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AGREEMENT ON THE CONSERVATION OF SMALL CETACEANS OF THE BALTIC, NORTH EAST ATLANTIC, IRISH AND NORTH SEAS

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10th MEETING OF THE PARTIES
Odense, Denmark, 10-12 September 2024
Agenda Item 6.2.2

GUIDELINES FOR CETACEAN-SENSITIVE MARITIME SPATIAL PLANNING FOR THE ASCOBANS AREA

(Prepared by the Working Group on Maritime Spatial Planning)

1. The 26th Meeting of the ASCOBANS Advisory Committee discussed marine spatial planning (MSP) and requested the Secretariat to establish an Intersessional Working Group to elaborate on how to best develop guidelines for cetacean-friendly MSP. The Secretariat circulated call for expression of interest in September 2022, and subsequently contracted Dr Cormac Walsh. The draft guidelines underwent a peer-review process, a Technical Workshop (June 2023), and the 28th Meeting of the Advisory Committee (September 2023). The final version is available in Annex 1 of this document. The related draft Resolution is available in ASCOBANS/MOP10/Doc.6.2.2a.

2. The high-level recommendations in the Guidelines are intended to inform maritime spatial planning policy and practice at national and international levels. Their role is to provide orientation and guidance for Maritime Spatial Planning (MSP) practitioners and those sectors guided by MSP policy (e.g. renewable energy) who do not have technical expertise with regard to cetacean management and transboundary marine conservation.

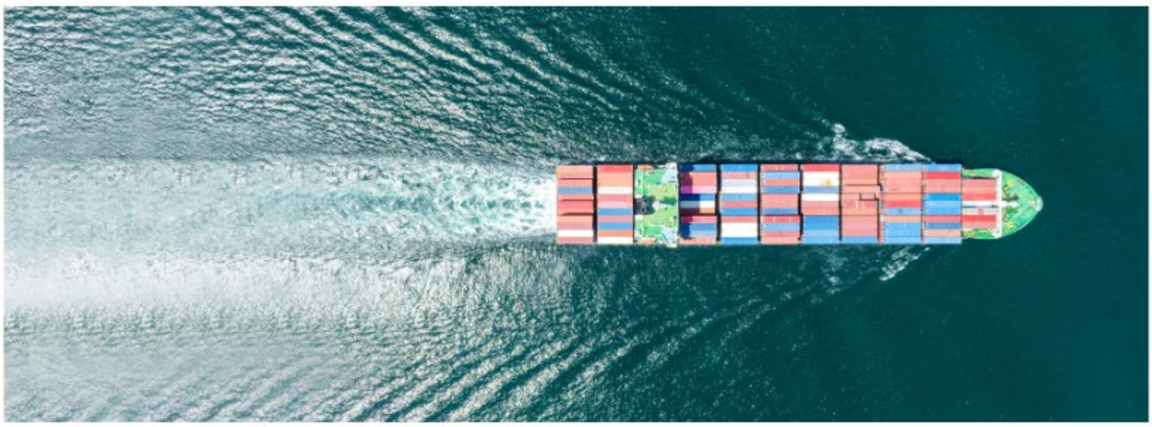
3. The review of threats to cetaceans and appropriate MSP responses is intended to provide an overview of the range of pressures facing cetaceans and possible MSP responses.

Action requested:

4. The Meeting of the Parties is requested to review and adopt the Guidelines in Annex 1.

Annex 1

GUIDELINES
FOR CETACEAN-SENSITIVE MARITIME SPATIAL PLANNING
FOR THE ASCOBANS AREA



GUIDELINES FOR CETACEAN-SENSITIVE MARITIME SPATIAL PLANNING FOR THE ASCOBANS AREA

Prepared by:
Cormac Walsh, Dr. Cormac Walsh Research & Consulting
Peter Evans, Sea Watch Foundation
Dave Wall, Irish Whale and Dolphin Group (IWDG Consulting)

Version: 6 June 2024

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Harbour porpoise by Peter Evans
Offshore wind, trawler, explosion, shipping by canva.com

Explanatory Note:

The high-level recommendations are intended to inform maritime spatial planning policy and practice at national and international levels. Their role is to provide orientation and guidance for Maritime Spatial Planning (MSP) practitioners and those sectors guided by MSP policy (e.g. renewable energy) who do not have technical expertise with regard to cetacean management and transboundary marine conservation. The review of threats to cetaceans and appropriate MSP responses is intended to provide an overview of the range of pressures facing cetaceans and possible MSP responses. The current text is based on an extensive review of the international scientific literature on cetacean conservation and maritime spatial planning conducted as part of the preparation process.

This document has benefitted from the comments and suggestions generously provided by expert reviewers in May / June 2023 and comments received at a technical workshop in June 2023 and the 28th Meeting of the ASCOBANS Advisory Committee (AC28) in September 2023.

The preparation of the guidelines has been made possible through funding provided by the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), and by the German Federal Agency for Nature Conservation (BfN).

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1. Introduction

1.1. Current Status and Policy Context

Maritime spatial planning (MSP) is an integrative policy instrument concerned with the coordination and management of human activities at sea, with the aim of facilitating the sustainable development of ocean resources and the protection of the marine environment (EU MSP Directive 2014, IOC & EC 2021). Ecosystem-based MSP is founded on the principle that all human activities at sea must be carried out in such a way that does not risk the integrity, resilience and health of marine ecosystems and is aligned with internationally agreed conservation objectives (EC & ECIEEA 2021). This document provides guidance on how to achieve cetacean-sensitive MSP, MSP that is aligned with the conservation and restoration of dolphin, whale and porpoise populations, in accordance with the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS 1992). The realisation of cetacean-sensitive MSP is dependent on a high degree of transboundary coordination and cooperation across countries, in the case of ASCOBANS, including both EU and non-EU member states.

The ASCOBANS agreement came into force in 1994 against the background of concern regarding the conservation status of cetaceans, particularly in the Baltic and North Seas. Since 2008, the ASCOBANS area has been expanded to include the Irish Sea and parts of the Northeast Atlantic. ASCOBANS is an independent UN agreement under the framework of the Convention on Migratory Species (CMS 1979), administered by the United Nations Environment Programme (UNEP). The ASCOBANS range covers large parts of EU waters as well as all of UK waters and extends into Norwegian and Russian waters. The corresponding CMS agreement for the Black Sea, Mediterranean Sea and contiguous areas of the Atlantic Ocean (ACCOBAMS) entered into force in 2001. The Parties to the ASCOBANS Agreement undertook “to cooperate closely in order to achieve and maintain a favourable conservation status for small cetaceans.” (ASCOBANS 1992, Res. 2.1). Favourable Conservation Status (FCS) is defined under the Convention on the Conservation of Migratory Species of Wild Animals (CMS 1979, Art. 1) in accordance with four criteria:

(1) Population dynamics data indicate that the migratory species is maintaining itself on a long-term basis as a viable component of its ecosystems;

(2) The range of the migratory species is neither currently being reduced nor is likely to be reduced on a long-term basis;

(3) There is, and will be in the foreseeable future, sufficient habitat to maintain the population of the migratory species on a long-term basis; and

(4) The distribution and abundance of the migratory species approach historic coverage and levels to the extent that potentially suitable ecosystems exist and to the extent consistent with wise wildlife management;

FCS in relation to small cetaceans is further specified under ASCOBANS Resolution 8.5 (ASCOBANS 2020). Here, it was agreed that: “the general aim should be to minimise (i.e. ultimately to reduce to zero) anthropogenic removals (i.e. mortality), and in the short term, to restore and/or maintain biological or management units to/at 80 per cent or more of the carrying capacity”. All Parties to the ASCOBANS Agreement and all ASCOBANS range states are furthermore Parties to the Convention on Biological Diversity (CBD). Under the Kunming-Montreal Global Biodiversity Framework, agreed under the auspices of the CBD in December 2022, it was agreed that Parties would engage in integrated spatial planning focussed on addressing biodiversity loss and would: “ensure that all areas are under participatory, integrated and biodiversity inclusive spatial planning and/or effective management processes addressing land- and sea-use change, to bring the loss of areas of high biodiversity importance, including ecosystems of high ecological integrity, close to zero by 2030, while respecting the rights of indigenous peoples and local communities” (CBD 2022, Kunming-Montreal Global Biodiversity Framework, Target 1). Under the OSPAR Convention for the North-East Atlantic (including Greater North Sea and Celtic Seas), fifteen contracting Parties in northern and western Europe are committed to the application of an ecosystem-based approach to marine management as well as to the development of tools that support an ecosystem approach, including MSP (OSPAR 2010a). Similarly, the nine Baltic Sea states are committed to the implementation of ecosystem-based MSP with the objective of reducing environmental pressures of sea-based human activities on the Baltic Sea ecosystem and strengthening the protection and restoration of marine species and habitats (HELCOM 2021, HELCOM-VASAB 2021). All ASCOBANS Parties are members of the International Whaling Commission (IWC) and have thereby committed themselves to the conservation of cetaceans, including, for example, the prevention of ship strikes, reduction of ocean noise and cetacean-sensitive development of renewables at sea, all of which are of direct relevance for MSP.

Cetaceans and their habitats are also 'highly protected' under European Union law[1]. The EU Habitats Directive commits Member States to ensure a favourable conservation status for natural habitats and their wild flora and fauna (EC 1992). The EU Marine Strategy Framework Directive (MSFD, EU 2008) requires Member States to achieve and maintain a 'Good Environmental Status' for the marine environment. The EU Maritime Spatial Planning Directive (MSPD; Directive 2014/89/EU; EU 2014) requires the implementation of an ecosystem-based approach to the planning and management of European seas. The EU Biodiversity 2030 Strategy (EC 2020) commits Member States to achieve a target of at least 30% of the land and 30% of the sea under protection by 2030. Strict protection is envisaged for areas of high biodiversity value or potential, accounting for at least one-third of all marine protected areas or 10% of the EU sea area. These targets have since become a cornerstone of the Kunming-Montreal Global Biodiversity Framework. Under the ESPOO Convention adopted in 1997 (UNECE 2017), European countries are obliged to notify and consult each other on all major projects likely to have significant adverse environmental impacts across international boundaries. The provisions of this convention are very relevant in the marine context, where the adverse impacts of resource extraction and other economic activities must be considered from a transboundary, regional seas perspective (Pinarbasi et al 2020, Moodie & Sielker 2022). It is recognised, however, that European-level legal protections have to date not been sufficient to generate effective conservation, notably for cetaceans (Evans 2018, Carlén et al. 2021). Indeed, both the EU Green Deal (EC 2019) and the EU Offshore Renewable Energy Strategy (EC 2020) call for a massive upscaling of offshore renewable energies, raising questions of compatibility with biodiversity and ecosystem conservation objectives.

Cetaceans in European waters face multiple threats arising from human activities. These include but are not limited to contaminants, habitat degradation, noise pollution, fishing bycatch and prey depletion. Threats vary in their severity both between species and across European sea basins. For example, certain whale species are particularly vulnerable to collisions with ships in areas of high whale density, such as the Bay of Biscay and waters of the Iberian Peninsula, whereas bycatch and habitat degradation due to eutrophication among other factors are potential pressures for harbour porpoise in the Baltic Sea (ICES WGMME 2019). ASCOBANS covers all odontocetes (toothed whales) besides the sperm whale, all of which depend upon acoustic cues both to navigate and locate prey, whilst all but the harbour porpoise produce tonal sounds that are used in communication. Sound is their primary sense, and thus, they are particularly sensitive to underwater noise. In excess, these can lead to mass strandings, injury, disorientation, displacement and behavioural change (Nowacek et al. 2007, Mann & Teilmann 2013, Wisniewska et al. 2018, Bernaldo de Quiros et al. 2019). In extreme cases, such as the unmitigated removal and explosion of underwater ammunition (CMS 2016) and active sonar use, underwater noise can be fatal for cetaceans (Goertner 1982, Finneran and Jenkins 2012). At the same time, benthic ecosystems may benefit from restrictions on fishing activity (in particular, scallop dredging and beam trawling) in and around the vicinity of offshore windfarms (Coates et al. 2016, Roach et al. 2018) with potentially positive indirect impacts on cetacean populations. On the other hand, localised recovery of benthic ecosystems may coincide with increased fishing pressure elsewhere due to displacement effects, and uncertainty remains regarding the overall impacts of offshore wind on benthic communities (Dannheim et al. 2020).

