Marine Mammals Thematic Assessment

OSPAR

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Marine Mammal Thematic Assessment

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. The Contracting Parties are Belgium, Denmark, the European Union, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Convention OSPAR

La Convention pour la protection du milieu marin de l´Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d´Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. Les Parties contractantes sont l´Allemagne, la Belgique, le Danemark, l´Espagne, la Finlande, la France, l´Irlande, l´Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume- Uni de Grande Bretagne et d´Irlande du Nord, la Suède, la Suisse et l´Union européenne

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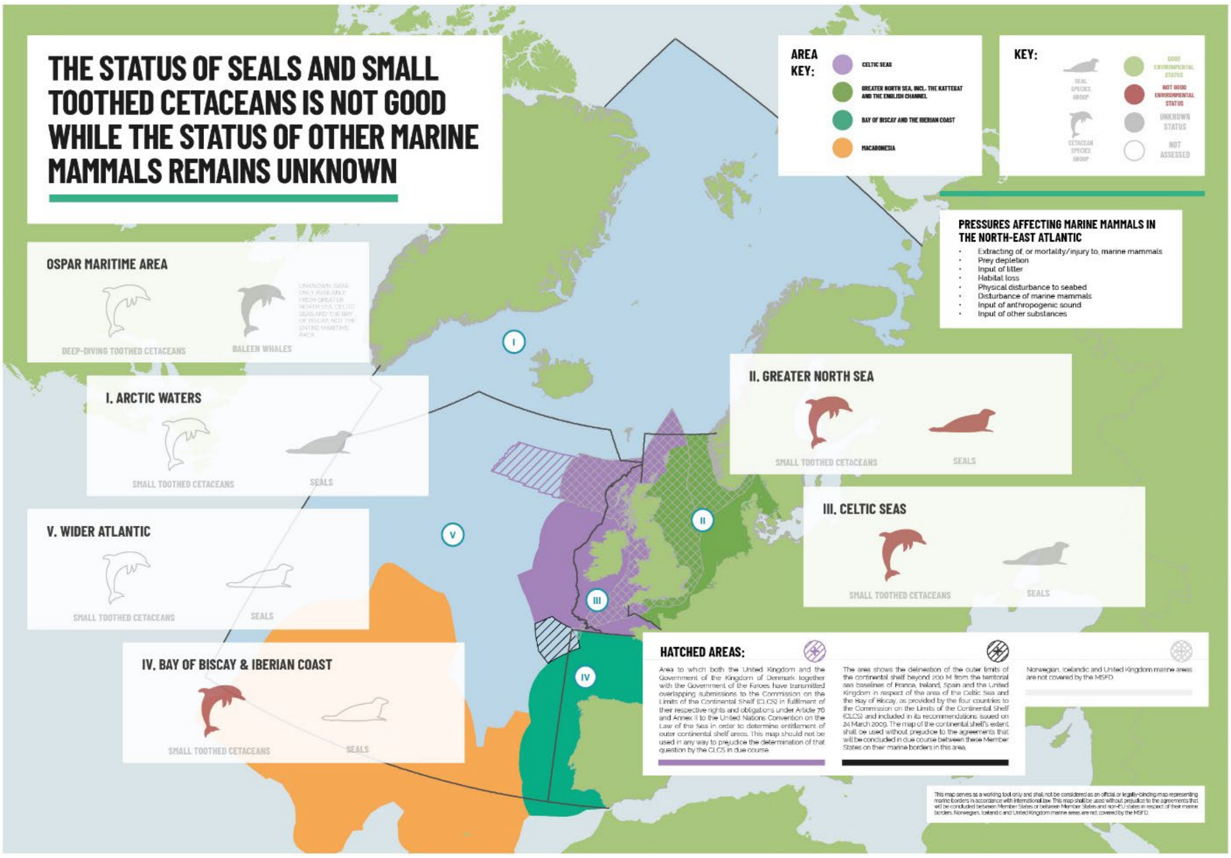
Executive Summary

Marine mammals have been and are subject to significant pressure from both natural impacts and human activity, which results in many populations and species not being in good status. Many pressures still occur on a wide scale today, such as incidental by-catch, or are even increasing, such as noise and hazardous substances, habitat loss or degradation of habitat. Marine mammals tend to have wide distributional ranges and some species are very rare. This makes the monitoring of marine mammals challenging, leading to a concerningly poor understanding of the distribution and population size of many marine mammal species.

As a result, the quantitative and qualitative assessments for marine mammals in the Quality Status Report (QSR) 2023 have revealed many species and populations to be in not good status. Moreover, limited improvement has been observed compared with previous assessments. For many species it is simply not known with confidence how well they are faring. With the environment expected to change rapidly in the future, for example through climate change, and given the shifts in the structure of food webs, where marine mammals often sit at the top, the continuing exposure to pollutants and society's shifting of food and energy production, for example, from land to sea, the threats to marine mammals are likely to remain at a high level.

There is limited evidence that the measures implemented to protect and improve the condition of marine mammal populations have been effective. However, the opportunity exists for more tailored measures and to improve the implementation of management measures. Similarly, there is a need to capitalise on the amount of data gathered through regionally coordinated monitoring, which would not only allow for a better understanding of marine mammal populations but also help in evaluating the effectiveness of measures that have been applied.



Q1. Identify the problems? Are they the same in all OSPAR Regions?

Many marine mammals are (top) predators and very mobile. This means that they are particularly susceptible to disturbances lower in the food web affecting their food and energy resources, and many are impacted by pressures occurring at various places in their wide distribution areas. Indirect pressures, such as reproductive disruption due to bioaccumulation of pollutants, act in addition to direct pressures on marine mammals, such as incidental by-catch, entanglement, vessel strikes or hunting.

There is a wide range of societal needs driving the human activities that exert pressure on marine mammals, both on the individual and at the population level. The complexity of impacts results in many challenges associated with successful protection and management of marine mammals; these challenges are compounded in the case of highly mobile species that also migrate outside the OSPAR Maritime Area.

OSPAR's QSR 2010 identified climate change, noise pollution, loss of habitat and prey, as well as by-catch, as the largest threats to marine mammals in the OSPAR Maritime Area. It was noted that cetaceans were especially threatened, being in some cases nearly extinct and in some cases not recovering, despite a moratorium on whaling. Because marine mammals are very mobile, designation of Marine Protected Areas (MPAs) was not expected to be sufficient as a protection measure: these MPAs, the QSR 2010 states, need to form an ecologically coherent network so that mobile species are protected at multiple (critical) life stages. The 2017 OSPAR Intermediate Assessment did not report recovery of cetaceans, in part because of data scarcity. For seals, grey seal abundance was largely increasing across the area assessed and grey seal pup production was observed to increase in most assessment units. However, it should not be forgotten that grey seals are still undergoing recovery and recolonization from massive declines in the past due to hunting and pollution. Harbour seal abundance was largely stable or increasing, but decreasing in some assessment units.

Climate change is expected to impact marine mammals directly by affecting habitat suitability and causing distribution shifts, owing to animals tracking preferred environmental (e.g., temperature) conditions. Further, climate change is expected to impact primary productivity and availability of prey (both in time and space), forcing marine mammals to track their prey. Climate change is also likely to lead to increased human activity and associated pressures in Arctic Waters. Measures to adapt to and mitigate climate change are likely to result in increasing noise pollution and disturbance, affecting marine mammals in nearly all regions. The expansion of renewable energy technologies will result in high disturbance during construction and decommissioning as well as increased ship traffic during the operational phases, increasing both impulsive and continuous noise pollution and thus affecting marine mammals’ behaviour and habitat use, and also impairing their hearing and causing injury. The whole spectrum of threats to marine mammals is still present in the OSPAR Maritime Area.

Grey seal. © Shutterstock

Q2. What has been done?

OSPAR has identified four marine mammal species of particular concern: the bowhead whale, the harbour porpoise, the northern right whale and the blue whale. OSPAR has adopted recommendations for actions both at the national level (e.g., recommendations to adopt legislation regarding human activities affecting the status of the selected species) and collectively (related to coordination of monitoring and exchange of knowledge) in order to address the threats to these species. Another OSPAR response aimed at the protection of marine mammals is the designation of Marine Protected Areas (MPAs). There are, however, still gaps in OSPAR's network of MPAs, and this lack of eco-coherence limits its effectiveness in protecting marine mammals. The OSPAR Noise Action Plan and the new OSPAR Marine Litter Regional Action Plan are positive developments for marine mammals.

Q3. Did it work?

It is not possible to answer if the existing measures are able to reduce the impact of the human activities and pressures that continue to undermine the status of marine mammal species in the North-East Atlantic. The assessment results do not give a clear indication of successful implementation of measures and environmental management. In some cases, such as the large whale species on the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR Agreement 2008-06), the current status is principally a consequence of historic whaling activities. These species remain in not good status, although at least for the blue whale there are some indications of improvement. Given the long generation time of many of the species involved it is important that a long view is taken when measures are evaluated. Also, the monitoring needs to be suitable for the (sometimes very) wide distribution and rarity of marine mammal species. Cooperation with other competent authorities, including the Convention on the Protection of the Marine Environment of the Baltic Sea Area – also known as the Helsinki Convention (HELCOM), the Agreement on the Conservation of Small Cetaceans of the Baltic, North-East Atlantic, Irish and North Seas (ASCOBANS), the North Atlantic Marine Mammal Commission (NAMMCO), the International Whaling Commission (IWC), the Conservation of Arctic Flora and Fauna (CAFF) Working Group of the Arctic Council and the relevant fisheries management organisations will be key to ensuring the coordinated responses result in an improved state for marine mammals.

For the blue whale there are some indications of improvement. © Shutterstock

Q4. How does this field affect the overall quality status?

The status of marine mammals is typically also an indicator of the health of the wider ecosystem. Given their ecologically important role in the food web, they strongly depend on the quality status of ecosystems and exert top-down control on lower trophic levels. Marine mammals provide many ecosystem services, and changes in their status have implications for the wider ecosystem. The decline of marine mammal populations would adversely affect the provision of ecosystem services, primarily through significant impacts on food web functionality; biodiversity loss; reduced nutrient cycling and carbon storage potential; and by reducing the benefits that society derives from experiencing marine mammals in the wild. The assessments presented in the QSR 2023 on the abundance and distribution of grey seals and harbour seals, on grey seal pup production, on the incidental by-catch of marine mammals and on the distribution and abundance of cetaceans indicate that many pressures on marine mammals persist and some are of increasing concern (e.g., noise and plastic pollution, hazardous substances). Small toothed cetaceans are not in good status in all the Regions where they were assessed: Greater North Sea (Region II), Celtic Seas (Region III) and Bay of Biscay and Iberian Coast (Region IV). The status of baleen whales and deep-diving toothed cetaceans is unknown because of a lack of data to inform the indicators. Grey seals, recovering from local extinctions in the past, were found to be in good status in both the Greater North Sea and in the Celtic Seas, whereas harbour seals were considered to be in not good status in the Greater North Sea. The status of harbour seals in the Celtic Seas is unknown because of a lack of data, though for sites where data are available, the abundance of the species is increasing. Data from Arctic Waters were too limited and/or patchy for holistic indicator assessments. The available data from Arctic Waters suggest positive trends for some species or populations and negative for others.

In the QSR 2023, the pilot assessment for persistent chemicals bioaccumulation in marine mammals from the OSPAR Regions (presented within the Hazard Substances Thematic Assessment) concludes that small toothed cetaceans, especially from the Greater North Sea and the Celtic Seas, are still at high risk of toxicity from legacy pollutants such as Polychlorinated Biphenyls (PCBs). Large knowledge gaps and the heterogeneity of the data prevented the integration of this information into the overall status assessment of marine mammals, but this hints at the necessity of increasing future efforts to achieve OSPAR's operational objectives of the 2030 North-East Atlantic Environmental Strategy (S2.O2 and S2.O3) in respect of marine pollution and the effects of climate change on chemicals bioavailability (strategic objectives 11, 12 and 13), since long-lived species at the top of the food web still exhibit extremely elevated levels of persistent organic pollutants.

Small toothed cetaceans are still at high risk of toxicity from legacy pollutants such as PCBs. © Shutterstock

Q5. What do we do next?

In the North-East Atlantic Environment Strategy (NEAES) 2030 OSPAR acknowledges the consensus among scientists that the health of the North-East Atlantic is at risk of further degradation and that urgent action is needed to address the loss of biodiversity and improve ecosystem functioning.

With regard to marine mammals, OSPAR has expressed its ambition to conserve marine biodiversity and ecosystems to achieve good status for marine mammal species (Strategic Objective 5), and to ensure sustainable use of the marine environment, with a special view to addressing cumulative impacts (Strategic Objective 7). Further, OSPAR commits itself to the regional coordination and implementation of the EU Marine Strategy Framework Directive (Council Directive 2008/56/EC) (MSFD) for those Contracting Parties that are also EU member states (SX.01) and to applying ecosystem-based management in coordination with fisheries management bodies and other competent organisations.

These Strategic Objectives (S) are to be achieved through several Operational Objectives (O).

- The MPA network is to be expanded to cover at least 30% of the OSPAR Maritime Area, making sure that it is ecologically coherent (S5.O1).
- MPA management is to be improved (S5.O2 and 3, S11.O2) and its resilience to climate change and ocean acidification increased (S11.O1).
- Agreed measures that allow threatened and declining mammals to recover will be implemented (S5.O5).
- The List of Threatened and/or Declining species will be revised to take climate change and ocean acidification impacts into account (S11.O3).
- Pressure on marine mammals will be prevented or reduced to allow achievement of good environmental status (S5.O4).
- Where the knowledge base needed to achieve OSPAR's objectives related to marine mammals is currently insufficient, OSPAR will undertake action to coordinate data collection and sharing (S5.O6).
- Methods to analyse cumulative impacts on marine mammals are to be (further) developed and the resulting knowledge will be used to reduce and/or prevent the severity of cumulative pressures on marine mammals (S7.O1).
- OSPAR commits itself to working with relevant competent authorities and stakeholders so as to minimise and, where possible, eliminate incidental by-catch of marine mammals (S7.O6).

The effective implementation of many of these objectives will depend heavily on national actions, which should continue to be reported through, for example, the implementation reporting requirements in the Recommendations on threatened and declining species and habitats.

OSPAR recognises the need to increase its focus on identifying and implementing collective actions which add value both to existing national actions and to the efforts of other international organisations. Overall, the 2019 implementation reporting indicates that there is a good level of engagement to implement the national actions within the Recommendations, in particular within the areas where the species and habitats are considered to be under threat and/ or in decline. The level of engagement in collective actions is clearly at a lower level, with some of the more complex actions not having been progressed and implemented. Many of the actions focus on monitoring and assessment, relatively few on response, but in either case there has been only modest progress. OSPAR will therefore develop a series of biodiversity action plans, starting with marine birds and coastal shelf benthic habitats, to identify priority response measures which are well-defined, add value and can be delivered within the resources available to the OSPAR Contracting Parties.

The QSR 2023 provides a powerful evidence base for action. OSPAR will strengthen its capacity to use this evidence base and all future assessments in order to support engagement with other international partners. Engagement cannot be an end in itself: the development of a practical approach to Ecosystem-Based Management (EBM) will provide the opportunity and the mechanism to share evidence and common objectives for more sustainable use of the marine environment. Working with interested partners and drawing on international best practice, OSPAR will design and implement a pilot project on EBM in one of the OSPAR Regions.

Progress against all of these challenging objectives for biodiversity will be tracked through OSPAR's NEAES Implementation Plan. A planned review in 2025 will provide an opportunity to adjust OSPAR's Strategy and, if necessary, take further action to protect and conserve biodiversity.

D - Drivers

Social and economic drivers of activities affecting marine mammals

All social and economic drivers have the potential to influence the quality status of marine mammals. Marine mammals provide a tangible and iconic focus for society's need to appreciate nature and biodiversity by conserving and sustainably using the oceans, seas, and marine resources. Marine mammals play a key role in marine ecosystems in terms of biomass, consumption and energy transfer, which emphasises their major ecological importance, and they are also major contributors to the marine cultural ecosystem services underpinning the tourism sector. Public concerns about the conservation of iconic species stimulate societal debate, driving public pressure on political debate and demands for action.

The list below presents the drivers of the main activities impacting marine mammals.

Society's need for stable economies, energy, and materials has been one of the main drivers for the extraction of minerals, oil and gas production and the development of offshore renewables. These activities have been linked to increases in underwater noise and releases of chemicals directly into the marine mammal habitat. The oil and gas industry is also one of the main contributors to climate change, and society's responses to mitigate and adapt to the effects of climate change have resulted in:

- the expansion of renewable energy technologies to meet society's need for energy, involving the introduction of associated infrastructure to the marine environment, which can either directly or indirectly affect marine mammals, their prey and their habitats;
- threats to society requiring coastal and flood protection, sea defences, levees and dikes, infrastructure that has the potential to either directly or indirectly affect marine mammals and their habitats.

Society's need for energy and national security has been linked to loud impulse noise which can seriously affect marine mammals.

Society's need for industrial processes and for the trade and movement of goods can introduce pollutants, including underwater noise and litter, to the marine environment, which can affect marine mammals. Shipments of goods by sea, and navigational dredging in support of shipping, can each contribute to the input or remobilisation of contaminants in the marine environment and the displacement of marine mammals. Vessel movements can disturb or displace marine mammals or cause injury or death through collisions.

Growing global human populations increase society's need for food, and fisheries, aquaculture and agriculture will help to meet this growing demand. These activities can influence contaminant and nutrient levels in the marine environment. Acoustic deterrents used to protect fish stocks can affect marine mammal behaviours. Some fishing activities and farming practices can be detrimental to marine mammals and lead to incidental catches of marine mammals as well as habitat loss and prey depletion.

Services related to society's need for health and well-being, such as waste treatment and disposal, can introduce pollutants to the marine environment. Activities related to leisure and tourism can result in disturbance, collision or other associated impacts.

Policy responses for managing human activities need to consider all these driving forces in order to meet society’s needs while reducing the risks to marine mammals and facilitate societal change.

Wind turbine foundation installation. © Shutterstock

A – Activities

Activities exerting pressures on marine mammals

Human activities are distributed widely across the North-East Atlantic, but their intensity and that of the pressures they impose on the marine environment vary greatly between OSPAR Regions and Sub-divisions. Some sea areas are affected by many activities; in others, only a few may be significant. The table below is taken from the Human Activities Thematic Assessment and gives a high-level summary of the intensity and trends of selected activities across the OSPAR Regions, based on the analysis in feeder reports. However, not all activities that affect marine mammals are currently assessed by OSPAR (**Table A.1**).

Renewable energy, aquaculture, military operations and tourism are expected to increase in the coming years. Future trends of some activities such as fisheries and shipping are uncertain, but their intensity is potentially going to increase in the OSPAR Maritime Area.

Table A.1: Summary of intensity and trends of selected human activities in OSPAR Regions. All the listed activities are relevant for marine mammals. Cell entries represent intensity (high, medium, low), trend since QSR 2010, and forecast trend to 2030. Symbols used: ↓ = decreasing trend, ↑ = increasing trend, ↔ = little change in intensity since QSR 2010; ? = future trends are uncertain. *Note that not all human activities are currently assessed directly by OSPAR

Main activities	Arctic Waters	Greater North Sea	Celtic Sea	Bay of Biscay and Iberian Coast	Wider Atlantic
Aggregates extraction					
Intensity	L	H	M	M	L
Trend since QSR2010	↔	↓	↔	↑	↔
Trend to 2030	?	?	?	?	?
Agriculture					
Intensity	L	H	M	M	L
Trend since QSR2010	↔	↔	↔	↔	↔
Trend to 2030	↔	↔	↔	↔	↔
Aquaculture					
Intensity	H	H	M	M	L
Trend since QSR2010	↑	↑	↔	↑	↑
Trend to 2030	↑	↑	↑	↑	↑
Fisheries					
Intensity	H	H	H	M	L
Trend since QSR2010	↓	↑	↑	↔	↔
Trend to 2030	?	?	?	?	?
Hunting and collecting*					
Intensity					
Trend since QSR2010					
Trend to 2030					
Military operations*					
Intensity					
Trend since QSR2010					
Trend to 2030					
Oil/gas production					
Intensity	M	H	M	L	L
Trend since QSR2010	↔	↔	↔	↔	↔
Trend to 2030	↔	↔	↔	↔	↔
Renewable energy					
Intensity	L	H	M	L	L
Trend since QSR2010	↑	↑	↑	↑	↔

Trend to 2030	↑	↑	↑	↑	↔
Shipping *Intensity* *Trend since QSR2010* *Trend to 2030*	 M ↔ ?	 H ↔ ?	 H ↔ ?	 H ↔ ?	 L ↔ ?
Tourism *Intensity* *Trend since QSR2010* *Trend to 2030*	 L ↑ ↑	 H ↑ ↑	 M ↔ ↔	 H ↑ ↑	 L ↑ ↑
Water management* *Intensity* *Trend since QSR2010* *Trend to 2030*					
Waste treatment and disposal* *Intensity* *Trend since QSR2010* *Trend to 2030*					

Human activities that interact with marine mammals fall under several MSFD headings as shown in the State section.

