronger participation from stakeholders, across sectorial interests, in preparing knowledge as well as in developing solutions and compromises
3. They will more clearly reveal how and if decisions (e.g. in Environmental Impact Assessments, area plans, development plans) take into account long term sustainability, ecosystem integrity and ecosystem services or not.

The literature also rather unanimously provide support for application of some kind of multi-criteria decision analysis tool (MCDA). MCDA can combine several types of data, qualitative and quantitative, monetary and non-monetary, apply GIS and spatial analyses or not. MCDA combines flexibility with structure.

Ongoing revisions of e.g. guidelines and toolboxes for best practice EIAs might be one venue for discussions about, and eventually provide advice on more use of MCDA in Norway, at least in bigger projects with potentially major impacts on ecosystems.

8.4.2 Development of ecosystem-based management should be actively linked with other existing measures in ecosystem - and nature conservation

A large body of literature, especially from marine ecosystem-based management, but also about forest ecosystem-based management, highlight advantages of combining efforts to strengthen conditions for ecosystem-based management and governance in general, with the use of other traditional measures in conservation management, such as protected areas (and networks of protected areas), but also more recent initiatives e.g. ecosystem restoration and the establishment of gene banks.

As such, the strive for cross-sectoral, integrated EBM should not go on the cost of sectoral achievements in making achievements in “easier” and “simpler” EMB, e.g. within fish and wildlife management, forestry and management of protected areas. Rather, lessons learned in intra-sectoral approaches to EBM has been, and still is, a good starting point for cross-sectoral EBM.

A range of other measures discussed frequently as part of more sustainable societies - that also can play a role in EBM, but not prominent in this review - are reforms of financial measures, such as offsetting, PES, cap-and-trade mechanisms and more innovative green financing mechanisms (Platjouw 2019).

8.4.3 Area planning and assessment processes on ecosystem-scale could be given more authority (regional plans and strategic impact assessments)

Spatial planning, and decisions on area use and conservation based on spatial planning is instrumental whether we are to achieve more or less ecosystem-based governance.

The Norwegian planning and building act opens up for a range of plans at different scales, at national, regional, municipal and lower scales. Most emphasis is on compulsory municipal. These are often centred towards local area-development plans. However, there is both a framework for, and significant traditions for regional planning in Norway. Regional plans are probably the type of plan that scale-wise fit best with an ecosystem approach, as they can cut across administrative borders at municipal and county levels. Previous plans have for instance had clear ambitions to achieve more ecosystem-based planning in mountainous areas in Norway.

A weakness with the existing regulations in Norway today is the rather weak legal position of regional plans. They are today primarily to be considered as guidelines and not as formal, binding plans, that national as well as local interests must adhere to. As Hanssen & Aarsæther (2018) points out, a stronger and more binding regional plan holds significant potential for more EBM in Norway.

While giving regional plans more formal authority and make them more binding might not be an easy task, it is likely easier than for instance more ambitious processes to break down sectorial barriers at the national level. Anyhow, from an EBM perspective, the principle of sectoral responsibility should be put under more critical scrutiny. The politically prioritized management sectors of traditional value-creating industries such as energy, mining, and aquaculture are political behaviours that impede on effective EBM.

The SEA instrument (Strategic Environmental Assessment) could also be developed in ways in which it could serve a more specific role in strengthening EBM (Geneletti 2011, Partidario & Gomes 2013).

8.4.4 Emphasis on developing more operable/instrumental and multidisciplinary indicators for ecosystem-based management

As discussed in chapter 6, good indicators is an important tool in EBM, whether they are anchored in formal, legal systems or not.

Research on the application of indicators highlight several shortcomings that do not only relate to their formal status and legal implications, but also to how they link (or not) between ecosystem states and relevant (possible) management measures. Another shortcoming is the lack of indicators addressing social, economic and governance dimensions of EBM.

These challenges and shortcomings should be continuously be considered and improved when fine-tuning and improving existing indicators, as well as when developing new. Good, functioning indicators generally depend on cross- or multidisciplinary teams cautious about linking drivers - states – pressures – impacts and responses though management measures and actions.