[1] EU currently applies to all ASCOBANS Parties, with the exception of the UK.

Policy responses need to be sensitive to the conservation requirements of individual species and be tailored to the specific conditions prevailing in each sea basin area. It should be recognised that the current intensification of economic activity at sea is actively supported through the EU's "blue economy" agenda (European Commission 2023a) and ocean-basin specific policy decisions, such as the Ostend Declaration for the North Sea (Ostend Declaration 2023), and will place additional pressure on an already stressed marine environment. Pressures on cetaceans due to noise pollution associated with pile-driving during the construction phase of wind farms (Bailey et al. 2010, Branstetter et al. 2018, Benhemma-Le Gall et al. 2021, Huang et al. 2023), for example, may compound existing pressures arising from long-established maritime activities such as commercial fishing and shipping. Major pollution incidents and near misses (e.g. MV Fremantle Highway in August 2023) demonstrate the vulnerability of marine ecosystems and the potential for catastrophic impacts from single incidents.

Observed and predicted impacts of climate change on cetaceans include changes in distribution, range and migratory movements, increased inter-specific competition, changes in behaviour and reproduction, changes in the distribution of prey species, changes to marine ecosystems, and increased exposure to contaminants and toxic algae (Sousa et al., 2019; Evans and Waggitt, 2020; van Weelden et al., 2021; Kebke et al., 2022). Some of the predicted changes threaten the future survival of some cetacean populations (Tulloch et al., 2019), while observed changes have exacerbated the collapse of threatened species (Meyer-Gutbrod et al., 2021). The increasing frequency of marine heatwaves can cause an immediate and long-lasting decline in cetacean reproductive success through impacts on prey species and ecosystems (Gabriele et al., 2022). Climate change and marine heatwaves can have indirect impacts, too, such as displacing cetaceans into areas where they are subjected to higher exposure to other negative impacts, such as entanglement (Santora et al., 2020). While some species (e.g. harbour porpoise) may be able to adapt to climate change by moving to colder waters (van Weelden et al. 2021), others, such as the white-beaked dolphin, may suffer significant habitat loss with potentially significant impacts for their conservation (Lambert et al., 2014; Nunny and Simmonds, 2020). Climate change projections indicate increased risks associated with extreme weather. Increased intensity of storm surges and coastal flooding pose risks to maritime infrastructure, such as wind farms, ships, pipelines and cables, with potential severe impacts on cetaceans and their habitats. Risk management and disaster risk reduction will need to be integrated within MSP (European Commission 2023b). Changes in human behaviour due to climate change (such as changes to shipping routes in arctic seas) may also lead to greater impacts on some cetacean populations (Nunny and Simmonds, 2020). Due to their sensitivity to climate and ecosystem change, cetaceans can have an important role as ‘sentinels’, indicators of the wider health status of marine ecosystems (Bossart et al. 2011, Williamson et al. 2021).

Under multiple stressor conditions exacerbated by climate change, critical thresholds are quickly reached, and irreversible adverse impacts on cetacean populations may result (National Academies of Sciences, Engineering and Medicine 2017). The precise measurement of such thresholds remains a scientific challenge due to the inherent complexity of marine ecosystems, the need for better interdisciplinary integration and the data limitations (Orr et al., 2022). Where such thresholds have been identified (e.g. with regard to underwater noise), it is imperative that they inform MSP. The accelerated deployment of offshore renewable energy risks adverse impacts on cetacean populations unless comprehensive mitigation measures are implemented and adhered to (e.g., Gill 2005, Madsen et al. 2006). Close coordination between neighbouring countries is critical to managing cumulative impacts on cetaceans and their habitats (Maxwell et al. 2013, Halpern et al. 2015, Platteeuw et al. 2017). For this reason, the implementation of effective ecosystem-based maritime spatial planning is essential to ensure that human activities at sea are compatible with cetacean conservation objectives (e.g., Hammar et al. 2020, Carlucci et al. 2021). An ecosystem-based approach requires planners to work within the limits of marine ecosystems whilst recognising that humans are a component of that ecosystem (Curtin and Prellezo 2010). Planners should, therefore, have regard to the cumulative impact of the full range of human activities at sea rather than focusing solely on the additional impacts from emerging activities or individual planning proposals (see also Birdlife International 2022). Unfortunately, recent evaluations of maritime spatial plans for Baltic and North Sea states indicate that current practice falls short of delivering effective ecosystem-based management and that more robust and thorough methodologies are required to assess likely cumulative effects and ecosystem sensitivity (Birdlife International 2022, WWF 2022).

Due to the complexity and dynamic nature of marine ecosystems and the interactions between marine ecosystems and human activities, it is, in many cases, not possible to scientifically pinpoint the critical threshold points at which significant adverse impacts may be expected to occur. Similarly, the cumulative impacts of multiple activities occurring simultaneously or within a delimited geographical space are not easily quantified, and decision-makers will need to work with a high degree of uncertainty. As a consequence of the above, it is imperative that the precautionary principle is adhered to, as enshrined in EU law[2] and committed to under both the OSPAR and HELCOM Conventions. This principle requires decision-makers to err on the side of caution to take preventative action, even where full information is not available or certain risks are not quantifiable.

Effective conservation of small cetaceans requires a combination of area-based and threat-based measures (Evans 2018). Area-based measures focus on the protection of specific habitats and species within defined geographical boundaries. Such measures may take the form of marine protected areas (MPAs) and/or dedicated zoning or Maritime Spatial Planning (MSP). Fundamentally, the ecological carrying capacity of individual areas and processes should guide such zonation. In some cases, networks of MPAs have been designated prior to the preparation of MSP. An ecologically coherent MPA network can, under these circumstances, form the backbone for ecosystem-based MSP, around which human activities are planned, but only if they are applied with a focus on areas and habitats that are important for a range of species. Improved monitoring and assessment are required to ensure the location and extent of protected areas are informed by current scientific data. Where MPA networks are not yet established, MSP may facilitate the identification of valuable and vulnerable marine habitats or ecosystems, which may be subsequently designated as MPAs and/or given effective protected area status through MSP zoning measures. In order to effectively allow for ecosystem restoration and provide sanctuary for stressed populations, protected areas should reduce and mitigate human activities with potential adverse impacts. In some cases, temporary or seasonal exclusions may be suitable, whereas in others, permanent exclusions are necessary, and again, MSP allows for the adoption of a more flexible approach to the management of ocean activities. Area-based conservation measures alone are, however, insufficient to ensure effective conservation. In addition, threat- or sector-based measures are required to address threats that are widespread and not specific to particular locations. Such threats include but are not limited to fisheries bycatch, ship strikes, contamination due to chemical pollution, underwater noise and marine litter. Threat-based measures are particularly necessary for highly mobile species, as is the case with cetaceans.

1.2. Ecosystem-based Maritime Spatial Planning and Cetacean Conservation

Maritime Spatial Planning (MSP) has evolved through a need to improve the management of the marine environment for the optimised use of marine resources whilst simultaneously protecting the marine ecosystem (Ehler and Douver, 2009). Maritime spatial planning may be defined as a "public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that usually have been specified through a political process" (Ehler & Douvere, 2009,18). The EU MSP Directive, similarly refers to MSP as "a process by which the relevant Member State's authorities analyse and organise human activities in marine areas to achieve ecological, economic and social objectives" (EU MSPD 2014, Art. 3). MSP essentially involves the establishment of a coordinated process that avoids or minimises, conflicts between different uses in the marine environment whilst maintaining ecosystem services that support these uses. MSP is concerned with both the regulation of uses of and claims on sea space and setting out medium and long-term integrated cross-sectoral visions for the future of marine space (Walsh et al. 2022).

[2] The precautionary principle was introduced into EU law and policy via the 1992 Treaty on the European Union (the Maastricht Treaty) Article 130(2) (now Article 191 (2) of the Treaty on the Functioning of the European Union), which stipulated that the EU's environmental policy was to adhere to the precautionary principle.

MSP may vary according to the objectives under which the process is established. It is, however, possible to identify the following key characteristics:

- **Area-based**: MSP involves managing areas within which a variety of uses of the marine environment and resources occur.
- **Ecosystem-based**: the health, functioning and interaction of components of the marine ecosystem are fully considered in a systemic, integrated manner.
- **Forward-looking**: the process is an anticipative one, not only looking at current activities but also future activities.
- **Science-driven**: all decisions are based on scientific information and evidence.
- **Transparent**: data and tools of different types support the decision-making process, and the information from these is freely available to stakeholders.
- **Participatory and integrated**: stakeholder participation and cross-sectoral integration are crucial in the entire process.
- **Adaptive:** activities are monitored, and plans are revised according to the observed effectiveness of actions and the receipt of new scientific information or evidence (see Ehler 2021).

Although zoning remains an important element of MSP, multi-use is receiving increased attention in a number of national jurisdictions. Multi-use may be defined as “the joint use of resources in close geographic proximity by either a single user or multiple users” (Schupp et al., 2019). It is understood to represent a radical departure from the concept of exclusive resource rights to embrace the “inclusive sharing of resources and space by one or more users” (ibid.). Multi-use has the potential to reduce the demand for space and, thus, the impact of human activities on marine ecosystems (Depellegrin et al. 2019, Stancheva et al. 2022). One study has identified the potential for multi-use to optimally combine aquaculture and biodiversity objectives at the Italian Mediterranean coast (Venier et al. 2021). The long-term vision of the Belgian maritime spatial plan calls for multiple-use to become the norm for all use of space within the Belgian North Sea by 2050 (Federal Public Service: Health, Food Chain Safety and Environment 2019). The Dutch Government has actively supported the development of multi-use pilot projects as part of a strategy aimed towards finding a balance between offshore wind, nature conservation and seafood production (Steins et al. 2021). Regulatory, technical and socio-economic factors, however, continue to present challenges to the widespread adoption of multi-use (also Stuiver et al. 2016). Whether multi-use can deliver improved conservation outcomes for cetaceans is uncertain.

Approximately half of the world’s maritime spatial plans, to date, have been drafted in Europe (Friess and Grémaud-Colombier, 2021). As such, the European Union (EU) has taken a higher-level role, supported by framework legislation and high-level policy initiatives in seeking to ensure coherence and compatibility in MSP development by individual member states (European Commission, 2018). In addition to supporting the local establishment of MSP in various locations in Europe, the EU is actively involved in applying MSP to address transboundary cooperation (European Commission, 2018, Hassler et al., 2018). Although MSP is, in essence, an area-based instrument, its role is not limited to zoning and area-based measures. It is increasingly recognised that MSP can play an important role in the coordination and sequencing of activities across time as well as space (as noted in the previous section). This is particularly relevant, for example, with regard to the coordinated sequencing of individual wind farm developments as well as with regard to seasonal restrictions for conservation purposes.