OSPAR acts as a coordination platform in the North-East Atlantic for the regional implementation of the EU Marine Strategy Framework Directive (MSFD) that aims to achieve a Good Environmental Status (GES) in European marine environments, as well as for the coordination of other national frameworks. The characteristics of GES are determined by the individual EU member states, based on criteria elements, threshold values and methodological standards set regionally or at EU level. Norwegian, Icelandic, United Kingdom, Greenlandic and Faroese marine areas are not covered by the MSFD.

Renewable energy generation (wind, wave and tidal power), including infrastructure, Nuclear energy and Transmission of electricity and communications (cables) [Production of energy]:
Society's need for energy, stable economies and to mitigate the effects of climate change are drivers for renewable energy generation, including the construction of associated infrastructure. Other associated activities include nuclear energy generation and transmission of electricity via power cables. Renewable energy generation in the marine environment is the only human activity directly driven by society's need to mitigate the effects of climate change, but in meeting this need, society also has to meet the needs of and appreciate nature and biodiversity. Renewable energy generation in the marine environment requires the development of infrastructures on coastal land. Harbour development may impact local coastal ecosystems through noise associated with blasting/drilling and the release of sediment and chemicals into the marine environment. It is crucial that measures to mitigate climate change do not counteract efforts to protect biodiversity. A healthy ocean contributes strongly to climate regulation. Further detail is provided in the relevant feeder report: Offshore Renewable Energy Generation.

Phases of these activities which can directly affect marine mammals are:

- The exploration phase often includes geophysical surveys. The removal of unexploded ordnance before construction can also produce very high levels of noise leading to physical injuries and/or, temporary or permanent hearing damage, and in the worst case can be fatal.
- The construction (and decommissioning) phases of offshore bottom-mounted renewable energy developments contribute to the input of impulsive noise into the marine environment. Construction (notably pile-driving of foundations) is a fixed- point source involving time-limited

activities which cease once the construction is complete, and there are mitigation techniques available.

- The construction of an increasing amount of renewable energy infrastructure, once completed, can induce barrier effects and impact marine mammal movements and migration.
- The operation of renewable energy infrastructure contributes continuous underwater noise into the marine environment. Such operation (notably blade rotations) is a fixed-point source involving ongoing activity throughout the lifetime of the development. The increasing activity of service vessels and associated ship traffic will also impact marine mammals and increase noise and disturbance. At local scale, the habitat will change due to the introduction of hard substrate; hydro- and morphodynamics as well as biogeochemistry will be impacted.
- Transmission of electricity through cables is the main source of input of other forms of energy into the environment. Once operational, these cables emit electromagnetic fields (EMF), which could be detected by marine mammals and/or could impact the behaviour of their prey.
- In addition to renewable energy, nuclear energy power stations are often located on the coast and often incorporate some form of cooling water intake/outfall with pipes running into the sub-tidal area.

Extraction of oil and gas, including infrastructure and Extraction of minerals [Extraction of non-living resources]:
Society's needs for energy and stable economies are drivers for the extraction of oil and gas. Society's need for material drives the extraction of minerals. The exploration, operation and decommissioning of oil and gas platforms and the associated infrastructure (pipeline and cables) directly interact with marine mammal habitats. The main interactions affecting marine mammal habitats can arise from the seismic surveys (impulsive noise) for oil and gas exploration, the vessel traffic associated with services to the platforms, operational noise emitted at the site and accidental spills during drilling or operation. Further detail is provided in the Offshore Industry Thematic Assessment. Extracting minerals through dredging can release chemicals directly into marine mammal habitat. Further detail is provided in the relevant feeder report: Extraction of non-living Resources.

Coastal defence and flood protection, Offshore structures (other than for oil/gas/renewables) and Land claim [Physical restructuring of rivers, coastline or seabed (water management)]:
Society's need to adapt to the effects of climate change, health and wellbeing and for stable economies are the drivers for land claim, coastal defences and flood protection, and offshore structures (other than oil/gas/renewables). Society's need for and appreciation of nature and biodiversity also drives the construction of coastal and flood defences. The structures associated with this activity can be located on or adjacent to marine mammal habitat and damage it. These activities will also introduce additional disturbance and noise during the construction phase.

Transport shipping and Transport infrastructure [Transport]:
Society's need for the trade and movement of goods drives transport, responding to the need for stable economies and the supply and demand of goods and services. Shipping directly interacts with marine mammals, producing continuous noise and causing obstructions. In addition, vessel strikes can lead to injury or death. Further detail is provided in the relevant feeder report: Shipping and Ports.

Fish and shellfish harvesting (professional, recreational) and Hunting and collecting for other purposes [Extraction of living resources]:
Society's need for food is a driver for fishing activities. Society's needs for food and the preservation of culture drive "hunting and collecting for other purposes". As an example, it can be mentioned the relatively small-

scale and localised hunting of marine mammals to maintain artisanal culture. Gears used to extract living resources may directly / indirectly interact with marine mammals. Smaller species of cetaceans in particular are still frequently incidentally by-caught in static nets and other fishing metiers. In some OSPAR Regions marine mammals are still commercially or traditionally hunted, which affects their populations. Further detail is provided in the relevant feeder report: Fisheries.

Aquaculture – marine, including infrastructure and Agriculture [Cultivation of living resources]:
Society's need for food is a driver for both marine aquaculture and agriculture. Aquaculture directly interacts with marine mammal habitat and can also potentially attract marine mammals. The input of extra nutrients, introduction of diseases and use of Acoustic Deterrent Devices can all potentially affect marine mammals. Agriculture indirectly interacts with marine mammal habitat, as run-off from pesticides can end up in the ocean and contaminate their environment. Further detail is provided in the relevant feeder reports: Aquaculture and Agriculture.

Waste treatment and disposal [Urban and industrial uses]**:**
Society's needs for health and wellbeing and for industrial processes drive waste treatment and disposal. Waste treatment and disposal can directly affect marine mammal habitats, contaminating them and causing eutrophication. Extremely high contaminant burden (mainly Polychlorinated Biphenyls PCBs and mercury Hg) is found in many species of marine mammals living the North-East Atlantic, often surpassing the estimated thresholds for toxicity effects (from molecular to tissue level). High PCBs and Hg levels have been shown to impair marine mammals' immune and reproductive systems as well as affect foetuses' neuronal development and motor activity. Further detail is provided in the relevant feeder report: Waste water.

Military operations [Security/defence]: Society's need for national security drives military operations, which directly interact with marine mammal habitats and can cause injuries and mortality. Military activities such as the disposal at sea of munitions, explosions/detonations, sonar use and exercises produce high levels of noise as well as unexpected noise at particular frequencies, which can elicit behavioural and physiological risk evasion responses in marine mammals, potentially leading to physical injuries, temporary or permanent hearing damage and, ultimately, death.

Tourism and leisure infrastructure and Tourism and leisure activities [Tourism and leisure]:
Society's need for health and wellbeing drives tourism and leisure. Tourism and leisure infrastructures can be located on or adjacent to marine mammal habitat and damage it. Tourism and leisure activities directly interact with marine mammals and their habitats, leading to disturbances which when repeated can impact populations, and to vessel strikes which can lead to injury or death. The tourism that takes place on and along the North-East Atlantic Ocean is particularly relevant because of its economic value and its dependence on the marine ecosystem. Activities such as boating, recreational fishing, marine wildlife watching, general beach recreation and cruises directly interact with marine mammal habitat. Tourism activities can contribute to physical disturbance, physical damage and physical loss of habitat. Further, some of these activities contribute to pollution, such as litter, underwater noise, contamination by hazardous substances, nutrient and organic enrichment. Further detail is provided in the relevant feeder report: Recreation and Tourism.

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P – Pressures

Multiple Pressures negatively impact marine mammals

There are numerous pressures on marine mammals across the North-East Atlantic caused by human activities. Their relative importance varies between species and OSPAR Regions, depending on the extent of the respective activities and the sensitivity of the species in its Region.

Climate change will affect marine mammals throughout the OSPAR Maritime Area, including directly on abundance and distribution, and also indirectly; details are provided in the Climate Change section.

The main other pressures affecting marine mammals are fishery (incidental by-catch in fishing gears, reduction in prey density, habitat loss) and shipping activities (mortality / injury due to collision with ships), disturbance (including tourism, shipping and wind farm activities), anthropogenic sound (including military sonar and pile-driving), litter (ingestion of plastics), man-made substances (e.g. bioaccumulation of toxic contaminants) and physical loss or disturbance of the sea-bed (which affects the prey of marine mammals). Seals are also under pressure on land (when breeding or moulting) from disturbance (e.g., tourism or coastal development) and habitat loss due to land reclamation.

Trends in the pressures are difficult to elaborate, but trends in the human activities exerting them could provide a suitable proxy for trends in the pressures themselves.

Human activities are creating multiple pressures, which have been shown to have negative impacts on marine mammals at both individual and population level (Butterworth *et al.*, 2017; Avila *et al.* 2018). These impacts range from increased stress and higher energetic costs, through sub-lethal effects on reproduction and immune function, to mortality and therefore declining populations (Hammond *et al.,* 2008).

These pressures fall under several MSFD headings, as shown in square brackets [].
OSPAR acts as a coordination platform in the North-East Atlantic for the regional implementation of the EU Marine Strategy Framework Directive (MSFD) that aims to achieve a Good Environmental Status (GES) in European marine environments, as well as for the coordination of other national frameworks. The characteristics of GES are determined by the individual EU member states, based on criteria elements, threshold values and methodological standards set regionally or at EU level.
Norwegian, Icelandic, United Kingdom, Greenlandic and Faroese marine areas are not covered by the MSFD.

Pressures are ranked comparatively. The number in brackets indicates the comparative ranking.

(1) Selective extraction of species, including non-target catches [Biological]: Fish and shellfish harvesting, at either professional or recreational level, can result in fisheries by-catch as well as entanglement, causing injury or mortality of marine mammals (Silva *et al.,* 2011; Reeves *et al.,* 2013). By-catch is widely considered to be the primary human-induced cause of mortality in marine mammals (Lent and Squires, 2017).

Marine mammals may be at risk of becoming incidentally by-catch depending on their behaviour and the fishing gears being used to harvest fish and shellfish. For example, static gears such as gillnets are prone to entangle harbour porpoises and seals. Pelagic pair trawlers have been identified as inducing by-catch of common dolphins, and creel pots can result in entanglement and by-catch, particularly of large baleen whales such as minke whales (ICES 2019).

(2) Input of anthropogenic sound (impulsive, continuous) [Substances, litter and energy]: Activities that emit anthropogenic noise into the environment include shipping, seismic surveys, tourism activities, aquaculture, military operations, dredging, mineral extraction, and the construction and operation of devices such as renewable energy turbines and water pumps, as well as oil and gas platforms. Underwater noise can be divided into two forms of pressure:

- Loud impulsive noise, typically from sonar, seismic surveys, pile-driving and explosions (Gordon *et al.*, 2003);
- Continuous noise, typically offshore renewable energy turbines, water pumps, shipping and acoustic deterrent devices (Erbe *et al.*, 2018).

Anthropogenic noise is a form of energy that can have behavioural and physiological impacts on marine mammals. The behavioural impacts can be changes in resting, breathing, diving patterns and vocalizations, changes in spatial relationships, and avoidance behaviour. Anthropogenic noise masking may interfere with social interaction, communication and foraging. Physiological impacts can be temporal threshold shift (TTS) or permanent threshold shift (PTS) (Saunders and Dooling, 2018). In the worst case, underwater noise can lead to injury or even death (Weilgart, 2007).

Input from noise and the pressure on marine mammals is linked with environmental impacts in the Underwater Noise Thematic Assessment.

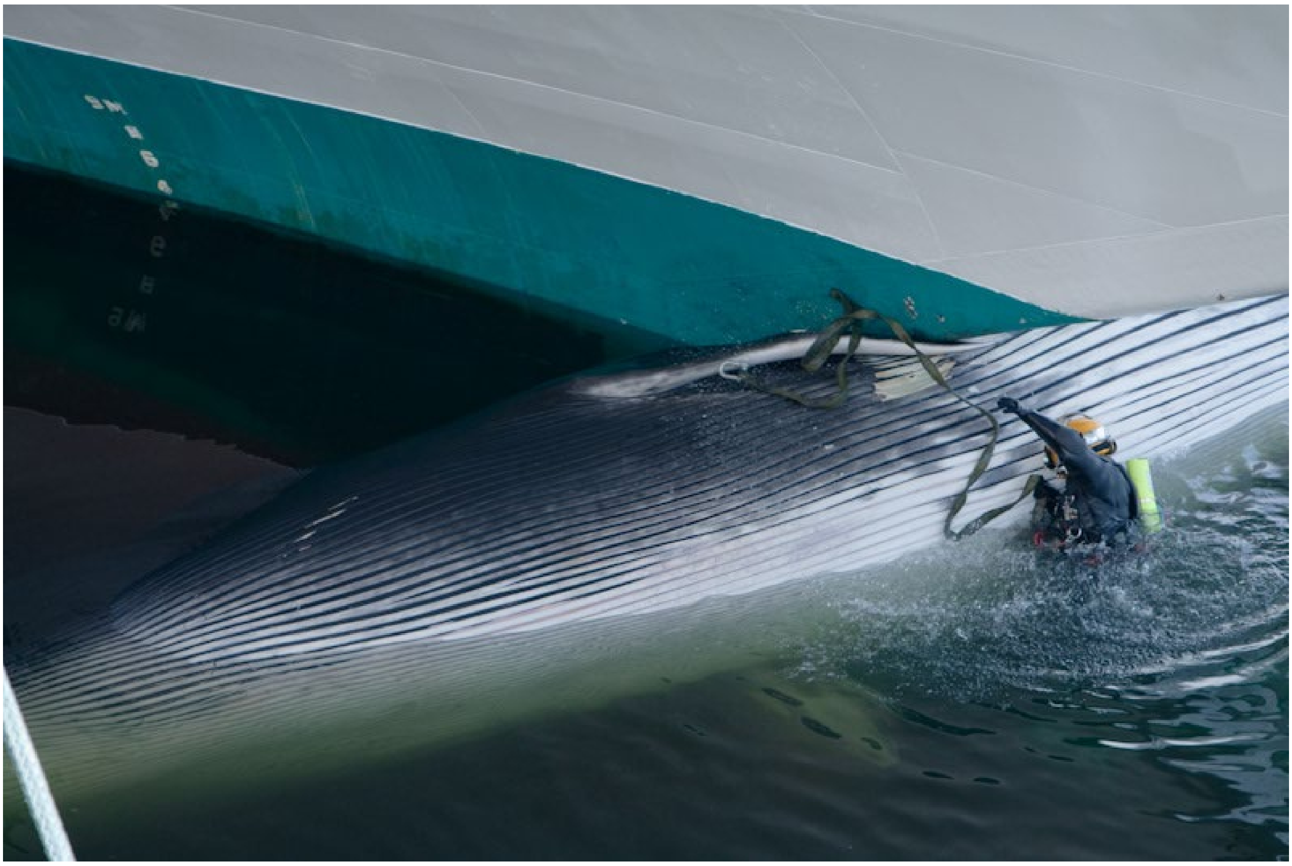
(3) Disturbance of species (e.g. where they breed, rest and feed) due to human presence [Biological]: Disturbance leads to (temporary) habitat loss or deterioration, displacement, lost energy acquisition and higher energy expenditure, with consequences for survival and reproduction, in marine mammals. Human

activities that disturb marine mammal species, due to their presence, include: (i) coastal development for physical restructuring of either rivers, coastline or seabed (water management), tourism and leisure infrastructure, nuclear energy, land claim (Nelms *et al.*, 2021); (ii) offshore constructions for the production of energy or extraction of non-living resources (with offshore wind farms occupying a large surface area) (Bailey *et al.*, 2014; Copping *et al.*, 2020); (iii) maritime traffic in any form (including fisheries and renewable energy) (Schoeman *et al.*, 2020); (iv) military operations (Siebert *et al.*, 2022); and (v) tourism and leisure activities (examples: recreational boating, sailing, wind-surfing, kite-surfing, coastal swimming, hiking) (Machernis *et al.*, 2018).

Dead porpoise. © Shutterstock

(4) Extraction of, or mortality/injury to, wild species (other activities) [Biological]: Collisions with vessels and tourism and leisure activities (e.g., whale- watching boats, recreational vessels, jet skis), lead to injury/mortality and can remove individuals from the population and the ecosystem (Panigada *et al.*, 2006; Van Waerebeek *et al.* 2007; Evans *et al.* 2011, Schoeman *et al.*, 2020). The expansion of tidal energy production has the potential to injure marine mammals through collisions with moving components of turbines (Wilson *et al.*, 2007, Hastie *et al.*, 2018, Onoufriou *et al.*, 2019; 2021). Rotor speeds are often relatively high, three times the collision speeds thought to kill large cetaceans during ship strikes (Vanderlaan and Taggart, 2007).

(5) Extraction of, or mortality/injury to, wild species (by commercial and recreational fishing) [Biological]: The removal of target species of fish and shellfish can cause reduced prey availability, affecting marine mammal abundance and health. In some countries in the OSPAR Regions, marine mammals are also still the targets of either commercial or traditional whaling and hunting, which leads to mortality (Clapham and Baker, 2009; Jog *et al*., 2022).



Whale struck by a boat. © Tyler Ingram

(6) Input of other substances (e.g., synthetic substances, non-synthetic substances, radionuclides) - diffuse sources, point sources, atmospheric deposition, acute events [Substances, litter and energy]**:** Synthetic and non-synthetic substances can cause physical harm to marine mammals. These substances can be spilt into the marine environment during activities such as oil and gas extraction, non-renewable energy generation, shipping, waste disposal, agriculture and mineral extraction (Das *et al.*, 2003). Marine mammals are often predators at the top of the food chain, indicating that they are sensitive to bioaccumulation, whereby toxic contaminants build up throughout the food chain, with the highest concentration found in its top predators (Moore, 2008). For example:

- Polychlorinated biphenyls (PCBs) can lead to reduced reproduction success or complete failure of the reproductive organs (Stuart-Smith and Jepson, 2017). See: OSPAR Pilot Assessment of Status and Trends of Persistent Chemicals in Marine Mammals.
- Mercury (Hg) can cause cancer, decreased learning abilities and damage to the nervous system (Kershaw and Hall, 2019).
- Lead (Pb) is highly toxic and can cause cancer and decreased learning ability (Das *et al.*, 2003).
- Cadmium (Cd) can also cause cancer and further reduces bone strength (Das *et al.*, 2003).

- Other, novel, persistent organic pollutants, such as polybrominated diphenyl ethers (PBDEs) or per- and polyfluoroalkyl substances (PFASs), can be found in high concentration in marine mammals. While they have not yet been attributed as the cause of decreased fecundity in those species, they have known effects on other species (Rotander *et al*., 2012; Fair and Houde, 2018).
- This all impacts the abundance, demography and distribution of marine mammals (Desforges *et al*., 2016).

Inputs from other substances and their pressures on marine mammals are closely linked with environmental impacts in the Hazardous Substances Thematic Assessment.

(7) Input of litter (solid waste matter, including micro-sized litter) [Substances, litter and energy]: The introduction of litter, whether land-based (e.g. rivers, industrial sources, tourism) or marine-based (e.g. shipping, fishing, aquaculture) can cause ingestion and entanglement leading to injury or death (Collard and Ask, 2021). For example, if a marine mammal is caught in lost fishing nets, the result can be injuries, reduced movement or even drowning (Simmonds, 2017). Input of litter into the environment can also affect the health and biological fitness of marine mammals (Fossi *et al*., 2018; Senko *et al*., 2020).

The input of litter and the pressure on marine mammals is linked with the environmental impacts of the Marine Litter Thematic Assessment.

(8) Physical loss (due to permanent change of seabed substrate or morphology and to extraction of seabed substrate) [Physical]: Loss of haul-out sites and the associated deterioration of habitat, particularly from coastal developments, coastal and flood defences and land claim, have consequences for the reproduction, distribution and habitat use of seals (Kovacs *et al.,* 2008; Baker *et al*., 2020). Loss of marine habitats due to the installation of infrastructure and the associated vessel activity can impact all marine mammals (Culloch *et al*., 2016; Benhemma-Le Gall *et al*., 2021).

