Study on Integrating an Ecosystem-based Approach into Maritime Spatial Planning

What are the lessons from current practice in applying Ecosystem-Based Approaches in Maritime Spatial Planning?

Results from the literature review

August – 2021

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EUROPEAN COMMISSION

The European Climate, Infrastructure and Environment Executive Agency (CINEA)
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Study on Integrating an Eco-system-based Approach into Maritime Spatial Planning

Final Task 2 Report:

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The European Climate, Infrastructure and Environment Executive Agency (CINEA)

LEGAL NOTICE

Luxembourg: Publications Office of the European Union, 2021

PDF	ISBN 978-92-95225-14-5	doi: 10.2926/13709	HZ-01-21-241-EN-N

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CAS	Complex Adaptive Systems
CBD	Convention on Biological Diversity
CEA	Cumulative Effect Assessment
CFP	Common Fisheries Policy
CIA	Cumulative Impact Assessment
D	Descriptor (as defined under the MSFD)
DAPP	Dynamic Adaptive Policy Pathways
EBA	Ecosystem-based approach
EBM	Ecosystem-based management
EBSA	Ecologically or Biologically Significant marine Area
EIA	Environmental Impact Assessment
EU	European Union
HELCOM	HELsinki COMmission (Baltic Marine Environment Protection Commission)
ICES	International Council for the Exploration of the Sea
ICZM	Integrated Coastal Zone Management
LSI	Land-Sea Interactions
MAES	Mapping and Assessment of Ecosystems and their Services
MAP	Mediterranean Action Plan
MES	Marine Ecosystem Service
MPA	Marine Protected Area
MSFD	Marine Strategy Framework Directive
MSP	Maritime Spatial Planning
MUC	Maritime Use Conflict
RDM	Robust Decision Making
RFMO	Regional Fisheries Management Organisation
ROA	Real-Option Analysis
SEA	Strategic Environmental Assessment
SES	Socio-Ecological System
TFEU	Treaty on the Functioning of the European Union (TFEU)
UN	United Nations
VASAB	Vision And Strategies Around the Baltic sea
VME	Vulnerable Marine Ecosystem
WFD	Water Framework Directive

1 INTRODUCTION

1.1 Maritime Spatial Planning, the regulatory framework and the challenges faced by an ecosystem-based approach

Despite the progressive development of the European Union (EU) policy framework, **marine ecosystems remain under significant pressure** in the different EU regional seas, threatening the status, health and functionality of marine biodiversity, as well as the goods and services they deliver. Pressures originate from maritime/marine sectors – including over-fishing, pollution from resource extraction activities or maritime transport and coastal tourism – and from many land-based sectors and human activities (including industry, agriculture, urbanisation and waste management) often located far from the sea.

At the same time, increasing attention is paid to the development of (new) economic activities at sea in an attempt to capture untapped resources that can contribute to the socioeconomic development of territories and populations. The **blue economy** is expected to continue to increase, creating challenges for management to keep pace and address cumulative multiple interactive impacts. The blue economy will require marine ecosystems to be in good health if they are to deliver the full benefits of a sustainable blue economy. With this expected future growth, it is essential that initiatives do not exert further pressure on marine ecosystems and deliver positive environmental and social outcomes, including for coastal communities. This requires adequate sharing and management of marine space that accounts for connections between marine ecosystems and the land-sea interface. Managing pressures at sea and competition between maritime sectors requires **spatial planning to account for pressures from individual sectors and their cumulative impacts**, taking into account the vulnerability and importance of marine ecosystems and services.

The EU adopted **Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning (MSP Directive)[1].** The Directive aims to: (a) reduce conflict between sectors and create synergies between activities; (b) encourage investment by creating predictability, transparency and clearer rules in the management and sharing of marine space; (c) protect marine ecosystems; and (d) increase cross-border cooperation between EU countries to support cost-effective development projects and initiatives, including for the effective protection of marine ecosystems. Member States must establish maritime spatial plans (MSP) by 2021 and implemented those plans thereafter.

To guide the implementation of the MSP in delivering sustainable societal outcomes and give due consideration to the protection of marine ecosystems, much attention has been given to the **application of ecosystem-based approaches** (EBA). Initially developed at the international level in the context of work carried out under the United Nation (UN) Convention on Biological Diversity (CBD) as early as the 1990s (in particular the development of the **Malawi principles**[2]), EBA (or ecosystem-based management, EBM) builds on a series of key principles to ensure that MSP (or any other planning and management process) delivers sound and sustainable societal outcomes. The principles relate as much

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0089&from=EN

[2] These principles emerged from a workshop on EBA organised in Lilongwe, Malawi, in 1998. They were then presented at the Fourth Meeting of the Conference of the Parties to the Convention on Biological Diversity in Bratislava, Slovakia. For the list of the 12 Malawi principles, see: http://www.fao.org/3/Y4773E/y4773e0e.htm#:~:text=Management%20objectives%20are%20a%20matter%20of%20societal%20choice.&text=Management%20should%20be%20decentralized%20to%20the%20lowest%20appropriate%20level.&text=The%20ecosystem%20approach%20should%20seek,conservation%20and%20use%20of%20biodiversity.

to the understanding of marine ecosystems and their interaction with socioeconomic activities as to the processes established to support their management.

Too often, these principles are addressed in the literature at a generic and conceptual level, with limited practical examples on implementation in practice under different environmental and socioeconomic contexts, knowledge availability or institutional setup. In a European context, their application addresses the connections between the MSP Directive and the **Marine Strategy Framework Directive 2008/56/EC (MSFD), adopted in 2008**. The MSFD aims to achieve clean, healthy and productive seas on the basis of ecosystem approaches, including by addressing cumulative pressures on the marine environment. As some of the key principles of EBA are embedded in the MSFD, addressing EBA in MSP requires examining the interplay between the two Directives and identifying how their integration can deliver EBA in MSP effectively, with potentially lower effort and transaction costs.

1.2 Study objectives and building blocks

The European Commission launched a *Study on Integrating an Ecosystem-based Approach into Maritime Spatial Planning*[3]. The main objective of the project is to **propose feasible and practical approaches and guidelines for applying the EBA in MSP** with the presently available information and to **develop a practical method or tool** for evaluating, monitoring and reviewing the application of EBA in MSP. To achieve these objectives, the project was divided into five tasks:

- Task 1: Baseline review/state of play of existing knowledge, research, tools and practices linked to the application of EBA in MSP and MSFD;
- Task 2: Critical analysis of the outcome of Task 1;
- Task 3: Development of a set of guidelines and tools for the application of EBA in MSP for EU Member States;
- Task 4: Development of MSP cases studies using an EBA, demonstrating the guidelines and tools developed in Task 3;
- Task 5: Organisation of a closing workshop.

The study was launched in December 2019 and is expected to end in June 2021.

1.3 Main focus of this report

This report summarises the knowledge available in the literature on the **practical application of EBA in MSP**, building on the review of the literature assembled under Task 1, complemented by additional references (e.g. relevant to a specific method, tool or EU policy) and targeted interviews with experts coordinating or involved in key projects relevant to EBA in MSP in different regional seas.

In particular, the report addresses the following five questions:

- **What** does EBA in MSP **require or imply**?
- **What evidence**, methods and practice can be found in the literature on the application of EBA in MSP?
- What **opportunities offered by other EU policies**, in particular by the **MSFD,** can facilitate the application of EBA in MSP?
- What are specific **transboundary issues and challenges** in applying EBA in MSP?

[3] The study has been awarded to a consortium that brings together Milieu Consulting (lead) with ACTeon, the Baltic Environment Forum (BEF), Fresh Thoughts, GRID-Arendal and Wageningen Research (WR – and specifically, Wageningen Economic Research and Wageningen Marine Research

- What is the **added value** of applying EBA in MSP?

These questions are addressed for different groups of EBA principles that share commonalities and similar focuses (see Chapter 2 for an explanation of the grouping). Although the aim was to treat all principles equally, the evidence available in the literature led to some principles receiving more attention than others. Also, limited evidence was found on the added value of applying EBA principles in specific contexts and marine territories. This stresses areas for which further work is required to enhance the knowledge base and support the integration of EBA in MSP at operational level.

This report is based on literature reviewed and information gathered through January 2021.

1.4 Structure of the report

The report is structured as follows:

- **Chapter 2** summarises the **main EBA principles** that were the focus of the literature review. It describes how those principles were allocated to four groups to guide the review of the available literature and present consolidated results, recognising in particular the links and synergies that exist between some of the EBA principles.
- **Chapters 3 to 6** address the questions presented above for each group of principles, outlining the approaches that were applied to:
  - Capture the **complexity** of the functioning of **marine ecosystems** (Chapter 3);
  - Investigate the **human-ecosystem connections and integration** (Chapter 4);
  - Account for **uncertainty** and support **adaptive management** (Chapter 5);
  - Organise the MSP **process and stakeholder mobilisation** (Chapter 6);
- **Chapter 7** provides **key conclusion**s, including the relevance and richness of the MSP literature in relation to the application of EBA, and how existing EU policies can help to support EBA in MSP. This helps to highlight particular areas and knowledge gaps that require further investigation beyond the scope of the present study.

2 FROM EBA CONCEPTS TO STRUCTURING THE LITERATURE REVIEW AND ASSESSMENT

EBA or EBM relies on the application of a series of key principles that maritime spatial planners need to follow to deliver sustainable and socially relevant MSP. The following box summarises the main principles reflected in the literature[4].

Box 1: Main EBA principles

The main principles that an EBA needs to follow in implementing MSP relate to the assessments to be carried out or the process to be put in place. These principles include:

- Consider the ecological integrity and biodiversity of marine ecosystems
- Consider ecosystem connections and define distinct boundaries
- Account for the dynamic nature of ecosystems
- Acknowledge uncertainty in assessments and decisions
- Consider appropriate spatial and temporal scales
- Make explicit human activities, their pressures and ecosystem services delivered as part of an entire Socio-Ecological System (SES)
- Take account of the cumulative impacts of human activities
- Make best use of up-to-date scientific knowledge
- Mobilise interdisciplinary science to address the different components of the SES
- Support integrated management accounting for all sectors and issues
- Support adaptive management of marine ecosystems that can respond to unexpected (climate, socioeconomic) changes, including by setting relevant long-term management objectives
- Apply the precautionary principle for issues and concerns where uncertainty is significant
- Develop appropriate monitoring for capturing the functioning and dynamics of the SES
- Give priority to sustainability as a policy objective, accounting for ecological goals and societal choices
- Mobilise stakeholders and support management at the lowest appropriate level

For the purpose of this study and to guide the literature review, the principles were combined into four groups accounting for links and synergies between them. These groups are:

- **Group 1 – Capturing the complexity of ecosystems.** Addressing ecological integrity and biodiversity, ecosystem connections and the dynamic nature of ecosys-

[4] See, for example, Long et al. (2015).

tems are elements of ecosystem complexity. It includes questions on the appropriate spatial and temporal scale for assessments and understanding, as well as cumulative impacts (positioned at the interface with Group 2 principles, see below).

- **Group 2 – Paying attention to human-ecosystem connections and integration.** Principles in this group include: identify ecosystem services and beneficiaries, account for global socioeconomic changes, account for social/economic/environmental aspects in assessments carried out to define the shared space and management rules, and ensure that human sciences are well represented in interdisciplinarity and human/decision-making processes considered. It also addresses issues of relevant spatial and temporal scales in relation to human activities and ecosystem services delivered.
- **Group 3 – Accounting for uncertainty to support adaptive management**. Key elements include how uncertainty is analysed and considered in different assessments relevant to Group 1 and Group 2 principles, how it is accounted for in the definition of the MSP and management rules, what (specific) methods and processes are in place to deliver adaptive management and how monitoring is established to capture and anticipate change and support adaptation in decisions[5].
- **Group 4 – Organising the MSP process**: addressing stakeholder mobilisation, the science-policy interface, the connection established between MSP and other (sector or environment) policies and strategies to deliver the 'integrated management' of space. Here, the challenge is to assess the coherence between the governance put in place, and the functioning and dynamics of the human-ecological systems addressed in the principles of the three previous groups, including the spatial and temporal scales at which governance is organised.

In parallel, specific attention was given to the relevance of methods, tools and approaches supporting the application of EBA principles at different stages or **steps of the MSP planning process**. While the IOC-UNESCO 2009 guidance[6] highlights MSP as a continuing and iterative process that learns and adapts over time and suggests a 10-step cycle for MSP, a simpler five-step cycle is presented in Table 1. This table illustrates how EBA principles are connected to the different planning steps, stressing the transversal nature of principles related to governance and stakeholder mobilisation, for example, or the selection of appropriate temporal and spatial scales.

Table 1: Linking EBA principles to MSP implementation steps

Key steps in the development and implementation of MSP	EBA principles
Step 1 – Define: setting the frame for the MSP, organising the MSP process and identifying its priority objectives and principles (societal goals)	Reflect societal choices in defining objectives
	Set distinct boundaries for the MSP
	Give priority to sustainability
Step 2 – Develop: stocktaking and analysing data and developing alternatives	Account for ecological integrity and biodiversity
	Consider ecosystem connections
	Account for the dynamic nature of marine ecosystems
	Ensure inter-disciplinarity
	Recognise human-ecosystem interactions in SES
Step 3 – Assess: assessing and weighing planning alternatives	Consider cumulative impacts
	Ensure inter-disciplinarity

[5] Adaptive management in MSP is sometimes limited to monitoring and the existing of a six-year planning cycle that can support changes in decisions. However, assessment methods that help to assess stability and resilience, intervention and governance pathways that can adapt to changing conditions and anticipation, are key to adaptive management.

[6] Ehler, C. and Douvere, F., Marine Spatial Planning: a step-by-step approach toward ecosystem-based management, Intergovernmental Oceanographic Commission and Man and the Biosphere Programme. IOC Manual and Guides No. 53, ICAM Dossier No. 6. Paris: UNESCO. 2009 (English), p. 18.

Key steps in the development and implementation of MSP	EBA principles
	Assess impacts on sustainability
	Recognise human-ecosystem interactions in SES
Step 4 – Implement: implementing and monitoring the plan	Apply the precautionary approach
	Appropriate monitoring
	Adaptive management
Step 5 - Follow-up: evaluating results and performance, and updating the plan	Appropriate monitoring
	Account for the dynamic nature of marine ecosystems
	Recognise human-ecosystem interactions in SES
	Adaptive management
Transversal principles relevant to all steps	Stakeholder involvement, governance and institutional set-up
	Use of scientific knowledge
	Set adequate spatial and temporal scales
	Acknowledge uncertainty

3 CAPTURING THE COMPLEXITY OF ECOSYSTEMS

3.1 What does EBA in MSP require/imply?

The requirement to capture the complexity of ecosystems is key in the *Developing* step but is already determined in the *Defining* step. The quality of the *Assessing* step and consequences for the subsequent *Implementing* and *Follow-up* steps are controlled by what can be achieved in the *Developing* step given the existing knowledge base. To guide the integration of EBA in MSP the practicalities are described for each of the EBA principles that apply to a specific step, together with how EBA in MSP can be made operational.

Defining

The EBA requires that 'decisions reflect societal choice'. This means that all policy objectives that reflect the state of the ecosystem (e.g. the MSFD, the Birds and Habitats Directives or, in case of MSP close to shore, the Water Framework Directive (WFD) and Integrated Coastal Zone Management (ICZM)), where applicable (e.g. in the Mediterranean Sea[7]), together provide a set of common objectives that need to guide the integration of ecological issues into MSP. For example, the MSFD sets out requirements for the good ecological status of Europe's oceans and calls for EBA, similar to the MSP Directive.