MSP can play an important role in providing a forum for dialogue and joint management of land-based pressures with an impact on the marine environment (Walsh 2021, Smith et al. 2022). Close alignment between MSP, land-use planning and river basin management (e.g. under the EU Water Framework Directive) is necessary to address, for example, issues of nutrient runoff from agriculture and domestic sources, i.e., integrated coastal zone and watershed management (e.g. Loiseau et al. 2012). Land-based pressures on the marine environment should be fully integrated within maritime spatial plans, in line with a ‘One Space’ integrated territorial planning approach (Kidd et al. 2019, ESPON 2020). MSP can also help to open a space for dialogue on fisheries management with a view to working with fisheries organisations to reduce bycatch and prey depletion. Marine ecosystem-based (EB) management (Long et al. 2015) and planning may be defined in different ways, leading at times to some confusion and a perception that it is a vague concept similar to sustainable development. An ecosystem-based approach, however, is legally well-defined[3] internationally and should be understood to imply that management practices and planning measures are informed by an understanding of ecosystem functioning as well as of the interactions between ecosystems and human activities. Ecosystem-based Maritime Spatial Planning (EB-MSP) is understood to require knowledge integration across scientific disciplines, governance integration across sectors and levels of government and transboundary integration across both the land-sea interface and political-administrative jurisdictional boundaries, whether international or sub-national (Lieberknecht 2020, WWF 2021). EB-MSP furthermore requires dynamic and adaptive management (Duck 2012, Maxwell et al. 2015). It is recognised that marine ecosystems are inherently dynamic across multiple timescales, that it is necessary to respond to long-term trends such as climate change and biodiversity loss, as well as to seasonal variations in species distribution and other variables. Effective examples of such dynamic management approaches are shipping speed limits, vessel avoidance of areas of whale presence, and other protective actions put in place when seasonally migrating North Atlantic right whales are detected outside (spatially and temporally) of seasonal area closures (Van Parijs et al. 2009, Silber et al. 2012, Conn and Silber 2013).

MSP is an adaptive, cyclical process, and therefore, regulations and mitigation measures need to be revised regularly as new information becomes available. Monitoring is also required to ensure effectiveness, to highlight unexpected events or results, and to identify if or when specific mitigation measures or regulations become redundant or need to be changed or enhanced. It is moreover becoming increasingly evident that MSP needs to become more responsive to external changes, such as technological developments and shifts in political priorities due to geopolitical concerns and/or energy security issues - one major current example being the Ukraine conflict and marine activities in the Black Sea and Baltic Sea. At the same time, MSP should continue to be underpinned by a rigorous assessment of ecosystem impacts and a thorough evaluation of alternative scenarios. Key elements of an ecosystem-based approach to MSP were set out and adopted by the 72nd Meeting of the VASAB Committee on Spatial Planning and Development of the Baltic Sea Region (CSPD/BSR) and approved by the 50th Meeting of the HELCOM Heads of Delegation (HOD 50-2016) for the Baltic Sea area in 2016. The Guidelines for the implementation of an ecosystem-based approach in MSP in the Baltic Sea area present an important step toward a common understanding of how the ecosystem-based approach can be applied in drawing up a spatial plan for a sea area in accordance with spatial planning legislation in force in the Baltic Sea countries[4]. Baltic Sea states have reaffirmed their commitment to the further development and implementation of EB-MSP in the Regional Baltic Maritime Spatial Planning Roadmap 2021-2030. In Table 1, these elements are set out in adapted form, and their relevance for cetacean-sensitive MSP is elaborated. These elements of an ecosystem-based approach apply to all sea basins in the ASCOBANS area and should not be viewed as specific to the Baltic Sea.

Table 1: Ecosystem-based MSP Elements and their Relevance for Cetacean-Sensitive MSP (following HELCOM & VASAB 2016)

EB-MSP Element	Description	Relevance for Cetacean-Sensitive MSP
Best available Knowledge and Practice	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.	This implies that planning measures and development projects should be informed by the best available relevant knowledge concerning cetacean populations and potential impacts and most effective cetacean conservation practice. This implies measures may need to be undertaken that incur additional costs for individual projects or types of development (e.g., use of adequate bubble curtains and similar technology to reduce noise

[3] HELCOM & VASAB 2016: https://helcom.fi/helcom-at-work/groups/helcom-vasab-maritime-spatial-planning-working-group/
[4] A revision of the HELCOM & VASAB guidelines on ecosystem-based MSP is currently ongoing. Revised guidelines are expected to be approved by the HELCOM-VASAB MSP WG and HELCOM Heads of Delegation in 2025.

EB-MSP Element	Description	Relevance for Cetacean-Sensitive MSP
		pollution during wind turbine construction - see Amaral et al. 2020, Bellmann et al. 2020, Wursig et al. 2000).
Precaution	Far-sighted, anticipatory and preventive planning shall promote sustainable use in marine areas and shall exclude risks and hazards of human activities on the marine ecosystem. Those activities that according to current scientific knowledge may lead to significant or irreversible impacts on the marine ecosystem and whose impacts may not be in total or in parts sufficiently predictable at present require a specific careful survey and weighting of the risks.	The application of a precautionary approach means that activities with potentially significant adverse impacts on cetaceans require measures to prevent any potential impacts. Where the potential impacts of certain activities are uncertain, regulators and planners should 'err on the side of caution', for example, give initial consent for a minimal, or lower volume of activity to begin with. Careful assessment and monitoring are required to ensure that such activities do not have an avoidable adverse impact on the conservation status of cetacean populations, prior to changing management regimes to increase levels of activity (with further monitoring of the effects of such increase).
Alternative development scenarios	Reasonable alternatives shall be developed to find solutions to avoid or minimise negative environmental and other impacts as well as impacts on ecosystem goods and services.	This principle requires the proactive assessment and development of realistic alternatives to reduce adverse impacts. Alternative actions are frequently a component of Environmental Impact Assessments, but too often alternatives are not really realistic, feasible or may be deliberately worse than the original offering to avoid changes in planned activities (Steinemann 2001). An openness to alternatives requires a continuous questioning of the status quo. It is also imperative that development proposals are considered in relation to existing and other planned activities, rather than in isolation in order to allow for an assessment of cumulative impacts and potential alternatives (Burris & Canter 1997).
Identification of Ecosystem Services	In order to ensure a holistic evaluation of effects and potentials, ecosystem services need to be identified. Ecosystem services encompass all direct and indirect contributions of ecosystems to human well-being – or in short, the benefits people obtain from nature. They include provisioning, regulating, cultural and supporting services[5].	Potentially relevant ecosystem services may include the functional role of cetaceans in maintaining healthy and resilient marine ecosystems as well socioeconomic values such as the value of cetaceans in terms of carbon capture (Pearson et al. 2022), as charismatic species, boosting wildlife tourism (Parsons et al 2003, Pacheo et al. 2021) and helping to raise public awareness of marine conservation issues, or their intrinsic value to the public (Scott & Parsons 2005, Naylor & Parsons 2018).
Mitigation	Measures are envisaged to prevent, reduce, and as fully as possible offset any significant adverse effects on the environment of implementing the plan	Maritime spatial plans should follow a strict mitigation hierarchy (e.g. Arlidge et al 2018). If significant adverse impacts cannot be prevented, proactive cetacean-specific measures should be implemented to mitigate adverse impacts cetacean on cetacean populations and restoration measures Implemented to offset any negative impacts, as mitigation measures rarely reduce a risk completely. These mitigation measures should be continuously monitored and evaluated to ensure

[5] Millennium Ecosystem Assessment: https://www.millenniumassessment.org/en/index.html,
IPBES: https://www.ipbes.net/glossary-tag/ecosystem-service

EB-MSP Element	Description	Relevance for Cetacean-Sensitive MSP
		that they are effective, and modified if they are not fully reducing impacts to cetaceans.
Relational Understanding	It is necessary to consider various effects on the ecosystem caused by human activities and interactions between human activities and the ecosystem, as well as among various human activities. This includes direct/indirect, cumulative, short/long-term, permanent / temporary and positive/negative effects, as well as interrelations including sea-land interaction.	Measures for cetacean conservation cannot be considered in isolation but should always be viewed and assessed within the context of the wider social and ecological systems. In some cases, targeted cetacean conservation measures may impact adversely on other taxa or indeed other cetacean species. In order to make informed decisions, an understanding of these complex relationships is needed.
Participation and Communication	All relevant authorities and stakeholders as well as the wider public shall be involved in the planning process at an early stage. The results should be communicated to all stakeholders and made available to the wider public in a transparent manner.	Inclusive and meaningful participation is required both to increase the acceptance and perceived legitimacy of plan measures, mitigate potential conflicts; and enhance the knowledge base for decision-making. Consultation and communication should occur early in the MSP process and care should be taken to listen to all voices, not just the loudest. Conducting both quantitative and qualitative social science surveys to assess levels of support Is essential early in the process to identify possible areas of support or conflict (Bennett et al. 2017, Bennett 2019, Sanborn & Jung 2021).
Subsidiarity and Coherence	Maritime spatial planning with an ecosystem-based approach as an overarching principle shall be carried out at the most appropriate level of governance and shall seek coherence between the different levels.	Plans at both subnational and national levels of governance are necessary to ensure both strategic oversight and the necessary level of detail required to implement an ecosystem-based approach. Plans at each level should be coordinated in terms of their knowledge base and planned conservation and mitigation measures.
Adaptation	The sustainable use of the ecosystem should apply an iterative process including monitoring, reviewing and evaluation of both the process and the outcome.	An adaptive, dynamic, iterative process is essential to ensure that continuous learning and reassessment take place and that planners and regulators can respond in a timely manner to new information (e.g. on cetacean population trends, impact severity or mitigation options) and unanticipated external change factors (e.g. major pollution incidents).

1.3. Building on Existing Good Practice

Cetacean-sensitive MSP is not well-established in Europe or elsewhere, although there have been some significant efforts to devise assessment methodologies for the integration of MSP and cetacean conservation in the Ionian Sea (Mediterranean Sea basin) (Carlucci et al. 2021). However, in the past two decades, the number of cases where the spatial allocation of parts of the ocean has been adapted specifically to the needs of cetaceans have been growing steadily, for example, the adjustment of shipping lanes to avoid ship strikes within the framework of the International Maritime Organization (IMO) (Vanderlaan et al. 2008). The integration of marine conservation and maritime spatial planning, more broadly, is at an early stage. Nevertheless, there are examples of good practices which should inform the further development and implementation of cetacean-sensitive MSP. In particular, progress has been achieved in the development of standards and thresholds for underwater noise. The MSFD Common Implementation Strategy Technical Group on Underwater Noise has prepared recommendations for EU threshold values for both continuous and impulsive underwater noise (TG NOISE 2022a, b). Both sets of recommendations were endorsed by representatives of the EU and associated countries under the auspices of the Czech presidency of the EU in November 2022. The threshold values have been set to inform EU Member States in their determination of Good Environmental Status as per the EU MSFD.

It is imperative that maritime spatial plans follow these recommendations in their regulation and spatial coordination of relevant activities. These recommendations are particularly relevant in relation to the construction, operation and decommissioning of offshore windfarms but also equally apply to established activities, including shipping, dredging and mining, military operations, underwater acoustic research and seismic surveys during oil and gas exploration. For example, in the Netherlands, a detailed methodology for the assessment of the potential effects of windfarm construction on harbour porpoises has been developed under the umbrella of the Dutch Framework for Assessing Ecological and Cumulative Effects – KEC 4.0, 2021 (Heinis et al. 2022). Maritime spatial plans should ensure critical thresholds for underwater noise are not exceeded based on the best available scientific knowledge in best practice impact assessment methodologies. A wide range of technical options for complying with noise limits is available, and indeed, technological advances are likely to lead to increasingly effective mitigation (OSPAR 2020, Koschinski & Lüdemann 2020). Mitigation measures should be continuously reviewed for efficacy, and rigorous enforcement and monitoring are essential to ensure such standards are met in practice.