Lost fishing gear. © Shutterstock

(9) Physical disturbance to seabed (temporary or reversible) [Physical]: Bottom-trawling fisheries, extraction of minerals, land claim, the construction of infrastructures (e.g. oil/gas/renewables) and the laying of cables and pipelines reduce prey availability and result in habitat loss (Todd *et al.*, 2015).

(10) Input of other forms of energy (including electromagnetic fields, light and heat) [Substances, litter and energy]**:** Electricity and communications cables can create electromagnetic fields (EMF). Cetaceans can sense EMFs and use the earth's geomagnetic field to navigate during their migration. Therefore, marine mammals could be sensitive to minor changes in the geomagnetic field. Depending on the persistence and magnitude of the EMF, the effects may include temporary change in swim direction, detours in migration routes or alteration of hunting behaviour (Torres, 2017). The result can be habitat loss and a change in distribution (Gill et *al.*, 2014; Kremers *et al.*, 2014; Ferrari, 2017).

(Unranked) Several impacts of **anthropogenic climate change** exert pressures on marine mammals in the North-East Atlantic. The changes in environmental conditions driven by climate change are likely to be exacerbating pressures, as follows:

- Extraction of, or mortality/injury to, wild species (other activities) [Biological];
- Physical loss (due to permanent change of seabed substrate or morphology and extraction of seabed substrate) [Physical];

- Disturbance of species (e.g. where they breed, rest and feed) due to human presence [Biological];
- Selective extraction of species, including non-target catches [Biological];
- Input of anthropogenic sound (impulsive, continuous) [Substances, litter and energy];
- Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) - diffuse sources, point sources, atmospheric deposition, acute events [Substances, litter and energy].

The impacts of human-induced climate change are described in more detail in the dedicated Climate Change section.

Climate change and the pressures on marine mammals are closely linked with environmental impacts in the Climate Change Thematic Assessment.

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S – State

The status of seals and small toothed cetaceans is not good while the status of other marine mammals remains unknown

The integrated status of marine mammal species was assessed by using the outcome of four indicators for 15 species, although not all indicators assessed all 15 species. These species were grouped into four functional groups, across three OSPAR Regions and the OSPAR Maritime Area. All the species groups that could be assessed, including seals in the Greater North Sea (Region II), and small toothed cetaceans in the Greater North Sea, Celtic Seas and Bay of Biscay and Iberian Coast, were not in good environmental status (**Figure S.1**). The status of all other species groups (baleen whales and deep-diving toothed cetaceans) in the OSPAR Maritime Area (with data available only in the Greater North Sea (Region II), Celtic Seas (Region III) and Bay of Biscay and Iberian Coast (Region IV)) and of seals in the Celtic Seas remains unknown due to limited data and time series.

Not all common indicators have been developed or extended to Arctic Waters (Region I) and the Wider Atlantic (Region V), and data deficiencies have impacted Arctic Waters assessments. Therefore, although a narrative is presented on the status of marine mammals for Arctic Waters, insufficient data were available for all common indicator assessments. No narrative exists for the Wider Atlantic.

“Not in good status” assessments are assigned to the OSPAR-listed blue whale and bowhead whale in Arctic Waters and the Wider Atlantic, and the northern right whale is considered to have been eliminated in the OSPAR Maritime Area.

A preliminary assessment of polychlorinated biphenyls (PCBs) in 30 species of marine mammals at the scale of the OSPAR Maritime Area was presented as a pilot assessment (“Pilot Assessment of Status and Trends of Persistent Chemicals in Marine Mammals”). This analysis was not included in the integration of marine mammal status but hints at high PCB toxicity risk in small toothed cetaceans in the Greater North Sea, Celtic Seas and Bay of Biscay and Iberian Coast, possibly contributing to the explanation for the trends given by the common indicators.

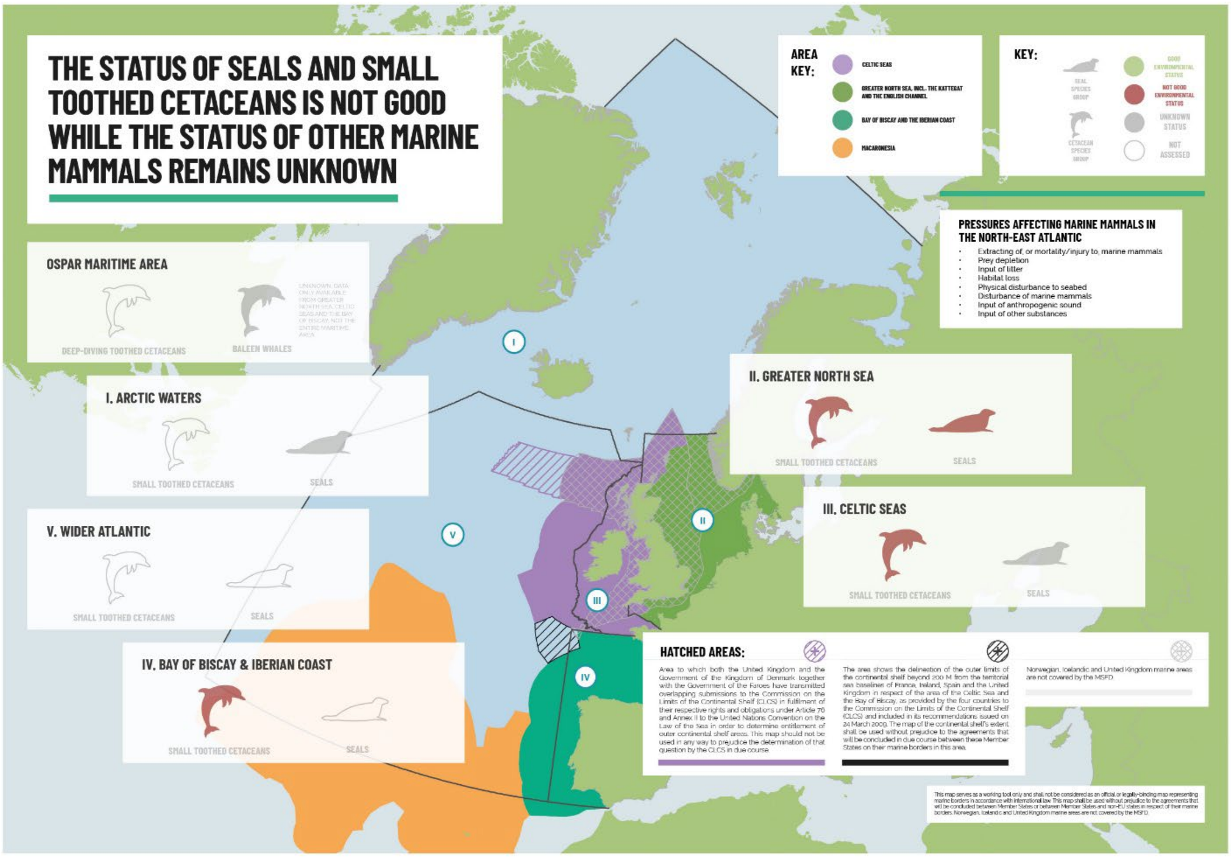

Figure S.1: Integrated status of marine mammal functional groups in the different Regions of the OSPAR Maritime Area. This graphic has been designed to follow the format outlined in McQuatters-Gollop et al. (2022)

The confidence of the assessment is medium in the Greater North Sea because of the limited number of species groups assessed, but the results of the assessments are mostly in consensus; the confidence is low in the Celtic Seas and Bay of Biscay and Iberian Coast due to medium agreement and either limited evidence or no data available to carry out common indicator assessments. See **Table S.1**.

Table S.1: Confidence in assessing the state of marine mammal functional groups

OSPAR Region	Arctic Waters (Region I)	Greater North Sea (Region II)	Celtic Seas (Region III)	Bay of Biscay and Iberian Coast (Region IV)	Wider Atlantic (Region V)
Confidence	Not assessed	Medium	Low	Low	Not assessed

OSPAR acts as a coordination platform in the North-East Atlantic for the regional implementation of the EU Marine Strategy Framework Directive (MSFD) that aims to achieve a Good Environmental Status (GES) in European marine environments, as well as for the coordination of other national frameworks. The characteristics of GES are determined by the individual EU member states, based on criteria elements, threshold values and methodological standards set regionally or at EU level. Norwegian, Icelandic, United Kingdom, Greenlandic and Faroese marine areas are not covered by the MSFD.

For the QSR 2023, the integrated assessments of marine mammals in each Region were largely based on four common indicator assessments (**Table S.2**).

Table S.2: Indicators used in the QSR 2023 marine mammal assessments for each OSPAR Region. *Denotes pilot assessment not considered for integration

Indicator	Status	Region I	Region II	Region III	Region IV	Region V
Seal Abundance and Distribution (M3)	Common	X	X	X		
Abundance and Distribution of Cetaceans (M5)	Common		X	X	X	
Grey Seal Pup Production (M5)	Common	X	X	X		
Marine Mammal By-catch (M6)	Common		X	X	X	
Marine Mammal By-catch in Arctic Waters (M6)*	Candidate	X				
Status and Trends of Persistent Chemicals in Marine Mammals*	Candidate	X	X	X	X	

Additional information on the status and trend of persistent chemicals in marine mammals is provided in the Pilot Assessment of Status and Trends of Persistent Chemicals in Marine Mammals. The information related to this indicator is given in the text but did not contribute to the integrated status of species groups.

The status of marine mammals is assessed for four 'functional groups' in the context of the Marine Strategy Framework Directive (Commission Decision (EU) 2017/848 of 17 May 2017) comprising species with similar structural, functional, or taxonomic characteristics, representing an ecological role in the marine ecosystems. The common indicator assessments available per species are indicated as a code (see list below for details). (*OSPAR acts as a coordination platform in the North-East Atlantic for the regional implementation of the EU Marine Strategy Framework Directive (MSFD) that aims to achieve a Good Environmental Status (GES) in European marine environments, as well as for the coordination of other national frameworks. The characteristics of GES are determined by the individual EU member states, based on criteria elements, threshold values and methodological standards set regionally or at EU level. Norwegian, Icelandic, United Kingdom, Greenlandic and Faroese marine areas are not covered by the MSFD.)*

Small odontocetes (toothed cetaceans):

- harbour porpoise (M4, M6)
- common dolphin (M4, M6)

- striped dolphin (M4)
- offshore bottlenose dolphin (M4)
- coastal bottlenose dolphin (M4)
- white-beaked dolphin (M4)
- white-sided dolphin (M4)

Deep-diving odontocetes (toothed cetaceans):

- Due to a lack of data, no species were assessed (see **Table S.4** for example species).

Baleen whales:

- minke whale (M4)
- fin whale (M4)

Seals:

- harbour seal (M3)
- grey seal (M3, M5, M6)

Within these functional groups, the common indicator assessments were integrated to provide an assessment of status for each species within each Region. A particular challenge to the integration of marine mammals was the different scale of the species-specific assessment units (AU) for each indicator. How these units were nested and divided between OSPAR regions is further described in the CEMP Guideline.

The output of the integrated assessment is presented for each OSPAR Region in a comprehensive table displaying the status of each species by criterion, the overall status of each species after integration of criteria/indicators and the overall status of the species group after integration from species status.

Integrated assessment approach

For cetacean species functional groups, the integrated assessments were based on the common indicators for Abundance and Distribution of Cetaceans (M4) and Marine Mammal By-catch (M6). The possible assessment outcomes for each common indicator in every assessment unit were threshold achieved, threshold not achieved, and unknown. These indicator assessments were first aggregated across AUs overlapping a Region, then integrated per species. Unknown outcomes (NA) due to insufficient data to compute a trend, or due to a null value within an assessment unit, were considered for aggregation or integration (see: CEMP Guideline).

The common indicator assessments are supplemented by status assessments for the OSPAR- listed blue whale and humpback whale. Additional information on the status of marine mammals in Arctic Waters is available from a candidate extension of the M6 indicator in Arctic Waters, in Marine mammal by-catch (M6).

For seals, the integrated assessment was based on Seal Abundance and Distribution (M3) and Grey Seal Pup Production (M5) and, for grey seal, also on Marine Mammal By-catch (M6). Each common indicator was assessed in each assessment unit as threshold achieved, threshold not achieved, inconclusive, or unknown. In the common indicator assessments Seal abundance and distribution (M3) and Grey seal pup production (M5) for seal species, an assessment could be inconclusive if confidence intervals spanned the threshold value and it was not possible to confidently determine whether a generated trend was achieving or not achieving the threshold values. An indicator outcome was considered unknown (NA) if there were no data or insufficient data to compute a trend within an assessment unit. Unknown outcomes were not considered for aggregation or integration, whereas inconclusive outcomes were considered from aggregation (see: CEMP Guideline).

Marine mammals within Arctic Waters are summarised separately below, since data availability limited the calculation of indicators and the effectiveness of an integrated approach.

Small toothed cetaceans

Based on the integrated outcomes, the status of small toothed cetaceans is not good across the Greater North Sea, Celtic Seas and Bay of Biscay and Iberian Coast (**Table S.3**). This is largely due to the not good status of each species in relation to the assessed mortality rate from incidental by-catch (M6) within the Regions, but is also due to the status outcome of coastal bottlenose dolphin and harbour porpoise within the Bay of Biscay and Iberian Coast, and of harbour porpoise within Celtic Seas under Abundance and distribution of cetaceans (M4). The harbour porpoise, also on the OSPAR Threatened and/or Declining Species and Habitats list, was assessed by applying the common indicators for abundance and distribution (M4) and by-catch (M6).

Table S.3: Small toothed cetacean species group common indicator outcomes (M4, M6) and integrated status. Green: indicator threshold achieved / status good; Red: indicator threshold not achieved / Status not good; Grey: unknown, data available but too scarce for indicator assessment; Blank: not assessed. OSPAR listed species are shown in italics

Small toothed cetaceans	Greater North Sea (Region II)			Celtic Seas (Region III)			Bay of Biscay and the Iberian Coast (Region IV)		
	M4	M6	Status	M4	M6	Status	M4	M6	Status
Harbour porpoise			not good			not good			not good
Common dolphin			not good			not good			not good
Offshore Bottlenose dolphin			unknown			unknown			unknown
Coastal Bottlenose dolphin			unknown			unknown			not good
White-sided dolphin			unknown			unknown			
White-beaked dolphin			unknown			unknown			
Striped dolphin									unknown
Status of small toothed cetaceans			not good			not good			not good

Bottlenose Dolphins. © Shutterstock

Deep-diving toothed cetaceans

The status of deep-diving odontocete species remains unknown across the OSPAR Maritime Area (**Table S.4**). There were some data from the Greater North Sea, Celtic Seas and Bay of Biscay and Iberian Coast for some species, but due to either limited or no data no common indicator assessments could be carried out and the status is Not Assessed.

Assessment units for deep-diving toothed cetaceans need to be defined to enable future assessments and currently remain a knowledge gap (see: CEMP Guideline).

Table S.4: Indicator outcomes (M4, M6) and status of deep-diving toothed cetaceans. Green: indicator threshold achieved/Status good; red: indicator threshold not achieved / Status not good; grey: unknown, data available but too scarce for indicator assessment; blank: not assessed

Deep-diving toothed cetaceans	OSPAR Maritime Area		
	M4	M6	Status
Risso's dolphin			
Long-finned pilot whale			
Beaked whales			
Sperm whale			
Status of deep-diving toothed cetaceans			not assessed

Baleen whales

The status of the functional group 'baleen whales' is unknown in the Greater North Sea, Celtic Seas and Bay of Biscay and Iberian Coast. Within this group, assessments of Abundance and Distribution of Cetaceans (M4) were able to be carried out for minke whale, but data were not available for other species under abundance and distribution (M4) and Marine Mammal By-catch (M6), limiting the integration's ability to report on overall status for the group. Results are presented by Region (**Table S.5**), where data were available, but noting that, for example, the minke whale assessment unit is a larger unit encompassing several Regions.

The status assessments for three OSPAR listed baleen whale species, the blue whale, the bowhead whale and the northern right whale (considered extirpated from the OSPAR Maritime Area) concluded that they are not in good status, and are summarised below under "Threatened and/or declining marine mammals". These assessments are more of a qualitative nature and therefore are not included in the integrated assessment.

Table S.5: Indicator outcomes (M4, M6) and status of baleen whales. Green: indicator threshold achieved/Status good; red: indicator threshold not achieved / Status not good; grey: unknown, data available but too scarce for indicator assessment; blank: not assessed

Baleen whales	Greater North Sea (Region II)			Celtic Seas (Region III)			Bay of Biscay and the Iberian Coast (Region IV)		
	M4	M6	Status	M4	M6	Status	M4	M6	Status
Minke whale									
Fin whale									
Status of baleen whales			unknown			unknown			unknown

Seals

The status of the grey seal remains good across Greater North Sea and Celtic Seas, although still reflecting the recovery from previous depletion. The status of seals as a species group (harbour seal and grey seal) in the Greater North Sea is not good, and overall is unknown in the Celtic Seas. Similarly, based on the indicator assessments for the abundance and distribution of the harbour seal species, the status is not good in the Greater North Sea owing to more than 25% (4 out of 12) of the associated assessment units not achieving the threshold values given the declining populations, and inconclusive in the Celtic Sea owing to uncertainty in the status of the species within Northern Ireland. See **Table S.6**.

While data from Arctic Waters were gathered as part of the common indicators for these species, the outputs are not included in this integration. This is because data for Arctic Waters seals were limited to a single country and so cannot be used to report on status at the wider Arctic Seas scale.

Table S.6: Indicator outcomes (M3, M5, M6) and status of seals. Green: indicator threshold achieved / Status good; red: indicator threshold not achieved / Status not good; orange: inconclusive; grey: unknown, data available but too scarce for indicator assessment; hatched: not applicable; blank: not assessed

Seals	Greater North Sea (Region II)				Celtic Seas (Region III)			
	M3	M5	M6	Status	M3	M5	M6	Status
Harbour seal				not good				unknown
Grey seal				good				good
Status of seals	not good				unknown			

Marine mammals in Arctic Waters

Marine mammal evaluation for Arctic Waters covers the northern Atlantic Ocean to the marginal ice zone for some seal species, harp- and hooded seals, and for cetaceans. The assessment is drawn from recent publications, mainly from 2020 to 2022 and not older than 2017. For coastal seals, grey seals and harbour seals, data from Iceland and Norway have been submitted, but in the case of Norway the data are patchy and the timeline too short, for an assessment to be made by OSPAR. The Norwegian timeline data series will be updated in 2023, although the trends are still given in the text based on national reports. Where given, information on possible drivers for the observed changes is presented.

Seal pup production:

Estimated harp seal pup production in the Greenland Sea was significantly lower than the estimates obtained in similar surveys in 2002, 2007 and 2012, while harp seals in the Greenland Sea have been stable since 2012 after a decline between 2005, 2007 and 2012, showing similar trends to the Barents Sea and White Sea harp populations (Biuw *et al.,* 2022). Large-scale environmental or ecological changes are considered possible causes for the decline.

As for grey seals, although monitored systematically for 20 years, the data are few, but some trends are suggested, with variable production along the Norwegian coast. There has been an increasing trend in the northern regions of Norway, and a recent decline in the southern part of the Norwegian coast in Arctic Waters. The reason behind these opposing trends is not known.

Cetacean abundance and distribution

The Norwegian Red List status of bowhead whales was changed from Critically Endangered (CR) to Endangered (EN) in 2021, based on acoustic monitoring in addition to observed registrations. The Spitsbergen stock is considered to be less than 230 individuals (88-560; Bachmann *et al.*, 2020; Cooke *et al.*, 2018; Kovacs *et al.*, 2020; Storrie *et al.*, 2018). Blue whales have been more often sighted, but this may be due to better monitoring.

The abundance of fin whales, humpback whales, sperm whales, killer whales, harbour porpoises, dolphins and northern bottlenose whales, has been assessed from line-transect survey data from 2002 to 2018 (Leonard, Øien, 2020a, Pike e*t al.*, 2019). The most recent estimates are summarized in **Table S.7**.

Table S.7: Best available estimates of abundance for cetaceans in Arctic Waters. CV denotes the coefficient of variation. The lower and upper bounds are for a 95% confidence interval

Species	Scientific name	Abundance	CV	Lower bound	Upper bound
Harbour porpoise	*Phocoena phocoena*	255 929	20%	172 742	379 175
White-sided or white-beaked dolphin	*Lagenorhynchus* spp.	192 767	25%	114 033	325 863
Killer whale	*Orcinus orca*	15 056	29%	8 423	26 914
Fin whale	*Balaenoptera physalus*	11 387	17%	8 072	16 063
Humpback whale	*Megaptera novaeangliae*	10 708	38%	4 906	23 370
Northern bottlenose whale	*Hyperoodon ampullatus*	7 800	28%	4 373	13 913
Sperm whale	*Physeter macrocephalus*	5 704	26%	3 374	9 643

The abundance of humpback whales has approximately doubled since the 1990s, with the largest increase in the Barents Sea. The pattern in distribution and abundance of fin whales and sperm whales is consistent with earlier surveys. The abundances of small odontocete species show stable distributions, with some variation in their estimates (Leonard, Øien, 2020b).