These Directives primarily determine the prerequisites for covering ecosystem complexity in the subsequent steps. The 'appropriate spatial and temporal scales' and 'distinct boundaries' principles may also influence decisions on how ecosystem complexity is incorporated in the MSP process, albeit to a lesser extent.

Pertaining to the 'decisions reflect societal choice' EBA principle, the MSFD has 'criteria and methodological standards, specifications and standardised methods for monitoring and assessment of essential features and characteristics and current environmental status of marine waters' that involve species groups of birds, mammals, reptiles, fish and cephalopods, as well as benthic and pelagic habitats (some with additional detail, e.g. specific species or broad habitat types). This is ideally the level of detail and ecosystem complexity that needs to be covered by the EBA-MSP scientific knowledge base. The degree to which this can be achieved, however - and thus how ecosystem-based the MSP process is – is, in reality, largely determined by the availability of relevant information.

This may also apply to the 'appropriate spatial and temporal scales' EBA principle, where the spatial scale required to assess ecosystem status (i.e. grid cells at a specific resolution) and how this is impacted by various anthropogenic pressures is not possible due to data limitations. The MSFD has three place-specific descriptors - seafloor integrity (D6), hydrographical conditions (D7), and energy and underwater noise (D11) that require the explicit consideration of spatial scale (European Commission, 2017). For D6, habitat state and the impact of fishing is assessed using high-resolution fisheries data collected through vessel monitoring systems (VMS). It is technologically feasible to use a spatial resolution of 1 km^2 or less when describing habitat status (seafloor integrity in the MSFD). In practice, and certainly in case of trans-boundary conditions where the MSP area or marine ecosystem crosses different national jurisdictional boundaries, the MSP process may need to rely on International Council for the Exploration of the Sea (ICES) maps, which use C-squares, a grid system with resolution of 0.05° longitude by 0.05° latitude (about 15 km^2 (3km x 5km) at 60°N latitude). This resolution is practical and acceptable in terms of the confi-

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[7] With the ICZM protocol adopted in 2008 - see https://paprac.org/iczm-protocol#:~:text=The%20ICZM%20Protocol%20was%20signed,Mediterranean%20and%20on%20the%20globe.

dentiality of data relating to individual fishing vessels when aggregating international efforts. Similar issues may apply to the temporal scale, e.g. where seasonal patterns apply and data are annual, at best.

Defining 'distinct boundaries' determines the extent of the spatial area considered for MSP. This may be restricted to the specific area to which the MSP applies or the whole ecosystem in which it occurs. Widening the area to include the whole ecosystem is arguably more ecosystem-based but is also likely to require an increased consideration of ecosystem complexity. A recognition of specific boundaries does not necessarily imply that those boundaries need to be applied in setting the MSP area, but, rather, points to the utility of making them explicit and considering transboundary issues in operational terms where required.

Developing

The three EBA principles that are key to considering ecosystem complexity in this step are 'ecological integrity and biodiversity', 'Consider ecosystem connections' and 'account for dynamic nature of ecosystems. 'Consider cumulative impacts' is also useful here.

Assessing

The EBA principle most relevant to ecosystem complexity is 'consider cumulative impacts', although other principles might be relevant in respect of their integration in the methods and tools developed for assessing cumulative impacts.

Main references addressing ecosystem complexity

Table 2 provides some examples from literature to illustrate how EBA in MSP can be made operational for each of the EBA principles that apply to a specific step. Some of the methods and tools are described in more detail below.

Table 2: Overview of literature sources addressing EBA principles relevant to ecosystem complexity

EBA principles, by key MSP step and transversal processes	Literature sources providing practical examples
Defining	
Decisions reflect societal choice	Piet et al. (2017)
Appropriate spatial and temporal scales	Piet et al. (2017) Stelzenmüller et al. (2013) Swedish Agency for Marine and Water Management (2017; 2019)
Distinct boundaries	Piet et al. (2017) Stelzenmüller et al. (2013) Swedish Agency for Marine and Water Management (2019)
Developing	
Ecological integrity and biodiversity	Borja et al. (2017) Piet et al. (2017) Swedish Agency for Marine and Water Management (2017; 2019)
Appropriate spatial and temporal scales	Piet et al. (2017) Stelzenmüller et al. (2013) Swedish Agency for Marine and Water Management (2017; 2019)
Consider ecosystem connections	Manea et al. (2020) Piet et al. (2017)
Account for dynamic nature of ecosystems	Manea et al. (2020) Piet et al. (2017)
Assessing	
Consider cumulative impacts	ADRIPLAN (2017) / Menegon et al. (2018)

EBA principles, by key MSP step and transversal processes	Literature sources providing practical examples
	Bergström et al. (2019) Piet et al. (2017) Ramieri et al. (2014) Swedish Agency for Marine and Water Management (2017; 2019)
Implementing	
Acknowledge uncertainty	Manea et al. (2020) Piet et al. (2017) Swedish Agency for Marine and Water Management (2019)

Piet et al. (2017) addresses all EBA principles and compared the EBA principles to requirements from the concept of resilience thinking, which provided the basis to assess the SES knowledge base in terms of its capacity to guide the development and implementation of EBM. It linked ecosystem aspects (according to Borgstrom et al., 2015), their match with EBM principles (Long et al., 2015), resilience thinking (including complex adaptive systems, CAS) and systemic approaches to solve wicked problems (DeFries and Nagendra, 2017).

The Tools4MSP Geoplatformrr[8] provides an important example for EBA in MSP, with built-in geospatial webtools to support MSP in adopting some EBA principles. The EBA principles 'ecological integrity and biodiversity', 'appropriate spatial and temporal scales', 'distinct boundaries' and 'donsider cumulative impacts' have been applied and the EBA principles 'acknowledge uncertainty' and 'recognise coupled social and ecological systems' have been mentioned. The webtools include cumulative effects assessment (CEA), maritime use conflict (MUC) analysis, MSFD pressure-driven CEA and a CEA-based marine ecosystem service threat analysis (MES-Threat). The tools were tested for the Northern Adriatic Sea, one of the most industrialised sea areas of Europe, using a case study modelling strategy.

3.2 What evidence, methods and practice are present in the literature?

In the sub-sections below, examples from literature are provided for the EBA principles per MSP step.

3.2.1 Defining

Setting decisions reflecting societal choice

Piet et al. (2017) provide guidance by providing templates and examples to make EBA operational in defining the societal goals to which MSP must contribute. Key societal goals should be identified based on the most relevant policy instruments and stakeholder consultation. These societal goals then determine:

- The identification of the elements of the SES that are relevant for assessments that support MSP;
- The indicators and their targets that will be used to compare different management and marine space allocation strategies;
- The indicators and targets that will be used for monitoring and evaluating (ex post) the implementation of the MSP.

[8] ADRIPLAN (2017); Menegon, Depellegrin, et al. (2018).

These societal goals should emerge from a co-design process mobilising stakeholders representing different groups and interests (see Chapter 6) and based on the identified policy objectives. Table 3 shows an example from a North Sea case study, indicating how societal goals could be derived from the relevant EU Biodiversity Strategy 2020 targets and describing how the goals' achievement could be assessed.

Table 3: Societal goals in the North Sea case study under relevant EU Biodiversity Strategy 2020 targets and the matching guidance for assessment[9]

Biodiversity Strategy	Policy Details	Assessment
Target 1: Fully implement the Birds and Habitats Directives	Conserve at least 10% of coastal and marine areas through effectively and equitably managed, ecologically representative, and well-connected systems of protected areas, and other effective area-based conservation measures (CBD, 2010). A central component of these Directives is the use of special conservation areas to help achieve their objectives, through a 'coherent European ecological network' (Natura 2000) covering both land and sea. The Natura 2000 network thus contains Special Areas of Conservation (SACs) designated to implement the Habitats Directive.	*Indicator: Extent of North Sea area covered by Natura 2000 SACs* *Target: a 'coherent European ecological network' (indicator yet unknown).*
Target 2: Maintain and restore ecosystems and their services	By 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems.	*Adopt or develop appropriate indicators for ecosystem services* *The green infrastructure target is achieved through a 'coherent European ecological network' (indicator yet unknown).* *Assess if 15% restoration of degraded ecosystems is achieved.*
Target 4: Ensure the sustainable use of fisheries resources	MSFD D3: Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock. GES is based on three criteria: exploited sustainably, consistent with high long-term yields, with full reproductive capacity.	*Fishing mortality (F) should be below the value of F expected to produce the high long-term sustainable yield (FMSY): F<FMSY.* *Spawning-stock biomass (SSB) should be at or above a biomass safeguard (MSY Btrigger) capable of producing maximum sustainable yield: SSB>MSY Btrigger for all stocks.*
Target 6: Help to avert global biodiversity loss	MSFD D1/D6: Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded, and benthic ecosystems, in particular, are not adversely affected.	*Spatial extent and distribution of physical disturbance pressures on the seabed. Unit of measurement is the extent of the assessment area physically disturbed in square kilometres (km^2).* *Spatial extent of each habitat type which is adversely affected, through change in its biotic and abiotic structure and its functions by physical disturbance. Unit of measurement is the extent of each habitat type adversely affected in square kilometres (km^2) or as a propor-*

[9] Piet, G., Delacámara, G., Gómez, C. M., Lago, M., Rouillard, J., Martin, R. and Van Duinen, R. (2017). Making ecosystem-based management operational, https://aquacross.eu/sites/default/files/D8.1_Making ecosystem-based management operational_v2_13062018.pdf

Biodiversity Strategy	Policy Details	Assessment
		tion (percentage) of the total natural extent of the habitat in the assessment area.

Appropriate spatial and temporal scales

The importance of this principle is often highlighted and is elaborated to some extent by (Stelzenmüller et al. 2013). Practical guidance on the monitoring and evaluation of spatially managed areas should be generally applicable at any spatial scale, independent of major natural and socioeconomic factors.

The scale at which components of the marine ecosystem are mapped depends on the scale at which operational objectives have been set, as well as on the availability of data. Stelzenmuller et al. (2013) carried out selected spatially managed area test cases (Southern North Sea and Baltic Sea) from local to transnational level to illustrate how priorities change when moving from one scale to another, the mechanisms for linking scales, and the implications for marine spatial management.

When defining the appropriate scales, it should be noted that[10] :

- Ecological processes and functions are scale-dependent and any boundaries defined may be arbitrary, making the detection of response and related changes difficult;
- The temporal scale is an important factor influencing the assessment of results and impacts of the MSP;
- Information is not always available at the relevant spatial or temporal scale for management.

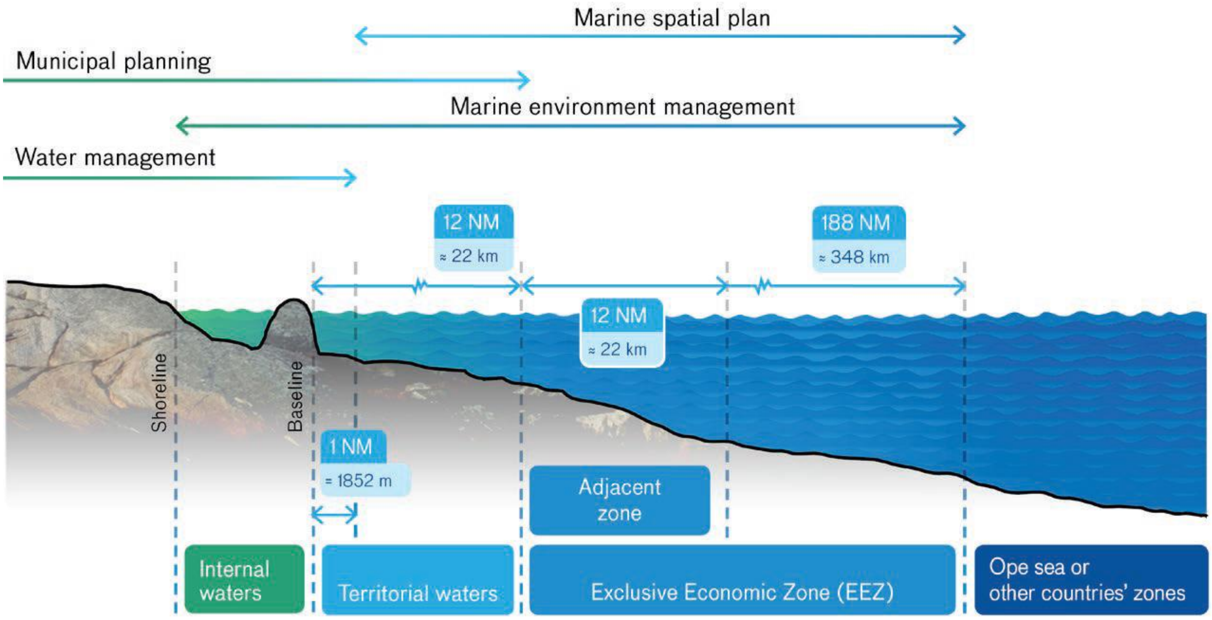
This principle is also addressed in the Developing step of MSP (see Section 3.2.2).

Distinct boundaries

Both jurisdictional and ecosystem boundaries should be considered when defining distinct boundaries within which MSP will be developed (Piet et al., 2017). An example of such boundaries can be found in the Swedish National Marine Plan (Swedish Agency for Marine and Water Management, 2019). The Plan applies different boundaries, including boundaries in the area of the law of the sea, jurisdictional boundaries relevant to different responsibilities (see Figure 1), and ecosystem boundaries. A fundamental principle of MSP (as part of marine and water management) is that it needs to be coordinated and integrated in all its component parts, as ecosystems know no political or economic boundaries. With water management strongly linked to marine management, water and marine ecosystem management are to be considered as a whole, looking at all human activities, pressures and ecosystems, from the source to the sea.

[1010] Stelzenmuller et al. (2013).

Figure 1: Terms, boundaries and planning responsibilities



Source: Swedish Agency for Marine and Water Management (2019). Note that the State shares planning responsibility for territorial waters with municipalities. In the Exclusive Economic Zone (EEZ), the State has sole planning responsibility.

Another example involving ecosystem boundaries is that of land-sea interactions (LSI), where the potential impacts of land-based activities on the marine ecosystem (e.g. from coastal tourism or agriculture further inland through riverine run-off) are explicitly considered as part of the MSP.

3.2.2 Developing

Ecological integrity and biodiversity

The principle 'ecological integrity and biodiversity' is mentioned in many studies without actual application[11], or is applied without showing practical examples[12]. Some studies provide practical examples, however[13].

Borja et al. (2017) tested and refined 13 available biodiversity indicators and compiled a set of publications and case studies. Integrated assessment of the status of marine biodiversity is - and has been - problematic compared to, for example, assessments of eutrophication and contamination status. This is chiefly a consequence of the fact that monitoring of marine habitats, communities and species is expensive, often collected at an incorrect spatial scale and/or poorly integrated with existing marine environmental monitoring efforts (Borja et al., 2017). Andersen et al. (2014) (in Borja et al., 2017) aims to introduce and describe a simple tool for integrated assessment of biodiversity status based on the HELCOM Biodiversity Assessment Tool (BEAT), where interim biodiversity indicators are grouped by themes: broad-scale habitats, communities and species, as well as supporting non-biodiversity indicators. Andersen et al. (2014) also reports the application of an initial

[11] Barbanti et al. (2015); Bergström et al. (2019); Campostrini et al. (2018); Department for Environment Food and Rural Affairs UK (2014); Ehler and Douvere (2009); Backer et al. (2013); Norwegian Ministry of Climate and Environment (2015).