The ability to monitor cetacean movement and behaviour has increased significantly in recent decades but requires ongoing investment of resources on a large scale. Established monitoring methods include aerial surveys, individual photo-identification, passive acoustic mapping and satellite tagging. Effective mitigation of adverse impacts due to shipping and fishing activity (e.g., continuous underwater noise, collisions, bycatch) will require improved information on vessel movements. In particular, vessels below 12 m in length are not required to carry Vessel Monitoring Systems (VMS). As a result, mapping of recreational boat activity is largely lacking (Evans 2018). Small fishing vessels can have a large impact on bycatch in some regional sea areas (e.g. Baltic Sea: Morkunas et al. 2022, Iberian Peninsula: Pierce et al. 2020) and can cause injuries via ship strikes and can contribute significantly to underwater noise impacts (e.g. Picciulin et al. 2022), especially when vessel speed is not regulated.

Maritime spatial planning should play an active role in a transition from static mapping of activities and marine mammals to dynamic ocean management based on near real-time high-resolution spatial data on both cetacean and vessel movements (Maxwell et al. 2015, Hazen et al. 2018). Examples of dynamic ocean management in practice include bycatch reduction initiatives (e.g., the New England scallop fishery, East Australian multispecies longline fishery and the Hawaii Turtlewatch programme). Rather than replacing existing zoning-based measures, dynamic management tools can complement existing measures. They are particularly suited to the conservation of highly mobile species such as cetaceans. Their implementation, however, requires the development of necessary infrastructure and comprehensive monitoring systems (e.g., passive acoustic buoys, communication systems, aerial surveys, networks of experienced observers) and the development of agreed protocols to ensure consistent response by fishing and other vessels to alerts received, and strict enforcement systems to ensure compliance. Their suitability in areas of low cetacean density (e.g. the Baltic Sea) remains to be tested. A dynamic system which does not have a high level of coverage, monitoring and enforcement is little better than no protection at all. The incorporation of dynamic elements within existing MSP systems can, however, help to strengthen the link between the strategic level of MSP and the day-to-day management of marine activities and resources.

2. High-level Recommendations

General Principles for Cetacean-Sensitive MSP

I. Maritime spatial plans should include measures to ensure a **Favourable Conservation Status** (ASCOBANS 1992) for cetaceans is maintained or achieved and ensure adverse impacts are mitigated following **Best Available Techniques** (BAT) and **Best Environmental Practices** (BEP) in order to minimise the overall impact. There should be an evaluation process to ensure that BATs and BEPs effectively achieve minimal impacts.

II. Maritime spatial plans should be **aligned with the achievement of conservation objectives in accordance with existing commitments**, including the ASCOBANS Agreement, Sea Basin cetacean conservation plans (e.g. ASCOBANS 2009, 2016a) and, where applicable, EU legislation and/or Regional Seas Conventions. The EU Marine Strategy Framework Directive calls for the achievement and maintenance of Good Environmental Status for marine ecosystems to be accorded priority over other interests. Similarly, cetacean-sensitive MSP should prioritise the achievement and maintenance of Favourable Conservation Status for cetaceans.

III. Cetacean-sensitive MSPs have the following characteristics:
- **Strategic direction**: MSP processes should be guided by an overall strategy or vision that outlines how to work towards long-term goals aligned with conservation objectives.
- **Spatial and temporal coordination**: Spatial planning is traditionally concerned with the spatial coordination of human activities. The dynamic nature of the marine environment requires that greater attention is paid to temporal coordination - both seasonally and in the longer term. Both spatial and temporal coordination are essential components of MSP.
- **Dynamic adaptation:** Maritime spatial plans should have the capacity to adapt to changes in the marine ecosystem as well as changes in our knowledge of such systems (e.g., in relation to changes in the distribution and mobility patterns of cetacean populations). They should be accompanied by thorough, independent monitoring, which, where feasible, is aligned with the MSFD and other relevant monitoring cycles. The policies and zoning provisions contained within maritime spatial plans should be subject to continuous and regular monitoring and revision at least every six years.
- **Incremental planning:** Planning of human activities at sea should occur in increments to allow for assessment and evaluation, based on the latest monitoring data, on a step-by-step basis. The duration of increments is largely dependent on the activity and the knowledge status of the impact of such an activity. Where there are knowledge gaps and/or significant uncertainties, increments should be shorter.
- **Mitigation of adverse impacts:** The mitigation hierarchy (avoid, minimise, remediate, offset) (Alridge et al. 2018) should be rigorously applied with respect to the projected impacts of all human activities occurring within the plan area. Offsetting should be used as a last resort and be nature-positive, resulting in an overall benefit to the cetacean population affected - which again should be established by thorough monitoring and evaluation (see Jacob et al. 2020).
- **Rigorous assessment of environmental impacts:** Maritime spatial planning should be accompanied by a rigorous and thorough assessment of environmental impact at both plan (SEA) and project (EIA) levels prior to activities (see Wright et al. 2013). Moreover, communication and coordination are required so that EIAs are not conducted in isolation, and the cumulative Impacts of multiple projects can be considered by managers. Rigorous monitoring and evaluation after projects have been initiated are required to assess the efficacy of mitigation and management methods, with feedback processes to ensure that future SEAs, EIAs and MSP cycles are better informed.

IV. Maritime spatial plans should be informed by a **functional understanding of marine ecosystems,** including a recognition that all human activities should be planned and carried out in such a way that does not lead to adverse impacts on the marine environment and is compatible with achieving and maintaining healthy and biodiverse marine ecosystems. A functional understanding of marine ecosystems requires:

- Identifying **core ecosystem components and their interlinkages** (species, habitats, processes).
- Assessing the **current conservation status of cetaceans** and other taxa.
- Identifying **recent and long-term trends** in population change.
- Assessing the **likely impacts of both existing and planned human activities** on the marine ecosystem.
- Identifying and assessing the **risks posed by low-probability, high-magnitude events** (e.g. major pollution incidents).
- Identifying **critical knowledge gaps and degrees of uncertainty** in relation to both cetacean distributions and the impacts of pressures arising from human activities.
- Estimating the **carrying capacity of the marine ecosystem** with respect to both individual activities and the cumulative impact of all current and planned human activities (Gusatu et al. 2021).
- Assessing the **compatibility of existing and planned human activities** with the conservation and restoration measures required to achieve **Favourable Conservation Status** for cetaceans and **Good Environmental Status** for the marine ecosystem.

V. Maritime spatial plans should be informed by the **precautionary principle**. This implies that where adverse impacts are considered possible or likely (e.g. within the SEA report or equivalent), **zoning should be conditional only** and subject to an assessment at project level, determining that significant adverse impacts are not likely to occur in this instance. Where scientific information is incomplete but adverse impacts are considered likely (based on available information), the activities in question should **not be granted consent unless effective mitigation can be guaranteed**.

VI. Maritime spatial plans should make explicit recommendations **not only on where activities should and should not occur but also on when they should occur**, taking account of seasonal variations in the spatial distributions and behaviours of cetaceans (e.g. Nachtsheim et al. 2020) and the cumulative impact of the co-occurrence of multiple activities (or instances of the same activity) occurring within a short period of time. **Co-occurrence of impulsive noise events should be avoided** wherever possible. Application of bubble curtains and other mitigation measures to reduce the absolute impulsive noise levels in line with established best practices is critical where impulsive noise cannot be avoided (e.g. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit 2013[6]).

Cetacean Conservation and Restoration

VII. Maritime spatial plans should make provision for an ecologically coherent network of **extensive cetacean conservation areas**. Their locations should be informed by an assessment of the spatial distribution and abundance of individual cetacean species, encompassing both breeding and feeding grounds (e.g. Gilles et al. 2009). The **critical sites for all cetacean populations that have an unfavourable population status** should be included in such zones. The conservation objectives should be designed in such a way as to improve the conservation status of the population concerned. Cetacean conservation areas may vary along a spectrum from restriction zones with regulations specific to one maritime activity (e.g. speed limits for shipping) to strictly protected areas. **Close cross-sectoral coordination** with the relevant public authorities (e.g., ministries and/or environmental protection agencies) is necessary to ensure that **conservation areas are designated as marine protected areas (MPAs)**.

[6] German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Concept for the protection of harbour porpoises from noise impact during the construction of wind farms.

VIII. Maritime spatial plans should engage **not only in cetacean conservation but also in ecological restoration**. Restoration may be defined as: "assisting the recovery of a degraded, damaged or destroyed ecosystem to reflect values regarded as inherent in the ecosystem and to provide goods and services that people value" (Martin 2017). Restoration is necessary **where cetacean populations, habitats or prey populations have experienced long-term decline and/or acute short-term decline**. Restoration may take active (e.g. species reintroduction, planting of seagrass meadows, saltmarsh restoration) or passive (e.g. setting aside large areas for natural regeneration) forms. Restoration can occur both inside and outside of protected areas and is not necessarily more successful in areas of low human impact (Fraschetti et al., 2021). The recently adopted Global Biodiversity Framework mandates "*that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, and marine and coastal ecosystems are under effective restoration, in order to enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity*" (CBD 2022). At the EU level, the EU Biodiversity Strategy (EC 2020) and Draft Nature Restoration Law (European Parliament 2023) require member states to restore at least 20% of their total marine (and terrestrial) territories, irrespective of the degradation status. All ASCOBANS Parties need to pay urgent attention to integrating these restoration goals into national MSPs.

IX. **Protected areas** should be included in maritime spatial plans, encompassing a **differentiated zoning system, including strictly protected no-take zones with a minimum of human activity and complementary zones where a limited range of compatible activities** are permitted. The boundaries between the zones should not necessarily be fixed. They can be **dynamically managed** in response to shifts in the distribution and health of relevant cetacean populations. In order to enact such dynamic management, MPAs require **continuous independent monitoring** and **adaptive management** based on the scientific results of this monitoring.

X. MSP zones designated for economic activities that could have a negative impact on cetaceans should not overlap with cetacean conservation areas and cetacean-relevant MPAs. **Appropriate scientifically informed buffer zones** (informed by the spatial impact of the respective economic activity) should surround the cetacean conservation and protected areas (Agardy et al. 2011). Several studies have shown that offshore wind turbine construction and seismic surveys can both have large-scale effects as underwater noise can carry across considerable distances and cause behavioural change as well as hearing damage (e.g. Kavanagh et al. 2019).

XI. Maritime spatial plans should ensure **connectivity between critical breeding, resting and feeding sites**, as well as the wider network of relevant MPAs. It is imperative that wind farms, aquaculture, shipping routes and other human activities **do not act as barriers or impediments to cetacean movement** (Fontaine et al., 2007, Gusatu et al., 2021).

XII. Where **adverse impacts are found to occur or** (in exceptional circumstances) unavoidable adverse impacts are expected to occur due to planned activities at certain locations, **remediation (direct compensation)** with a demonstrable overall positive impact on affected cetacean populations should be implemented. Subsequent monitoring is required to determine if the remediation actions have had a sufficient beneficial impact on cetacean populations and that unavoidable adverse impacts are not only compensated for but there is a **net benefit to the population**.

XIII. Where the **abundance or health of a cetacean population has declined over at least six years**[7], the maritime spatial plan should detail how the actions within the plan will contribute to **reversing this trend** and **contribute to ecosystem restoration**. Such measures should be commenced within 12 months of plan adoption.

[7] This six-year time period is aligned with EU MSFD monitoring cycles

Environmental Assessment

XIV. **Strategic Environmental Assessments** (SEAs; EU 2001) used in MSP processes should explicitly include **cetacean species** and **map their habitats and connectivity corridors** in order to subsequently assess how the favourable conservation status is being impacted and ultimately to inform the maritime spatial plan. SEAs should further **demonstrate alignment** with internationally agreed conservation objectives.