There is little spatial overlap between seasonally occurring (migratory) whales and the three Arctic resident whales (beluga, narwhal and bowhead whales). Belugas are coastal while bowhead whales and narwhals are associated with sea ice. By contrast, the migratory species were found over the shelf and along its edges (Vaquie-Garcia *et al.*, 2017). Cetacean distribution within the Barents Sea, including toothed cetaceans, is presented in the joint Norwegian-Russian survey reports from the annual Barents Sea Ecosystem survey (latest report of Prozorkevich, van der Meeren 2022, Ch. 12).

Furthermore, mapping of migration and distribution patterns has shown several key marine mammal hotspots, areas with high species richness and areas important for common resting, nursing, moulting and foraging. The marginal ice zone (MIZ) of the Greenland Sea and northern Barents Sea, the waters surrounding the Svalbard Archipelago and a few North-east Greenland coastal sites were all key marine mammal hotspots (Hamilton *et al.*, 2021; 2022; Løviknes *et al.,* 2021).

Feeding humpback whales. © Shutterstock

Marine mammal incidental by-catch

Some incidental by-catch data are provided as registered by-catch by the Norwegian reference fleet, but they are not sufficient for assessing by-catch mortality in many marine mammal species. Several registrations are also expected to be incorrect with respect to species identification, particularly for seals. However, the species registered by the Norwegian authorities over the past 40 years are:

- hooded seal
- bearded seal
- harbour seal
- grey seal
- harbour porpoise
- humpback whale
- minke whale
- killer whale
- beluga
- pilot whale

Harbour seals and harbour porpoises are presumed to be most commonly incidentally by-caught from the above list, while the other species are infrequent and not common as by-catch. Moan *et al*., (2020) estimated porpoise by-catch for the period 2006-2018 in Norwegian commercial gillnet fisheries using the Norwegian reference fleet data. By-catch of harbour porpoise in Norwegian gillnet fisheries has been unsustainable for several of the last 13 years but is decreasing due to a recent reduction in monkfish fishing effort (Moan *et al*., 2020). A recent NAMMCO (North Atlantic Marine Mammal Commission) working group concluded that by-catch of harbour porpoises in Norwegian waters is unsustainable and recommended its reduction (NAMMCO, 2022).

Threatened and/or declining marine mammals

The harbour porpoise is one of the four cetacean species on the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR Agreement 2008-06) and has been assessed with the common indicators. Therefore, this section describes the large whale species, drawing on the dedicated status assessments. The three large whale species that have been added to the OSPAR List have all suffered severe historical declines due to whaling and all are still considered to be in poor status.

In recent years, there have been indications of an increase in the population of blue whales from surveys conducted around Iceland, where the species congregates in summer. A potential recovery of the population from the historical threat of whaling will be slow due to the long life cycle of the species. Blue whales are rare throughout the North-East Atlantic. This low density makes it difficult to assess the scale and trend of impacts from human activities.

Bowhead whales in the OSPAR Maritime Area are part of the Spitsbergen stock, which has been estimated to number a few hundred animals. Calves have only rarely been observed in the population and the species has a very long lifespan. The current main threats are direct and indirect effects from climate change, as the species is heavily dependent on areas of sea ice to find its prey species and is sensitive to increased disturbance from human presence and predation from killer whales, which may increase as the sea ice retreats.

The northern right whale is considered eliminated in the OSPAR Maritime Area. Occasional sightings are believed to belong to populations west of the OSPAR Maritime Area. Chances of a recovery in the OSPAR Maritime Area are considered non-existent in the short term.

All three of the OSPAR-listed large whales are rarely registered in the OSPAR Maritime Area and information is scarce. It has not been possible to carry out a quantitative assessment for any of these species, although a qualitative status assessment was carried out for them (**Table S.8**).

Table S.8: Status assessment outcomes and status of threatened and / or declining marine mammals.

Legend: ↓ decreasing trend or deterioration of the criterion assessed; ↑ increasing trend or improvement in the criterion assessed; ↔ decline or deterioration of the criterion has been halted.
Assessment type: 1 – direct data driven, 2 – indirect data driven

	Blue whale		Bowhead whale	Northern Right whale				
Region	I	V	I	I	II	III	IV	V
Distribution	↔	↔	↔[1,2]	↔[1,2]	↔[1,2]	↔[1,2]	↔[1,2]	↔[1,2]
Population size	↑	↔	↓[1,2]	↓[1,2]	↓[1,2]	↓[1,2]	↓[1,2]	↓[1,2]
Condition	?	?	?	?	?	?	?	?
Previous OSPAR status assessment								
Status (overall assessment)	poor	poor	poor	poor	poor	poor	poor	poor

PCB pollution in Marine mammals

The pilot assessment for "Status and Trends of Persistent Chemicals in Marine Mammals" concluded that small toothed cetaceans is the functional group of marine mammals most at risk of high toxicity from legacy pollutants such as Polychlorinated Biphenyls (PCBs). Specifically, harbour porpoises, killer whales and bottlenose dolphins from the Greater North Sea and the Celtic Seas present PCB levels often above the existing thresholds for reproductive impairment.

A major outcome of this pilot assessment is the urgent need for structural and harmonised protocols for PCB data acquisition, including for the list of congeners and the tissue matrix analysed, as well as integration on a spatial scale to allow geographical comparison. Future scientific efforts should focus on filling the existing gaps and homogenize the information at OSPAR scale.

The large knowledge gaps and heterogeneity of data did not allow this information to be used for the integration of the overall status of marine mammals, but hints at the potential influence of chemical pollution in species such as the harbour porpoise, for which status is assessed as not good (**Table S.3**).

These results underline the necessity of increasing future efforts to achieve OSPAR objectives with regard to marine pollution (as proposed in the Hazardous Substances Thematic Assessment, assigning particular priority to the development of better assessment criteria, the management of pollutant disposal into the marine environment and understanding of the potential impact of climate change on chemical bioavailability (North-East Atlantic Environment Strategy (NEAES) 2030 Operational Objectives S1.O2, S1.O3 and Strategic Objectives S.10, S.11 and S.12).

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I – Impact (on ecosystem services)

Marine mammals are thought to have mainly positive impacts on marine ecosystem services

The impacts of marine mammals on ecosystem services in the OSPAR Regions have not been quantified in this report, as impact indicators on ecosystem services have yet to be developed and implemented. Based on expert judgement, a few overall comments are provided here:

- As top predators, marine mammals exert a top-down control in marine ecosystems which is important for the sustained provision of current services;
- Large marine mammals, such as whales, contribute to climate regulation through the accumulation of large amounts of carbon in their bodies or by enhancing primary production (the so-called 'whale pump');
- Decreased abundance of marine mammals may lead to reduced top-down control on food webs; to biodiversity loss / decline; or to reduction of the benefit that many people derive from experiencing marine mammals in the wild;
- Mainly positive impacts of marine mammals on ecosystem services were identified by Thematic Assessment (TA) experts. However, these are currently not quantified;
- A thorough assessment of the impacts on ecosystem services requires the development and implementation of dedicated impact indicators.

Impacts on Ecosystem Services: Method for the development of the Schematic

This section evaluates the impact that changes in the state of marine mammals observed in the QSR 2023 assessments has on the ecosystem services that the North-East Atlantic provides. It was developed through literature review combined with expert judgement, using the same methodology across all thematic assessments. Several workshops involving ecosystem services experts and marine mammal experts were held to discuss and agree the results presented below.

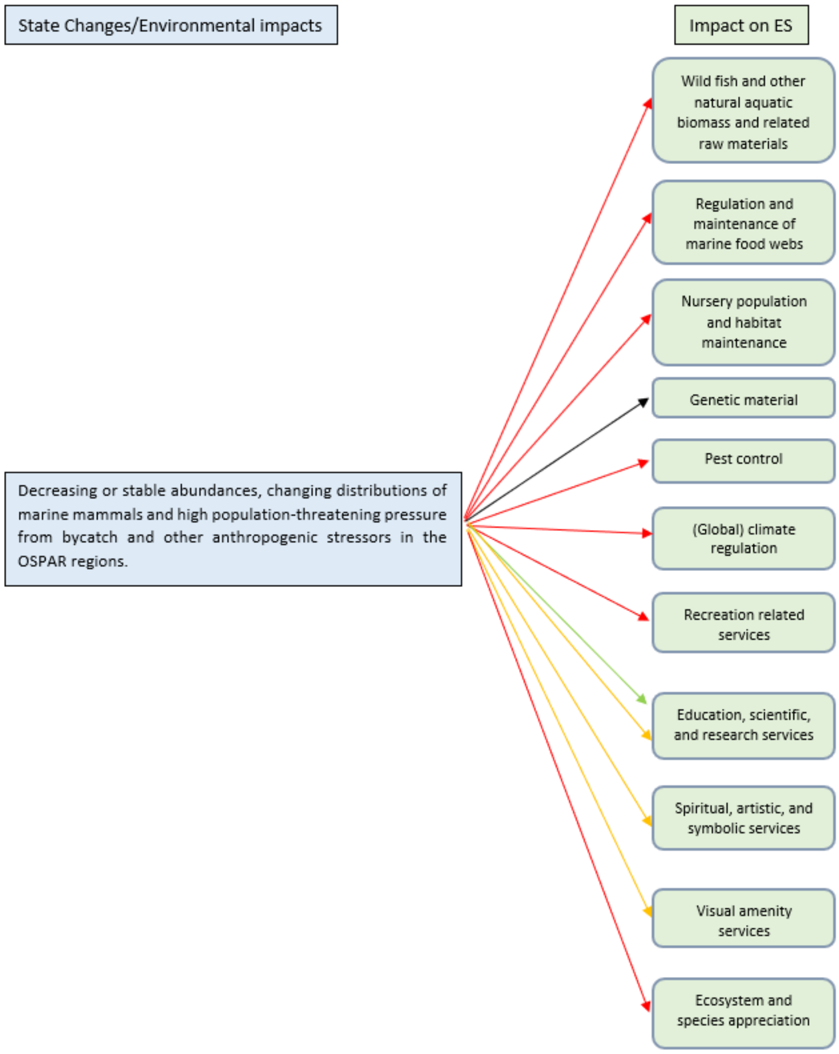

Figure I.1: Schematic depicting the 'State (changes)' – 'Impacts on ES' linkages for the Marine Mammals Thematic Assessment. The ecosystem services (ES) shown are those considered most relevant in relation to the Marine Mammals Thematic Assessment. Each arrow also denotes an expert estimate of the nature and magnitude of the impact (black arrow = recognition of the existence of the impact but no clear negative or positive impact (uncertain nature), orange arrow = neutral impact, red arrow = negative impact, green arrow = positive impact)

Detailed rationale for the role that marine mammals (and their state) play in the provision of ecosystem services

Besides the physical damage or death of organisms, which can negatively affect ecosystem services in a relatively straightforward way, it should be noted that the alteration of feeding behaviour, reproductive behaviour, fertility, reproductive success, mobility and other characteristics as a result of different environmental impacts can also affect ecosystem services. It is known that the introduction of non-indigenous species, exposure to marine litter or other substances (e.g., contaminants such as PBDEs or PCBs) can lead to alterations in reproductive rates, fecundity and metabolic mechanisms, while disturbances related to noise and other human activities can cause impacts such as displacement from habitats. Human presence with its activities (e.g., ecotourism, coastal and offshore constructions, ship traffic, and related underwater noise) can create disturbance to marine mammals, leading to temporary or permanent loss of breeding, nursery, haul-out and feeding habitats or displacement from such areas. This leads to increased energy expenditure and loss of energy gains for affected individuals, with negative consequences for survival, reproduction (reproductive success/output) and fitness (OSPAR BDC, 2021b). Habitat loss and changes in marine mammal distribution can also result from impacts on the behaviour of marine mammals. Alterations in diving, swimming direction and migration routes, breathing and resting patterns, vocalisation, changes in avoidance behaviour and masking may result from exposure to underwater noise (for more details see the Underwater Noise Thematic Assessment and other pressure-related thematic assessments). Behavioural impacts may also result from exposure to electromagnetic fields (EMF), for example from installed electricity cables (OSPAR BDC, 2021b), although there is currently very limited evidence of the effects of EMF on marine mammals.

Marine mammals may be injured and/or killed (including (local) extinction) as a result of collision (e.g., with tidal devices, commercial or recreational vessels), by-catch (during commercial or recreational fisheries), extraction (commercial or traditional whaling and seal hunting still present in some OSPAR Contracting Parties), exposure to underwater noise (e.g., from seismic surveys or pile-driving associated with the offshore industry – for more details see physiological impacts in 'Underwater Noise Thematic Assessment'), ingestion, entanglement, and diseases caused by /associated with marine litter (for more details see the Marine Litter Thematic Assessment), and exposure to and bioaccumulation of synthetic and non-synthetic substances (for more details see the Hazardous Substances Thematic Assessment). All these impacts affect the health, survival, abundance, and distribution of marine mammals in the OSPAR Maritime Area (OSPAR BDC, 2021b).

Several traits have been identified in the literature relating to categories such as morphology, behaviour, demography and physiology that are comparable across different groups of marine megafauna (large fishes, marine mammals, and seabirds) and underpin the ecosystem functions performed by these organisms, in turn supporting the provision of ecosystem services by these groups. These traits include body size, body mass, migration, mortality rate, fecundity, reproductive success, survival rate, reproductive location and feeding strategy. For example, mobility and mortality rate (traits) are associated with nutrient transport (ecosystem function), which in turn enables the provision of ecosystem services such as nursery population and habitat maintenance (through biodiversity promotion) and regulation and maintenance of marine food webs (through nutrient cycling) (Tavares *et al*., 2019). Consequently, if these traits are adversely affected, for example due to habitat loss or exposure to pollutants, negative consequences for the provision of ecosystem services can be expected. The identification of links between state changes /environmental impacts and ecosystem services was also based on this reasoning.

Indeed, given the observed improvement in the status of marine mammal populations a positive impact on the provision of associated ecosystem services can be expected. The opposite is to be expected when a population declines. The following elaborates on the role that marine mammals (and their state) play in the provision of an ecosystem service. In this respect, it should be noted that most of the existing literature concerning ecosystem services does not deal with those services provided specifically by a single functional group of marine mammals such as seals, but rather mainly with ecosystem services provided by marine mammals as a whole. Therefore, in analysing the link between marine mammals (and their state) and ecosystem services, reference will often be made to the generic role that marine mammals play in the provision of ecosystem services.

Wild fish and other natural aquatic biomass and related raw materials: Although marine mammals still constitute dietary components in some parts of the world, they are often excluded from the definition of seafood (Ziegler *et al.*, 2021). Today, whale meat is consumed, albeit in a significantly limited way, by local communities for subsistence and as a cultural practice (thus also related to spiritual, artistic, and symbolic services), in countries such as Iceland, Norway and Greenland, and in the Faroe Islands (Cook *et al.,* 2020; NAMMCO, 2021a; NAMMCO, 2021b). Among Icelanders, for example, there has been limited consumption of whale meat in the post-World War II period; rather, it is promoted to tourists as a novelty food product or exported (Cook *et al.,* 2020). Seals in the North-East Atlantic area are also still hunted for their meat and related raw materials. In Greenland, Inuit culture is still found to be based more on subsistence hunting than fishing. Nowadays, there is still a food preference for traditional Greenlandic foods, including seal meat, over other types of (often imported) foods. Among the most frequently hunted seal species are the harp seal and the hooded seal, while the grey seal and harbour seal are protected species. As an indirect consequence of EU seal policy, which prohibits the trade of seal (by-)products, seal hunting in Greenland has recently decreased. However, seal meat is still consumed by locals in Greenland and sold in local open markets along with seal skins, which are the most commercially valuable by-product (Ziegler *et al.,* 2021). Historically in Iceland, seal hunting focused almost exclusively on seal pups, which were caught primarily for their skin. Although less significant, the meat, blubber, and fins also played a role in local human consumption in the past. In 2019, Iceland introduced a general ban on seal hunting, with the exception of special licences for subsistence use (NAMMCO, 2020). In the Faroe Islands, traditional seal hunting essentially ended in the late 1960s, and there is currently no tradition of using seal meat, blubber, or skin (NAMMCO, 2020). Marine mammals may also be subject to non-lethal effects related to the exposure and bioaccumulation of pollutants such as heavy metals and organic compounds that do not directly compromise biomass supply but may compromise biomass quality as they accumulate in specimens whose meat may be consumed (Cook *et al.,* 2020). However, in countries where marine mammals are still regularly consumed, such as Greenland, following a traditional diet that includes marine mammal meat is still often recommended because the benefits are considered to outweigh the risks (Ziegler *et al.,* 2021).

Seal skins are a commercially valuable by-product sold in local markets in Greenland. © Shutterstock

Regulation and maintenance of marine food webs: The movement of marine mammals through the marine ecosystem contributes to the cycling of nutrients from feeding areas to the surface, and large cetaceans also play a role in the transfer of nutrients downwards after death (whale fall; Noordegraaf, 2020; Quaggiotto *et al.,* 2022). Marine mammals such as whales and seals can increase primary productivity in their feeding areas by concentrating nitrogen near the surface through the release of faecal plumes that are likely to remain in the euphotic zone (the so-called 'whale pump'; Roman and McCarthy, 2010). Also, marine mammals with a predatory role act as sources of nutrients which they redistribute to the marine ecosystem and, in the case of pinnipeds, back to the shoreline due to their high mobility and rapid turnover of nutrients via excretion and egestion (Roman *et al.*, 2014). This translocation and recycling of nutrients contributes to the growth of wild animals, plants, and other biomass (e.g., increasing phytoplankton productivity) that support the balance of entire food webs (Hammerschlag *et al.,* 2019). Environmental impacts can alter predator-prey interactions and may lead to a trophic mismatch (Erbe *et al.*, 2018). This negatively affects the balance of marine food webs (Smith and Bannister, 2016). In addition, marine mammals such as killer whales, small cetaceans, and seals play key roles as top predators in the marine food web (e.g., Kizska *et al.*, 2022). For this reason, human-driven population declines in certain species of marine mammals could affect the availability of prey resources for other marine mammals, birds or fish populations, thereby impacting food web dynamics (Hammerschlag *et al.,* 2019; Smith and Bannister, 2016).

Nursery population and habitat maintenance: There is evidence that the abundance and distribution of marine mammals can significantly affect the structure and function of some habitats. For example, they are known to play a role in the maintenance of underwater habitats including kelp beds (Noordegraaf, 2020; Smith and Bannister, 2016). Therefore, their absence due to a decrease in their abundance could lead to an alteration of these habitats as well as related changes in food web dynamics (Smith and Bannister, 2016). In addition, after death, the whales' carcasses form an immediate rich habitat in the deep-sea environment that supports certain whale-fall specialist invertebrates. Thus, the decline of marine mammals that perform this function may result in the degradation of habitats and the species that occur in them (Hammerschlag *et al.*, 2019).

Genetic material: The physical movement of animals in the water column, especially large marine mammals such as whales, contributes to the distribution of nutrients and oxygen in the water, increasing primary production (as previously mentioned for the service of 'regulation and maintenance of marine food webs'). Areas with higher primary production also tend to be associated with greater availability of prey and biodiversity. By supporting greater biodiversity and thus the greater genetic diversity associated with it, large marine mammals contribute to the supply of genetic material in terms of intermediate service that is the basis for the supply of aquatic biomass that is then consumed by humans (final ecosystem service; Haines-Young and Potschin, 2018; Cook *et al.,* 2020).

Pest control: In discussing ecosystem services, Culhane *et al,*. (2019) distinguish between pest (which is a nuisance) and disease (which causes harm) control, with an acknowledgement that the distinction can be context-dependent. Apex predators may contribute to the removal of sick and aged individuals in their prey species. Mathematical modelling of this predation process suggests that predators can reduce both the prevalence (proportion of hosts infected) and mean intensity (number of parasites per host) of parasites in their prey (Packer *et al.,* 2003). Marine mammals can, as apex predators, affect to some extent the transmission of infectious diseases whose transmission depends on the density of host organisms (Packer *et al.,* 2003). However, there is currently little documented evidence of the provision of this ecosystem service by marine mammals. The current consensus about predator effects on parasites emphasizes that such effects are heavily context-dependent (Richards *et al.,* 2022). It remains nevertheless possible that a decline in apex predators may lead to an increase in prey density, with possible increased transmission of density-dependent infectious diseases (Hammerschlag *et al.,* 2019). Similarly, if predatory marine mammals target non-native pest species as their prey, they may contribute to their control (Hammerschlag *et al.*, 2019). Moreover, pest control is underpinned by a balanced food web and therefore all components of the marine ecosystem are relevant to the provision of this ecosystem service, including marine mammals (Culhane *et al.*, 2019).