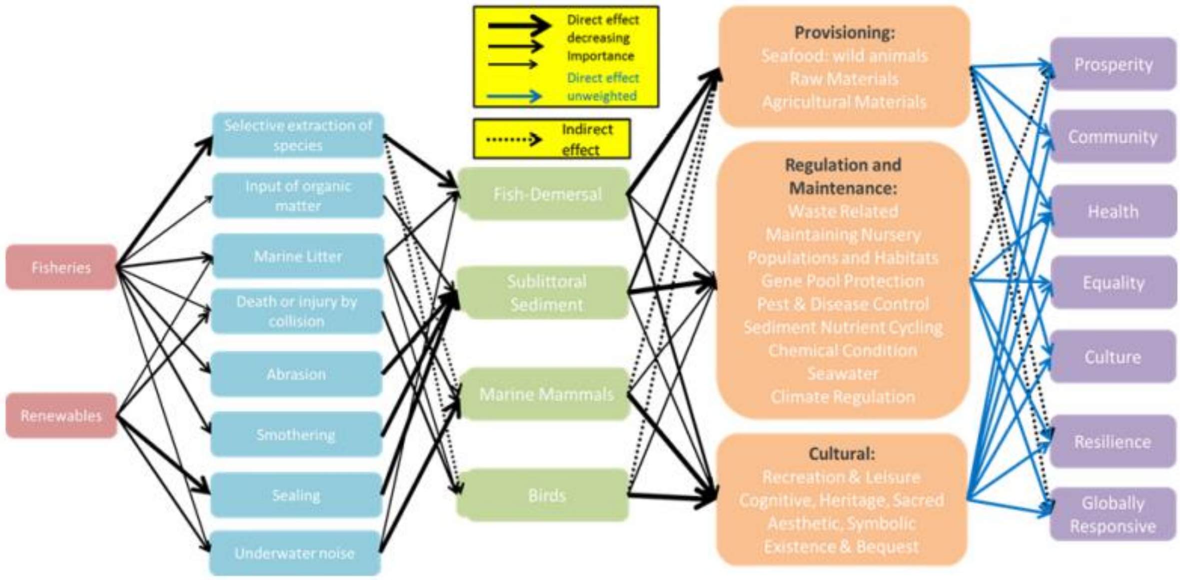
[12] ADRIPLAN (2017); Stelzenmüller et al. (2013).

[13] Borja et al. (2017); Piet et al. (2017); Swedish Agency for Marine and Water Management (2017, 2019).

indicator-based assessment of biodiversity status of Danish marine waters where the biodiversity status of Danish marine waters has been tentatively classified. Examples (including maps with calculated biodiversity status and confidence) are shown.

Another example is the linkage framework (see Figure 2), where different ecosystem components represent biodiversity. The framework illustrates the elements of the SES that are relevant for assessments supporting MSP. The ecological system emerging from the identification of the relevant human activities, their pressures, and affected ecosystem components (representing biodiversity) provide ecosystem services that contribute to societal well-being. This represents the supply-side. The components represented in the relevant SES need to be covered by the case study-specific knowledge base. Each case study should undertake an assessment of the quality of its knowledge base to inform EBA.

Figure 2: Linkage framework illustrating relevant elements for assessment of SES in the North Sea Case Study



Source: Piet et al. (2017).

Appropriate spatial and temporal scales

Depending on the scale of the operational objectives and the availability of data in the spatially managed area (see Section 3.2.1), information is not always available at the relevant spatial or temporal scale for management. Stelzenmüller et al. (2013) reviewed several studies and noted that:

- A mismatch of scales makes it difficult for managers to account for the joint human-natural systems of tomorrow and to incorporate those into their planning processes;
- Spatial management measures need to be aligned in such a way that they address objectives from the local to regional scales.

In the case of the Swedish National Marine Plan, the analysis is carried out at different levels (e.g. for a specific location that requires particular attention, for Sweden as a whole, for the Baltic region, or for a given ecosystem). Different planning options are compared and their consequences analysed from economic, social and ecological perspectives (Swedish Agency for Marine and Water Management, 2019). This is described in more detail in the next chapter.

Consider ecosystem connections

The connections between the different ecosystem components are part of ecosystem integrity. The connections may involve predator-prey relationship (through the foodweb) but also competition for space or other limited resources, for example. Where the linkage framework (Figure 2) shows the direct interactions with human activities, integrating the connections between ecosystem components may allow inclusion of (the main) indirect impacts of human activities. This, however, must be balanced against increased complexity, greater requirements of the knowledge base, and the integration of (more) EBA.

Connectivity between different habitats is particularly relevant from an MSP perspective. One of the five ecological principles considered by Manea et al. (2020) is 'species and habitat connectivity' where longitudinal, latitudinal or vertical (i.e. surface waters and deep-sea environments) may be relevant. Spatial identification of priority areas of conservation may involve identification of Marine Protected Areas (MPAs), Vulnerable Marine Ecosystems (VMEs), or the identification of Ecologically or Biologically Significant Marine Areas (EBSAs). However, functional connectivity is poorly embedded in the identification process of both VMEs and EBSAs. An approach that does incorporate connectivity is that of critical habitats, i.e. the subset of habitat that is essential to the survival and recovery of species (Camaclang et al., 2015). Critical habitats are intended as nodes of connectivity suitable for hosting the recovery of endangered species in the future, thus ensuring their persistence in time (Camaclang et al., 2015). This approach to the spatial identification of priority areas is thus suitable for implementation of the EBA principle 'consider ecosystem connections'[14].

Account for dynamic nature of ecosystems

Piet et al. (2017) provided a number of recommendations to account for the dynamic nature of ecosystems, especially variation in the ecological part of the SES (e.g. due to perturbation):

- The use of longer time-series provides a better knowledge base that can capture (part of) the dynamic nature of ecosystems;
- Assessments need to identify exogenous drivers (such as climate change, macroeconomic developments) that will impact the functioning of ecosystems. Some attention to feedback loops is required, distinguishing in particular feedback that maintains desired regimes versus break or disturb feedback that maintains undesired regimes in the functioning of ecosystems;
- In many cases, causal relationships directing the functioning of ecosystems are non-linear. Thus, look for non-linearities in the system, as these are often the cause of the dynamic nature.

Manea et al. (2020) identified the (seasonal) variability of dynamic processes as part of the missing knowledge for the deep Mediterranean MSP and suggested several strategies to overcome the limits due to this lack of empirical knowledge:

- Habitat mapping techniques and predictive suitability models are highly informative and fundamental in assessing both habitats and species distribution, when supported by reliable data. Supporting scientific research is essential, as is incorporating timely new knowledge in plans;
- Climate and cumulative impact models that assess present and future environmental conditions through scenario analysis can be suitable tools, as they often incor-

[14] Manea et al. (2020).

porate multiple sources of information through expert judgement, which is necessary to overcome the lack of knowledge when decisions are needed (Manea et al., 2020);
- The continuous up-take of new knowledge and strict relationship between science, policy and managers will be essential to predict future conditions (see Chapter 6).

3.2.3 Assessing

Consider cumulative impacts

Menegon et al. (2018) presents a comprehensive set of built-in geospatial webtools, including a cumulative impact analysis tool, that can support MSP and the integration of environmental management objectives in the planning process in coherence with EBA. Implemented in the Tools4MSP interoperable GeoPlatform (ADRIPLAN, 2017), it has been applied in cases studies, with results presented as CEA scores in maps and statistics. The tool is designed to assess the potential cumulative impacts of maritime activities on the marine environment. The tool was tested for the Adriatic-Ionian sub-basin but can be applied to any marine research area. The stepwise methodology implemented for the cumulative impact assessment tool is shown in Figure 3 and includes:

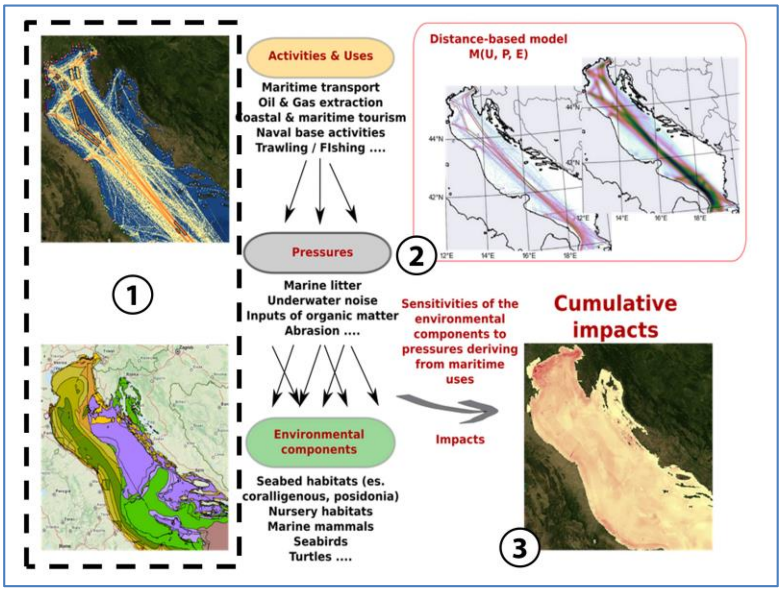
1. The collection of geospatial datasets on human activities and environmental components;
2. Expert-based analysis of sensitivity scores, including the definition of their confidence level;

Computation and visualisation of geospatial results of the cumulative impact assessment (see Source: ADRIPLAN (2017).

Note: P: Pressure; U: human use; E: environmental component.

3. Figure 4).

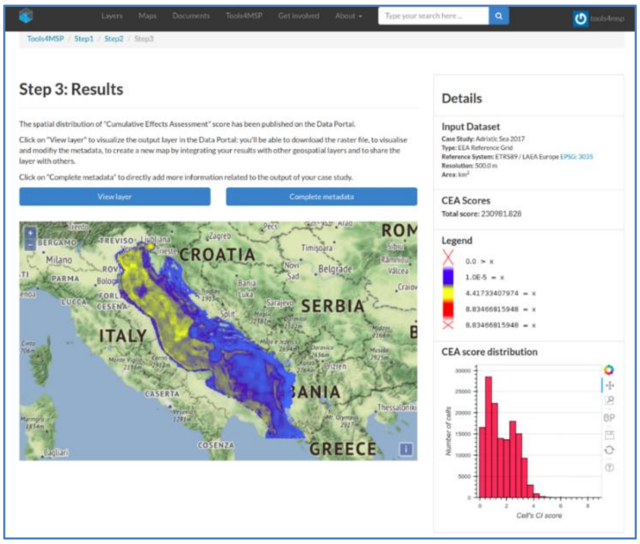
Figure 3: Stepwise methodological approach to the cumulative impact assessment



Source: ADRIPLAN (2017).

Note: P: Pressure; U: human use; E: environmental component.

Figure 4: Example of Graphical User Interface presenting geospatial and statistical results



Source: Menegon, Sarretta, et al. (2018).

More examples of approaches for addressing cumulative impacts are available in the literature[15].

3.3 What opportunities offered by other EU policies and legislation can facilitate the application of EBA?

The analysis of the main EU policies (MSFD, WFD, Biodiversity Strategy, Common Fisheries Policy (CFP) and Strategic Environmental Assessment (SEA) Directive illustrates how key policies and legislation can help understandings of the complexity of marine ecosystems and internalise that understanding in the MSP process. More specifically:

- The **WFD** provides information on different land-based pressures linked to agriculture, industry, population (and related water services: drinking water and wastewater treatment). This information can be used to understand factors that influence the current state of marine ecosystems and how these are affected by land-based pressures. It can also help to identify hotspots of poor quality where it would not be possible to develop some maritime activities, such as aquaculture if land-based pressures are not significantly reduced. Not all land-based pressures are considered in the WFD. For example, the WFD does not formally address litter challenges, although litter from the land can be integrated in the WFD River Basin Management Plans (RBMPs) and Programme of Measures (PoM)[16]. In some cases, the knowledge and modelling tools developed under WFD implementation consider the impacts of land-based pressures (e.g. nutrient discharge) on the quality of coastal waters but not impacts on marine ecosystems.
- The **MSFD** aims to achieve Good Environmental Status (GES) of the EU's marine waters and to protect the resource base on which marine-related economic and social activities depend. It is the first EU legislative instrument related to the protection of marine biodiversity, as it contains the explicit regulatory objective that

[15] See, for example, Bergström et al. (2019), Piet et al. (2017), Ramieri et al. (2014), Swedish Agency for Marine and Water Management (2017, 2019).

[16] This is the case in France where the second RBMPs for river basin districts that have a significant coastal component are addressing litter to supporting the achievement of the MSFD objectives.

'biodiversity is maintained by 2020', as the cornerstone for achieving GES. The Directive enshrines an EBA in the management of human activities impacting on the marine environment, integrating the concepts of environmental protection and sustainable use. In order to achieve its goal, the Directive establishes European marine regions and sub-regions on the basis of geographical and environmental criteria. The Directive lists four European marine regions, the Baltic Sea, the Northeast Atlantic Ocean, the Mediterranean Sea and the Black Sea, with Regional Sea Conventions (RSCs) put in place to coordinate Member States' actions, including with those of third countries in the same region or sub-region**.** Cooperation between the Member States of one marine region and with neighbouring countries sharing the same marine waters is already taking place through these RSCs. In order to achieve clean, healthy and productive seas with GES, each Member State was required to develop a strategy for its marine waters (marine strategy). In addition, because the Directive follows an **adaptive management approach**, the marine strategies must be kept up-to-date and reviewed every six years. The work on MSFD implementation is done in the framework of the Common Implementation Strategy of the MSFD, with expert groups established for specific issues (e.g. marine litter, noise). It provides considerable information on the pressures and state of marine ecosystems, building on the knowledge provided by the WFD for land-based pressures. Some of these data are drawn from reporting under other EU legislation, including the CFP and the Birds and Habitats Directives. The quality of the information available varies considerably between descriptors and sources of pressures, with better knowledge available for water quality, (fish) biomass or marine biodiversity than for emerging descriptors like noise.

- The **Birds and Habitats Directives** provide data on protected marine species as well as on protected areas, specifically those designated as Natura 2000 sites. The Natura 2000 site management plans, in particular, should provide detailed information on ecosystems within their boundaries, and potentially in a broader geographical context.
- Monitoring and reporting obligations under the **CFP** will deliver information on fish stocks and landings, as well as the spatial distribution of fishing vessels (through VMS) that can help in assessing current state and pressures imposed by fisheries[17], and can provide further data.
- The procedures for SEA under the **Environmental Impact Assessment (EIA)** and **SEA Directives** should gather and assess information on environmental impacts in general, and on the current state of ecosystems in particular, so as to identify a baseline from which to measure the impacts of MSP. In some Member States, the SEA process can run in parallel with the preparation of the MSP, facilitating coordination on EBA aspects and enrichment of the EBA analysis. In others, the SEA is carried out sequentially after the MSP, verifying and building on the analysis carried out in planning.