XV. **Project-level environmental impact assessments** should be conducted in a thorough and rigorous manner according to harmonised, scientifically informed methodologies. Planning authorities should provide for **safeguards and oversight mechanisms** that effectively ensure that environmental impact assessments are conducted on an **objective basis, independent of commercial interests**.

XVI. Maritime spatial plans should be accompanied by a **detailed spatially explicit assessment of the cumulative effects** of human activities (both existing and planned) on cetaceans (e.g. Halpern et al. 2015, Halpern et al. 2018, Quemmerais-Amice et al. 2020). This assessment, to be published within the SEA report (or equivalent), should include the following:

- **Sensitivity matrix** of likely anthropogenic pressures on individual cetacean species (e.g. windfarm noise impact during the construction period on harbour porpoises)
- **Identification of the degree and character of key threats** at the species level
- **Computation/extrapolation of cumulative effect scores** for each pressure for each grid square within a **high-resolution spatial grid** (e.g. 1 x 1km or 500m x 500m) (Hammar et al. 2020).

XVII. Cumulative effects assessments should be conducted for **multiple distinct planning scenarios** with **differing intensities and spatial distributions** of human activities. These scenarios should be **plausible** and, where possible and relevant, **consider shifting policy priorities**. The differences in the impacts of alternative planning scenarios should be made clearly visible. The preferred planning scenario should be selected to **ensure minimal adverse impact**.

Information Sharing and Transboundary Cooperation

XVIII. In order to ensure that maritime spatial plans and consenting procedures are informed by accurate and up-to-date information, it is imperative that **data and knowledge pertaining to the marine ecosystem and potential threats** are shared **among all stakeholders.** It is imperative that the data gathered in the course of project-level environmental impact assessments is **shared with MSP decision-making bodies**. Protocols and oversight mechanisms should be developed and implemented to **prevent the withholding of relevant information** that might influence the capacity of planners to make informed decisions. The **public interest in ensuring healthy and diverse ecosystems** should be placed above private concerns regarding commercially sensitive data.

XIX. Maritime spatial plans have a **responsibility to educate users of marine space and other stakeholders** so as to improve the **capacity for evidence-informed decision-making**. This means that information on the spatio-temporal distribution, abundance and population health status of cetaceans within the plan area should be provided within the plan itself (on maps and in text form). Maritime spatial plans should **provide clearly accessible information** on long-term trends in species abundance. Formal plans should be **accompanied by online maps with up-to-date information**.

XX. Maritime spatial plans should take **explicit account of transboundary impacts**. The current status of the **cetacean species and regional populations** (e.g. North Sea, Belt Seas and Baltic Proper harbour porpoises) should be considered rather than solely the spatial distribution and abundance of cetacean species within the plan area (e.g., EEZ and/or coastal waters). In line with the Espoo Convention, maritime spatial plans should consider the **impact of current and planned activities in neighbouring jurisdictions.**

XXI. Maritime spatial plans should include **commitments to coordinated planning and monitoring efforts**. **Monitoring methodologies** should be harmonised across the ASCOBANS Area. A **regional seas approach**[8] is recommended to ensure transboundary coordination and coherence of planning, environmental assessment and monitoring efforts.

XXII. Where individual maritime spatial plans only cover parts of the national waters, such as the coastal zone or the Exclusive Economic Zone, a **consistent and coherent approach** should be adopted. The **same categories for cetacean conservation areas should be used at the various national and sub-national levels,** and the cetacean management approaches in each plan should be integrated and based on a **common evidence base**.

XXIII. The terms of reference of the **ASCOBANS Working Group on MSP** should be extended to encompass a coordination role in the development of **common assessment and monitoring methodologies for cetacean-sensitive MSP** and the sharing of relevant cetacean conservation expertise. The Working Group should **liaise and collaborate**, where possible and practical, with the WGs of other relevant IGOs, such as the European Commission MSP Assistance Mechanism and MSP Platform[9], HELCOM, ICES, OSPAR and VASAB.

[8] https://www.unep.org/explore-topics/oceans-seas/what-we-do/regional-seas-programme

[9] The European MSP Platform is an information and communication gateway designed to offer support to all EU Member States in their efforts to implement MSP. It is a product of the MSP Assistance Mechanism implemented by CINEA on behalf of DG MARE.

3. Overview of Assessment of Cetaceans Impacts from Selected Sectoral Activities

In the following, we provide an overview assessment of three of the most significant maritime activities that can be regulated via MSP: offshore renewable energy, vessel traffic (shipping and boating) and fisheries, including aquaculture. In each case, the specific threats, impacts on cetaceans and potential policy responses are outlined. Where relevant, we also address the potential positive impacts of the above activities on cetaceans. Maritime spatial planning must consider a wider range of activities and claims on sea space, including military use, sand and gravel extraction, oil and gas exploration and research activity. Further details on the broad spectrum of specific threats and pressures are found in Chapter 4.

3.1 Offshore Renewable Energy

The planned expansion of offshore renewable energy (ORE) capacity is projected to have significant impacts on marine ecosystems. Selecting appropriate locations for offshore wind farms (OWFs) and other forms of ORE requires careful, evidence-informed, ecosystem-based planning. It is imperative that site selection is informed and guided by ecological criteria. To date, the spatial distribution of installed and planned ORE has been determined by national policy and regulatory factors as much as by considerations of suitability and carrying capacity.

Table 2: Summary of adverse impacts of ORE on cetaceans

Threats	Impacts	Policy measures
Impulsive noise impacts during OWF construction (see 4.4.1 below)	Disturbance leading to behavioural change, displacement (e.g. Benhemma-Le Gall et al. 2021).	Fine-scale spatial and temporal coordination to prevent co-occurrence of impulsive noise events. Use of BAT and BEP mitigation techniques such as double bubble curtains to reduce noise impacts. Application and rollout of alternative floating turbine foundations to avoid pile driving.
Continuous noise impacts of maintenance vessels (see 4.2.5 below)	Disturbance leading to, behavioural change, displacement (e.g. Stöber & Thomsen 2021)	Independent monitoring and continuous assessment. Restrictions on vessel and trip numbers, and vessel speeds, including seasonal restrictions as appropriate. Regulation and management of how service vessels moor offshore, ensuring that vessels minimize noise emission at all times.
Physical barrier effects due to offshore wind farms and wave devices	Potential impacts on habitat connectivity and cetacean mobility in areas of high ORE density (e.g. central North Sea) (Gussatu et al. 2021)	Rigorous assessment of cumulative effects at the sea-basin scale to ensure that barrier effects do not occur
Collision risk from tidal turbines	Overlap between high energy sites and important foraging areas for cetaceans, leading to physical injury or death; also displacement from important feeding habitat (Benjamins et al. 2015)	Independent monitoring and continuous assessment. Systems for temporary shut-downs when animals come too close.

It is anticipated that technological developments (e.g. floating turbines and increasing deployment of tidal, wave, and other forms of energy generation) will impact the overall spatial distribution of ORE across northern and western Europe, potentially counterbalancing the existing concentration of activity in the North Sea and southwest Baltic Sea. ORE impacts and potential impacts on cetaceans are summarised in Table 2 above. Potential benefits of ORE for cetaceans are summarised in Table 3.

Table 3: Summary of potential benefits of ORE for cetaceans

Potential benefits for cetaceans	Effects	Policy Measures
Habitat enrichment due to restrictions on fishing activity in OWFs.	Positive impacts on benthic habitats and communities. Potential indirect impacts on cetacean populations (Coates et al. 2016, Roach et al. 2018).	Imposition of strict restrictions on fishing activity in and adjacent to OWFs. Continuous monitoring to ascertain direct and indirect ecosystem impacts
Offshore structures, including wind turbine foundations can act as artificial reefs and become foraging grounds for cetaceans	Positive impact on cetacean populations (e.g. Fernandez-Betelu et al. 2022)	Decommissioned wind turbines may be left in situ to reduce noise impact and allow for continued use as artificial reefs

3.2 Vessel traffic (Shipping and Boating)

Shipping has significant adverse impacts on marine ecosystems and cetacean populations in particular (Table 4). The volume of shipping traffic in the ASCOBANS area is high and projected to increase in coming decades, notably fast service vessels for the offshore wind industry, which emit particularly high levels of underwater noise. Particularly, high densities of shipping traffic are found in the southern North Sea and the English Channel. Unfortunately, maritime spatial plans and related policies have, to date, failed to effectively regulate the volume of shipping activity, irrespective of concerns regarding the carrying capacity and health of marine ecosystems. Enhanced transboundary cooperation and regulation may be necessary to ensure that critical thresholds are not exceeded. Shipping activity is a major source of continuous underwater noise, with long-term implications for the health of cetaceans at both individual and population levels. Shipping poses a significant risk due to the potential for large quantities of contaminants to enter the marine ecosystem as a result of major pollution incidents. Maritime spatial plans should take into consideration that increased volumes of shipping will lead to an increased probability of major pollution incidents and other accidents occurring. Shipping activity furthermore poses a significant collision risk for cetacean species. Whereas detailed monitoring data are available through AIS for large commercial vessels, it is increasingly evident that motorised recreational boats have significant adverse impacts, including disturbance effects, collision risk and as a contributor to continuous underwater noise.

Table 4: Summary of adverse impacts of shipping and boating on cetaceans

Threats	Impacts	Policy measures
Continuous underwater noise (see 4.2.5 below)	Disorientation, feeding disruption and reduced energy intake, behavioural change, displacement (e.g. Findlay et al. 2023)	Independent monitoring and enforcement of noise thresholds; speed restrictions, rerouting of shipping lanes and establishment of buffer zones between sensitive areas and shipping lanes; incentives for quiet ship and propeller design
Collision risk (see 4.2.6 below)	Risk of lethal and sub-lethal injury, behavioural change, displacement (e.g. Peltier et al. 2019, Ritter & Panigada 2019)	Rerouting of shipping lanes; speed restrictions, dynamic management measures (where applicable)
Disturbance from recreational boating and wildlife tourism (see 4.2.7 below)	Disorientation, behavioural change, displacement, lethal and sub-lethal injury (e.g. Peel et al. 2018, Olaya-Ponzone et al. 2023)	Guidance and regulation for wildlife tourism operators and recreational boat users

Threats	Impacts	Policy measures
Risks of oil / chemical / hazardous substance pollution from container ship accidents (see 4.1.1 below)	Potential acute and long-term impacts on cetacean population health from pollution incidents (e.g. Wan et al. 2022)	Rigorous assessment of cumulative effects at the sea-basin scale to ensure such risks are minimised; speed restrictions.

3.3 Fisheries and Aquaculture

Both fisheries and aquaculture pose significant risks for cetaceans in European waters. Bycatch, the unintended capture of non-target fish species and marine mammals in fishing nets, represents the biggest threat to cetaceans globally (Elliot et al., 2023). Commercial fishing also contributes to the depletion of prey species (Pierce et al., 2022).

Table 5: Summary of adverse impacts of fisheries and aquaculture on cetaceans

Threats	Impacts	Policy measures
Bycatch (see 4.1.2 below)	Cetacean mortality and injury	Seasonal restrictions, independent monitoring, restrictions on the use of certain types of gear
Prey depletion (see 4.1.3 below)	Impact on health of cetacean populations	Quotas and restrictions on critical fish species, restrictions on the use of certain types of gear
Underwater noise	Disorientation, behavioural change, displacement	Speed restrictions, restrictions on the use of certain types of gear, independent monitoring
Introduction of contaminants (see 4.1.1 below)	Acute and long-term impacts on cetacean population health from aquaculture	Site-specific management and monitoring, site selection following strict ecological criteria

Depleted fish stocks have a direct impact on the viability of cetacean populations and, together with other factors, limit the scope for cetacean populations to recover and achieve a favourable conservation status. Fishing activity, furthermore, is a major contributor to underwater noise and disturbance of the seabed. Aquaculture poses significant risks due to contaminant pollution, eutrophication and entanglement in anti-predator nets (HELCOM 2018, Mazzariol et al. 2018, Carballeira Brana et al. 2021).