(Global) climate regulation: Large marine mammals such as whales contribute to climate regulation by accumulating large amounts of carbon in their bodies. After their death, the carcasses lock up significant amounts of organic carbon on the sea floor, representing, in the case of whale falls, a potential sink for anthropogenic carbon (Cook *et al.*, 2020; Quaggiotto *et al.,* 2022). Moreover, marine mammals, through their role in increasing primary productivity, influence carbon fluxes in the marine ecosystem (Pershing *et al.*, 2010; Tynan 2004; Riisager-Simonsen *et al.,* 2020).

Recreation related services: On-site observation of marine mammals such as seals and whales is widespread in Europe at long-standing dedicated public sites which receive tens of thousands of visitors annually (e.g., Chanonry Point in the Moray Firth, Scotland; the Wadden Sea) and at new sites which form as the animals become accessible for viewing (e.g., Newburgh seal beach, Scotland). In addition to watching from land, dolphin-, seal- and whale-watching tourism is mature in OSPAR areas and includes activities such as swimming with the animals and watching them from vessels. Porpoises and dolphins can be seen, for example, along the Scottish coast (Noordegraaf, 2020). It follows that negative impacts on the health of marine mammals and a decline in their abundance may in turn negatively impact the benefit that many people derive from experiencing marine mammals in the wild (Cook *et al.,* 2020; Smith and Bannister, 2016).

Education, scientific, and research services: Marine mammals are a central topic in much scientific research. Proof of this is the large number of studies involving marine mammals that can be found in different literature online databases (Noordegraaf, 2020). Also, the public display of captive marine mammals can make people more aware and appreciative of them, but it is extremely controversial (Smith and Bannister, 2016). However, precisely because this ecosystem service can also be a benefit experienced offsite, for example by visiting a museum, a decline in marine mammals can also have a neutral impact on this ecosystem service as it is not directly influenced by the current state of marine mammal populations (Cook *et al.,* 2020; Culhane *et al.*, 2019).

Spiritual, artistic, and symbolic services: Marine mammals such as whales are a core part of cultural values and traditions for several OSPAR coastal communities. Furthermore, they can be a source of inspiration for various types of artistic expression, including sculpture, painting, drawing, and film-making. However, precisely because this ecosystem service can also be a benefit experienced offsite, for example through artistic representations, a decline in marine mammal abundance can also have a neutral impact on this ecosystem service as it is not directly influenced by the current state of marine mammal populations (Culhane *et al.*, 2019). In addition, marine mammals are known to play a role in the maritime culture and spiritual identity of several local communities, including Icelandic ones (Cook *et al.*, 2020).

Visual amenity services: Marine mammals provide this service because they can convey a 'sense of place' through their direct vision or through their artistic representations (for example, works of art that use marine wildlife as inspiration; UK NEA, 2011c). Different marine mammals fall into a category termed 'charismatic megafauna' (Cook *et al.*, 2020). However, precisely because this ecosystem service can also be a benefit experienced offsite, for example through the observation of artistic representations, a decline in marine mammals can also have a neutral impact on this ecosystem service as it is not directly influenced by the current state of marine mammal populations (Culhane *et al.*, 2019).

Ecosystem and species appreciation: This ecosystem service represents the value placed on species (i.e., charismatic or not) of marine mammals simply by knowing that they exist and that they and their natural environment are in a good state, even if perhaps the very people who place this value on them will never see them. In fact, the relative rarity of and aesthetic qualities associated with marine mammals means that their preservation is often appreciated even without them being directly present in the environment of the people who place this value on them (Cook *et al.*, 2020). This ecosystem service also includes knowing that future generations will have the opportunity to enjoy marine mammals (Noordegraaf, 2020). Therefore, a significant decline in marine mammal populations can negatively affect the provision of this service.

As a final point, one which is somewhat emblematic of the importance of marine mammals in providing ecosystem services, reference can be made to the fundamental role of cetacean carcasses. In addition to the role that cetacean carcasses may have in relation to ecosystem services such as regulation and maintenance of marine food webs, nursery population and habitat maintenance, and (global) climate regulation, mentioned earlier, these ecological components can be simultaneously associated with a vast array of ecosystem services. Cetacean carcasses provided food and materials to early civilizations around the world (e.g., by supplying useful raw materials for the production of tools, meat, fertilizer and oil). Stranded carcasses were fundamentally important to the survival and cultural development of coastal communities such as the Inuit (Quaggiotto *et al.,* 2022). As humans developed toward modern society, their relationship with marine mammals also changed. More recently, by contrast with the relationship that humans had with cetacean carcasses in the past, cultural services have become the dominant benefits associated with stranded cetaceans, through services such as scientific discovery, on- and offsite education, enhancement of public awareness, and ecotourism. People tend to associate the appearance of cetacean carcasses with the magnificence of nature (Quaggiotto *et al*., 2022). In addition, scientists collect stranded specimens to improve the understanding of these aquatic mammals, and skeletons have been collected for display in museums. Many environmental education activities have focused on large cetacean strandings, with potentially positive effects for marine mammal conservation. Cetacean carcasses are also now used as indicators of ocean status, and strandings provide useful information for studying the effects of anthropogenic impacts on marine ecosystems. However, declining population abundances, highly threatening (anthropogenic) pressures and stressors and modern carcass disposal policies currently threaten the ecosystem services provided by cetacean carcasses (Quaggiotto *et al*., 2022).

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R – Response

Responses and measures taken by OSPAR to protect marine mammals

- OSPAR has identified four marine mammal species of particular concern within the OSPAR Maritime Area and has adopted Recommendations for actions to be taken at the national level and collectively to address threats to these species.
- Marine Protected Areas (MPAs) are an important response for the protection of marine mammals, but there are still gaps in the OSPAR MPA network. There are opportunities for future development of the network, including in management effectiveness.
- There are also several measures under way to regulate the key activities and pressures affecting marine mammals.
- The development of the Noise Action Plan and the new Marine Litter Regional Action Plan (RAP ML 2) is positive for marine mammals.

Cooperation with other competent authorities, including the Agreement on the Conservation of Small Cetaceans of the Baltic, the North-East Atlantic, Irish and North Seas (ASCOBANS), the North Atlantic Marine Mammal Commission (NAMMCO), the International Whaling Commission (IWC), the Conservation of the Arctic Flora and Fauna (CAFF) Working Group of the Arctic Council and relevant fisheries management organisations is crucial to ensuring that cumulative responses result in an improved state for marine mammals.

Marine Mammal R-section ANNEX: The section development has been supported by the collation of relevant measures:

Section overview:

This section describes the responses to minimise the effect of human activities, their resulting pressures or impacts on ecosystem services, and which aim to improve the state of marine mammals in the North-East Atlantic. These responses can include the development of policy, legislation and measures to manage or regulate specific human activities or to mitigate impacts on ecosystem services.

The primary focus is on responses that have been adopted by the OSPAR Commission for implementing the Contracting Parties' commitments under the OSPAR Convention and the strategic objectives of the North-East Atlantic Environment Strategy (NEAES) 2030. Article 22 of the OSPAR Convention requires that the Contracting Parties report to the OSPAR Commission at regular intervals on the steps they have taken to implement OSPAR Decisions and Recommendations, the effectiveness of the measures and the problems encountered in the implementation. This section aims to describe the progress made in implementing these measures and whether they are working in terms of achieving the ambitions set out in the NEAES 2030. The section attempts to set OSPAR's responses in the wider policy context and looks at responses by other competent organisations, where these are pertinent to addressing marine mammals in the context of the

North-East Atlantic. The section considers the diversity of marine mammals that are resident in or frequent the OSPAR Maritime Area. A subset of these species is represented in the indicator assessments, and four species have been nominated by OSPAR Contracting Parties as being of particular concern and so listed as threatened and/or declining species. OSPAR's responses focus on these listed species.

There are several entry points in NEAES 2030 for future action relating to marine mammals, in particular:

Strategic Objective 5: Protect and conserve marine biodiversity, ecosystems and their services to achieve good status of species and habitats, and thereby maintain and strengthen ecosystem resilience.

> **S5.O1:** By 2030, OSPAR will further develop its network of Marine Protected Areas (MPAs) and Other Effective area-based Conservation Measures (OECMs) to cover at least 30% of the OSPAR Maritime Area to ensure it is representative, ecologically coherent and effectively managed to achieve its conservation objectives.
>
> **S5.O2:** By 2022, OSPAR will identify barriers to the effective management of MPAs, and by 2024 take steps to address them appropriately to enable all OSPAR MPAs to achieve their conservation objectives.
>
> **S5.O3**: By 2024, OSPAR will establish a mechanism to provide that where Contracting Parties are authorising human activities under their jurisdiction or control that may conflict with the conservation objectives of OSPAR MPAs in the Area Beyond National Jurisdiction (ABNJ), these activities are subjected to an Environmental Impact Assessment (EIA) or Strategic Environmental Assessment (SEA).
>
> **S5.O4:** By 2025 at the latest, OSPAR will take appropriate actions to prevent or reduce pressures to enable the recovery of marine species and benthic and pelagic habitats in order to reach and maintain good environmental status as reflected in relevant OSPAR status assessments, with action by 2023 to halt the decline of marine birds.
>
> **S5.O5**: By 2025, OSPAR will have implemented all agreed measures to enable the recovery of OSPAR Listed threatened and/or declining species and habitats and will take additional measures as needed.

Strategic Objective 7: Ensure that uses of the marine environment are sustainable, through the integrated management of current and emerging human activities, including addressing their cumulative impacts.

> **S7.O6:** OSPAR will work with relevant competent authorities and other stakeholders to minimise, and where possible eliminate, incidental by-catch of marine mammals, birds, turtles and fish so that it does not represent a threat to the protection and conservation of these species and will work towards strengthening the evidence base concerning incidental by-catch by 2025.

There are a number of linkages to other thematic assessments, including: Food webs Thematic Assessment, Underwater Noise Thematic Assessment, Marine Litter Thematic Assessment, Climate Change Thematic Assessment

The reader is referred to the following feeder reports for additional information on some of the key human activities affecting marine mammals: Fisheries, Offshore Renewable Energy Generation, Aquaculture, Shipping and Ports

Measures adopted by OSPAR

This section focuses on measures that have been adopted by OSPAR and draw on efforts to protect and conserve marine mammals of particular concern, on the establishment of an ecologically coherent and well managed network of MPAs, as well as on specific measures that OSPAR has adopted to address human activities and pressures and improve the conservation status of these species.

The implementation status of all OSPAR Measures was reported in 2021.

Addressing marine mammal species in decline and under threat

OSPAR Contracting Parties have identified four marine mammal species that are of particular concern in the North-East Atlantic and included in the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR Agreement 2008-06) (the OSPAR List): the bowhead whale (*Balaena mysticetus*), the blue whale (*Balaenoptera musculus*), the northern right whale (*Eubalaena glacialis*) and the harbour porpoise (*Phocoena phocoena*). The OSPAR List, which was first adopted in 2003 and updated in 2008 and 2021, guides the OSPAR Commission in setting priorities for its further work to conserve and protect marine biodiversity in implementing Annex V of the OSPAR Convention. Recommendations for actions to protect and conserve these marine mammal species were adopted by OSPAR between 2011 and 2014.

Table R.1: Listing by other international measures. The International Union for Conservation of Nature (IUCN) Red List status and assessment year is shown between brackets. 'Y' means "yes, listed"

	Bowhead whale	Blue whale	Northern right whale	Harbour porpoise
IUCN Red List	Y (Least Concern, 2018)	Y (Endangered, 2007)	Y (Critically endangered, 2020)	Y (Least concern, 2020)
CITES (1975) Appendix 1/ CITES EC reg 338/97	Y	Y	Y	
CMS (1979) Appendix 1	Y	Y	Y	
CMS (1979) Appendix 2				Y
EU Habitats Directive 92/43/EEC Annex II				Y
EU Habitats Directive 92/43/EEC Annex IV	Y	Y	Y	Y

The purpose of these Recommendations is to reach agreement on actions to be taken nationally and collectively to strengthen the protection of the listed marine mammal species, recover their status and ensure that they are effectively conserved in the OSPAR maritime area. A 'Common Understanding' of the Recommendations was adopted in 2013 (OSPAR Agreement 2013-13). The Recommendations are broad in nature, addressing a range of human activities and pressures. Actions to be taken nationally include steps to ensure appropriate national legislation for the protection of the four marine mammal species, consideration of how to strengthen the knowledge base, monitoring and assessment, steps to manage key human activities, a call for the designation of MPAs and awareness raising. Collective actions include coordination of monitoring and assessment, enhancing knowledge exchange, collaboration and maintaining cooperation with relevant competent organisations in addressing key pressures (such as fishing and shipping), and research.

The most recent implementation reporting took place in 2019, with the next reporting due in 2025. A detailed overview of the scope and range of actions implemented in this reporting round can be found in the implementation status of all OSPAR Measures. The level of implementation of the Recommendations varies considerably. The harbour porpoise has been considered separately from the other cetacean species.

The northern right whale has an estimated remaining population of less than 500 animals

Progress in implementing the Recommendations

The northern right whale used to have a North-East Atlantic distribution but is now almost exclusively found in the north-west around the United States and Canada with an estimated remaining population of less than 500 animals (Frasier *et al*., 2022; Pettis *et al*., 2022). The blue whale is more commonly recorded in the OSPAR Region although data are limited due to its predominantly offshore distribution. The emphasis in implementation has been placed on collective action, with some national activities implemented where relevant. Only a very limited number of countries reported implementation through legislative and administrative action. National legislation or actions have been implemented to protect the blue whale and the northern right whale, by Denmark in respect of Greenland, by France and by the United Kingdom, and by Norway for the bowhead whale (N.B. this species only occurs in Arctic Waters). Research, survey or observation activities were reported more widely for the three whale species as part of a broader, not species-specific, cetacean monitoring programme.

The harbour porpoise has a much wider geographic distribution and, according to the OSPAR List (OSPAR Agreement 2008-06), is considered to be under threat and in decline in the Greater North Sea (Region II) and Celtic Seas (Region III). Implementation of the Recommendations was reported by nine Contracting Parties, namely all those where this species is considered to be under threat and in decline, and by other countries where the species occurs. Contracting Parties that are EU Member States are required to strictly protect the harbour porpoise and designate Special Areas of Conservation (SACs) under the EU Habitats Directive (Council Directive 92/43/EEC). Five of the Contracting Parties– Denmark, Ireland, the Netherlands, Sweden and the United Kingdom – have reported their adoption of national conservation plans either specifically for the harbour porpoise or including this species. While all the reporting Contracting Parties described monitoring activities as part of their implementation of the Recommendation for harbour porpoise, there were differences in the approaches taken, with some Contracting Parties citing their participation in the Small Cetaceans in European Atlantic waters and the North Sea (SCANS) cetacean assessments, and others acting via national monitoring or both. It would be helpful to better understand the compatibility and comparability of the different surveys to know if and how these can better contribute to the regional knowledge base. A number of Contracting Parties also have processes in place to address strandings and undertake post-mortem examinations. A review and cross-country comparison of stranding networks and their activities has been published by the International Council for the Exploration of the Sea (ICES, 2021a).

Awareness-raising activities targeting relevant sectors and the general public are being developed and implemented widely by reporting Contracting Parties in support of the listed species. Some examples of information campaigns/ citizens' science initiatives reported by Contracting Parties are given below:

- The UK Cetacean Strandings Investigation Programme and Scottish Marine Animals Stranding Scheme engages through the web, social media, mobile apps, publications and campaigns to improve reporting and recording of stranded animals around the United Kingdom.
- The 'Rude to Intrude' campaign aims to reduce disturbance of whales and dolphins.
- The www.marinemammals.be website is the result of a long collaboration between the Royal Belgian Institute of Natural Sciences (RBINS) and the University of Liège on marine mammals. The website provides information and data on species, sightings and strandings, as well as guidance on what people should do if they encounter a stranded marine mammal.
- The Irish Whale and Dolphin Group runs extensive public information campaigns on small cetaceans in Irish waters, including on the harbour porpoise.
- Marine Mammals science education is an EU-funded project to further increase young people's interest in natural science and to prevent shortage of specialists in science, technology, engineering and mathematics (STEM).

As previously noted, the rarity of the large whale species provides a particular challenge to implementation of the Recommendations; however, Ireland reported that recent survey work to understand the blue whale has highlighted new information regarding the frequency and timing of blue whale occurrence in its maritime area, linked to the annual life cycle and also to potential foraging habitats during the migration phase.

The work of other competent international organisations and collaboration with them are relevant to the implementation of collective actions and required for the successful protection and conservation of marine mammal species. Specifically for the harbour porpoise, this includes ASCOBANS, the Trilateral Cooperation on the Protection of the Wadden Sea, and the work undertaken through relevant ICES (International Council for the Exploration of the Sea) working groups, which links to the collective actions.

Are these measures working?:
Status assessments show the blue whale, bowhead whale, northern right whale and harbour porpoise populations to be in 'not good' state, implying that the measures taken to date are not effective. The current round of reporting has demonstrated the conservation action taken at the national level; however, it has been difficult to objectively assess the level of implementation of many of the actions in the Recommendations, and at this stage it is not possible to assess objectively whether or not these are proving to be effective.

The adoption of a Roadmap for the implementation of collective actions within the Recommendations for the protection and conservation of OSPAR listed Species and Habitats (2017-2025) (The Roadmap) has supported the implementation of collaborative efforts across thematic boundaries within OSPAR as well as informing or supporting actions implemented at the national level. However, it is not yet possible to report on the impact or effectiveness of the collective actions.

To improve our understanding of a measure's effectiveness, we need to be able to track how a response measure is reducing the human activity or pressure of concern, and whether this in turn results in an improvement in the status of the species in question. Progress has been made in understanding the linkages between activities, pressures and status, but there remain a number of challenges which limit our ability to determine whether or not the measures are effective: there is a need for more spatial data – which has large gaps, especially beyond the coastal zone; the Recommendations addresses many actions – some specific, others more general, making it difficult to determine linkages and causality between action and effect of the individual actions and where more effort could have the biggest effect; and finally there is a need to take into account the time lag between taking an action and seeing if it is having the desired effect. This time lag depends on a number of factors, including some specific to each species' life history.

Considering listed marine mammal species within Environmental Impact Assessment

Consideration of the approval of marine licences for certain activities and projects requires some kind of environmental impact assessment (EIA), in order to screen potential impacts and enforce conditions which reduce impacts on species, including marine mammals. In 2010, OSPAR adopted Recommendation 2010/05, with the aim of ensuring that the features of the OSPAR List are specifically taken into consideration when (EIAs) of human activities are being prepared.

The most recent reporting on the implementation of Recommendation 2010/05 took place in 2020. Contracting Parties that are also EU Member States reported that they carry out this Recommendation through the national legislation adopted to implement EU's Environmental Impact Assessment (EIA) Directive (Council Directive 2011/92/EU as amended by 2014/52/EU), and Strategic Environmental Assessment (SEA) Directive (Council Directive 2001/42/EC). Some Contracting Parties also point to other relevant legislation that complements their EIA and SEA obligations. Examples are the EC Habitats Directive (Council Directive 92/43/EEC) including the Natura 2000 network, the Habitats Directive assessments which are required for any plan or project likely to have an effect on a protected site, and the EU Marine Strategy Framework Directive (Council Directive 2008/56/EC). As another example, the German Federal Nature Conservation Act 2017 gives special protection to ensure that harbour porpoises (also an OSPAR listed species) are taken into account during habitat regulation assessments (HRA) of the German North Sea.

Is the measure working?:
Overall, the approach of using EIA and SEA legislation is an important mechanism for promoting the protection of OSPAR-listed threatened and/or declining species and habitats. The fact that the OSPAR List

(OSPAR Agreement 2008-06) and Recommendation 2010/05 are non-binding can mean that the effectiveness of implementation is dependent on overlaps with national practice.

Current reporting on the application of Recommendation 2010/05 focuses on the extent to which species and habitats in the OSPAR List (Agreement 2008-06) are expressly included within the scope of EIAs/SEAs. It is not possible to determine whether those assessments have resulted in effective mitigation measures or otherwise resulted in the reduction of impacts, and this could be a useful area for further good practice sharing. Lack of knowledge about the distribution and status of habitats has been identified as a practical barrier.