While these directives, in principle, provide knowledge that can help in addressing the complexity of marine ecosystems, the format and focus of that information complicates their use. Particular limitations relate to:

- **Space** – information collected under the different directives cannot easily be connected to the main components of marine ecosystems that are the focus of an MSP process. In some cases, information might not cover the entire marine ecosystem, with more attention given to coastal areas than others (further in the sea/high-sea) parts of the ecosystem that are relatively information-poor (it is more complex and costly to collect data and information there). In other cases, the aggregation used

[17] The information is also relevant to the human-marine ecosystem relationships, as landing helps to capture the socioeconomic importance of the fisheries sector.

for the different directives (e.g. coastal water bodies for the WFD or marine regions for the MSFD) might not represent the right units for the MSP process (except for MPAs under the MSFD that will be addressed as such in the MSP process).

- **Time** – much of the information provided by these directives is 'one-off', related to a given year or to a few years at a time interval that might not help with capturing the dynamic functioning of marine ecosystems. At the same time, limited attention is given to how marine ecosystem are likely to evolve (pressures, state, challenges with different descriptors) over time under a business-as-usual scenario, including climate change. Even where more attention is given to the past and to the future, this can be limited in terms of spatial coverage, for example linked to specific research activities or to the development of a maritime project that required specific financial assessments. Time also relates to when information is provided: SEA of MSP can come too late in the MSP development process, at a time when most decisions are already made. Carrying out SEA-like assessments at early stages of the MSP process (including when updating plans) that address cumulative impacts for different marine space-sharing options are likely to ensure that cumulative impacts are adequately considered when choosing the option that will form the basis for the final MSP.

Addressing the complexity of marine ecosystems does not mean looking systematically at all issues and causal relationships all the time. This would simply create confusion and allocate (scarce) human resources to issues of limited relevance and marginal societal added value. Of key importance is to identify the priority components and causal relationships of (complex) marine ecosystems, building on sound screening and priority-setting mechanisms and methods that account for expertise and contributions from a wide range of stakeholders (see Chapter 6 for a discussion of early stakeholder involvement). If such a screening process is not well established, there is a risk that efforts to collect information and carry out assessments will not be cost-effective in highlighting main challenges and supporting a sound MSP.

3.4 Addressing transboundary issues and challenges

Applying an EBA means understanding the connections between ecosystem components that may fall under different jurisdictions, Member States or third countries. The main challenges will be linked to the possibility of obtaining sufficient data across those boundaries with an adequate level of consistency (how they are assessed, type of information, spatial coverage).

The different EU directives all consider transboundary issues and challenges and should, therefore, facilitate addressing transboundary issues in the MSP process. However, it might not be straightforward with knowledge produced under the WFD. While the WFD addresses transboundary issues in international river basins (in particular with upstream-downstream connections between water uses and aquatic ecosystems, and considering coastal waters shared by neighbouring countries), there is no formal mechanism for combining and sharing WFD knowledge between countries that share the same regional sea, although this can take place when RSCs play an active coordination role. Secondly, limitations remain when EU and non-EU countries share a marine ecosystem. Here, the challenges are more significant because of differences in regulatory frameworks. RSCs, in cooperation with other regional organisations such as regional fisheries management organisations (RFMOs), can facilitate the setting up of an MSP process at the transboundary scale, potentially taking a leading role to ensure that the functioning of the full (transboundary) ecosystem is considered and investigated. For example, the Helsinki Commission (HELCOM) has undertaken a range of work to develop common data and mapping for the Baltic Sea[18] and has worked with VASAB to support a range of common work related to MSP.

3.5 What is the added value?

Addressing the complexity of marine ecosystems in all their (priority) dimensions is essential to support a sound MSP that balances the protection of marine ecosystems with socio-economic (blue economy) developments.

- If the connections between components of the ecosystem are not well understood, there is a high risk that activities developed in one part of the marine ecosystem will have negative impacts on activities carried out elsewhere, or on the status of marine ecosystems, including in MPAs. This would then undermine the (potentially costly) efforts to manage and protect marine ecosystems.
- If there is no clear understanding of cumulative impacts (for the current situation and for different options for sharing marine space), activities developed in different parts of the marine ecosystems can result jointly in more significant impacts on marine ecosystems, again undermining efforts to protect those systems.
- When the dynamic functioning of the marine ecosystem is well understood, the MSP proposed can account for future changes and is likely to be a useful tool in guiding investment and protection activities in the medium-term.

[18] See https://maps.helcom.fi/website/mapservice/ and, specifically for MSP, https://basemaps.helcom.fi/

4 HUMAN-ECOSYSTEM CONNECTIONS AND INTEGRATION

4.1 What does EBA in MSP require/imply?

The key to EBA is understanding the SES and the multiple (positive and negative) interactions between human activities and the functioning of the marine ecosystem. This requires understanding:

- The socioeconomic importance of **human activities**, be it maritime or land-based, **that impose pressures** directly or indirectly (via fresh water) on marine ecosystems. In some cases, pressures and their impacts on the environmental status of marine ecosystems can limit the potential for blue economy developments in some parts of the marine ecosystem, resulting in **foregone development opportunities** that could be assessed. If such blue economy developments were considered a priority, they could steer the implementation of measures addressing pressures, thereby contributing to environmental status improvements.
- **Human activities** that benefit, directly or indirectly (via the value chains of maritime/marine products and services), from the **ecosystem services** provided by marine ecosystems. Understanding the socioeconomic value and societal importance of these services and their beneficiaries can help: (a) assessing the potential socioeconomic impacts of different maritime planning options that are considered in the MSP process; and (b) selecting the option that delivers the best societal outcome, including maximising the benefits obtained from ecosystem services delivered by the sustainable shared use of maritime space.

Much like understanding the complexity of the marine ecosystem (see Chapter 3), addressing the human dimension of marine ecosystems requires due attention to be given to **space and time**. In order to be relevant and useful, the analysis of human activities in connection with marine ecosystems needs to: (a) provide results at **(disaggregated) scales** that are relevant to the MSP process and to the different options considered for sharing maritime space; (b) help understanding the **dynamics of human activities** (including in terms of resulting pressures) by providing knowledge on past and future developments including for defining the business-as-usual scenario that the MSP process needs to use as reference; and (c) help understanding **changes in human activities** that might result from different sharing space options and thus anticipate potentially (unintended) negative changes for human activities themselves and for the protection of marine ecosystems[19].

The socioeconomic information that is obtained, including information on the societal importance of ecosystem services delivered to different human activities and combined with information on the costs of the measures proposed for implementing and managing the MSP, can then **feed into economic** (cost-benefit analysis (CBA)) or **wider** (multi-criteria analysis) **assessments** of different options[20] considered for the sharing of maritime space. Combined with stakeholder considerations and contributions, this can help in identifying the optimal allocation of maritime space to be considered in the MSP.

[19] For example, translocation of fishing efforts resulting from the MSP that can threaten the sustainability of fish stocks in new areas, or changes in maritime transport routes that can degrade ecosystems preserved so far.

[20] Best combined with the SEA of these different options to address environmental concerns, including in relation to cumulative impacts.

4.2 What evidence, methods and practice are evident in the literature?

The MSP literature provides very limited evidence on the socioeconomic and human dimensions of maritime space and MSP. When the literature refers to human activities, it often limits the analysis of these activities by presenting qualitative and quantitative information (e.g. number of fishers, or tourists) that explains the order of magnitude and the importance of pressures imposed on marine ecosystems. Information on the socioeconomic importance of sectors can sometimes be provided for blue economy sectors that are expected to develop as a result of the implementation of the MSP. Information on the economic importance of current users of the maritime space, on sectors imposing pressures (including land-based), on the economic value of ecosystem services provided by marine ecosystems, and on possible socioeconomic impacts is rarely mobilised and is, at best, qualitative. There did not appear to be any full-fledged CBA carried out to support MSP processes.

Nevertheless, socioeconomic information on different facets of marine ecosystems can be found beyond the literature on MSP, including knowledge developed in the context of other directives and policy processes (see next section). The following paragraphs illustrate the type of socioeconomic information that could be developed or could feed into the MSP process in order to pay increased attention is given to the human part of the SES.

Assessing the socioeconomic importance of blue economy sectors

The **blue economy** encompasses all sectoral activities that are marine-based (activities undertaken in the ocean, sea and coastal areas) or marine-related (activities which use products and/or produce products and services from the ocean or marine-based activities). The established sectors are a major contributor to the EU blue economy and include: marine living resources, marine non-living resources, marine renewable energy, port activities, shipbuilding and repair, maritime transport and coastal tourism. Information on the socioeconomic importance of these sectors is available at the aggregated and national scales, and generally also provided as a result of the **MSFD Economic and Social Assessment**[21].

At the aggregated EU scale[22], in 2018 the established sectors employed close to five million people, generated around EUR 750 billion in turnover, EUR 218.3 billion in gross value added, and EUR 95 billion gross operating surplus (profit). The contribution of the blue economy established sectors to the EU-28 economy in 2018 was 1.5% in terms of gross value added and 2.2% in terms of employment. Total gross added value increased by 15% compared to 2009. In absolute terms, the four largest Member States (Spain, Germany, Italy and France) are the largest contributors to the EU blue economy both in terms of employment and gross value added. The gross added value of established blue economy sectors was EUR 218.3 billion. Coastal tourism is the largest blue economy sector (40% of gross added value) in the EU. The sector plays an important role in many Member State economies, especially in southern EU Member States, and it shows the highest growth in gross added value: +16% compared to 2017. Maritime transport (16%) and port activities (16%) are the second and third largest sectors. The total employment by blue economy sectors was five million in 2018, an increase of 12% compared to 2017. Coastal tourism is the most important sector, accounting for 62% of total employment, followed by marine living resources (11%) and port activities (11%).

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[21] European Commission (2018). Economic and social analysis for the initial assessment for the Marine Strategy Framework Directive. DG Environment, Brussels. P. 66 (MSFD Guidance Document 1).

[22] See: European Commission, DG MARE, The EU Blue Economy Report 2020, 2020_06_BlueEconomy-2020-LD_FINAL-corrected-web-acrobat-pro.pdf; European Commission, DG MARE, Blue indicators dashboard, Blue indicators online dashboard | 'DG Mare Blue Economy' (europa.eu).

Other relevant emerging and innovative sectors include: marine renewable energy, blue bioeconomy and biotechnology (economic activity associated with the use of renewable aquatic biological biomass), marine minerals, desalination, maritime defence, and submarine cables. Data availability for these sectors is still relatively low but they offer significant future potential. The blue energy emerging sector, including tidal energy, wave energy, floating offshore wind, hydrogen generation and floating solar photovoltaic energy, has developed rapidly in recent decades, supported by EU research and development (R&D) funding (expenditure on ocean energy was EUR 420 million in 2019). The blue economy is linked to many other economic activities and its impact goes beyond the abovementioned sectors. All sectors have indirect and induced effects, and each has important multiplier effects on income and employment in other sectors of the economy.

Investigating the economic importance of marine ecosystem degradation

The MSFD asks Member States to assess the economic costs imposed on society as a result of the (current and future) degradation of the environmental status of marine ecosystems. These costs - **cost of degradation of marine ecosystems** - can be evaluated in different ways, e.g. by assessing a lost profit/gain, or an increase in production or mitigation costs imposed by the current quality of marine ecosystems. The assessment of the cost of degradation can be quantitative or qualitative. The cost of degradation usually measures the damage caused to several environmental categories: water, air quality, agricultural land, forests, waste, and coastal zone. Cost of degradation estimates are based on standard valuation techniques, depending on data availability in each country. In practice, the assessment faces issues such as the definition of the reference scenario and the difficulty of estimating monetary values (in particular for sectors that benefit from a healthy ecosystem but do not operate in markets and thus have no market value).

Member States have evaluated the cost of degradation of the marine ecosystem in the context of their MSFD ESA, although it is not yet clear if this information was used effectively in MSP processes carried out by individual Member States. Three approaches were used[23]: the cost-based approach, the ecosystem services-based approach, and the thematic-based approach. Member State reporting shows significant differences in estimates of the cost of degradation[24]. In absolute terms, the cost of degradation varies between EUR 3 million/year (Belgium) to EUR 2,540 million/year (France). In relative terms, it varies from EUR 0.3/inhabitant/year (Belgium) to EUR 363/inhabitant/year (Malta).

Investigating the social and economic importance of marine ecosystems and the services they deliver

Healthy marine ecosystems provide a variety of ecosystem services and benefits. For example, MPAs provide benefits beyond their sole conservation objectives, such as[25]:

- Food provision: Imposing restrictions on certain fishing gear or fishing in general proved to have significant positive effects on the conservation of commercial species, through the increase in biomass of large fish, as well as an increased reproductive potential within the MPA, the increased survival rate of larvae and the spillover of adult fish to nearby fishing grounds. These positive impacts may in fact compensate fishers for the loss of fishing grounds imposed by MPA establishment, and eventually help to increase yields.

[23] European Commission (2012). Guidance for 2012 reporting under the Marine Strategy Framework Directive. DG Environment, Brussels.

[24] ACTeon (2021 – forthcoming). Analysis of the reported results of the MSFD Economic & Social Assessment.

[25] Russi, D., Pantzar, M., Kettunen, M., Gitti, G., Mutafoglu, K., Kotulak, M. and ten Brink, P. (2016). Socioeconomic benefits of the EU Marine Protected Areas. Report prepared by the Institute for European Environmental Policy (IEEP) for DG Environment, https://ec.europa.eu/environment/nature/natura2000/marine/docs/Socio%20-Economic%20Benefits%20of%20EU%20MPAs.pdf

- Climate change mitigation: The conservation of important marine and coastal ecosystems such as mangroves, saltmarshes and seagrasses helps to contribute to climate change mitigation, as these species serve as important carbon sinks.
- Nature-based tourism and recreation: The EU's gross value added from coastal and natural based tourism is around EUR 183 billion each year and employs over 3.2 million people[26]. MPA establishment can render a specific site more attractive and increase tourism revenue. However, as tourism may lead to destruction of sensitive sites, it requires good management and monitoring.
- Coastal security: Coastal and intertidal ecosystems such as seagrass beds, mudflats, saltmarshes and biogenic reefs provide important benefits to coastal communities and infrastructure as they help with stabilising sediments and reducing erosion, thereby reducing the effects of storm surges, waves and floods. Proper planning and establishment of MPAs will help to conserve these ecosystems, which serve as natural protective barriers. In the long-term, this will help to protect local communities from the effects of extreme climate events and reduce their need to build expensive coastal protection infrastructure.
- Opportunities for blue biotech, bioprospecting and research: some marine species and their biological and genetic diversity are gaining international recognition, particularly in the production of certain food products, medicinal products, biofuels and textiles. While the development of these economic activities may result in monetary benefits for communities and may lead to innovations in sustainable industrial production, they may also damage fragile ecosystems. Through the establishment of MPAs and imposing restrictions on development of certain areas, these resources may be preserved for a long term and create a sustainable blue biotech sector.
- Other socioeconomic benefits: Well-managed protected areas help to enhance the well-being of local communities and non-resident users. They can offer opportunities for cultural, spiritual, educational and recreational activities[27].

Categorised differently, the social impacts of protected areas include[28]: well-being and health; human rights and access to resources; knowledge and education; livelihoods; local culture; social relations; social equity, inclusion and empowerment.