4. Threats to Cetaceans and Appropriate MSP Measures

As outlined above, cetaceans face a wide range of threats from a broad spectrum of human activities. There is considerable variation in terms of the relative significance of individual threats both geographically, across the ASCOBANS range area, and between cetacean species. Table 6 below provides an overview of the key threats to the conservation status in each of the regional sea areas within the ASCOBANS range. Threats are classified as High (red), Medium (amber) or Low (green). This overview assessment is based on more detailed work carried out by the ICES Working Group on Marine Mammal Ecology (ICES WGMME 2019). Only those threats classified as medium or high for at least one regional sea area are included in this overview. In the final two right-hand columns of Table 3, each threat is classified by sector as well as by spatial distribution. The range of applicable MSP measures is very different for those threats that might be considered to be *widespread* (found across a sea basin with limited spatial differentiation), *relatively location-specific* (associated with activities at certain locations or found within certain geographical areas but which cannot be easily localised to specific point sources) and *highly location specific* (associated with specific point source activities). In the text below, each threat is described in detail with reference to relevant scientific literature. Potential MSP measures and opportunities for cross-sectoral coordination are highlighted in each case.

Table 6: Overview matrix of threats, spatial distribution, species and sectors

Threats	**Regional Sea**				**Cetacean Species**[10]	**Sector**	**Spatial Distribution**
	Baltic Sea[11]	**Greater North Sea**	**Celtic Seas**	**Bay of Biscay & Iberian Peninsula**			
Contaminants	H	H	H	H	harbour porpoise, killer whale, bottlenose dolphin, common dolphin, striped dolphin, long-finned pilot whale	Land-sea	Widespread
Habitat degradation	M	L	L	L	harbour porpoise	Land-sea	Relatively location-specific
Litter (including plastics and discarded fishing gear)	L	M	M	M	harbour porpoise, dolphins, minke whale, beaked whales, bottlenose whale, Risso's dolphin	Fishing	Widespread
Sonar	H	M	H	H	harbour porpoise, minke whale, long-finned pliot whale, killer whale, bottlenose whale, beaked whales	Military	Relatively location-specific
Seismic surveys	H	M	H	H	harbour porpoise, minke whale, bottlenose whale, beaked whales, long-finned pilot whale, killer whale, bottlenose dolphins, common dolphin, white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin	Oil and gas	Relatively location-specific

[10] Note that only cetacean species covered by ASCOBANS are included in this table. Larger cetaceans such as sperm whales and fin whales are also impacted by some of the threats detailed in Table 6.
[11] Including Belt Seas and Kattegat.

Threats	**Regional Sea**				**Cetacean Species**[10]	**Sector**	**Spatial Distribution**
	Baltic Sea[11]	**Greater North Sea**	**Celtic Seas**	**Bay of Biscay & Iberian Peninsula**			
Pile-driving[12]	M	M	M	0	harbour porpoise, minke whale, bottlenose dolphin	Offshore wind	Highly location-specific
Underwater Explosions	H	M	0	0	harbour porpoise, minke whale, bottlenose dolphin	Military / offshore wind	Highly location-specific
Shipping (noise)	M	M	M	M	harbour porpoise, minke whale, bottlenose dolphin,	Shipping	Relatively location-specific
Collision with ships	L	M	M	H	Minke whale, bottlenose dolphin	Shipping	Relatively location-specific
Collision with tidal turbines	L	L	M	L	Harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin, minke whale	Offshore renewabl e energy	Highly location specific
Overfishing of prey species	M	M	M	M	harbour porpoise, minke whale, bottlenose dolphin, common dolphin, white-beaked dolphin, Atlantic white-sided dolphin	Fisheries	Widespread
Removal of non-target species (by-catch)	H	H	H	H	harbour porpoise, minke whale, common dolphin, white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin, striped dolphin, bottlenose dolphins	Fisheries	Widespread
Disturbance (e.g. wildlife watching and recreational boating)	L	M	M	M	coastal bottlenose dolphin	tourism	Relatively location-specific

[12] In line with the ICES WGMME (2019) assesment, pile driving is classified as an emerging threat across the Baltic Sea, Greater North Sea and Celtic Seas. This threat may be considered likely to become a high-level threat in the near future as the expansion of offshore wind continues.

4.1. Widespread Threats

4.1.1. Contaminants

Spatial Distribution: high across all regional seas, highest in the Baltic and North Seas
Species most impacted: harbour porpoises, bottlenose dolphins, killer whales
Sources of threat: marine pollution incidents, wastewater treatment plants, coal-fired power stations, leaching from buildings and household materials, agriculture, urban runoff, atmospheric deposition of industrial plant emissions, military Installations and equipment, maritime sources (e.g., shipping, oil spills), PCBs (e.g. HELCOM 2018, OSPAR 2022).

Multiple contaminants present in the marine environment are known to have negative impacts on cetaceans. The contaminants of highest conservation concern are polychlorinated biphenyls (PCBs), which are known to have a negative effect on cetacean reproduction and health. Although production has been banned since 2001, they persist in marine ecosystems and food chains. Within the ASCOBANS area, the highest levels of PCBs in the marine environment occur in the Baltic Sea (HELCOM 2010, 2018) and Greater North Sea, followed by the Celtic Seas and Bay of Biscay (OSPAR 2010, 2017). The cetacean species with the highest levels of PCB contamination in Europe include killer whales, bottlenose dolphin, striped dolphin and harbour porpoise (Jepson et al. 2016). Heavy metals are also known to cause a range of negative effects on marine mammals, including neurological damage, organ damage, reduced reproductive success, and death (Das et al. 2002). Although heavy metals are in decline in many European seas, they remain a significant problem in some areas, including the North Sea and the Baltic Sea (EEA 2019). The average life expectancy of Baltic and North Sea harbour porpoises has been found to be dramatically reduced due to exposure to contaminants, severely impacting the ability of the populations to reproduce (Sonne et al. 2020; Siebert et al. 2007).

Appropriate MSP and policy responses:
Recognition that the wildlife health and fitness status of cetacean populations is poor as a result of high contaminant load and that, therefore, the overall resilience and ability to adapt to stressors is much reduced. Cumulative impact assessments should guide MSP. There is a need for stricter regulation of wastewater treatment plants and other sources of pollution and water quality monitoring under WFD and MSFD. This issue should be highlighted in maritime spatial plans but needs to be tackled elsewhere.

4.1.2. Bycatch

Spatial Distribution: high across all regional seas, critical in the Baltic Sea
Species most impacted: harbour porpoise, common dolphin, minke whale, and humpback whale
Sources of threat: commercial fisheries

Bycatch remains the single largest threat to cetaceans globally, with an estimate of at least 300,000 cetaceans killed each year (Elliot 2020) and can impact all cetacean species. In the ASCOBANS area, the species of greatest concern are harbour porpoise, common dolphin, minke whale, and humpback whale. Bycatch data may be insufficient to estimate bycatch rates for many areas and fisheries due to insufficient reporting compliance, monitoring and data collection (Hanke et al. 2020; Murphy et al. 2021; Dolman et al. 2021, Pierce et al. 2021).

Harbour Porpoise

Bycatch of this species is of primary concern in the ASCOBANS area, with the main gear types involved being gill nets (Lusseau et al., 2023). Annual porpoise bycatch in the UK was estimated at 1098 animals for 2017 (Northridge et al. 2018), while bycatch in the Celtic Sea ecoregion (Subarea 7 only) represented between 1.1 and 2.4% of the porpoise population estimate for that area (ICES, 2018) and was potentially above the 1% precautionary environmental limit recommended by ASCOBANS as an indication that bycatch levels may have an impact on the population (ASCOBANS

2016b). Estimated bycatch mortality rates for the Iberian Peninsula also appear to suggest that the number of porpoises killed annually is likely to be unsustainably high (Pierce et al., 2021).

Common Dolphin

Bycatch of common dolphins has been reported in pelagic trawl and purse seine fisheries, 'very high vertical opening' bottom-pair trawl fisheries, as well as (bottom-set) gillnets and long lines (Murphy et al., 2021). Annual bycatch mortality levels across the NE Atlantic have been estimated in the hundreds or low thousands from independent observer programmes, although not all fisheries have been assessed (ICES 2016a, Murphy et al. 2013). Since 2005, overall numbers of common dolphin strandings have been increasing along the coasts of Ireland, the UK, and France (Murphy et al. 2021) and in 2016, ICES advised the European Commission that bycatches of common dolphins may be unsustainable (ICES 2016a). This was followed by a call for emergency measures to reduce bycatch in the Bay of Biscay and recommendations for mitigation measures from ICES (2020, 2021, 2022).

Minke Whale

Bycatch of minke whales in the ASCOBANS area primarily focuses on entanglement in static fishing gear, particularly static pot fisheries (Northridge et al. 2010). Up to 30 minke whales are likely to be entangled in fishing creel lines in Scotland each year, with an estimated fatal entanglement rate of 2.3% per annum for the west coast of Scotland (Leaper et al. 2022).

Humpback Whale

Bycatch of humpback whales in the ASCOBANS area also focuses on entanglement in static pot fisheries, with six humpback whales estimated entangled in fishing creel lines in Scotland each year (Leaper et al. 2022). Estimated mortality rates of humpback whales in fishing gear in Scotland were judged not to be sustainable, and Scottish inshore waters may act as a high mortality sink for NE Atlantic humpback whales (Ryan et al. 2016). Humpback whales within the ASCOBANS area may also be subject to entanglement risks in other areas of their migratory range. A scar analysis of 379 humpback whales in Iceland revealed that at least 24.8% of individuals had a history of prior entanglement when first encountered (Basran et al. 2019).

Appropriate MSP and policy responses:
Concerted efforts should be made to improve the monitoring of fisheries and bycatch. Dynamic management measures should be piloted and implemented within maritime spatial plans. Continuous monitoring focusing on medium to high-risk fisheries is required. Mitigation can be achieved via targets set in consultation with fishermen. Temporary closures of areas of high bycatch should be considered (Dolman et al. 2016, Evans 2019).

4.1.3. Overfishing of Prey Species

Spatial Distribution: medium threat across all regional seas
Species most impacted: harbour porpoise, minke whale, bottlenose dolphin, common dolphin, white-beaked dolphin, Atlantic white-sided dolphin
Sources of threat: commercial fisheries

While a direct impact of overfishing of prey species on cetaceans is often difficult to prove due to most cetacean species having varied diets, the collapse of herring in the North Sea during the 1960s and the overfishing of sand eel around the Shetland Islands in the 1990s were both implicated in the concurrent decline of harbour porpoise in those regions (Reijnders 1992, Borges & Evans, 1997). Indeed, the collapse of the sand eel stock in the northern North Sea may well explain a large southward shift in harbour porpoise distribution in the North Sea between 1994 and 2005 (Hammond et al. 2013). Harbour porpoises are particularly vulnerable to prey depletion due to their high metabolic demands (Wisniewska et al. 2016, Booth 2020). Other cetacean species have also been shown to be vulnerable to prey depletion, whether from overfishing or other causes (Bearzi et al.