Within the NEAES 2030, OSPAR will establish a mechanism by 2024 to provide that, where Contracting Parties are authorising human activities under their jurisdiction or control that may conflict with the conservation objectives of OSPAR MPAs in the Area Beyond National Jurisdiction (ABNJ), these activities are subjected to an EIA or SEA (Operational Objective S5.O3).

The OSPAR Network of Marine Protected Areas

Within OSPAR, MPAs are understood as areas for which protective, conservation, restorative or precautionary measures have been instituted for the purpose of protecting and conserving species, habitats, ecosystems or ecological processes of the marine environment (as defined in OSPAR Recommendation 2003/3 implementing Annex V of the OSPAR Convention). In 2003, OSPAR adopted a Recommendation to establish an ecologically coherent and well managed network of MPAs, which was then amended in 2010. By 1 October 2021, the OSPAR network of MPAs numbered 583, including eight that have been collectively designated in the ABNJ. The MPA network has a total surface area of 1 468 053 km^2, covering 10,8% of the OSPAR Maritime Area and thus achieving the spatial coverage component of Aichi Biodiversity target 11 of the United Nations Convention on Biological Diversity (CBD) and Sustainable Development Goal 14, target 14.5, to conserve at least 10 per cent of coastal and marine areas by 2020.

MPAs as a response for the conservation of marine mammals

Provided that effective measures are in place inside an MPA, it can play an important role as part of a wider suite of management measures in the protection and conservation of marine mammal species with geographically distinct life history characteristics, such as the areas important for feeding, breeding and hauling out. Marine mammal species can be highly mobile and use large areas that span multiple jurisdictions, including the open seas beyond national jurisdiction. MPAs could improve the conservation status of marine mammals in these critical locations by reducing or removing the pressures from human activities that may cause disturbance, reduce prey abundance or result in incidental by-catch. MPAs have been found to be particularly promising where an ecosystem-based approach is taken to their management and they form part of a broader network, and where the management and monitoring of the network explicitly considers climate change (Hoyt, 2021).

The OSPAR Recommendations for the conservation and protection of the four marine mammal species that have been listed by OSPAR include an action to consider whether there are sites that justify selection as MPAs for the protection of populations of these species. The 2019 implementation reporting against these Recommendations identified that, in the case of the harbour porpoise, seven Contracting Parties have designated MPAs for the protection of this species: Denmark, France, Germany, Ireland, the Netherlands, Sweden and the United Kingdom. Belgium reported that evidence indicated that there were no suitable sites for the protection of the harbour porpoise within its waters, and thus that no MPAs had been designated for this species.

For wide-ranging marine mammal species that use habitats over vast areas, including outside of national jurisdiction, protection on the high seas is critical (Hooker *et al.*, 2011). Within the OSPAR MPA network, eight have been collectively designated in ABNJs. Blue whales were identified as a species of concern in four of these MPAs: Milne Seamount Complex, Charlie-Gibbs South, Charlie-Gibbs North High Seas and the North Atlantic Current and Evlanov Sea basin. Other cetaceans have been identified as being of concern in all eight of the OSPAR MPAs in ABNJs.

The ecological coherence of the OSPAR MPA network for OSPAR listed marine mammals:

One of the criteria for understanding whether the MPA network can be considered ecologically coherent involves how well represented the OSPAR listed marine mammal species are within the network (representativity) and how many MPAs these species occur in (replication). This can help identify where the network may need to be further strengthened.

The 'one out all out' principle applies, so if there is either insufficient representativity or replication within the network for one region where the species is under threat and/or decline, then the criterion for ecological coherence is not met. Of the four species of marine mammals listed as threatened and/or declining, the harbour porpoise and bowhead whale are considered to be adequately represented and replicated by the OSPAR MPA network. Further consideration is required across all OSPAR Regions except for the Wider Atlantic (Region V) where the protection of mammals is considered to be adequate. It was outside of the scope of the OSPAR MPA status assessment to consider the ecological coherence of marine mammal species not on the OSPAR List. See **Table R.2**.

Table R.2: Overview of the ecological coherence (representation and replication) of listed threatened and declining (T and D) marine mammals within the OSPAR MPA network (Source: Table 2.5 of the 2021 MPA Status Assessment)

Key:

There is MPA protection in OSPAR Region(s) where the species is considered to be under threat/ subject to decline
The species is not protected in a Region where it is considered to be under threat and subject to decline
The species is not known to occur in that Region
The species is present in the Region and protected but not considered to be under threat or in decline

The number indicates the number of MPAs with the species identified as a conservation objective

OSPAR T&D mammal species	I - Arctic Waters	II - Greater North Sea	III - Celtic Seas	IV - Bay of Biscay and Iberian Coast	V - Wider Atlantic
Balaena mysticetus -Bowhead whale	2				
Balaenoptera musculus -Blue whale	0	0	0	0	8
Eubalaena glacialis -Northern right whale	0	0	0	0	2
Phocoena phocoena -Harbour porpoise	0	34	23	15	1

Management status of the OSPAR MPA network

At the 2010 OSPAR Ministerial Meeting in Bergen, Norway, OSPAR ministers committed to ensuring that the OSPAR MPA network is well-managed, namely that coherent management measures have been set up and are being implemented to achieve the conservation objectives of the protected features. While there is no formal agreement on what constitutes 'well managed' in terms of an MPA, the following four questions have been posed in order to help understand the progress made in implementation: whether the MPA management has been documented, whether measures to achieve the conservation objectives of the MPA are being implemented, whether monitoring is in place to assess if the measures are working and, finally, whether the MPA is moving towards its intended conservation objectives.

OSPAR has made progress in managing the MPA network. The 2021 status assessment showed that 88% of the MPAs in the OSPAR network have either full or partial management information in place which is publicly documented. The report showed that 83% of the measures considered to be required in order to achieve conservation objectives had been implemented since assessments began in 2016, a rise of 17%. Another area of improvement is the increase in the monitoring to detect progress towards achieving conservation objectives. The assessment showed that 75% of OSPAR MPAs have either full or partial monitoring programmes, albeit these are largely based on the ability to monitor sea users' compliance with the rules and regulations associated with OSPAR MPAs, as opposed to direct site condition monitoring, which is costly. Nearly half of OSPAR MPAs are thought to be moving towards achieving their conservation objectives. It is important to note that the percentage of OSPAR MPAs achieving or moving towards their conservation objectives has increased over time, from 36% to 44% and 49% in 2016, 2018 and 2021, respectively. Despite improvements in understanding the management status of the MPA network, it is still difficult to determine whether the protected features of the OSPAR MPAs are moving towards their conservation objectives, owing to lack of site-specific information or long-term monitoring programmes, as noted above.

Future OSPAR work should focus on implementing the management measures considered necessary to achieve the conservation objectives of the protected features of MPAs. In parallel, there is a need for long-term monitoring programmes to be established to evaluate the effectiveness of management measures so as to be able to conclude with greater confidence whether the conservation objectives of the protected features of OSPAR MPAs are being achieved. In addition, further progress is needed to improve methods of evaluating whether the OSPAR MPA network is sufficiently well-managed to support a more sophisticated assessment of the OSPAR MPA network's ability to deliver a genuine conservation benefit to targeted habitats, species and ecological processes, as well as the wider marine environment.

For OSPAR MPAs in ABNJs, there should be continued effort to further the Collective Arrangement (OSPAR Agreement 2014-09) and to cooperate through other mechanisms such as Memoranda of Understanding with the relevant management authorities and thus enable them to consider appropriate management actions to help deliver the conservation objectives for the OSPAR MPAs in ABNJs.

Is this measure working?:

OSPAR is progressing towards key metrics in terms of area-based protection; however, there are still gaps in the geographic coverage of marine mammals, in ecological coherence and in understanding whether or not management is effective. Within the North-East Atlantic Environment Strategy (NEAES) 2030, Contracting Parties have committed to further develop the OSPAR network of MPAs and other effective area-based conservation measures (OECMs) by 2030 so as to cover at least 30% of the OSPAR Maritime Area and ensure that it is representative, ecologically coherent and effectively managed to achieve its conservation objectives (NEAES 2030 Operational Objective S5.O1). This ambition is in line with the global target under negotiation within the Convention on Biological Diversity.

The OSPAR mandate is restricted when it comes to the management of certain human activities. Effective implementation relies on action by the Contracting Parties in areas within their national jurisdiction, and with other competent organisations in areas beyond their national jurisdiction. However, the common ambition of a regionally coherent network is important and brings useful attention to the protection of threatened and /or declining species. Within NEAES 2030, OSPAR has committed to establishing a mechanism by 2024 which will provide that, when Contracting Parties are authorising human activities under their jurisdiction or control that may conflict with the conservation objectives of OSPAR MPAs in the ABNJ, those activities are subjected to an EIA or SEA.

The requirement for regular reporting provides a valuable mechanism for tracking progress and accountability. There is, however, a need to continue improving the availability of data relating to the OSPAR MPA network so as to inform those responsible for managing different human activities in the marine environment. This includes information on the features that are protected and the management plans that are in place, and the development necessary to deliver on NEAES 2030 Operational Objective S11.O2. By 2023, and every six years thereafter, OSPAR will conduct a regional-scale assessment of the OSPAR MPA network in respect of the resilience of marine biodiversity to climate change, with the aim of ensuring that the network provides a good representation of species and habitats and that its spatial design and management regime remains relevant.

Understanding the management effectiveness of the MPAs within the network, and of the network itself, remains an important gap to address. By 2022, OSPAR will identify barriers to the effective management of MPAs, and by 2024 take steps to address them appropriately to enable all OSPAR MPAs to achieve their conservation objectives (NEAES 2030 Operational objective S5.O2).

Other OSPAR measures responding to relevant human activities and pressures:
Fish and shellfish harvesting (professional, recreational) and Hunting and collecting for other purposes [Extraction of living resources]:

Article 4 of Annex V of the OSPAR Convention states that no programme or measure concerning a question relating to the management of fisheries must be adopted under this Annex. Where the Commission considers that action on such a question is desirable, it must draw that question to the attention of the competent authority or international body. Where action within the competence of the Commission is desirable to complement or support action by those authorities or bodies, the Commission must endeavour to cooperate with them. Where there are "questions relating to the management of fisheries" at the national level, they will be considered within the context of the Contracting Parties' different legislation and management regimes (OSPAR Agreement 2013-13). For the avoidance of doubt, in the context of the OSPAR Convention, the management of fisheries includes the management of marine mammals.

The "Collective Arrangement between competent international organisations on cooperation and coordination regarding selected areas in areas beyond national jurisdiction in the North-East Atlantic" (Collective Arrangement, OSPAR Agreement 2014-09) is a formal agreement between legally competent authorities with responsibility for managing human activities in ABNJs in the North-East Atlantic. It has successfully provided a framework for productive dialogue not only between OSPAR and the North-East Atlantic Fisheries Commission (NEAFC), but also for other relevant competent organisations. In 2017, a joint commitment was submitted under target 4.c of SDG 14, through which both secretariats committed to further promote the Collective Arrangement and widen its collaborative scope with the secretariats of other intergovernmental organisations and with bodies in other regions and sectors. Under NEAES 2030, OSPAR will work with relevant competent authorities and other stakeholders to minimise, and where possible eliminate, incidental by-catch of marine mammals, birds, turtles and fish so that it does not represent a threat to the protection and conservation of these species, and will work towards strengthening the evidence base concerning incidental by-catch by 2025 (Operational objective S7.O6).

Please refer to Important measures taken by other competent bodies for more information about measures implemented by other competent organisations relevant to OSPAR's work. See: OSPAR Feeder Report 2021 - Fisheries.

The Collective Arrangement, 2023

Renewable energy generation (wind, wave and tidal power), including infrastructure, Nuclear energy and, Transmission of electricity and communications (cables) [Production of energy]: Commitments to increase renewable energy production are leading to the rapid and, in some areas, extensive development of marine renewable infrastructure. There are measures being taken that have relevance for the conservation and protection of marine mammals, including those relating to environmental impact assessment, the EU Directive establishing a framework for maritime spatial planning (Council Directive 2014/89/EU), as well as guidance on taking nature conservation into account in renewable developments. Mitigation measures such as appropriate siting, management of installation procedures, and turbine design are being used to address potential impacts of offshore wind energy.

OSPAR produced guidance on environmental considerations for offshore wind farm development in 2008 (OSPAR Agreement 2008-03). This guidance is intended for approval authorities, to help them identify issues that may be associated with the environmental impacts of development at all stages of operation and decommissioning. It includes minimum criteria for EIAs to apply in order to minimise impacts on marine mammals, including from noise: "*Possible effects on marine mammals can be divided into behavioural disturbance (including displacement), masking, and injury either as temporary threshold shift (TTS), permanent threshold shift (PTS), or other injuries such as tissue damage and, in extreme cases, death if the animal is very close to pile-driving activities*", and also covers measures to minimise disturbance from construction vessels and equipment, such as the use of timing windows (see also **noise** below). The guidance refers to other measures relevant to managing impacts from the development of renewable energy infrastructure, including the EU Habitats Directive (Council Directive 92/43/EEC) and the Environmental Impact Assessment (EIA) (Council Directive 2014/52/EU). A 2020 survey of OSPAR Contracting Parties showed that the offshore wind guidance was generally fully implemented or that implementation was in progress, although not all Contracting Parties provided information for the survey. OSPAR also maintains a database on individual marine renewable developments, including tidal, wave and offshore wind.

For OSPAR Contracting Parties that are also EU Member States, the European Commission's offshore renewable energy strategy COM(2020)741 refers to the Birds and Habitats Directives with a view to ensuring that developments do not have negative impacts on listed species or habitats and that any potential impacts are reduced or minimised. The EU has developed guidance (Commission notice C (2020)7730) which provides information on the impact of wind farm development on marine mammal (seal and cetacean) species included in Annex II and IV of the Habitats Directive, at different phases of construction and operation, and potential mitigation measures. The guidance highlights the need to consider the potential impacts of noise on marine mammals from offshore wind developments, in particular impulsive noise from pile driving of foundations. These impacts may include physical effects such as damage to hearing, and behavioural effects such as driving animals away from favoured habitats. Mitigation measures can include appropriate siting of developments, alternative design (floating platforms), scheduling of activities to avoid sensitive periods (although hard to implement for species with long sensitive periods, such as harbour porpoise), engineering and surveillance approaches to reduce the risk of noise impacts, and deterrents. The EU Wildlife Sensitivity Mapping Manual published in 2020 also provides practical guidance on renewable energy planning within the European Union.

In some OSPAR Contracting Parties, recent developments have seen national laws modified so that the expansion of offshore renewables is treated as a matter of "overriding public interest", thus enabling these projects to override existing nature conservation laws. At EU level this is also being considered within RePowerEU.

By 2023, OSPAR has agreed to develop common principles, and by 2024 guidance, for promoting and facilitating sustainable development and the scaling-up of offshore renewable energy in such a way that cumulative environmental impacts are minimised (NEAES 2030 Operational Objective S12.O4).

Windfarm © Paul Langrock

Extraction of oil and gas, including infrastructure [Extraction of non-living resources]:
Oil production activities can affect marine mammal habitats and cause physical loss or degradation of habitat, through noise generated by seismic surveys for oil and gas exploration, vessel traffic associated with services to the platforms, operational noise emitted at the site (see also noise below) and accidental spills during

drilling. While this activity is in decline, there are still more than 1 350 operational installations, with an increasing number reaching their end of life in the next two decades. OSPAR is the key international organisation addressing the environmental aspects of offshore oil and gas activities in the North-East Atlantic. OSPAR has adopted a wide range of programmes and measures to reduce pollution from all phases of offshore activities. These include the reduction of oil in produced water, substantial restrictions on the use and discharge of organic-phase drilling fluids, and the banning of dumping or leaving in place disused offshore installations, subject to derogation in certain specified cases. Nearly all offshore operators have followed OSPAR's promotion of environmental management systems for offshore installations to support the objectives of the 2010-2020 Offshore Oil and Gas Industry Strategy and have adopted comparable schemes. Measures under the 2010-2020 Offshore Oil and Gas Industry Strategy have had a high level of implementation and an assessment of the discharges and spills show that the OSPAR measures have led to decreases in the discharges of both hydrocarbons and the most harmful offshore chemicals, see: Offshore Industry Thematic Assessment

The petroleum-related activities in the Arctic follow strict measures to avoid spills of oil or other pollution of toxic materials and to prevent damage to both marine mammals and other parts of the Arctic ecosystems.

Coastal defence and flood protection, Offshore structures other than oil/gas/renewables and Land claim [Physical restructuring of rivers, coastline or seabed (water management)]:
Dredging and the dumping of waste and other matter have been well regulated since the Oslo Convention came into force in 1974. OSPAR has adopted Guidelines for the management of dredged material at sea (OSPAR Agreement 2014-06) designed to assist Contracting Parties in managing dredged material in ways that will prevent and eliminate pollution in accordance with Annex II to the 1992 OSPAR Convention, and protect marine species and habitats in the OSPAR Maritime Area in accordance with Annex V. The Guidelines set out a Best Environmental Practice approach for minimising both the amount of material dredged and the impacts of dredging and disposal. They include specific information on the appropriate placement of dredged material in relation to the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR Agreement 2008-06). National authorities use these guidelines to manage dredging and dumping and to minimise effects on the marine environment; they also serve as a tool which Contracting Parties that are also EU Member States can use to manage the dredged material that is subject to current European Directives (such as the Water Framework Directive (Council Directive 2000/60/EC), the Marine Strategy Framework Directive (Council Directive 2008/56/EC), the Natura 2000 areas under the Birds and Habitat Directives (Council Directive 2009/147/EC and Council Directive 92/43/EEC). The Waste Framework Directive (Council Directive 2008/98/EC) has also been identified by Contracting Parties as having implications for the management of dredged material, in addition to relevant national legislation.

Since 2000, the assessment and licensing procedures for dredged materials in most OSPAR countries have included action levels for contaminant loads based on OSPAR guidelines. Since 1998, OSPAR has also had guidelines in place on the dumping of fish waste. The management of dredged materials should respect the natural processes of sediment balance. Selecting the appropriate location for a dumpsite is essential to minimise environmental impact. Several dumpsites have been relocated by applying the OSPAR guidelines. For example, a planned site in the Weser estuary was relocated after a site survey detected a mussel bank. Dumpsites have also been relocated or closed to avoid impacts on MPAs, fisheries and shipping. The ban on dumping vessels or aircraft has been implemented successfully. A report on the use of OSPAR guidelines was presented to its Environmental Impacts of Human Activities (EIHA) Committee in 2020. Returns from Contracting Parties reported that 2014 dredging guidelines were being fully implemented in the majority of the OSPAR Maritime Area (Section 6.46 of OSPAR Feeder Report 2021- Shipping and Ports). Under NEAES 2030, OSPAR will assess, review and potentially revise the OSPAR criteria, guidelines and procedures relating to the dumping of wastes or other matter and to the placement of matter by 2023 (Operational Objective S7.O4).

Transport - Shipping and Transport infrastructure [Transport]:

See: Noise

Please refer to Important measures taken by other competent bodies for more information about measures implemented by other competent organisations relevant to OSPAR's work to address threats from shipping activities, including those relating to prevention of ship strikes. See: OSPAR Feeder Report 2021 - Shipping and Ports.

Input of anthropogenic sound (impulsive, continuous) [Substances, litter and energy]:

Underwater Noise Thematic Assessment

Many of the human activities that take place in the OSPAR Maritime Area generate noise that contributes to the general background level of noise in the sea and can have negative impacts on marine mammals. Anthropogenic sound sources are categorised as impulsive or continuous (ambient). Impulsive sound sources include percussive pile-driving for inshore and offshore construction (for example windfarms), seismic surveys (using airguns) to inspect subsea oil and gas deposits, explosions, and some sonar sources. Continuous sound sources are mainly from shipping. By 2025, OSPAR will agree a regional action plan setting out a series of national and collective actions and, as appropriate, OSPAR measures to reduce noise pollution (NEAES 2030 Operational Objective S8.O1).

Case study: Noise regulation at windfarm construction sites

As is the case across Europe, offshore windfarms are developing rapidly in the German North and Baltic Seas, with associated increases in noise, particularly the impulsive noise associated with pile-driving in the installation phase. In response to concerns about the impact of this noise on the harbour porpoise, the most abundant cetacean species regularly occurring in the German North and Baltic Seas, in 2008 the German government established noise mitigation value criteria for the regulation of pile-driving work in relation to offshore wind farm development, in order to minimise the impact on sensitive species such as the harbour porpoise. Subsequent efforts, including cooperation with industry members, led to the development of noise abatement systems that enable compliance with these mitigation values (Bellmann *et al.*, 2020).