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Appendix 1: Search string, Scopus, 24 June, 2019

((TITLE-ABS-KEY (forest W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (range* W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (coast* W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (river* W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (basin W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (urban AND (integrated OR management OR governance) AND ecosystem*)) OR (TITLE-ABS-KEY (marine W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (lake* W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (wetland* W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (ocean* W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (wood* W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY ((pasture OR pastoral) W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (grassland* W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (mountain* W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (terrestrial W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (freshwater* W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (shore* W/5 (integrated OR management OR governance))) OR (TITLE-ABS-KEY (meadow W/5 (integrated OR management OR governance)))) AND ((TITLE-ABS-KEY (ecosystem*)) OR (TITLE-ABS-KEY (biodiversity)) OR (TITLE-ABS-KEY (environment* W/3 (management OR governance))) OR (TITLE-ABS-KEY ("water framework directive" OR "2000/60/EC")) OR (TITLE-ABS-KEY ("natura 2000")) OR (TITLE-ABS-KEY (ramsar OR "Convention on Wetlands")) OR (TITLE-ABS-KEY ("Convention on Biological Diversity")) OR (TITLE-ABS-KEY (unclos OR "United Nations Convention on the Law of the Sea" OR losc OR "law of the sea convention")) OR (TITLE-ABS-KEY ("Habitats Directive" OR "Directive 92/43/EEC")) OR (TITLE-ABS-KEY ("Marine strategy framework directive" OR "Directive 2008/56/EC")) OR (TITLE-ABS-KEY ("Convention for the Protection of the Marine Environment of the North-East Atlantic" OR ospar)) OR (TITLE-ABS-KEY ("birds directive" OR "Directive 2009/147/EC")) OR (TITLE-ABS-KEY ("berne convention" OR "bern convention" OR "Convention on the Conservation of European Wildlife")) OR (TITLE-ABS-KEY ("maritime spatial planning directive" OR "Directive 2014/89/EU"))) AND ((TITLE-ABS-KEY (resilience OR resilient)) OR (TITLE-ABS-KEY (integrated W/3 (management OR governance))) OR (TITLE-ABS-KEY ((law OR legal OR regulation OR regulatory OR legislation) AND (ecosystem*))) OR (TITLE-ABS-KEY (adaptive W/3 (law OR management OR governance))) OR (TITLE-ABS-KEY (decision-making W/3 (management OR governance OR ecosystem*))) OR (TITLE-ABS-KEY ("Policy change")) OR (TITLE-ABS-KEY (management W/3 ecosystem*)) OR (TITLE-ABS-KEY (stakeholder* W/3 (involvement* OR engagement OR participat*))) OR (TITLE-ABS-KEY ("Policy implementation")) OR (TITLE-ABS-KEY ("spatial planning")) OR (TITLE-ABS-KEY ("policy strateg*")) OR (TITLE-ABS-KEY (politic* AND ecosystem*)) OR (TITLE-ABS-KEY ("system* transform*")) OR (TITLE-ABS-KEY (holistic W/3 (management OR governance))) OR (TITLE-ABS-KEY ("govern* strateg*")) OR (TITLE-ABS-KEY (multisector*)) OR (TITLE-ABS-KEY ("Multi-level governance" OR "multi level governance" OR "multi-level governance")) OR (TITLE-ABS-KEY ("government administrat*")) OR (TITLE-ABS-KEY ("administrative boundaries")) OR (TITLE-ABS-KEY (("policy-making" OR policymaking OR "policy making") W/3 (management OR governance OR ecosystem*))) OR (TITLE-ABS-KEY (governance W/3 ecosystem*)) OR (TITLE-ABS-KEY ("govern* transform*")) OR (TITLE-ABS-KEY ("govern* coordination")) OR (TITLE-ABS-KEY ("area-based management" OR "area based management"))) AND (LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (

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OR LIMIT-TO (PUBYEAR , 2009) OR LIMIT-TO (PUBYEAR , 2008) OR LIMIT-TO (PUBYEAR , 2007) OR LIMIT-TO (PUBYEAR , 2006) OR LIMIT-TO (PUBYEAR , 2005)
) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re") OR LIMIT-TO (DOCTYPE , "ch") OR LIMIT-TO (DOCTYPE , "bk") OR LIMIT-TO (DOCTYPE , "ed"))
AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Swedish") OR
LIMIT-TO (LANGUAGE , "Danish") OR LIMIT-TO (LANGUAGE , "Norwegian"))

* An identical search (apart from proximity operators adjusted from "W/*" to "Near/*", because of of database preferences) was conducted in Web of Science the same day.

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