2008, Ward et al. 2009, Ford et al. 2010, Kershaw et al. 2021, Cunen et al. 2021). Long-term declines have been recorded for many commercial fish species in the ASCOBANS area. Declines in sand eel, cod and whiting have been recorded in the Greater North Sea, sole and cod in the Irish Sea, and whiting in the Celtic Seas (OSPAR 2010, 2017, ICES 2022). Cod in the Kattegat has declined markedly in the past 50 years, and herring in the Gulf of Riga (Baltic Sea Region) and sprat in the western Baltic (2001-2016) have been assessed as having unfavourable status (HELCOM 2018). Herring stocks in the Celtic Sea and West of Scotland/Ireland have also severely declined since the 1960s (Marine Institute 2021). The overall impact of these and other stock declines of important prey species for cetaceans in the ASCOBANS area is still poorly understood.

Appropriate MSP and policy responses:

- Fisheries regulations (ICES, CFP, European Commission 2023c), MPAs with internationally agreed no-take zones
- This issue should be highlighted in marine spatial plans but needs to be tackled also via sectoral measures.
- Management of recreational fishing.

4.1.4. Litter (incl. plastics and discarded fishing gear)

Spatial Distribution: Medium threat across all regional seas with the exception of the Baltic Sea (low threat)
Species most impacted: various deep-diving whale species (e.g. sperm whale, beaked whales)
Sources of threat: lost/discarded fishing gear, land-based sources

Marine plastic litter is a major pollutant of marine habitats and is now ubiquitous in the ASCOBANS Area (OSPAR 2010, 2014, 2017, HELCOM 2018). The major sources of marine plastic litter are from land-based sources and from the fishing industry. Impacts of macro litter on cetaceans focuses on the ingestion of macro plastics by deep diving species such as sperm whales (*Physeter macrocephalus*), beaked whales and some oceanic dolphins (Baulch & Perry 2014, Lusher et al. 2018, Fossi et al. 2018), and in at least some cases the ingested plastic has resulted in the death of the animal (Fossi et al. 2018). Entanglement in fishing gear is an issue for some baleen whale species in the ASCOBANS Area, such as minke whale (*Balaenoptera acutorostrata*) and humpback whale (*Megaptera novaeangliae*). Such entanglements may involve either active fishing gear or lost/discarded gear (netting, ropes).

Appropriate MSP and policy responses:
Fisheries regulations targeting the producers of goods that end up as marine litter in order to aim for a circular economy (EU 2019), public awareness, and beach and estuary clean-ups. This issue should be highlighted in maritime spatial plans but needs to be tackled via sectoral measures.

4.2. Relatively Location-Specific

4.2.1. Habitat degradation

Spatial Distribution: medium in Baltic Sea, otherwise low
Species most impacted: harbour porpoise
Sources of threat: disturbance of the seafloor through sand and gravel extraction, dredging, bottom trawling, and eutrophication, leading to habitat depletion. The likely primary cause in the Baltic Sea is eutrophication (nutrient pollution and resulting anoxic areas and harmful algal blooms) due to run-off from agriculture, wastewater treatment and other land-based sources.

The development of offshore structures for oil and gas extraction, aquaculture and renewable energy may result in physical loss of habitat for cetaceans through removing feeding habitat and/or excluding cetaceans from preferred feeding areas either on a temporary or long-term basis, an alternative view is that offshore structures have the potential to act as new habitat for prey species and as de facto protected areas for prey species and cetaceans. Coastal habitat loss may result from ports and harbour developments and infilling or enclosure to create new land or develop tidal renewable energy (Waters and Aggidis 2016). Bottom trawling and scallop dredging can irreversibly alter or remove some types of benthic habitats, such as oyster reefs (Pogoda 2019) and have had the widest impact on seabed habitats of any human activity (Eigaard et al. 2017).

Species-specific habitat loss may result from climate change. This is particularly the case for cold temperate and arctic species (MacLeod 2009, Chambault et al. 2018). Exclusion from preferred habitat on a short- or long-term basis can result from disturbance due to vessel traffic, water sports, underwater noise (e.g. ship noise, ADDs on aquaculture sites, seismic surveys, or offshore renewable energy developments) (Campana et al. 2015, Götz, and Janik 2013, Findlay et al. 2018, Kavanagh et al. 2019), or from chemical pollution events (Fisher et al. 2016). The pollution of coastal and transitional waters by phosphates and nitrates from land-based agricultural activities is a problem in the ASCOBANS area, with the Baltic Sea being of particular concern (EEA 2019). The consequences of coastal water enrichment (combined with the effects of warming seas) include algal blooms, which may impact coastal ecosystems and prey species, as well as potentially directly impact cetaceans through the release of algal toxins. Toxic algal blooms have been known to cause mass mortality in cetaceans in the United States and elsewhere (Fire et al. 2015, Haüssermann et al. 2017). Cetacean habitats can be degraded by a wide range of activities; while some impacts are local, others are widespread. Benthic habitats can be extensively degraded or permanently altered by scallop dredging and bottom trawling (Eigaard et al. 2017, Rijnsdorp et al. 2018) and dredging for sand and aggregates (Teaca et al. 2019, HELCOM 2018). Habitat degradation may reduce the value of habitat for cetaceans or, in extreme cases, result in effective habitat loss. The degradation or loss of benthic habitat can result in the direct loss of foraging opportunities but can also have impacts on the wider marine ecosystems on which cetaceans depend. Pelagic habitats can also be degraded by noise pollution, chemical contaminants, litter, vessel traffic, and overfishing.

Appropriate MSP and policy responses:
Restrictions on agricultural runoff, improved water quality monitoring under WFD (European Court of Auditors 2016) and protection of marine and coastal waters under EU MSFD. Large-scale nature restoration of relevant habitats, including those for prey species (e.g. reefs, seagrass). This issue should be highlighted in maritime spatial plans (land-sea interactions).

4.2.2. Sonar

Spatial Distribution: high in Baltic, Celtic Seas, Bay of Biscay and Iberian Peninsula
Species most impacted: beaked whales (Cuvier's beaked whale, Sowerby's beaked whale, etc)
Sources of threat: military use for navigation, detection of submarines, use in research, offshore wind turbine siting, and by the oil and gas industry.

The impact of mid-frequency (1-10 kHz) active sonar (primarily used by the military to detect submarines) on cetaceans has been identified as a significant conservation threat for deep-diving cetaceans (Evans and Miller 2004, Parsons 2017). In addition to disturbance and physical injury, the use of military mid-frequency active sonar has been linked to mass mortality in beaked whales and some other cetacean species linked to behavioural and physiological responses to sound (Bernaldo de Quirós et al. 2019, Parsons 2017, Jepson et al. 2013). Such mass mortality events can have potentially significant conservation impacts on local populations (Dolman et al. 2010, Brownlow 2018).

Appropriate MSP and policy responses:
- Restrictions on sonar use in areas of cetacean abundance or vulnerability
- Independent monitoring
- Close exchange and coordination with the military (e.g. nationally and through NATO).

4.2.3. Seismic surveys

Spatial Distribution: high in Baltic, Celtic Seas, Bay of Biscay and Iberian Peninsula
Species most impacted: harbour porpoises, baleen whales and deep-diving whales
Sources of threat: oil and gas exploration, offshore wind siting

Seismic surveys are the primary survey method currently in use by the oil and gas industry for locating deposits beneath the sea floor. They are also used in site surveys prior to the installation of rigs, wind farms and tidal energy installations. Seismic airguns produce loud impulse sounds with source levels up to 260–262 dB re 1 μPa-m (Thomsen 2009). Most of the energy produced by air gun arrays is in the low-frequency range below 300 Hz (Richardson et al. 1995), but some noise at higher frequencies is also generated.

Baleen whales and deep diving whales are thought to be most impacted by seismic surveys, with disturbance and disruption to foraging noted at tens of kilometres from the source (Nowacek et al. 2007, Miller et al. 2009), and a risk of permanent or temporary auditory injury to animals at close range (Nowacek et al. 2007, Southall et al. 2019). Strandings of deep-diving cetaceans have been linked to seismic survey activity (Castellote and Llorens 2015; McGeady et al. 2016), although direct evidence linking the two is elusive. Deep diving whales, and in particular beaked whales, may be particularly susceptible to the impacts of seismic noise due to their specific habitat requirements, restricted habitat availability and the extreme physiological limits at which they live (Tyack et al. 2006, Barlow and Gisiner 2006, Wright et al. 2011).

Reaction to seismic surveys has also been noted in dolphins and porpoises (Thompson et al. 2013), and temporary auditory injury has been recorded in porpoises (Kastelein et al. 2017). Seismic surveys may last for weeks or months, and a single seismic survey is capable of ensonifying thousands of square kilometres of ocean, leading to potential masking of communication signals over wide areas (Clark and Gagnon 2006, Sutton et al. 2013). The effects of such chronic noise exposure on cetaceans over ocean basin scales is poorly understood, but alteration to vocalisation rates and sighting rates have been reported (Clark and Gagnon, 2006; Kavanagh et al., 2019).

Appropriate MSP and policy responses: Avoidance and mitigation measures (see Parsons et al. 2019, Wright and Cosentino 2015), environmental impact assessments to ensure minimal impact, independent monitoring, and time period-specific to prevent co-occurrence with other impulsive noise events are recommended. Alternatives to seismic surveys include vibroseis (BOEM 2014).

4.2.4. Shipping Noise

Spatial Distribution: Medium across all regional seas (the busiest shipping routes in the ASCOBANS Area are the southernmost part of the North Sea and the English Channel, the southwestern Baltic, and across the outer part of the Bay of Biscay)
Species most impacted: harbour porpoise, whales (particularly baleen whales)
Sources of threat: commercial shipping

Shipping is the most widespread source of noise pollution in our ocean (OSPAR 2009) and is recognised as a chronic, habitat-level stressor (Williams et al. 2020). Large ships typically have sound source levels of 160-220dB re 1μPa @ 1m at frequencies of 2-100Hz (Richardson et al. 1995, NRC 2003). As with all chronic noise, the impacts of shipping noise on cetaceans are poorly understood, but impacts may include elevated stress levels (Rolland et al. 2012), exclusion from preferred habitat (Carome et al. 2022), masking of communication sounds, and masking of natural ocean sounds (Clark et al. 2009, Weilgart 2017, Erbe et al. 2019). Shipping noise primarily impacts low-frequency species such as baleen whales, but dolphins and porpoises can show strong avoidance reactions to ships (Dyndo et al. 2015) and smaller vessels (Pirotta et al. 2015). The busiest shipping routes in the ASCOBANS Area are the southernmost part of the North Sea and the English Channel, the southwestern Baltic, and across the outer part of the Bay of Biscay (OSPAR, 2010, 2017, Evans et al. 2011, HELCOM 2018).

Appropriate MSP and policy responses:
Speed reduction and rerouting (IMO 2023). Rerouting of shipping lanes to reduce noise impact has been successfully conducted by Canadian authorities (via the IMO) in the Bay of Fundy at the southeastern Canadian coast (Vanderlaan et al. 2008). Dynamic management measures should be piloted and implemented within maritime spatial plans. Adoption of IMO ship design guidelines and

national guidelines where available (e.g. those of the German 'Blue Angel' quality mark for environmentally-friendly products[13]), in accordance with best available technology (BAT) principle.

4.2.5. Collision with ships

Spatial Distribution: high in the Bay of Biscay, medium in the Greater North Sea and Celtic Seas
Species most impacted: baleen whales, sperm whale[14]
Sources of threat: commercial shipping

Collisions between ships and cetaceans have mostly been reported in large whales (e.g. fin whale and sperm whale) and involving fast-moving ships (>10 knots) (Laist et al. 2001, Vanderlaan and Taggart 2007). Areas of highest collision risk are where high densities of large whales overlap with areas of high shipping density. Within the ASCOBANS area, the Bay of Biscay is the area of highest whale collision risk (Evans et al. 2011). Ferries, sailing yachts, passenger vessels and whale-watching boats accounted for most of the identified whale strikes in the International Whaling Commission (IWC) Ship Strike database (Winkler et al. 2019). High-speed ferries have been of particular concern in cetacean collision injuries and deaths (Ritter et al., 2019). Small vessels can also cause physical injury or death to cetaceans, including dolphins and porpoises (Feingold & Evans 2014, Peel et al. 2018, Olaya-Ponzone et al. 2023).