Several health and social benefits are associated with the protection and enhancement of biodiversity in the EU, in particular in relation to the Natura 2000 Network. Assessing these benefits can support policy recommendations and promote linkages between socioeconomic and environmental policies at EU level. Health and social benefits of nature and biodiversity protection cover a wide range of benefits[29], not all of which are relevant to marine ecosystems investigated in a MSP process: direct and indirect health benefits; improved air quality and health benefits; improved climatic conditions and addressing heat stress; noise reduction benefits; pleasant, peaceful and less stressful environment; healthier lifestyle; outdoor recreation and physical activity; well-being – living in an attractive

[26] Ecorys (2013). *Study in support of policy measures for maritime and coastal tourism at EU level*. Final report of a study for the European Commission, DG Maritime Affairs & Fisheries, https://ec.europa.eu/maritimeaffairs/sites/maritimeaffairs/files/docs/body/study-maritime-and-coastal-tourism_en.pdf .

[27] Russi, D., Pantzar, M., Kettunen, M., Gitti, G., Mutafoglu, K., Kotulak, M. and ten Brink, P. (2016). Socioeconomic benefits of the EU Marine Protected Areas. Report prepared by the Institute for European Environmental Policy (IEEP) for DG Environment, https://ec.europa.eu/environment/nature/natura2000/marine/docs/Socio%20-Economic%20Benefits%20of%20EU%20MPAs.pdf

[28] Jones, N., Graziano, M. and Dimitrakopoulos, P. G. (2020). 'Social impacts of European Protected Areas and policy recommendations'. *Environmental Science and Policy*, 112, 134–140. doi: 10.1016/j.envsci.2020.06.004.

[29] ten Brink, P., Mutafoglu, K., Schweitzer, J-P., Kettunen, M., Twigger-Ross, C., Baker, J., Kuipers, Y., Emonts, M., Tyrväinen, L., Hujala, T. and Ojala, A. (2016). The health and social benefits of nature and biodiversity protection. A report for the European Commission (ENV.B.3/ETU/2014/0039), Institute for European Environmental Policy, London/Brussels, https://ec.europa.eu/environment/nature/biodiversity/intro/docs/Health%20and%20Social%20Benefits%20of%20Nature%20-%20Final%20Report%20Main%20sent.pdf

location; promoting social cohesion: quality of green public spaces, reduced social tension; and opportunities for involvement in volunteering, employment and management.

Additional examples presenting the results of valuation of ecosystem services include[30]:

- An assessment of the values of ecosystem services in Ireland and the contributions of provisioning, regulation and cultural marine ecosystem services to Irish society[31]. For example, the annual economic value of recreational services, fisheries and aquaculture, carbon absorption services and waste assimilation services were estimated at EUR 1.6 billion, EUR 664 million, EUR 819 million and EUR 317 million, respectively.
- To support a review of the Finnish Marine Strategy in 2018, a primary valuation study was carried out using a contingent valuation method[32]. Covering the 11 GES descriptors of the MSFD, the study estimated that failure to achieve GES would cost Finland between EUR 432 and 509 million annually. The survey stressed the high importance placed on cultural ecosystem services by Finnish citizens, with values given to a healthy marine environment independent of respondents' distance from the sea/coastline, and whether or not they use the sea themselves[33].

Assessing costs and benefits

CBA can be a powerful tool to feed the debate on whether protection and conservation measures should be implemented, and to compare different measures, by evaluating the costs and benefits to society of such measures, and their distribution across society. Measures include the creation of MPAs or measures to reduce plastic pollution. Previous studies[34] highlighted the limited application of CBA in the marine domain, as a result of the many challenges in respect of the application of CBA to the protection and conservation of marine ecosystems.

It is often challenging to **assess the physical (biological) effects of a measure,** in other words, the effectiveness of a measure. For example, after an MPA is implemented, the with-MPA scenario is observable, whereas the without-MPAs is unobservable and values can thus be difficult to estimate[35]. Similarly, when designing an MPA, it can be difficult to estimate the expected impacts, as the MPA is open and thus influenced by what happens outside. In this case, bioeconomic models are used to simulate with-MPA and without-MPA scenarios[36]. In the case of plastic pollution, estimating the effectiveness of available

30 See, for example, European Marine Board (2019). Valuing marine ecosystems. Taking into account the value of ecosystem benefits in the blue economy. Future Science Brief, N° 5 April 2019.

31 Norton, D., Hynes, S. and Boyd, J. (2018). Valuing Ireland's coastal, marine and estuarine ecosystem services. EPA Research, report n°. 239.

32 Nieminen, E., Ahtiainen, H., Lagerkvist, C. J. and Oinonen, S. (2019). 'The economic benefits of achieving Good Environmental Status in the Finnish marine waters of the Baltic Sea'. *Marine Policy*, 99 (September 2018), 181–189, https://doi.org/10.1016/j.marpol.2018.10.014

33 Similar studies have since been carried out for Germany and Sweden. Articles presenting the results of these studies are not yet published.

34 See, for example, Plan Bleu, ACTeon and Arcadis (2019). Socioeconomic analysis of marine litter key best practices to prevent/reduce single use of plastic bags and bottles, https://planbleu.org/en/publications/socioeconomic-analysis-of-marine-litter-key-best-practices-to-prevent-reduce-single-use-of-plastic-bags-and-bottles/ (in French).

35 Davis, K.J., Vianna, G.M.S., Meeuwig, J.J., Meekan, M.G. and Pannell, D.J. (2019). 'Estimating the economic benefits and costs of highly-protected marine protected areas'. *Ecosphere*, 10(10), https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/ecs2.2879

36 Idem.

measures proved challenging. In a study carried out for Plan Bleu[37], estimates of the expected effectiveness of measures at Mediterranean level were based on (scarce) available literature.

For protection and conservation measures, their bio-physical effects are not the only measure of effectiveness, as other more 'intangible' effects can, in principle, enhance bio-physical effectiveness over the longer term. In a study for the Mediterranean sea[38], for example, the effectiveness of measures against plastic pollution was considered to comprise the following dimensions: maximum litter reduction/removal potential, in terms of weight of avoided plastics per year; entrance or permanence of plastic in the marine environment, as from an environmental perspective it makes a difference whether or not plastics reach the sea; and awareness-raising potential and incentives, which reinforce the litter reduction potential of a measure (for example by decreasing use).The second and third dimensions are not usually considered in standard CBA, although they should receive attention in decision-making processes.

In the case of protection and conservation measures, **all costs and benefits should be carefully identified**, including[39]: (a) direct costs and benefits, including all financial costs and benefits linked to design, implementation, enforcement and compliance; (b) direct economic impacts – on the cost side, this category includes economic losses or gains for one specific sector following the introduction of a measure (e.g. increase/decrease of production/sales), as well as employment impacts of the measure; and (c) indirect benefits resulting from environmental improvement: reduced plastic waste into the sea can result in economic benefits for some economic groups, such as savings in the fishing sector due to reduced cleaning and repair operations. In addition, measures against plastic pollution can result in increased delivery of ecosystem services, with benefits for a range of activities dependent on GES. Indirect benefits associated with existence and option values are also part of this category, but these were not assessed in this study. In addition, the opportunity costs of implementing conservation or protection measures should also be assessed[40].

The **distribution of costs and benefits** among society requires specific attention, as it provides crucial information to the decision-making process, including identifying compensatory measures and/or instruments that can make some impacts more acceptable to social groups. Illustrations of costs and benefits of measures against plastic pollution in the Mediterranean assessed with specific reference to socioeconomic groups helped to capture sectors and groups bearing the costs or enjoying the benefits[41]. As a first step, the pathways of plastic bottles and bags from production to the sea were identified, specifying the part of the system that would be targeted by measures proposed for addressing plastic pollution. Based on this, socioeconomic groups involved in marine plastic pollution were identified. Other groups were included in the analysis if relevant, as well as society as a whole.

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[37] Plan Bleu, ACTeon and Arcadis (2019). Socioeconomic analysis of marine litter key best practices to prevent/reduce single use of plastic bags and bottles, https://planbleu.org/en/publications/socioeconomic-analysis-of-marine-litter-key-best-practices-to-prevent-reduce-single-use-of-plastic-bags-and-bottles/ (in French).

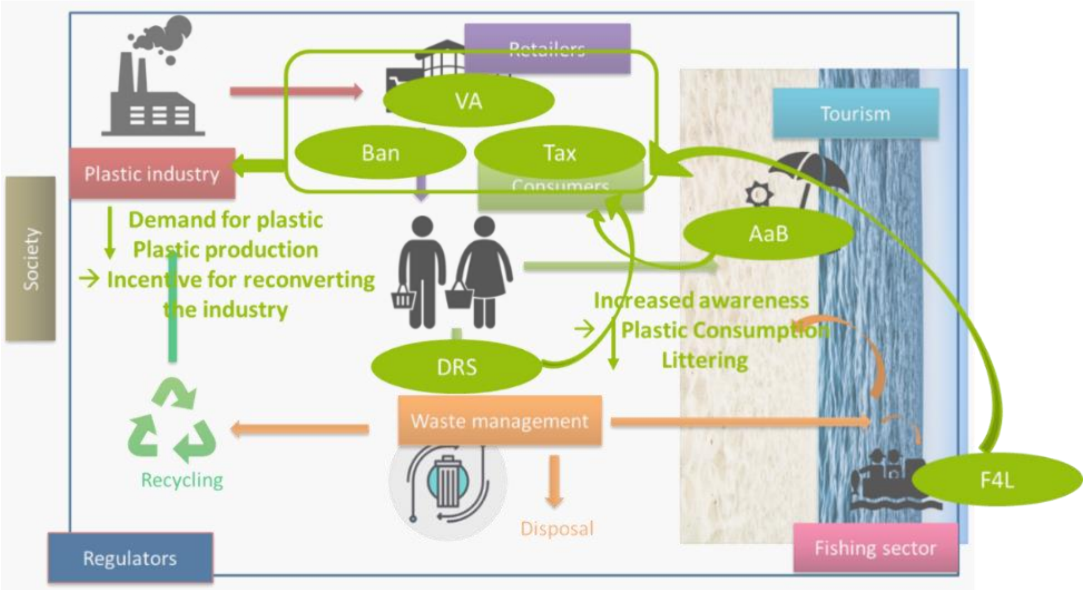
[38] Idem.

[39] Idem.

[40] OECD (2017). Marine Protected Areas: economics, management and effective policy mixes. OECD Publishing, Paris, https://read.oecd-ilibrary.org/environment/marine-protected-areas_9789264276208-en#page4. Davis, K.J., Vianna, G.M.S., Meeuwig, J.J., Meekan, M.G. and Pannell, D.J. (2019).' Estimating the economic benefits and costs of highly-protected marine protected areas'. *Ecosphere*, 10(10), https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/ecs2.2879

[41] Plan Bleu, ACTeon and Arcadis (2019). Socioeconomic analysis of marine litter key best practices to prevent/reduce single use of plastic bags and bottles, https://planbleu.org/en/publications/socioeconomic-analysis-of-marine-litter-key-best-practices-to-prevent-reduce-single-use-of-plastic-bags-and-bottles/ (in French).

Figure 5: Illustrating the framework for assessing distributional impacts resulting from different measures



Source: Plan Bleu (2019).

Protection and conservation measures can deliver **market benefits**, such as increased fish production, but also **non-market benefits**, such as non-commercial tourism and recreation activities. Several valuation techniques (e.g. travel cost method, revealed preference techniques) can be applied to assess these costs. However, some attributes of an MPA, such as those related to the deep sea, lack any direct connection to market activities or values and preclude the use of revealed-preference valuation methods[42]. In the Plan Bleu study, a standard CBA was not conducted. Rather, a mixed evaluation was carried out, based on values available in the literature and case studies – when monetary or quantitative figures could not be found, non-market benefits were included in the assessment in a qualitative way. This approach, although unable to provide clear estimates of the net benefits of these measures, can still be effective in informing the decision-making process. In addition, it is essential to pay specific attention to the double-counting of benefits[43] by: (i) clearly identifying which benefit types are captured in the studies used as source evidence; or (ii) where this is uncertain, adopting a cautious approach to avoid double counting.

Conventional CBA tends to show that most ecosystem restoration programmes are not worthwhile in economic terms. This is because **discounting** significantly reduces future net benefits from restoration, with benefits discounted using the time perspective (the discounting clock) of the current generation only. Instead, it is proposed to apply a generational CBA, which discounts net benefits from the perspective of all generations[44].

[42] Davis, K.J., Vianna, G.M.S., Meeuwig, J.J., Meekan, M.G. and Pannell, D.J. (2019). 'Estimating the economic benefits and costs of highly-protected marine protected areas'. *Ecosphere*, 10(10), https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/ecs2.2879

[43] Idem.

[44] Sumaila, U.R. (2001). Generational cost benefit analysis for evaluating marine ecosystem restoration. sea around us: North Atlantic, p. 3, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.114.1543&rep=rep1&type=pdf

Finally, existing studies point out that **data availability** can be a major issue for CBA of protection and conservation measures in the marine environment, including[45]: (a) data may not exist to support quantitative estimates of ecological and fishing outcomes; (b) lack of relevant non-market valuation studies, such that quantification of non-market benefits is limited; (c) government and fishers' records need to be readily available so that community benefits and industry baselines of catch levels are known; (d) existing cost data may be highly aggregated. As a solution to these issues, the study recommends further research (e.g. on biological population modelling and non-market valuation studies) and the standardisation of reporting for fisheries data and government marine expenditure. An alternative approach could be that adopted in the Plan Bleu study, which does not conduct a standard CBA but, rather, provides an overview of monetary, quantitative or qualitative assessments/estimates of costs and benefits.

4.3 What opportunities offered by other EU policies and legislation can facilitate the application of EBA?

The economic and social assessments carried out under the **MSFD** can provide information on the socioeconomic importance of maritime use, future trends in socioeconomic sectors, the costs of degradation and values of ecosystem services (see section above). However, the review of available socioeconomic information made available and reported by Member States, stresses its high heterogeneity and different levels of completeness.

The economic assessments carried out in the context of the **WFD** can provide information on the economic importance of land-based activities and on (some of the) benefits that can be obtained from achieving good water status for all waters, including coastal waters. However, it is often difficult to separate benefit information relevant to MSP from that to marine waters.

Information on fisheries (landing, employment, etc.) can be obtained from reporting and assessment obligations under the **CFP**.

SEA and assessments carried out for Natura 2000 sites can provide some socioeconomic information, including the economic values of ecosystem services provided by protected sites. Some Member States have explored the assessment of ecosystem services within SEA, although this is not widespread. Some economic assessments are also carried out in relation to the implementation of the Bathing Water Directive and can provide economic information on leisure and tourism-related activities, and the ecosystem services these sectors benefit from[46].

Information on ecosystem services can be obtained from the EU **Mapping and Assessment of Ecosystems and their Services** (MAES) initiative[47]. MAES aims to deliver comprehensive and reliable information on the status of biodiversity, ecosystems and ecosystem services that address marine ecosystems. Combined with available socioeconomic information from other valuation studies, it can help with assessing the socioeconomic importance of marine ecosystems, building on a coherent assessment framework. Such work is expected to continue under the EU **Biodiversity Strategy to 2030** and its follow-up

[45] Davis, K.J., Vianna, G.M.S., Meeuwig, J.J., Meekan, M.G. and Pannell, D.J. (2019). 'Estimating the economic benefits and costs of highly-protected marine protected areas'. *Ecosphere*, 10(10), https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/ecs2.2879

[46] Hanley, N., Hynes, S., Patterson, D. and Jobstvogt, Niels (2015). 'Economic valuation of marine and coastal ecosystems: Is it currently fit for purpose?' *Journal of Ocean and Coastal Economics*, 2(1). DOI:http://dx.doi.org/10.15351/2373-8456.1014 (14).