Input of litter (solid waste matter, including micro-sized litter) [Substances, litter and energy]:

Marine Litter Thematic Assessment

Marine litter causes harm to marine mammals through entanglement or ingestion. OSPAR has been at the forefront of international efforts to tackle the marine litter problem since the adoption of its first Regional Action Plan on Marine Litter (RAP ML) (2014-2021). A Second Regional Action Plan on Marine Litter (RAP ML 2) was adopted in 2022 and will continue the work of preventing and significantly reducing marine litter in the North-East Atlantic, including action to build an evidence base for understanding harm and developing appropriate measures as well as an action to prevent abandoned, lost and discarded fishing gear and the Fishing For Litter initiative (OSPAR Recommendation 2016/01), a scheme that works with key stakeholders to remove marine litter from the sea and the seabed.

The OSPAR Marine Litter Thematic Assessment reports that there are positive signs of a decrease in the quantities of litter found on OSPAR beaches and in the floating litter in the North Sea, over the last 10 years. When considered against the upward trend in plastic production and consumption in Europe over a similar period, this suggests that progress has been made on preventing plastics from entering the marine environment. The successful implementation of this new RAP will be crucial to building on and maintaining momentum towards achieving OSPAR's objective of preventing inputs of and significantly reducing marine litter.

Other relevant activities or pressures

Tourism and leisure infrastructure has been identified as an activity affecting marine mammals, but no measures have been taken by OSPAR directly to address these. Actions to raise awareness with respect to the OSPAR listed species, for example by targeting the general public, are being developed and implemented widely by Contracting Parties (see section 2.1). Commitment to monitoring and the enabling of monitoring mechanisms are urgently needed in order to evaluate adequately tourism and recreation pressure and its impact.

The OSPAR actions related to the management of hazardous and radioactive substances are relevant to marine mammals. For measures taken by OSPAR see Radioactive Substances Committee Thematic Assessment, and Hazardous Substances Thematic Assessment.

OSPAR has not taken measures to address the impacts of aquaculture on marine mammals.

Important measures taken by other competent bodies

This section highlights measures taken by other competent bodies that are important for improving the status of marine mammal populations in the North-East Atlantic.

General conservation measures

Under Article 13 of the EU Marine Strategy Framework Directive (Council Directive 2008/56/EC) (MSFD), EU Member States are required to take measures to achieve or maintain good environmental status by 2020. Status assessments under Article 8 and environmental targets under Article 10 help to identify where these measures are needed. According to the assessment published in 2018 (COM/2018/562 final) (EC, 2018) of the programmes and measures applicable to marine mammals, most Member States reported having taken spatial protection measures through the Habitats Directive to protect habitats, including breeding and feeding areas, with most of the new measures addressing underwater noise. Member States also made linkages to measures taken through regional maritime organisations as well as ASCOBANS. Other measures included reducing the impact from lost fishing gear, mitigation of oil pollution, awareness raising, and encouraging sustainable tourism. For the most part, good environmental status of marine mammals was not achieved by 2020.

Under ASCOBANS, species action plans have been adopted for the harbour porpoise in the North Sea (2012) and the Western Baltic, Belt Sea and Kattegat (WBBSK) (2009), and for the North-East Atlantic common dolphin (2019), in order to improve data, mitigate the threats being faced by these species and build awareness.

Blue whales have been protected worldwide since 1966, and no deliberate catch of blue whales has been recorded since 1978 (Cooke, 2018).

Fish and shellfish harvesting (professional, recreational) and Hunting and collecting for other purposes [Extraction of living resources]:

Hunting/ marine mammal harvesting:

As noted above, the management of fish and shellfish harvesting on marine mammals is outside the competence of the OSPAR Commission. However, OSPAR can communicate an opinion on these matters to the competent authorities for the protection and management of marine mammals, including the IWC, NAMMCO, and to other bodies regulating the relevant human activities, such as the International Maritime Organization (IMO) and the Arctic Council's CAFF Working Group. The IWC is the main international organization in charge of protecting large whales in the world and assessing their status. NAMMCO is a regional body for cooperation in the conservation, management and study of cetaceans and pinnipeds in the North Atlantic. NAMMCO provides management advice to the Faroe Islands, Greenland, Iceland and Norway on the conservation status of blue whales. Blue whales are protected by all NAMMCO member countries. The Arctic Council is the leading intergovernmental forum promoting cooperation, coordination and interaction among the Arctic States, Arctic indigenous communities and other Arctic inhabitants on common Arctic issues, in particular on issues of sustainable development and environmental protection in the Arctic.

Whale hunting has been allowed in limited quotas by Norway (minke whales) and Iceland (fin and minke whales).

The Norwegian seal hunt is restricted in terms of seal numbers, time and place. Harp seals are hunted in the Greenland Sea (West Ice) under quota. Unweaned pups and lactating mothers are fully protected. Licensed, recreational hunting for grey and harbour seals along Norway's coast, and for ringed and bearded seals along the coast of Svalbard, is permitted under sub-national regulations (NAMMCO, 2021).

Incidental by-catch

In EU Member States, cetaceans are offered strict protection under Article 12 of the EU Habitats Directive (Council Directive 92/43/EEC) or equivalent national legislation. Additional obligations on Member States include the conservation of cetacean populations and the monitoring and mitigation of incidental by-catch and other anthropogenic impacts under the Marine Strategy Framework Directive (Council Directive 2008/56/EC) (MSFD) and the Technical Conservation Measures Regulation (Regulation (EU) 2019/1241). The latter includes technical measures for the conservation of fisheries resources and the protection of marine ecosystems, including actions to minimise incidental by-catch of cetaceans. Protected, Endangered and Threatened Species (PETS) by-catch monitoring is further required in the context of the EU-MAP (Regulation (EU) 2017/1004). National monitoring of by-catch by EU Member states is collated, evaluated and reported on by the International Council for the Exploration of the Seas (ICES). Beyond the EU, some OSPAR Contracting Parties have established national legislation: in Iceland, incidental by-catch of marine mammals must be recorded in fisheries logbooks according to Regulation 746/2016 on Catch Books. These measures focus on sustainable fisheries however, rather than on a broader ecosystem approach or on by-catch monitoring of PETS. The EU MAP is not well-suited to the dedicated monitoring of PETS in high-risk fisheries, since its main focus is on statistically sound random sampling of all commercial fisheries (EC-JRC-STEFC 2021).

Within the OSPAR Region, ASCOBANS has species action plans in place for harbour porpoise in the North Sea (2009), the Western Baltic, the Belt Sea and the Kattegat (2012) and for common dolphin in the North-East Atlantic (2019); these include actions relating to incidental by-catch. Individual countries also have action plans, for example, the Netherlands, see: [Updated Conservation Plan for the Harbour Porpoise *Phocoena phocoena* in the Netherlands].

For cetaceans, examples of the population impacts identified by ICES include potential extinction of the local population of harbour porpoise off Iberia (Carlén *et al*., 2021); by-catch mortality of common dolphins or porpoises in excess of removal limits (set to meet the ASCOBANS conservation objective with a high likelihood; see Genu *et al*., 2021) in the Bay of Biscay and Iberian Coast Ecoregion, the Celtic Seas, the western English Channel and the Greater North Sea (ICES, 2021b); and by-catch mortality also in Icelandic Waters, the Barents Sea and the Norwegian Sea (ICES 2022b). ASCOBANS highlights that, in all parts of its agreement area, the annual by-catch rate for harbour porpoise is significantly above the ASCOBANS definition of 'unacceptable interactions', being, in the short term, a total anthropogenic removal above 1.7% of the best available estimate of abundance (ASCOBANS Resolution 3.3). For seals, the threshold was achieved for incidental by-catch mortality of grey seals. However, high incidental by-catch risk was found in the southern part of the Celtic Seas, therefore indicating a smaller local population size than is evident at the wider assessment unit level (see: OSPAR Indicator Assessment on Marine Mammal By-catch). The ICES also reports that by-catch of seals in recent years in Icelandic waters is estimated to be 9–19% of local populations for harbour seal and 8–24% for grey seal; in the Norwegian Sea, grey seal pup production declined between 2007 and 2015 in mid-Norway, possibly as a result of increased by-catch (Bjorge *et al*., 2017), implying that existing measures are not enough.

The NEAES 2030 states that "*OSPAR will work with relevant competent authorities and other stakeholders to minimise, and where possible eliminate, incidental by-catch of marine mammals, birds, turtles and fish so that it does not represent a threat to the protection and conservation of these species and will work towards strengthening the evidence base concerning incidental by-catch by 2025*" (Operational Objective S7.O6). This will increase attention on the effects of incidental by-catch, including for marine mammals; OSPAR should take into consideration, and where possible collaborate with, the relevant by-catch studies and working groups (in the framework of OSPAR, European Commission, ICES, Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS), ASCOBANS) and their conclusions in the future.

Entanglement

The entanglement of marine mammals in active gears as well as in Abandoned, Lost and Discarded Fishing Gear (ALDFG) is a persistent issue in the North-East Atlantic. Measures have been implemented to address this issue, including via the NEAFC Scheme of Enforcement Art 7, 7a and 7b, net marking, removal or disposal of unmarked or illegal gear and garbage at sea, and retrieval of lost gear; also, the FAO Voluntary Guidelines on the Marking of Fishing Gear.

Transport - Shipping and Transport infrastructure [Transport]:

The QSR 2010 identified physical and other impacts, including noise and collision with marine mammals, as one of the main threats from shipping*.* Ship strikes can cause death or injury to cetaceans, but the lack of good data on populations and on animals affected means that the impact is difficult to assess (EMSA/EEA, 2021). National reporting under ACSOBANS includes the reporting of deaths from possible ship strikes. Decreasing sea ice in Arctic waters is expected to provide greater access to marine traffic, increasing the risk to marine mammals. The IWC has developed a strategic plan for mitigating the impacts of ship strikes on cetacean populations (https://iwc.int/ship-strikes). The plan covers measures such as re-routing and speed reduction; better reporting of incidents; development and use of avoidance technologies; and identifying high risk areas where high volumes of shipping overlap with high numbers of whales. The IWC also maintains a global database on ship strikes. The IMO developed guidance on reducing the risk of ship strikes with cetaceans in 2009 (MEPC.1/Circ.674), recognising that minor routeing changes in high-risk areas could lead to substantial reduction in strikes and was possibly the best measure for reducing ship strikes (MEPC 69). None of the high-risk areas so far identified in the plan is within the OSPAR region, although the Strait of Gibraltar is identified as a high-risk area within the Mediterranean for fin and sperm whales (Cates *et al.,* 2017).

The designation of Particularly Sensitive Sea Areas (PSSAs) under the IMO is a response designed to address the potential environmental threat from shipping in ecologically sensitive areas. The guidance on the designation of PSSAs (Resolution A.982(24)) identifies these hazards as relating to operational discharges; accidental or intentional pollution including noise; and physical damage to habitats, and may include ship strikes of marine mammals. An example is the PSSA designation of Western European waters in 2004, in which the presence of emblematic marine mammal species is highlighted as one of the reasons for designation.

Case study: In the United States, mandatory seasonal speed restrictions have been implemented since 2008 to reduce vessel strikes to northern right whales. A 2020 assessment of the effectiveness of these measures showed some signs of reduced ship strike and no impacts on vessel safety (NOAA, 2021)

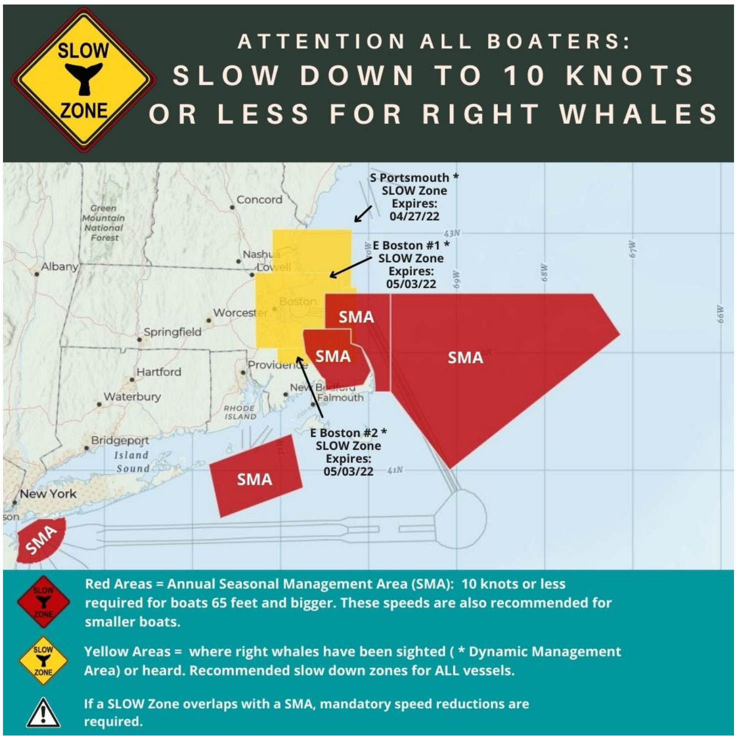

Figure R.1: Slow down notifications from the National Oceanic and Atmospheric Administration (NOAA) received by boaters.

Regional differences

There have been responses designed to address the status of marine mammals across the North-East Atlantic, both within and outside national jurisdiction. Owing to the increased level of human activities in the coastal zone, more responses relate to these activities. Contracting Parties that are also EU Member States are obliged to implement the Habitats Directive, which affords protection to marine mammals, and to implement the MSFD, including through projects such as Mystic Seas, which also extends to the Wider Atlantic region (Region V) of the OSPAR Maritime Area. Within Arctic Waters (Region I), most measures are related to commercial exploitation of certain species, such as fin whale, minke whale, hooded and harp seals. There are also measures in place to prevent negative impacts resulting from offshore oil production. No measures are in place to address pressures from shipping, fisheries or noise.

Gaps and opportunities

Are we doing enough?

It is not possible to answer whether the existing measures are able to reduce the pressures and human activities that continue to undermine the status of marine mammal species in the North-East Atlantic. In some cases, such as the large whale species on the OSPAR List, the current status is principally the result of historic activity. These species remain in poor status, although at least for the blue whale there are some indications of improvement.

Are there other types of responses that could be undertaken by OSPAR to improve the status of marine mammals?

Incidental by-catch: Measures to address marine mammal incidental by-catch are being implemented by the relevant competent organisations. However, marine mammal by-catch monitoring and management remains inadequate (ICES 2022a). Management requires objectives to be set in accordance with conservation objectives set by policy. In particular, the thresholds in the context of incidental by-catch of protected species such as marine mammals represent an upper limit for anthropogenic removals; that is, the limit beyond which the risk of not achieving conservation objectives is unacceptable. Threshold setting methods (Palialexis *et al.*, 2021) rely on a management strategy evaluation framework that requires unambiguous quantitative and time-bound conservation objectives (Genu *et al.,* 2021). These conservation objectives for marine mammals have yet to be set by policy makers in the North-East Atlantic (ASCOBANS, 2015b; ICES, 2007, 2009, 2013, 2020). OSPAR, via its Marine Mammal Expert Group, has interpreted the ASCOBANS conservation objective of restoring / maintaining populations to mean 80% of carrying capacity for assessing incidental by-catch, given the current lack of policy guidance on quantitative conservation objectives. Under the NEAES 2030, OSPAR has committed to work with the relevant competent authorities and other stakeholders to minimise, and where possible eliminate, incidental by-catch of marine mammals, birds, turtles and fish so that it does not represent a threat to the protection and conservation of these species, and will work towards strengthening the evidence base concerning incidental by-catch by 2025 (Operational Objective S7.O6). This gives increased attention to the effects of incidental by-catch, including for marine mammals. OSPAR will be able to take into consideration relevant incidental by-catch studies in the framework of its own expert groups, HELCOM (Convention on the Protection of the Marine Environment of the Baltic Sea Area – also known as the Helsinki Convention), the European Commission, the ICES, ACCOBAMS, ASCOBANS, and their future conclusions, in particular with respect to the current conservation objective that requires review in order to ensure that the applied level of caution is appropriate. See knowledge gap section in indicator assessment Marine Mammal By-catch.

In terms of potential future actions to address this gap, OSPAR could consider the following types of actions:

- Notify the IWC of its concern about the status and conservation of the OSPAR listed whale species populations and request that issues relative to the status of this stock and threats should be treated as priority issues within the IWC;
- Notify NAMMCO of its concern about the status and conservation of the OSPAR listed whale populations and request that issues relative to the status and threats should be treated as priority issues on the NAMMCO agenda;
- Given the expected opening of new shipping routes in the Arctic and the associated increase in shipping traffic, not only in the Arctic but also in the North-East Atlantic in general, OSPAR could notify the IMO of its concern about the potential danger of ship strikes.

Address marine litter: Plastics in the ocean have impacts on ecosystem health, including harm to marine mammals through entanglement or ingestion, and economic impacts on sectors such as coastal tourism and fisheries. The Second Regional Action Plan on Marine Litter will cover the development of an evidence base for understanding harm as well other measures that could be developed within OSPAR, and also action to prevent, locate and retrieve Abandoned, Lost and Discarded Fishing Gear (ALDFG).

Address anthropogenic noise: By 2025 OSPAR will agree a regional action plan setting out a series of national and collective actions and, as appropriate, OSPAR measures to reduce noise pollution (NEAES 2030 Operational Objective S8.O1). This provides a good opportunity to take collective action to minimise this pressure on marine mammals.

Adapt responses in the light of climate change impacts: The impacts of climate change will result in changes in habitat suitability and prey abundance and will require a dynamic approach to ensuring the effectiveness of the OSPAR MPA network for marine mammals. By 2023, and every six years thereafter, OSPAR will assess at regional scale the OSPAR network of Marine Protected Areas in respect of the resilience of marine biodiversity to climate change, with the aim of ensuring that the network provides a good representation of species and habitats and that its spatial design and management regime remains relevant (NEAES 2030 Operational Objective S11.O2).

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Cumulative Effects

Cumulative effects assessment for marine mammals

It should be noted that the Sankey plots and associated narratives in this thematic assessment are an illustrative representation of a complex set of interactions between DAPSIR components (Driver-Activity-Pressure-State-Impact-Response) at the coarse North-East Atlantic scale and should be considered and interpreted alongside the supporting full thematic assessment narrative. The Sankey plots should thus be applied with caution and not considered or used as the sole basis for management decisions.

A range of human activities contribute pressures which cumulatively have the potential to impact the state of marine mammals and associated ecosystem services (with consequences for societal drivers, e.g., food, energy, space, health, biodiversity). The extraction of or mortality/injury to species, input of anthropogenic sound, disturbance of species, prey depletion, input of litter and input of substances are the predominant pressures. Following a Driver-Activity-Pressure-State-Impact-Response (DAPSIR) framework and a weighting exercise, an indicative assessment of cumulative effects has been undertaken (see: CEMP Guideline for details) as a first step to describing potential pathways of cumulative causes and consequences of change in the ecosystem linking these to impacts on ecosystem services.

The Marine Mammals Thematic Assessment describes the connectivity between the relevant DAPSIR components. The bow-tie analysis provides a schematic of potential impact pathways describing the cumulative causes and consequences of change in the ecosystem, demonstrating that multiple human activities are contributing to multiple pressures which can lead to multiple impacts on the state of marine mammals and the associated ecosystem services. A better understanding of this complex pattern surrounding the effect of human activities on ecosystem state and ecosystem services is critical if OSPAR is to explicitly apply the ecosystem approach in order to target management measures appropriately.

The evidence underpinning the analyses described in this chapter is drawn from the Driver, Activity, Pressure, State, Impact and Response chapters of this thematic assessment, and it should thus be read and interpreted alongside the extended narratives provided therein. The Human activities and Pressure sections of this thematic assessment provide detail on the threats that the left-hand side of the Sankey plot (**Figure CE.1**) poses to marine mammals. The State section of this thematic assessment provides details of the ecosystem state shown in the centre of the Sankey plot (**Figure CE.1**) illustrated for marine mammals. The right-hand side of **Figure CE.1** incorporates the impact on ecosystem service scores so as to present the APSI components of the marine mammal "ecosystem" in a single plot. This is consistent with North-East Atlantic Environment Strategy (NEAES) 2030 Operational Objective S7.O3: "By 2025 OSPAR will start accounting for ecosystem services and natural capital […] to recognise, assess and consistently account for human activities and their consequences in the implementation of ecosystem-based management."

Figure CE.1 shows the complex combinations of human and pressures on state changes (left-hand side) and state changes on ecosystem services (right-hand side); however, there is currently insufficient understanding and evidence to be able to directly track from left to right, hence the single bar in the centre. This should be a focus of study to inform future assessments.