Appropriate MSP and policy responses:
Speed reduction and rerouting (IMO (2023). Dynamic management measures should be piloted and implemented within maritime spatial plans.

4.2.6. Disturbance from Recreational and Wildlife Tourism Activity

Spatial Distribution: medium threat in Greater North Sea, Celtic Seas, Bay of Biscay and Iberian Peninsula
Species most impacted: bottlenose dolphin, harbour porpoise
Sources of threat: recreational activity and wildlife tourism

The increasing popularity of water sports and coastal activities, including whale and dolphin watching (Constantine and Bejder 2007, OSPAR 2010, 2017), is likely to lead to increased disturbance to cetaceans. At its most extreme, collisions between water sports and nature-watching vessels and cetaceans can result in the death or injury of individuals (Feingold & Evans 2014, Peel et al. 2018, Olaya-Ponzone et al. 2023). Other impacts include disturbance to animals during foraging, resting, socialising or breeding (Schaffar et al. 2009, Marino et al. 2012, Pirotta et al. 2015, Hoarau et al. 2020, Currie et al. 2021) from vessel presence or noise pollution (Burnham et al. 2021). Such disturbance may lead to reduced energy intake and increased energy expenditure with possible impacts on reproductive success and survival (Pérez-Jorge et al. 2016, Senigaglia et al. 2016). Coastal cetacean species are most likely to be affected by marine tourism activities. There is some evidence that cetaceans can adapt to the presence of whale-watching vessels, but this may be context- or individual-specific (New et al. 2013, Di Clemente et al. 2018). The degree to which populations are affected by disturbance depends on the nature of the population, with closed populations most sensitive, while large, open populations with no food limitations are able to better tolerate disturbance (New et al. 2020). Disturbance may also alter the balance in marine ecosystems, leading to lower biodiversity and fewer 'rare' species (Sutton et al. 2021).

Appropriate MSP and policy responses:
Regulations and international codes of practice have been established with relevant operators (e.g. International Whaling Commission Whale Watching Handbook[15]). Seasonal speed restrictions have been introduced within some protected areas.

[13] https://produktinfo.blauer-engel.de/uploads/attachment/de/Flyer_BE_Seeschiffe_web.pdf
[14] Note these species are not covered by the ASCOBANS Agreement.
[15] https://wwhandbook.iwc.int/en/

4.3. Highly Location-Specific Threats

4.3.1. Pile-driving / wind farm construction

Spatial Distribution: medium threat in the North Sea, Baltic Sea, Kattegat and Belt Seas, and Celtic Sea (e.g. Gusatu et al. 2021), projected to increase significantly in coming years.
Species most impacted: harbour porpoise
Sources of threat: wind farm construction

Pile-driving is used to insert metal pilings into the seabed to support offshore installations such as wind turbines. It can produce loud impulse sounds with source levels up to 243-257 dB re 1 µPa-m (Thomsen 2009). Most of the energy produced by pile driving is in the low-frequency range below 500Hz, but some noise at higher frequencies is also generated (Tougaard et al. 2009a; Dähne et al. 2013). Harbour porpoises have been observed to show negative reactions to pile driving at distances of 20 km or more (Tougaard et al. 2009a, Benhemma-Le Gall et al. 2021). Although porpoises have been noted to return after the construction phase of such developments (Brandt et al. 2018), during construction, porpoises and other cetaceans may be effectively excluded from preferred foraging or breeding areas. A planned increase in the construction of offshore wind and tidal energy sites within the ASCOBANS area may lead to impacts on porpoises and other cetaceans from pile driving noise, with cumulative impacts possible from adjacent developments. A considerable increase in potential impacts from planned offshore wind farm expansion in the North Sea is predicted by 2050 (Gușatu et al. 2021).

Appropriate MSP and policy responses:
Project-level environmental impact assessments with independent oversight are essential, along with a need for careful temporal and spatial planning at the regional /national level to minimise the co-occurrence of impulsive noise events. There is a need for continuous independent monitoring to minimise adverse impacts on cetacean populations and to ensure cetaceans return following the construction phase. Need for an incremental adaptive planning approach. In accordance with Best Available Techniques and Best Environmental Practices, alternative non-percussive pile-sinking methods and floating turbine technology should be applied where possible. Double bubble curtains can serve as noise-dampening mitigation measures. It is critical that established noise mitigation thresholds are being maintained as offshore wind turbines grow increasingly larger.

4.3.2. Underwater Explosions

Spatial Distribution: High threat in the Baltic Sea, medium threat in the Greater North Sea, Belt Seas and Kattegat
Species most impacted: harbour porpoise, minke whale, bottlenose dolphin
Sources of threat: site clearance prior to construction of marine installations (also due to controlled explosion of WWII ordnance)

Explosion of military ordinance has significant potential impacts on harbour porpoises. Blasting may also be required for site clearance prior to the construction of marine installations. Explosive blasts are one of the strongest point sources of any man-made sound. Source levels vary with the type and amounts of explosives used and the water depth at which the explosion occurs. Source levels range from 272 to 287 dB re 1 µPa zero to peak at 1 m distance (for 1–100 lb. TNT) (Thomsen 2009). Low frequencies are generated with most energy between 6–21Hz (Richardson et al. 1995). Of extra concern is that blasting also produces shockwaves capable of killing or severely injuring marine mammals in the vicinity of the blast (Ketten 1995).

Appropriate MSP and policy responses:
Project-level environmental impact assessments with independent oversight are essential, along with a need for careful temporal and spatial planning at the regional/national level to minimise the co-occurrence of impulsive noise events. Mitigation measures include acoustic deterrent devices to scare away animals prior to explosions and double bubble curtains to dampen noise levels (Koschinski & Lüdemann 2020). Continuous independent monitoring is also required to minimise

adverse impacts on cetacean populations and to ensure cetaceans return following noise exposure. There is a need for an incremental adaptive planning approach.

4.3.3 Collisions with Tidal Turbines

Spatial Distribution: Medium threat in the Celtic Seas and northern North Sea, otherwise low
Species Most likely to be impacted: Harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin, minke whale
Sources of Threat: turbines for tidal energy generation

Concerns have been expressed over the potential risk to seals and cetaceans of collisions with tidal turbines (Benjamins et al., 2015; Sparling et al., 2015; Onoufriou et al., 2019). Areas where turbines exploit tidal energy have been deployed already, include the Orkney Islands (Greater North Sea), Strangford Lough in Northern Ireland and off the coast of West Wales (Celtic Seas), with many further areas proposed, particularly around the UK. Potential interactions have been anticipated, especially for harbour porpoise, which commonly utilise tidal stream environments, as well as some dolphins and seals (Benjamins et al., 2016; Waggitt et al., 2017). In those areas of the European Atlantic where tidal currents are strong, there are good prospects for the deployment of tidal turbines as a source of offshore renewable energy. The deployment of tidal turbines is still very much in the experimental demonstration phase. So far, no actual incidents have been reported, with tagged seals taking aversive action (e.g. Sparling et al., 2018; Joy et al., 2018). With emphasis on improving energy security and alternative renewable energy sources, there are prospects for greatly increased deployment of tidal turbines.

5. Future Outlook: Towards Cetacean-Sensitive Maritime Spatial Planning

It is not unusual for maritime spatial plans to include long-term visions, providing a future perspective on the use of marine space in thirty- or forty years' time. Indeed, maritime spatial plans should be accompanied by clear statements of strategy, outlining how the individual regulatory steps contained within the plan are envisaged to work together with sectoral measures to achieve desired outcomes. Based on current trends, a continued increase in maritime economic activity across the ASCOBANS area, with a corresponding increase in risk to cetacean populations, is likely. Existing pressures will be compounded by the impacts of climate change, with significant impacts on the health and integrity of marine ecosystems, including cetaceans and other taxa. Increased volume and density of human activities and resulting pressures will increase the risk of high-magnitude, low-frequency events with severe and acute impacts on cetacean populations. Based on current legislation and policy initiatives, there is potential for significant progress in the implementation of ecosystem-based maritime spatial planning with a much closer alignment between maritime spatial planning, ecosystem management and marine protected area designation and management. Protected areas alone, however, will not be sufficient to achieve cetacean conservation objectives. Increased regulation and reduction in the intensity of sectoral uses are both necessary to ensure the medium- and long-term viability of cetacean populations.

The use of maritime space will be subject to ongoing evaluation based on ecological criteria, including systematic assessments of cumulative impacts and analysis of short-, medium- and long-term trends. Technological advances will likely lead to more effective mitigation measures and increased opportunities for the multiple-use of marine space. The realization of cetacean-sensitive MSP will require a firm commitment by Parties and their relevant national agencies, as well as early leaders in the private sector (e.g. shipping, offshore wind) and other critical stakeholders. Investment in adequate capacities (e.g. monitoring), assessment methodologies and transboundary coordination at both strategic and operational levels will be essential to a coherent, coordinated, evidence-based approach. Cetacean-sensitive MSP will require a combination of both active and passive area-based conservation and restoration measures, seasonal restrictions, mitigation and remediation to allow cetacean populations to achieve and maintain a favourable conservation status.

The further development and implementation of cetacean-sensitive MSP represents a test case of scientifically informed ecosystem-based MSP. Achieving favourable conservation status for cetaceans should be viewed in terms of their role as a key indicator of the health and resilience of marine ecosystems more generally and as an essential step to achieving international biodiversity targets.

List of Abbreviations

ACCOBAMS: Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area

ASCOBANS: Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas

BAT: Best Available Technology

BEP: Best Environmental Practice

CBD: Convention on Biological Diversity

CINEA: European Climate, Infrastructure and Environment Executive Agency

CMS: Convention on the Conservation of Migratory Species of Wild Animals

CSPD/BSR: Committee on Spatial Planning and Development of the Baltic Sea Region (of VASAB)

dB re 1 µPa: technical measurement of sound pressure level

EB-MSP: Ecosystem-Based Maritime Spatial Planning

EB: Ecosystem-Based

EC: European Commission

EEA: European Environment Agency

EIA: Environmental Impact Assessment

EU CFP: European Union Common Fisheries Policy

EU MSFD: European Union Marine Strategy Framework Directive

EU MSPD: European Union Maritime Spatial Planning Directive

EU WFD: European Union Water Framework Directive

EU: European Union

HELCOM: Baltic Marine Environment Protection Commission – Helsinki Commission

ICES WGMME: International Council for the Exploration of the Seas Working Group on Marine Mammal Ecology

ICES: International Council for the Exploration of the Seas

IMO: International Maritime Organisation

IOC: International Oceanographic Commission

MPA: Marine Protected Area

MSP: Maritime Spatial Planning

NATO: North Atlantic Treaty Organisation

ORE: Offshore Renewable Energy

OSPAR (Commission): Oslo-Paris Commission

OSPAR (Convention): Convention for the Protection of the Marine Environment of the North-East Atlantic

OWF: Offshore Windfarm

PCB: Polychlorinated biphenyl

SEA: Strategic Environmental Assessment

TG NOISE: European Union Technical Group on Underwater Noise

UNECE: United Nations Economic Commission for Europe

UNEP: United Nations Environment Programme

VASAB: Visions and Strategies Around the Baltic Sea

VMS: Vessel Monitoring Syste

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