[47] See http://biodiversity.europa.eu/maes and https://ec.europa.eu/environment/pubs/pdf/factsheets/maes/en.pdf

actions, which include the preparation (in 2021) of a European action plan to conserve fisheries resources and protect marine ecosystems.

Similar to knowledge on the complexity of marine ecosystems, the format and focus of the socioeconomic information produced by these directives does not make their use straight-forward. MSP planners face many limitations in using that information, which is rarely available at spatial scales that are relevant to MSP, often lacks the required disaggregation in terms of the sectors considered (e.g. when using basic socioeconomic statistics), is not coherent between maritime sectors and ecosystem services, and is often fragmented and incomplete. The available information can also be rather outdated. These directives – particularly the MSFD and WFD - provide limited information on future trends of the main economic considerations and their likely (direct and indirect) impacts on the status of marine ecosystems.

4.4 Addressing transboundary issues and challenges

Capturing the socioeconomic component of the SES in a transboundary context does not face any specific methodological challenge. Rather, the main problems is finding data and information that is sufficiently coherent to assess the importance of different maritime sectors, or the socioeconomic values of ecosystem services the sea delivers. When socio-economic studies are carried out, they often focus on impacts within set administrative boundaries, paying limited attention to ecosystem services delivered to, and benefits obtained by, economic activities in other countries.

Current initiatives at the scale of the different RSCs for sharing socioeconomic information and assessment results obtain a transboundary picture of the socioeconomic dimensions of marine waters. The Convention for the Protection of the Marine Environment of the Northeast Atlantic (OSPAR) Commission, for example, has a dedicated work area on economic and social analysis[48], with specific attention given to the economic description of the use of the marine environment, ecosystem services and natural capital, and costs and benefits of measures and economic analyses. Economic and social analyses are also the focus of activities under HELCOM at the scale of the Baltic Sea[49]. Regional initiatives are taking place under UN/Mediterranean Action Plan (MAP) for the Mediterranean Sea (Plan Bleu/ACTeon/Arcadis, 2019). Of interest are the valuation studies following a similar methodology that have been carried out by several countries Finland, Sweden and Germany), a multi-country initiative that will shed light on the socio-economic importance of healthy marine ecosystems in a transboundary context. However, such multi-country assessment initiatives at the scale of regional seas remain rare.

4.5 What is the added value?

Assessing the socioeconomic dimensions of marine ecosystems, including values of ecosystem services, can help to identify an **optimal sharing of maritime space** that accounts for both economic and environmental protection objectives. This is expected to contribute to the cost-effective achievement of the objectives of the MSP.

At the same time, the socioeconomic knowledge on ecosystem services can help stakeholders and citizens to better capture the importance of marine ecosystem protection, jus-

[48] See https://www.ospar.org/work-areas/cross-cutting-issues/economic-social-anaylsis

[49] See, for example, https://www.helcom.fi/wp-content/uploads/2019/08/HELCOM_Economic-and-social-analyses-in-the-Baltic-Sea-region_pre-publication.pdf

tifying its integration into the MSP. Strengthening the narrative on the integration of marine ecosystem protection in MSP can raise citizens' and stakeholders' **awareness and ocean literacy**.

The review of the literature, however, did not provide evidence on the added value of investigating the socioeconomic dimensions of marine ecosystems and MSP, nor on the related costs incurred by the authorities involved in the MSP planning process.

5 ACCOUNTING FOR UNCERTAINTY TO SUPPORT ADAPTIVE MANAGEMENT

5.1 What does EBA in MSP require/imply?

Capturing the complexity of the ecological system, its dynamics and interactions with human activities so that it can support MSP is likely to require substantial datasets and information. In the majority of cases, insufficient knowledge will be available to assess all main causal relationships between human activities, their pressures, the functioning and state of marine ecosystems, and the ecosystem services they deliver. Even when there is enough information available, unexpected changes may affect maritime activities and marine ecosystems. Such unexpected changes might be related to unpredictable global changes (e.g. climate events, natural or man-made disasters, health pandemics) or to the dynamic nature of ecosystems. Overall, this implies that **uncertainty** will be part of the MSP process, and that provisions should be made to identify the main sources of uncertainty, account for them in planning to share marine space, and respond to unexpected situations in a timely manner so as to minimise negative impacts.

Examples of approaches to reduce or better account for uncertainty and its potential negative impacts include: (a) use longer (past) time series for investigating probable conditions and their range, thereby better capturing the dynamics of the SES in question; (b) invest in forecasting and forward-looking methods for understanding possible future global (socioeconomic and climate) scenarios and extreme conditions these might impose on the marine ecosystem investigated; (c) carry out sensitivity analyses for the main variables and factors impacting human activities, their pressures and the functioning of marine ecosystems, and investigate how options proposed for sharing and managing marine space will remain relevant and effective under different sets of conditions; (d) set monitoring such that it captures global changes that can help to anticipate changes in the functioning of the ecosystem; (e) strengthen feedback loops that maintain desired regimes, and break or disturb feedback that maintains undesirable regimes.

Shifting certainty-based management to **adaptive management** is one response to uncertainty. It recognises uncertainty as a fact and assesses the capacity of systems or mechanisms to respond to that uncertainty. It favours feedback loops that swiftly provide signals for redirecting action, and gives priority to measures and actions that will be relevant (and cost-effective) irrespective of conditions, that can be easily reverted or that can pave the way for additional complementary action with limited effort.

Managing uncertainty and adaptive management both have implications for the planning and implementation processes. They also require sound communication to all stakeholders and the wider public, if uncertainty and adaptive management are to be accepted and their implications understood.

5.2 What evidence, methods and practice are present in the literature?

Evidence on methods and approaches that address **uncertainty** in a MSP context are rare, but examples are found in the Swedish National Marine Plan. In the context of MSP in the deep Mediterranean Sea[50], attention to uncertainty reflects unexplored and missing

[50] See for example Manea, E., Bianchelli, S., Farelli, E., Danovaro, E. and Gissi, E. (2020). 'Towards an ecosystem-based marine spatial planning in the deep Mediterranean Sea'. *Science of The Total Environment,* 715:136884. DOI: 10.1016/j.scitotenv.2020.136884.

knowledge related to the deep Mediterranean, supporting the application of the precautionary principle as a key component of the ecosystem-based management of deep-sea ecosystems. Acknowledgement of uncertainty requires transparency on the quality of the knowledge base, such as through assessment of uncertainties or reporting of crucial (model) assumptions. There is no evidence in the literature on the application of the **precautionary principle** that would guide MSP decisions in terms of boundaries of different spatial units allocated to specific maritime sectors or the management rules to be applied to different parts of the marine ecosystem.

One of the key principles of EBA is to deliver **adaptive management** that can deal with the inherent uncertainty of macro and global changes (including climate change), socioeconomic development and functioning of the complex ecological system. Learning-by-doing that builds on sound monitoring will help to adapt solutions where outcomes of decisions are uncertain because of complex system dynamics. However, the literature contained no specific method supporting adaptive management (e.g. pathway analysis or real option analysis) at the planning stage of MSP development. Nor is there any evidence of decisions taken with regard to the MSP itself (in terms of limits in areas allocated to specific uses e.g.) that could be adapted if ecological and socioeconomic conditions change unexpectedly. With increasing emphasis on climate change, and the expected developments of the blue economy in marine space, more attention should be paid to methods currently developed and applied in other policy areas (such as climate change, flood risk management), as outlined in Box 2.

Box 2: Examples of assessment methods that can support adaptive management

Different methods have been developed to support decision-making and the selection of optimal investments under conditions of risk and uncertainty for the management of natural resources in the context of climate change[51]. Selected examples of approaches that might be relevant to marine policy and to MSP are presented below.

- **Real options analysis** (ROA)[52] assesses the value of flexibility that can then be integrated into CBA or CEA frameworks. It investigates future possibilities to expand, shrink, delay, speed up, or terminate investments. Although it is mainly focused on investment in physical assets, its core principles could help to address risk and uncertainty in the management of natural resources to prioritise actions that can be easily adapted and modified.

- The **Dynamic Adaptive Policy Pathways (DAPP) approach**[53] aims to support the development of an (adaptive) plan that is able to deal with high uncertainty conditions, similar to those experienced in planning for the management of marine ecosystems. Central to the approach is the exploration of **adaptation pathways** that describe a sequence of actions or investments over time to achieve pre-specified objectives under uncertain changing conditions. It builds on the identification of **adaptation tipping points** that specify conditions under which a given portfolio of actions will fail and thus when new actions will be required to achieve the objectives. The adaptation pathway analysis helps to identify actions and management rules that might be seen as very promising under current knowledge, but that might lead to dead ends if external conditions vary significantly, or others that might be less promising initially but able to easily shift to (prepare for) other actions if conditions change significantly.

[51] See, for example, Hallegatte, S., Shah, A., Lempert, R., Brown, C. and Gill, S. (2012). Investment decision making under deep uncertainty: Application to climate change (Policy Research Working Paper 6193). https://doi.org/10.1596/1813-9450-6193; Watkiss, P., Hunt, A., Blyth, W. and Dyszynski, J. (2015). 'The use of new economic decision support tools for adaptation assessment: A review of methods and applications, towards guidance on applicability'. *Climatic Change*, 132, 401–416, https://doi.org/10.1007/s10584-014-1250-9.

[52] See, for example, an application in the field of flood risk management: Jarl, M., Kind Jorn, H., Baayen, W.J. and Botzen, W. (2018). Benefits and limitations of Real Options Analysis for the practice of river flood risk management. Water Resources Research. https://doi.org/10.1002/2017WR022402

[53] See https://www.deltares.nl/en/adaptive-pathways/

- **Robust Decision Making** (RDM) identifies combinations of physical and socioeconomic factors that best distinguish futures in which a given policy meets or misses its goals, in combination with deliberation processes that help stakeholders linked to the decision to reach a common understanding of the challenges and a consensus on action (even if they disagree on expectations about the future)[54].

5.3 What opportunities offered by other EU policies and legislation can facilitate the application of EBA?

Uncertainty and adaptive management receive limited attention in the main EU directives relevant to MSP and there is no initiative or sharing of experiences between Member States on possible approaches, process and methods that could support adaptive management. In relation to climate change, the WFD requires Member States to carry out a climate check of their PoM. However, such climate checks are fairly general and do not lead to changes in priorities and measures proposed in the PoM.

The main adaptive dimension of the MSFD and WFD is their iterative principle. The six-year planning cycles provide opportunities for revisiting priorities and modifying the PoM, based on results from their assessment and implementation. This gives important insights into the revisions needed to address specific remaining issues.

Accounting for uncertainty is an important element of EU legislation: the Biodiversity Strategy to 2030 underlines that the Treaty on the Functioning of the European Union (TFEU) states that EU environmental policy shall be based on the precautionary principle.

5.4 Addressing transboundary issues and challenges

In a transboundary context, the level of uncertainty is likely to be higher because of the inherent complexity of the wider marine ecosystem, differences (not always captured) in socioeconomic and institutional contexts, and the lack of coherence in the knowledge (due to differences in formats and protocols for data collection in different countries). The difference is likely to be more significant when non-EU countries are sharing marine space, as they use different regulatory frameworks, including in relation to setting their ocean knowledge system.

5.5 What is the added value?

With increasing recognition of the importance of climate change and global socioeconomic changes that will affect marine ecosystems, more attention needs to be paid to mechanisms that can address uncertainty as part of the long-term relevance and adaptive character of MSP. Assessment methods and processes that support adaptive management can help to identify, for example: (a) 'no-regret' measures and options that will be relevant and effective whatever changes take place; (b) investments and management rules that can easily be adapted (e.g. strengthened or reversed) if conditions evolve in a direction that had not been foreseen.

This can help to limit costs that would result from measures implemented that later prove at inadequate and irreversible. It can guide the identification of areas at sea whose future

[54] See also the comparison between RDM and DAPP in: Kwakkel, J., Haasnoot, M. and Walker, W.E. (2016). 'Comparing Robust Decision-Making and Dynamic Adaptive Policy Pathways for model-based decision support under deep uncertainty'. *Environmental Modelling & Software*, 86, 168-183, https://www.sciencedirect.com/science/article/pii/S1364815216307186

ecological conditions are very uncertain, both as a result of direct anthropic measures from evolving land-based and maritime sectors and from climate change (e.g. impacting the distribution of fish stock), allowing adaptative marine protection measures to be set up or guiding blue economic sector developments in more favourable areas in the long-term. More generally, if accompanied by adequate communication and information, it can help to strengthen the culture of risk among all actors involved, impacted by, or benefitting from, the state of marine ecosystems.

6 ORGANISING THE MSP PROCESS

6.1 What does EBA in MSP require/imply?

Implementation of the MSP Directive and organisation of the MSP process require all stakeholders to be mobilised, i.e. representatives from local, regional and national public bodies and administration, representatives from the various professional and users' organisations related to the sea and the coast, researchers and scientists from human and natural sciences, and the wider public. Such mobilisation is required throughout the planning process, from its early stages (scoping, drafting and consulting) to its final stages (implementing, evaluating and learning) (see Figure 6).

Figure 6: Mobilising stakeholders throughout the MSP planning process

Figure 2-2
The Planning Process Loop of MSP and ICZM. Developed by A. Morf & co-authors

Source: Giacometti et al. (2020).

As summarised by Giacometti et al., 'Stakeholder involvement should be considered a continuous process that accompanies MSP at all stages, rather than a single event. As planning teams, socioeconomic settings, national interests and priorities change, so do stakeholders and their roles. Therefore, planners have the continuous challenge to be flexible and perceptive of the changing needs of stakeholders and the stakeholder involvement approaches and tools they use' (2020, p.9)[55].

Several publications warn that there are no one-size-fits-all solution, but, rather, calls for adapted stakeholder involvement. Several levels of involvement are possible for stakehold-

[55] Giacometti, A., Morf, A., Gee, K., Kull, M., Luhtala, H., Eliasen, S. Q. and Cedergren, E. (2020). Handbook: Process, Methods and Tools for Stakeholder Involvement in MSP. BONUS BASMATI Deliverable 2.3, www.bonusbasmati.eu

ers and the general public, ranging from information, consultation and deliberation to collaboration, co-decision-making or even process responsibility[56]. If the first levels correspond to the legal basis required by the MSP Directive and the MSFD (see Section 6.c), the latter aim to build MSP capacity among the stakeholders involved.

Depending on the chosen level of stakeholder involvement, the methods and tools used by project managers may vary, with methods potentially combined depending on the goal of the process[57]. Examples include online or on-site meetings, thematic groups, world cafés, participatory mapping, participatory scenario-building or gaming[58]. (See discussion of case studies based on some of these methods and tools in the next section.)

Reflecting the science-policy interface, the MSP process and 'the allocation and development of human uses shall be based on the latest state of knowledge of the ecosystems as such and the practice of safeguarding the components of the marine ecosystem in the best possible way' (HELCOM-VASAB, 2016[59]). This implies a particular focus on the involvement of scientists, both from the natural sciences (ecology, biology, climatology, etc.) and the social and human sciences (geography, economy, sociology, etc.) at several stages of the MSP process, particularly during the defining phase of the project objectives.

6.2 What evidence, methods and practice are present in the literature?

The literature review showed that even though stakeholder involvement and stakeholder participation are often mentioned, it is rarely as interactive or encompassing as those two principles imply. In practice, stakeholders are mostly mobilised via consultation mechanisms, such as the organisation of stakeholder meetings and stakeholder interviews.

Within the SIMNORAT[60] project (2017-2019), for example, stakeholder involvement was implemented through interviews to collect feedback. A series of national and bi-national workshops was also organised. During these workshops, the SIMNORAT project organisers used brainstorming and mind-mapping methods to collect participants' contributions in post-it sessions ('*an open discussion structured by key points formalized with post-its. […] Post-it notes were shared, displayed and translated to the entire group*'[61]). In addition, a serious role-playing game called 'MSP Challenge' fostered discussions between participants.

In the ADRIPLAN[62] project (2013-2015), the adopted participatory strategy led to participatory planning and co-decision-making. The project team used various facilitation techniques to engage stakeholders from different groups. Meetings, workshops and conferences were organised for institutional stakeholders, with questionnaires and interviews for technical and institutional stakeholders, as well as '*key stakeholders'* involved in the use and management of marine spaces of the Adriatic-Ionian area. Social media and a dedicated website were used for communication purposes. Finally, a data portal was created

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[56] Idem.

[57] Idem.

[58] See, for example, Lodewijk, A., Mayer, I., Keijser, X., Warmelink, H., Fairgrieve, R., Ripken, M., Abramic, A., Kannen, A., Cormier, R. and Kidd, S. (2019). 'Communicating Maritime Spatial Planning: The MSP Challenge approach'. *Marine Policy*, https://doi.org/10.1016/j.marpol.2019.02.057

[59] HELCOM-VASAB (2016). Guideline for the implementation of ecosystem-based approach in Maritime Spatial Planning (MSP) in the Baltic Sea area.

[60] 'Supporting the Implementation of Maritime Spatial Planning in the North Atlantic Region'.

[61] SIMNORAT (2019). Potential approaches for stakeholder engagement on marine spatial planning and outcomes of pilot testing, https://www.msp-platform.eu/sites/default/files/potential_approaches_for_stakeholder_engagement_on_marine_spatial_planning_and_outcomes_of_pilot_testing_d14.pdf

[62] 'Developing a maritime spatial plan for the Adriatic-Ionian region'.

so that stakeholders could '*access, share, comment and process available data, and suggest new datasets*'[63].

Another interesting example of stakeholder involvement is the FishMPABlue2[64] project (2017-2019). A permanent and formal cooperation platform was set up to engage fishers in decision-making. A joint committee comprising MPA managing bodies and local fishers' representatives was organised and was responsible for the main decisions concerning the implementation of the project pilot actions. In order to increase fishers' engagement, the project targeted the strengthening of existing fishers' organisations and the development of new cooperation platforms. This consisted of supporting their applications for funding or supporting them to contribute to other fisheries' organisations, particularly at European level.

A final example is the Eforie (Romania) case study from the MARSPLAN-BS[65] project (2015-2017). A participatory planning meeting took place, during which participants were invited to contribute via an interactive planning method called Sketch Match. The same project (MARSPLAN-BS) also included an extensive study of LSI relevant to MSP, which was the main focus of one case study in the cross-border area of the Burgas Bay (shared between Bulgaria and Romania).

In general, stakeholder knowledge is often collected through meetings or workshops. There is little information as to how this knowledge is effectively integrated into MSP management plans, and how it might affect decisions on boundaries for areas dedicated to specific maritime uses or management rules to support sustainable management of marine ecosystems and the development of maritime activities.

Scientists are often mobilised in MSP projects and initiatives (e.g. as members of scientific committees or workshop invitees), but rarely with very wide interdisciplinarity. The FishMPABlue2 project is an interesting example. In one of its case studies (Cabo de Palos in Spain), a local governance committee was set up and included biologists and economists. The French National Parks of Port-Cros and the Calanques on the French Mediterranean coast are also good examples of the integration of scientists from varied disciplines (biology, geology, geography, architecture, ethnology, economy, etc.). For both parks, a scientific committee was established, involving researchers from different disciplines. Their goal is to advise the Parks' administrative boards, together with a social, economic and cultural board. In the Calanques National Park, human and social sciences researchers represent half of the scientific committee members. Here again, however, how scientists' advice contributes to MSP (decisions) is not documented.

Resource requirements depend heavily on the level of involvement planned for stakeholders. The higher the level of involvement, the higher the resources required to support stakeholder mobilisation. However, the literature seldom provides information on the costs incurred as a result of stakeholder involvement, or the management of a scientific committee supporting policy and strategic decisions.

[63] Barbanti, A., Campostrini, P., Musco, F., Sarretta, A. and Gissi, E. (Eds.) (2015). Developing a Maritime Spatial Plan for the Adriatic-Ionian Region. CNR-ISMAR, Venice, IT.

[64] 'Fishers and marine protected areas, a partnership for sustainability in the Mediterranean'.

[65] 'Cross-border maritime spatial planning in the Black Sea – Romania and Bulgaria'.

6.3 What opportunities offered by other EU policies and legislation can facilitate the application of EBA?

Stakeholder mobilisation is referred to in all key directives that can support or link to MSP. Table 4 summarises key stakeholder mobilisation requirements set out in the MSFD, WFD and the SEA Directive.

Table 4: Key articles and requirements related to stakeholder involvement in the MSFD, WFD and SEA Directive

Policy	Key articles and requirements related to stakeholder involvement
MSFD	• Article 13: PoM […] Those measures shall be devised […] taking into consideration the types of measures listed in Annex VI. […] In Annex VI: Last type of measure listed is 'Communication, stakeholder involvement and raising public awareness' • Article 19: 'Public consultation and information 1. In accordance with relevant existing Community legislation, Member States shall ensure that all interested parties are given early and effective opportunities to participate in the implementation of this Directive, involving, where possible, existing management bodies or structures, including Regional Sea Conventions, Scientific Advisory Bodies and Regional Advisory Councils. 2. Member States shall publish, and make available to the public for comment, summaries of the following elements of their marine strategies, or the related updates, as follows: (a) the initial assessment and the determination of good environmental status, as provided for in Articles 8(1) and 9(1) respectively; (b) the environmental targets established pursuant to Article 10(1); (c) the monitoring programmes established pursuant to Article 11(1); (d) the programmes of measures established pursuant to Article 13(2)'
WFD	• Article 14: Public information and consultation: Member States shall encourage the active involvement of all interested parties in the implementation of this Directive, in particular in the production, review and updating of the RBMPs. Member States shall ensure that, for each river basin district, they publish and make available for comments to the public […] • Article 18: Participants [in the reporting] should include representatives from the competent authorities, the European Parliament, NGOs, the social and economic partners, consumer bodies, academics and other experts
SEA Directive	Article 6 – Consultation: '4. Member States shall identify the public for the purposes of paragraph 2, including the public affected or likely to be affected by, or having an interest in, the decision-making subject to this Directive, including relevant NGOs, such as those promoting environmental protection and other organisations concerned. 5. The detailed arrangements for the information and consultation of the authorities and the public shall be determined by the Member States' Article 7: Transboundary consultation 'Where such consultations take place, the Member States concerned shall agree on detailed arrangements to ensure that the authorities referred to in Article 6(3) and the public referred to in Article 6(4) in the Member State likely to be significantly affected are informed and given an opportunity to forward their opinion within a reasonable time-frame' Article 8 Decision-making

Policy	Key articles and requirements related to stakeholder involvement
	'The environmental report prepared pursuant to Article 5, the opinions expressed pursuant to Article 6 and the results of any transboundary consultations entered into pursuant to Article 7 shall be taken into account during the preparation of the plan or programme and before its adoption or submission to the legislative procedure'

In practice, many Member States apply these requirements lightly in respect of the wider public, i.e. organising a consultation process for citizens. At the same time, different stakeholder working meetings and dedicated processes are organised to collect knowledge and consolidate assessments. There is substantial variation in the extent of consultation across (and sometimes within) Member States and the methods used. These have included permanent and ad hoc stakeholder advisory groups, thematic workshops and broad public surveys, in addition to formal, written consultation procedures.

Mobilising stakeholders for MSP implementation can benefit from these existing processes: (a) to identify the right stakeholders to be mobilised; (b) to potentially connect the MSP process to other processes, strengthening synergies and increasing cost-effectiveness, while limiting stakeholder mobilisation fatigue. This is clearly an issue, with the MSFD mobilising many of the same stakeholders as the MSP. Joining stakeholder processes for both the MSFD and MSP would help to reduce transaction costs while facilitating synergies and integration between the two Directives. This implies bringing the MSP review cycle in line with the MSFD six-year cycle, an approach that several Member States have already put into practice.

Stakeholder mobilisation can benefit from current processes and initiatives supporting ICZM. Connecting the MSP and ICZM processes could be effective in mobilising land-based stakeholders and addressing the LSI within the MSP process. In the Mediterranean Sea, for example, Article 14 of the ICZM protocol signed in 2008[66] makes specific recommendations in relation to stakeholder mobilisation[67]. Building on these would help to strengthen the MSP stakeholder process, provided adequate synergies were established.

6.4 Addressing transboundary issues and challenges

Applying EBA to MSP requires ecosystems to be managed within the limits of their functioning and at the appropriate scale. This means potentially managing transboundary ecosystems that cover two or more countries. In this case, relevant stakeholders representing interests from the different countries (e.g. as representatives of sectors imposing pressures on shared marine ecosystems or benefitting from ecosystem services delivered) should be invited into the MSP process. This is further supported by the MSP Directive, which requires coordination of MSP management plans between countries sharing common ecosystems.

[66] See, for example, the ICZM protocol adopted in 2008 for the Mediterranean Sea basin, https://paprac.org/iczm-protocol#:~:text=The%20ICZM%20Protocol%20was%20signed,Mediterranean%20and%20on%20the%20globe

[67] Article 14 of the Protocol, on participation: *With a view to ensuring efficient governance throughout the process of the integrated management of coastal zones, the Parties shall take the necessary measures to ensure the* ***appropriate involvement in the phases of the formulation and implementation of coastal and marine strategies, plans and programmes or projects*** [bold added]*, as well as the issuing of the various authorisations, of the various stakeholders, including: the territorial communities and public entities concerned; economic operators; non-governmental organisations; social actors; the public concerned* (http://paprac.org/storage/app/media/Dokumenti/Protocol_publikacija_May09.pdf).

Such participation shall involve inter alia consultation bodies, inquiries or public hearings, and may extend to partnerships.

The SEA Directive includes requirements for transboundary consultations where there may be significant effects on the environment in another Member State's territory.

Mobilising stakeholders in a transboundary management context faces many challenges, particularly in relation to (cultural) differences in perception of challenges and solutions, or language challenges requiring the translation of documents and discussions. Overall, there is limited experience with cross-border stakeholder involvement, although this is rapidly evolving as a result of current MSP projects and initiatives[68]. The literature reviewed tends to show similar trends in other European Seas as those evident in the Baltic Sea.

HELCOM is an interesting example of transboundary cooperation on marine ecosystem protection (via common work on data, maps and methods) that can facilitate the implementation of MSP obligations, ensuring that connections between MSP processes carried out by individual Member States/countries are taken into account. Several of their workshops are held in turn by member countries (nine countries and the European Commission are members of HELCOM).

The European Commission has supported a range of projects that bring Member States together to develop methods and exchange information. The SIMNORAT project, for example, covered MSP in the Bay of Biscay and the Iberian Coast (OSPAR IV). Three countries (Portugal, Spain and France) were involved in the MSP process. Representatives from the British authorities were invited to attend the final conference of the project, during which the results were shared with stakeholders and each national authority (the Conference of Peripheral Maritime Regions of Europe). In the ADRIPLAN project, workshops gathered stakeholders from six countries (EU and non-EU) to discuss MSP in the Adriatic Sea. In the ongoing MARSPLAN-BS II project (the successor of MARSPLAN-BS), special attention is paid to transboundary cooperation with non-EU Black Sea countries through the involvement of relevant MSP experts in the Advisory Board of the project, as well as through their active participation at project meetings and thematic workshops.

6.5 What is the added value?

There is substantial added value in organising an MSP process based on the involvement of stakeholders and scientific expertise. The value depends heavily on the level of mobilisation of stakeholders, including scientists, in the process. Involving diverse stakeholders, including the general public, in an MSP process can deliver:

- In the short-term: increase the transparency, understanding and acceptance of the MSP process and strengthen its legitimacy; address expectations of all parties, prevent possible misunderstandings and conflict by improving dialogue among stakeholders and MSP managers; benefit from stakeholders' local, experiential and vernacular knowledge and improve the relevance of the MSP final plan; improve the effectiveness of the final decisions taken in the frame of the MSP process and make them potentially longer-lasting.
- In the long-term: promote cross-sector dialogue and learning and improve relationships between stakeholders; promote capacity-building and empower stakeholders, particularly marginalised stakeholders who usually do not have a voice in MSP processes despite being impacted by it (eg. fishers in the FishMPABlue2 project).

The added value in strengthening the interface between scientists and policymakers lies in the production of up-to-date and comprehensive MSP management plans, adapted to the

[68] Giacometti, A., Morf, A., Gee, K., Kull, M., Luhtala, H., Eliasen, S. Q., Cedergren, E. (2020). Handbook: Process, Methods and Tools for Stakeholder Involvement in MSP. BONUS BASMATI Deliverable 2.3, www.bonusbasmati.eu

targeted ecosystems. Such plans are more likely to tackle the increasing complexity of MSP, ecosystem conservation and economic development, particularly in the context of climate change.

Finally, the added value of involving stakeholders and scientific expertise in MSP processes depends on the stage at which they are involved. For instance, stakeholders may benefit more from information given at the beginning of the MSP process, which enables them to take part in the later decision-making process. For scientists, consultation in the 'evaluating and revising' phase of the MSP process may be very relevant, ensuring that it remains up-to-date with the latest scientific advances.

No information is available on the added value of (different types of) stakeholder mobilisation in the MSP process.

7 DISCUSSION AND CONCLUSIONS

EBA aims to provide a **more holistic understanding** of marine ecosystems, making explicit the interlinkages between the different components of the ecosystem and related human activities, as well as supporting greater stakeholder involvement. While EBA is referenced in many reports and articles, it is often presented as a concept or broad implementation philosophy to 'give space to ecology' within the MSP process and decisions. Operational applications on what to do and how to do it are infrequent in the literature, as these are still underway as part of different MSP projects and are not yet fully assessed or published. Understanding the specificities of EBA is complicated by the fact that many of its principles are basic requirements set out in the MSP Directive for Member States to apply (e.g. accounting for ecosystem services, or supporting stakeholder mobilisation).

Consequently, there is little practical evidence on the development and on-site application of approaches centring EBA principles in the MSP literature reviewed.

- Practical applications related to understanding the **ecological functioning of marine ecosystems** are found in the Baltic Sea basin, where EBA has become an integral part of MSP and transboundary cooperation is encouraged through projects and HELCOM coordination. Experiences in other sea basins have been more limited, however. The literature offers good example of integrated assessment of ecosystem conditions, cumulative impact assessment and designation of green infrastructure (GI), although it is not always easy to equate these examples to other marine ecosystems and MSP areas, given the knowledge needs demanded by these methods. Indeed, their application is contingent on the availability of high-resolution spatial data on ecosystems' condition and knowledge of their interactions with human pressures and ecosystem service supply.
- Few approaches and methods have been applied to **capture the social and economic dimensions of marine ecosystems**. MSP studies that estimate the social and economic value of ecosystem services are rare, as are those that carry out economic assessment of full plans. Rather, economic approaches have chiefly focused on discrete elements of plans or on a limited number of ecosystem services. Indeed, the majority of the evidence available today on the social and economic dimensions of marine ecosystems comes from the economic and social assessments required under the implementation of the MSFD, or from studies focusing on individual sectors (e.g. fisheries) or marine protection measure (e.g. MPAs).
- **Adaptive management** is seldom addressed in the MSP literature, despite the considerable uncertainty and unexpected impacts of global (including climate) changes. While uncertainty or the implications of climate change receive some attention in other components of the EU regulatory framework, such as the MSFD or WFD, these remain limited. Very often, the monitoring of marine ecosystems and the six-year planning cycle offered by these two Directives is considered adaptive management, with limited attention then given to methods to develop truly adaptive plans or monitoring systems that can understand the tipping points that can anticipate management changes.
- **Stakeholder mobilisation** is frequently referenced in the literature. It covers however a broad range of mobilisation modes, with the large majority being consultation of key stakeholders from within set administrative boundaries that are unlikely to correspond to ecosystem boundaries. Transboundary stakeholder mobilisation is particularly limited and is rarely considered, even for marine ecosystems whose pressures and services delivered relate to activities beyond national boundaries. Scientists are often involved in MSP projects via workshops and committees but with limited 'inter/transdisciplinarity' (e.g. involvement of social scientists). More attention could be paid to setting up mechanisms to facilitate synergies with other stakeholders (e.g. from the MSFD, WFD, ICZM) and deliver more effective stakeholder mobilisation.

One implication of paying limited attention to the practical application of EBA principles in MSP is that there is little information available on the costs and benefits of applying EBA. Assessing the added value of EBA thus remains restricted to a qualitative narrative combining different hypotheses on possible impacts.

Some examples of methods and tools that can help to implement some EBA principles in MSP exist outside of the MSP literature, e.g. in reports and articles that address ICZM and that can usefully illustrate how to address the land-sea interface, the MSFD or the development of MPAs. In the case of adaptive management, assessment methods and tools are mainly developed beyond the purely marine community, e.g. in relation to climate change, flood management. These can, however, serve as source of inspiration for the MSP community.

Table 5 summarises the quality and relevance of the knowledge identified in the literature on **operational application of the main EBA principles in MSP,** based on the review of literature presented here.

Table 5: Practical applications of methods, tools and approaches for key EBA principles in MSP presented in the literature

Main EBA principles		Addressed in MSP literature
Group 1 – Capturing the complexity of ecosystems	Ecological integrity and biodiversity	
	Ecosystem connections	
	Dynamic nature of ecosystems	
	Cumulative impacts	
Group 2 – Paying attention to the human-ecosystem connections and integration	Identify ecosystem services and beneficiaries – and assess their values	
	Assess the economic importance of maritime sectors	
	Carry out socioeconomic assessments of options for allocating marine space	
	Provide an understanding of long-term socioeconomic (global and sectoral) developments	
Group 3 – Accounting for uncertainty to support adaptive management	Make uncertainty explicit	
	Apply methods for assessing implications of uncertainty	
	Apply methods supporting adapting management	
Group 4 – Organising the MSP process	Mobilise stakeholders	
	Establish a sound (interdisciplinary) science-decision interface	

Note: from white = hardly or poorly addressed in the literature, to dark blue = include practical examples following good EBA practice available

To implement EBA in MSP, Member States can build on the requirements of existing directives in terms of process, information and data. The MSFD and – to a lesser extent – the CFP are most relevant in respect of data that help to capture the functioning of marine ecosystems and their socioeconomic dimensions (including the socioeconomic importance of ecosystem services delivered). SEA can provide further knowledge on cumulative impacts. However, when implementing these directives, care must be taken to ensure that the knowledge they produce is 'fit for purpose' to respond to the needs of the MSP. This is particularly so for the provision of information: (a) at **spatial scales** and for units of marine ecosystems that are 'MSP relevant'; and, (b) with sufficient **temporal coverage** to capture the dynamics of the SES in the past and in the future and thus better understand uncertainty and support adaptive management approaches.

Table 6 summarises some of the EBA challenges and solutions that can be considered at the various steps of the MSP implementation process. It illustrates how the MSP process can build on the requirements, outputs and decisions under other directives and initiatives (in particular the MSFD, WFD, SEA, ICZM) and thereby facilitate the application of EBA in MSP.

Table 6: Potential contributions from existing EU directives to the application of EBA in MSP

Key steps of the MSP cycle	What 'area managers' need to do?	What is EBA-specific in each step/activity?	What is the added value of applying EBA thinking?	Which tools & methods can help to make EBA a reality?	What is required to apply these tools and methods?	What do other regulatory obligations (MSFD, WFD, SEA, MAES, etc.) deliver to 'support the job'?
Defining	• Identify problem(s) that MSP can solve • Define the geographical boundaries of the plan • Make objectives explicit • Establish the right stakeholder process to support the planning process (see transversal issues below)	• Ensures that conflicts between maritime activities and ecosystem protection are well spelled out and addressed in following steps • The boundaries of the MSP should be adapted to account for ecologically-relevant boundaries • Ensure that set ecological objectives (WFD, MSFD, CFP, Biodiversity Strategy) are duly considered • Consider wider societal objectives including concerns of local (coastal) communities	• Incorporate environmental issues (e.g. biodiversity conservation) operationally together with maritime activities in trade-offs that will be addressed by spatial planning • Reminder of the importance of considering ecological objectives (ensuring that these are duly considered) and the attention needed for marine ecosystem protection	• Focus group with diverse numbers of experts and stakeholders (alternative tools: deliberative processes) • Mapping stakeholders and parallel stakeholder processes (linked to MSFD, ICZM, etc.)	• Think carefully about which stakeholders to involve and who they represent (avoid bias) • Ensure mechanisms are set for obtaining agreement from all involved on context-specific urgencies and priorities	• The WFD and the MSFD will help to bring forward priority ecological issues that need to be considered in the MSP planning process • Consider mechanisms that can establish synergies with ongoing stakeholder processes (e.g. in relation to MSFD, ICZM)
Developing	• Assess current state of marine ecosystems, main activities and their pressures, taking account of their use of maritime space and including socioeconomic importance • Identify ecosystem services delivered, how they contribute to human welfare and who their beneficiaries are • Characterise use conflicts and identifying current environmental, social and economic implications of use conflicts	• Conduct a cumulative effects assessment (CEA) and make the ecosystem carrying capacity explicit. Consider the dynamic nature of the ecosystem (e.g. spatial distributions of ecosystem components may change due to climate change). Consider pressures from land-based sources and activities • Make explicit the ecosystem services supplied and their beneficiaries, including when falling outside the spatial boundaries set for the MSP • Select alternative options that account for set ecological objectives – and consider nature-based solutions in defining some of the options	• Direct and indirect effects through ecosystem connections are well considered • Apply appropriate spatial boundaries depending on the issue considered for the MSP process. • Assess the environmental and socioeconomic effects of current activities and use of the maritime space at appropriate spatial and temporal scales	• CEA • EIA • Ecosystem service approach (ESA) – including valuation of ecosystem services • Expert consultation - to transform EBM principles to develop relevant indicators for capturing impacts – and to define alternative options for the use of	• Need to combine data and information from different sources (challenges in terms of availability, scale at which the information is available, etc.), with challenges in obtaining information for components of the SES that are beyond national administrative boundaries • Set mechanisms that facilitate access to and structuring of data	• Application of CEA in relation to the status assessment for the MSFD can contribute to the identification of the main threats and hence activities considered for MSP • MSFD implementation requires knowledge on ecosystem services. However, the characterisation of these services, and of activities benefitting from these services outside of the area of Member State jurisdiction, is rarely/not always carried out. MAES also provides information on the assessment of ecosystem services (mapping and potentially values)

Key steps of the MSP cycle	What 'area managers' need to do?	What is EBA-specific in each step/activity?	What is the added value of applying EBA thinking?	Which tools & methods can help to make EBA a reality?	What is required to apply these tools and methods?	What do other regulatory obligations (MSFD, WFD, SEA, MAES, etc.) deliver to 'support the job'?
	• On the basis of the above, identify different options for sharing maritime space. These may include offsetting current and potential threats of activities (including new activities whose development is under discussion)	• Consider set protected areas in light of their potential for nature-based solutions and multifunctional solutions that can mitigate/limit potential threats • Make explicit uncertainty – and consider these when identifying options for sharing and managing marine space		maritime space	produced in the context of other policies (see next column) • Existing or new knowledge on values of ecosystem services (monetary values, semi-qualitative valuation, qualitative valuation, other)	• Results of the economic and social assessment of the MSFD, and potentially the WFD (with regard to activities in the coastal zone or estuaries – see link to ICZM) can be used. When carried out, the assessment of the costs of degradation resulting from current impacts can also be used. On many occasions, however, the information available might not be sufficiently disaggregated to be connected to different (coherent) units • MAES can provide some information on ecosystem service valuation. However, it is not yet developed as a fully operational tool that can be easily mobilise by MSP planners. Nor does it provide information that easily links activities/pressures and the capacity to supply ecosystem services
Assessing	• Assess *ex ante* the likely social, economic and environmental impacts (including as part of SEA) of the different alternatives • Assess their operational feasibility (e.g. enforcement mechanisms, resources required) • Share and discuss these *ex ante* impact	• Carry out assessments of proposed alternatives accounting for cumulative effects on the wider ecosystem, assessing how alternatives impact the ecosystem • Account for environmental and socioeconomic impacts (costs and/or benefits) outside the MSP area, either through the reallocation of activities or the knock-on effects on beneficiaries of the ecosystem services supplied	• Make explicit impacts of different options on different components of marine ecosystem health • Make explicit impacts of different options on ecosystem services and on beneficiaries of these services (including beyond administrative boundaries) • Make explicit social impacts, including impacts	• CEA • EIA • CBA, cost-effectiveness analysis, Multi-Criteria Analysis • Threshold analyses, risk analyses and sensitivity analyses of assessments	• Sufficient time allocated to this step (often, most efforts are allocated to the previous step, with insufficient time and resources allocated to the assessment of options) • Mechanisms for sharing assessment results with	• SEA can deliver relevant information on potential environmental impacts of the alternatives, if carried out at an early stage (which is rarely the case) and if it includes the wider (e.g. through reallocation) and/or indirect environmental impacts • MSFD economic assessment of the PoM might include some (scant) infor-

Key steps of the MSP cycle	What 'area managers' need to do?	What is EBA-specific in each step/activity?	What is the added value of applying EBA thinking?	Which tools & methods can help to make EBA a reality?	What is required to apply these tools and methods?	What do other regulatory obligations (MSFD, WFD, SEA, MAES, etc.) deliver to 'support the job'?
	assessment results within the stakeholder process and propose adaptations in the options considered to account for stakeholder feedbacks • Selection the optimal option • Public consultation - on the basis of the assessment results, via the regular decision-making (political) process	• Give specific attention to options that enhance resilience and are adaptive • Make best use of the precautionary principle when deciding on the most relevant (optimal) option	on local (coastal) communities) • Ensure that feedback from stakeholders is well considered to propose adaptations to the options considered – and to choose the optimal option • Gain public acceptance for the proposed MSP/optimal option	• Pathway analysis (link to adaptive management)	stakeholders sufficiently early consider stakeholder feedback when choosing the optimal option	mation on costs and benefits. The spatial relevance of the information provided and its use in supporting MSP is unclear • Assessments of different measures and management options carried out under ICZM processes can help to address pressures impacts in respect of land-based sectors
Implementing		• Apply the precautionary principle when new developments are requested when deep uncertainty on ecological impacts				
Follow-up		• Monitor within and potentially outside MSP area (in relation to risk of reallocation of activities, ecosystem services supply elsewhere) • Monitor different components of the SES (not limited to ecological indicators) to anticipate changes and the need to adapt management	• Provide a comprehensive understanding of the effects (positive and negative) of the plan as soon as these can be observed – including unintended effects	• Upgrade key steps and conduct analyses again		• Monitoring under existing directives such as the MSFD and the WFD (land-based sources) will help to capture ecological impacts of the MSP within Member State territories • Monitoring under ICZM initiatives can help to capture land-based changes relevant to MSP
Transversal activities						
Stakeholder mobilisation	Organisation of the stakeholder mobilisation (consultation minimum) throughout MSP process	Ensure that MSP governance and stakeholder mobilisation effectively reflects the ecological assessments carried out in terms of functioning of the wider ecosystem and delivery of ecosystem services	• Bring a wide diversity of interest – from the marine ecology/environmental community, from local (coastal) communities that might	• Stakeholder mapping • In-depth interviews • Focus groups • Workshops (with presen-	• Stakeholder involvement is resource and time-intensive and stakeholder fatigue must be avoided	• Both the MSFD and SEA include consultation processes, sometimes combined. Consultation rarely involves stakeholders from 'outside' the administrative boundaries relevant to the MSFD or Member State.

Key steps of the MSP cycle	What 'area managers' need to do?	What is EBA-specific in each step/activity?	What is the added value of applying EBA thinking?	Which tools & methods can help to make EBA a reality?	What is required to apply these tools and methods?	What do other regulatory obligations (MSFD, WFD, SEA, MAES, etc.) deliver to 'support the job'?
		• 'Characterisation': make sure that stakeholders outside the set administrative (spatial) boundaries (e.g. beneficiaries of ecosystem services) are represented • *Ex ante* assessment of alternatives: make sure that stakeholders representing areas potentially impacted by relocation of activities are well represented	be less involved in existing regulatory processes • Gain acceptance for the MSP by duly considering feedback and contributions	tations/ discussion groups, etc) • Conflict management • Scenario analysis • Vision sharing • Back-casting	• Need to establish dedicated mechanisms for discussing transboundary issues and solutions to bring coherence • Specific attention required for mobilising representatives of land-based sectors	While it can be used as a basis, it requires some adaptation • Build on stakeholder processes and consultation organised under SEA, ICZM, etc.
Reporting and communication	• Reporting at key steps of the MSP process • Communicating the MSP process, main choices/decisions and impacts	• Make explicit the challenges and impacts (current and those of different alternatives) that fall outside the set maritime area considered for the MSP • Develop visuals/maps beyond the administrative boundaries of the set area (including on land) that illustrate the dependencies of the areas from land-based activities (imposing pressures) and its role in delivering ecosystem services outside of the area		• Develop narratives that help to communicate the implication (benefit) of the optimal option/the MSP	• Reporting and communication to a wide range of stakeholders representing multiple (all) interests, including beyond national boundaries	• MSFD monitoring can provide spatial maps of some pressures and potential threats • SEA should provide strategic maps of potential threats (inland and at sea), and link this to ecosystem services through MAES. Maps produced under the MSFD are usually focused on marine (administrative) sub-regions without making explicit ecological and socioeconomic impacts beyond the MFSD (sub)region of reporting

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HZ-01-21-241-EN-N

doi: 10.2926/13709
ISBN 978-92-95225-14-5

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of the European Union