Overall, confidence in the evidence for the weighted bow-tie analysis outputs presented in this marine mammal thematic assessment are described as **medium for evidence** and **medium for degree of agreement**. Additionally, separate confidence assessments have been applied to each module.

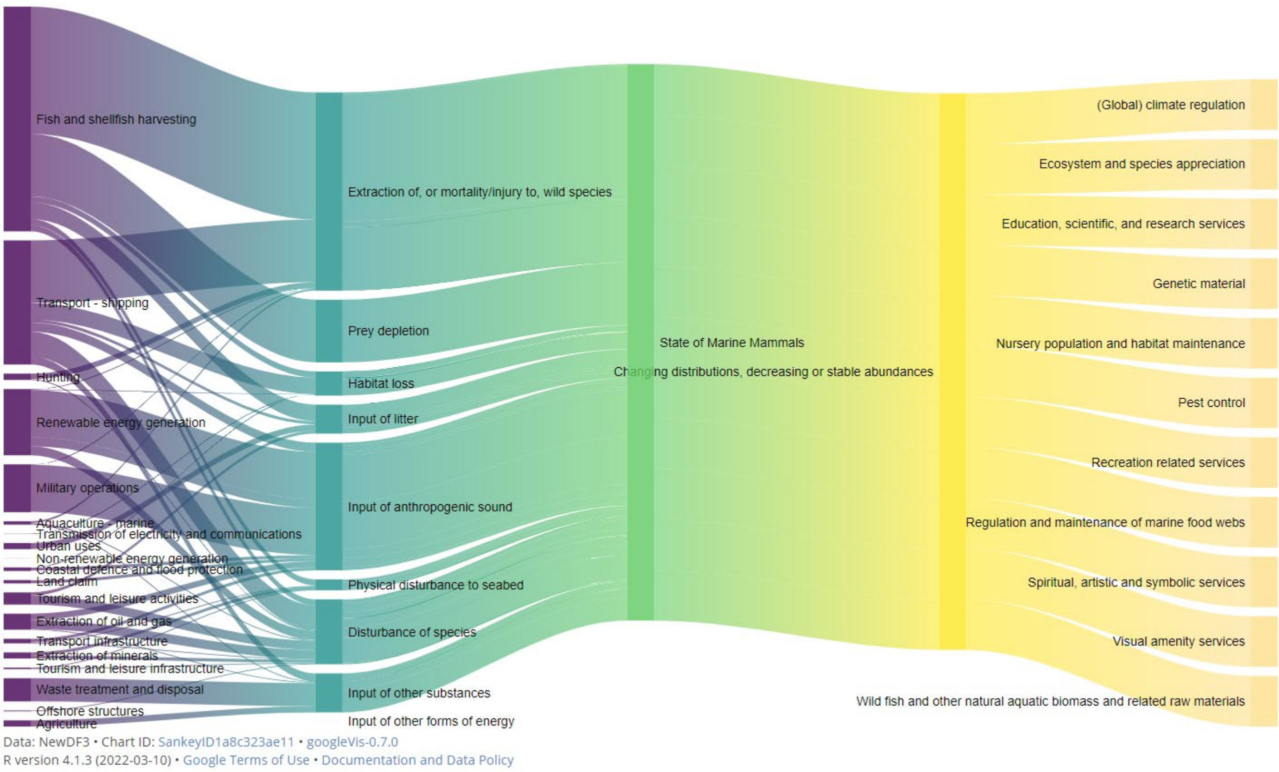

Figure CE.1a: Impact potential of marine mammals for exposure to pressures from human activities in the North-East Atlantic. Columns left to right: Activity, Pressure, State, Environmental Impact, Ecosystem Service. Derived from Exposure score (Extent x Frequency of pressure) x Degree of Impact score (in terms of whether impact i Acute or Chronic). Pressures with a low Degree of Impact score have been removed for clarity. 'Impact' in this context does not consider the persistence of the pressure or the resilience of the ecosystem associated with that pressure. Were these parameters to be included, the relative contribution for some pressures will most likely increase and score higher in the relative ranking. Links are weighted to indicate relative contribution to impact. A wider link = greater potential for impact.

It should be noted that the Sankey plots and associated narratives in this thematic assessment are an illustrative representation of a complex set of interactions between DAPSIR components at the coarse North-East Atlantic scale and should be considered and interpreted alongside the supporting full thematic assessment narrative. The Sankey plots should thus be applied with caution and not considered or used as the sole basis for management decisions.

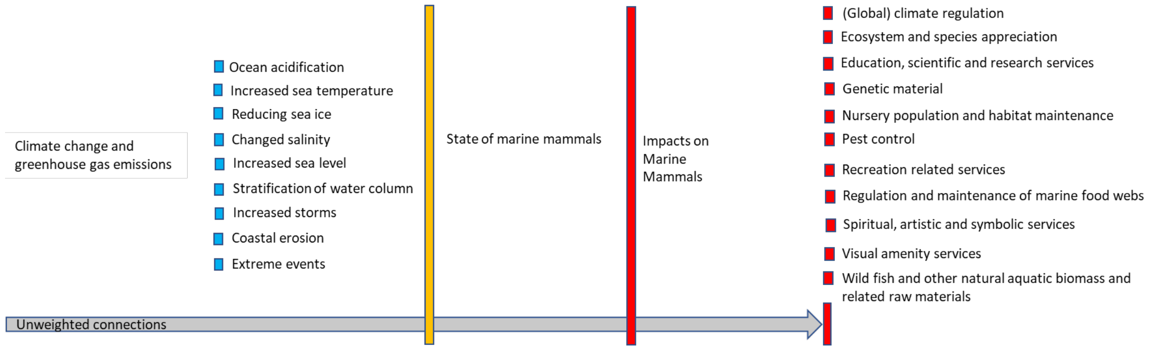

Figure CE.1b: Unweighted assessment of the contribution of climate change and greenhouse gas emissions to pressures affecting marine mammals in the North-East Atlantic

Figure CE.1 demonstrates the complex relationships between the collective pressures from human activities and the quality status of marine mammals. This complexity suggests that while single-issue responses may be effective, in order to fully apply ecosystem-based management OSPAR need to consider the causes and consequences of changes in ecosystem state more holistically, by

- recognising that any measures to reduce impacts whilst critical to ecosystem health could have potential consequences for maintaining ecosystem services to meet society's needs, which in turn has consequences for the viability of human activities in the North-East Atlantic;
- recognising that pressures may have additive, multiplicative, synergistic or antagonistic interactions when combined which has implications for the nature of the threats posed to marine mammals and how best to manage those threats.

Methodology

[CEMP Guideline]

A modified bow-tie analysis (Cormier *et al.,* 2018, Cormier *et al.,* 2019) was developed to identify and connect all the DAPSIR components, integrating these into either a pressure- (e.g. underwater sound, litter, hazardous substances, eutrophication) or a biodiversity receptor- focused analysis of the causes and consequences of change (e.g. pelagic habitats, benthic habitats, fish, marine birds, marine mammals). For the biodiversity assessments, the APS connections are weighted to determine which are the most important, using an adaptation of the Options for Delivering Ecosystem-Based Marine Management (ODEMM) pressure assessment (Robinson *et al.,* 2013 and Knights *et al.,* 2015) focusing on:

1. **Exposure module:** spatial extent and frequency for all activity pressure combinations on state to generate exposure weightings;
2. **Impact potential module:** spatial extent, frequency of occurrence and impact potential for all activity pressure combinations on state to generate impact potential weightings;
3. **Risk module:** spatial extent, frequency of occurrence, impact potential for all activity pressure combinations on state combined with pressure persistence and ecosystem resilience to generate risk weightings.

The SI (ecosystem services) connections are weighted to determine which are the most important (Cornaccia, 2022).

The impact potential and ecosystem services outputs are combined and presented in Sankey diagrams (**Figure CE.1**).

Confidence in this weighted bow-tie analysis exercise for marine mammals has been assessed following the QSR 2023 guidance. Confidence is based on two criteria to communicate the degree of uncertainty in the key findings: (i) level of evidence and (ii) degree of agreement.

Exposure module
Confidence Assessment: Evidence – Medium; Consensus – Medium

Pressures from human activities have been demonstrated in the assessments for the QSR 2023 to be widely distributed in the OSPAR Maritime Area. The presence of pressures does not automatically lead to adverse impacts. However, in the first instance consideration of the spatial and temporal extents of pressures provides a useful basis for our consideration of cumulative effects within a risk-based approach (in line with the North-East Atlantic Environment Strategy principle and strategic approach).

The exposure module describes the extent of the pressure from human activities in the North-East Atlantic. It considers the spatial extent and frequency of the human activity - pressure combinations that have been identified as important for marine mammals (derived from spatial extent score multiplied by the frequency score). Exposure only relates to the pressure cell in the DAPSIR schema (**Figure CE.1**). Consideration of exposure in isolation provides a coarse cross-cutting assessment to provide an early identification which allows OSPAR to develop management strategies for pressures to prevent / minimise impacts.

The: Hazardous Substances Thematic Assessment, Marine Litter Thematic Assessment, Underwater Noise Thematic Assessment, Offshore Industry Thematic Assessment, Human Activities Thematic Assessment, and Climate Change Thematic Assessment describe pressures on marine mammals. The Radioactive Substances Committee Thematic Assessment identifies inputs of radionuclides from a range of human activities but has concluded that there are no significant radiological impacts on biodiversity from the current levels of radionuclides.

Climate change (Climate Change Thematic Assessment) and Ocean Acidification pressures have been identified as important for marine mammals (Marine Mammals Thematic Assessment – Climate Change). Input of anthropogenic sound, disturbance of species, input of radionuclides, input of litter, input of substances and extraction of, or mortality/injury to, wild species; physical disturbance of the seabed; and input of nutrients are also important and have the highest exposure scores, demonstrating the ubiquitous nature of some of these pressures in the North-East Atlantic.

The exposure scores support the importance that OSPAR places on these pressures under the North-East Atlantic Environment Strategy (NEAES) 2030:

- Strategic Objective 1 intended to tackle eutrophication through limiting inputs of nutrients and organic matter (and the work of the Hazardous Substances and Eutrophication Committee (Eutrophication Thematic Assessment).
- Strategic Objective 2 intended to prevent pollution by hazardous substances (and the work of the Hazardous Substances and Eutrophication Committee (Hazardous Substances Thematic Assessment) and the Offshore Industry Committee (Offshore Industry Thematic Assessment)).
- Strategic Objective 3 intended to prevent pollution by radioactive substances (and the work of the Radioactive Substances Committee (Radioactive Substances Committee Thematic Assessment)).
- Strategic Objective 4 intended to prevent inputs and significantly reduce marine litter (Marine Litter Thematic Assessment) (and the work of the Environmental Impacts of Human Activities Committee (Human Activities Thematic Assessment)).

Strategic Objective 5 intended to protect and conserve marine biodiversity and ecosystems (this Marine Mammals thematic assessment and the work of the Biodiversity Committee, including the other biodiversity thematic assessments: Pelagic Habitats Thematic Assessment, Benthic Habitats Thematic Assessment, Fish Thematic Assessment, Marine Birds Thematic Assessment Food webs Thematic Assessment.

- Strategic Objective 8 intended to reduce anthropogenic underwater noise (Underwater Noise Thematic Assessment) (and the work of the Environmental Impacts of Human Activities Committee (Human Activities Thematic Assessment)).
- Strategic Objective 9 intended to safeguard the structure and functions of the seabed/marine ecosystems by preventing significant habitat loss and physical disturbance (this Marine Mammals thematic assessment and the work of the Biodiversity Committee, including the benthic habitats thematic assessments (Benthic Habitats Thematic Assessment)).
- Strategic Objectives 10 intended to raise awareness of climate change and ocean acidification; 11 to facilitate adaptation to the impacts of climate change and ocean acidification; and 12 to mitigate climate change and ocean acidification.

Multiple human activities have been identified as exerting these pressures in the North-East Atlantic. Any actions to manage these pressures and to prevent or reduce impacts on state, either individually or cumulatively (collectively), will need to consider if and how these human activities might best be targeted (and the consequences for the associated drivers and ecosystem services), within an Ecosystem Approach (CEMP Guideline).

Impact potential module:
Confidence Assessment: Evidence – Medium; Consensus – High

The impact potential is incorporated with the exposure module (spatial extent and frequency) for pressures from specified human activities (derived from the aggregated exposure score multiplied by the degree of impact score). Impact potential here relates to the generic severity of the interaction in terms of its effects on the ecological component expressed in the categories of: low potential for significant impact, chronic impact or acute impact (Robinson *et al*., 2013). **Figure CE.1** shows the combined weighted scores for exposure and impact potential.

Any activity-pressure combinations with a Degree of Impact score of Low was filtered out, following discussion with the expert group. This is the case with the input of radionuclides, for example, based on the conclusions in the Radioactive Substances Committee Thematic Assessment, as these have been demonstrated to have a low potential to result in a significant impact based on the available evidence. Other pressures filtered out as having low potential for significant impact are disturbance of species from non-renewable energy, land claim and subsea cables; habitat loss from extraction of minerals; anthropogenic sound from aquaculture – marine, offshore structures and subsea cables; marine litter from extraction of oil and gas and offshore structures; nutrients from agriculture and waste water treatment and disposal; input of other forms of energy from coast and flood defence, extraction of oil and gas, land claim, non-renewable energy, tourism and leisure infrastructure, subsea cables, transport – shipping and transport infrastructure; and physical disturbance of the seabed from extraction of oil and gas, non-renewable energy, offshore structures, subsea cables and offshore structures.

The relative ranking of pressures changes when impact is considered (**Figure CE.1**). Mortality and injury of marine mammals due to fisheries incidental by-catch/entanglement and vessel collisions ranked the highest. Also high-scoring were input of anthropogenic sound from multiple activities (with construction noise (e.g., pile-driving) associated with offshore wind farm development and military operations showing the greatest contribution); and prey depletion associated with fishing activity and disturbance of species from a wide variety of human activities. Input of other substances (chemical contaminants), input of litter and habitat loss from multiple human activities were also shown to be important for marine mammals. The importance of climate change and ocean acidification pressures for marine mammals are described in this thematic assessment. Additionally, the Climate Change Thematic Assessment and Ocean Acidification Other Assessment provide details of the contributing human activities. There is low confidence in the incorporation of these pressures directly into the weighted bow-tie analyses (**Figure CE.1a**), so these are shown separately in **Figure CE.1b**.

Risk module

Confidence Assessment: Evidence – Low; Consensus – Low

Given the low confidence scoring, the outputs from the risk analyses have not been included in this thematic assessment for the QSR 2023. Details of the criteria applied in the risk module are described in the CEMP Guideline.

Regional Summary of likely cumulative effects

Confidence Assessment: Evidence – High; Consensus – Medium

While the weighted bow-tie analyses displayed in the Sankey diagrams have been produced at the North-East Atlantic scale, consideration can also be given to where regional differences may arise by cross-referencing other assessments in the QSR 2023.

The Marine Mammal Thematic Assessment identifies the cumulative pressures for marine mammals (but attempts no regional breakdown of pressures) in terms of both exposure and impact:

The list below summarises the main pressures impacting marine mammals, with information on associated activities. Please note that activity-pressure combinations scored as low impact based on the current available evidence were filtered out from the Sankey diagram in **Figure CE.1a.** However, the activity-pressure links listed below relate to the unfiltered outputs used in the Exposure assessment:

- Extraction of, or mortality / injury, to wild species from fish and shellfish harvesting; fishing activities; military operations; hunting; aquaculture; extraction of minerals (aggregates); Collision injury / mortality from transport – shipping; renewable energy generation;
- Input of anthropogenic sound from renewable energy generation; military operations; transport – shipping; extraction of oil and gas; aquaculture; non-renewable energy generation (nuclear); offshore structures; subsea cables; transport infrastructure; land claim; coastal defence and flood protection;
- Prey depletion associated with fishing activities;
- Disturbance of species from transport – shipping; renewable energy generation; tourism and leisure activities; extraction of oil and gas; aquaculture; military operations; non-renewable energy generation (nuclear); offshore structures; fishing activities; subsea cables; transport infrastructure; land claim; extraction of minerals (aggregates); coastal defence and flood protection; tourism and leisure infrastructure;
- Input of other substances from waste treatment and disposal; agriculture; transport – shipping; urban uses; industrial uses; extraction of oil and gas; aquaculture; military operations; non-renewable energy generation (nuclear); extraction of minerals (aggregates);
- Input of litter from fish and shellfish harvesting and fishing activities; urban uses; transport – shipping; tourism and leisure activities; industrial uses; extraction of oil and gas; aquaculture; offshore structures;
- Habitat loss from transport – shipping; fish and shellfish harvesting; offshore structures; fishing activities; extraction of oil and gas; subsea cables; transport infrastructure; renewable energy generation; land claim; extraction of minerals (aggregates); coastal defence and flood protection; tourism and leisure infrastructure; non-renewable energy generation (nuclear);
- Physical disturbance to the seabed from fish and shellfish harvesting; fishing activities; extraction of minerals (aggregates); extraction of oil and gas; transport – shipping; non-renewable energy generation (nuclear); offshore structures; subsea cables; transport infrastructure; land claim; coastal defence and flood protection; tourism and leisure infrastructure;
- Input of other forms of energy from extraction of oil and gas; transport – shipping; non-renewable energy generation (nuclear); offshore structures; subsea cables; transport infrastructure; land claim; coastal defence and flood protection; tourism and leisure infrastructure.
- Input of nutrients from agriculture; waste water treatment and disposal;
- Input of other substances (e.g., radioactive substances);
- Climate change and ocean acidification pressures.

OSPAR does not have evidence for all human activities, but a regional breakdown of the relative intensities of the activities Agriculture; Aquaculture; Extraction of minerals (aggregates); Oil and Gas; Nuclear; Renewable Energy; Fisheries; Shipping and Tourism has been extracted from the supporting evidence for the QSR 2023 and is summarised below. The direct influence of the cumulative pressures from these activities on marine mammals is likely to follow similar trends in intensity within the Regions. Certain pressures spread beyond the spatial extents of the human activities, but as there is insufficient evidence currently available, trends in indirect cumulative pressures have not been considered.

Offshore Industry Thematic Assessment describes:

- low relative intensity of Oil and Gas sector activity in the Bay of Biscay and Iberian Coast (Region IV) and Wider Atlantic (Region V);
- moderate relative intensity of Oil and Gas sector activity in Arctic Waters (Region I) and Celtic Seas (Region III);

- high relative intensity of Oil and Gas sector activity in Greater North Sea (Region II).

Radioactive Substances Committee Thematic Assessment describes:

- no Nuclear sector activity in Wider Atlantic (Region V);
- low relative intensity of Nuclear sector activity in Arctic Waters (Region I);
- moderate relative intensity of Nuclear sector activity in Bay of Biscay and Iberian Coast (Region IV);
- high relative intensity of Nuclear sector activity in Greater North Sea (Region II) and Celtic Seas (Region III).

Human Activities Thematic Assessment describes:

- low relative intensity of Aggregate Extraction sector activity in Arctic Waters (Region I) and Wider Atlantic (Region V);
- moderate relative intensity of Aggregate Extraction sector activity in Celtic Seas (Region III) and Bay of Biscay and Iberian Coast (Region IV);
- high relative intensity of Aggregate Extraction sector activity in Greater North Sea (Region II);
- moderate relative intensity of Agriculture sector activity in Celtic Seas (Region III) and Bay of Biscay and Iberian Coast (Region IV);
- high relative intensity of Agriculture sector activity in Greater North Sea (Region II);
- moderate relative intensity of Aquaculture sector activity in Celtic Seas (Region III) and Bay of Biscay and Iberian Coast (Region IV);
- high relative intensity of Aquaculture sector activity in Arctic Waters (Region I) and Greater North Sea (Region II);
- low relative intensity of Fisheries sector activity in Wider Atlantic (Region V);
- moderate relative intensity of Fisheries sector activity in Bay of Biscay and Iberian Coast (Region IV);
- high relative intensity of Fisheries sector activity in Arctic Waters (Region I), Greater North Sea (Region II) and Celtic Seas (Region III);
- low relative intensity of Offshore Renewable Energy sector activity in Bay of Biscay and Iberian Coast (Region IV);
- moderate relative intensity of Offshore Renewable Energy sector activity in Celtic Seas (Region III);
- high relative intensity of Offshore Renewable Energy sector activity in Greater North Sea (Region II);
- low relative intensity of Tourism sector activity in Arctic Waters (Region I) and Wider Atlantic (Region V);
- moderate relative intensity of Tourism sector activity in Celtic Seas (Region III);
- high relative intensity of Tourism sector activity in Greater North Sea (Region II) and Bay of Biscay and Iberian Coast (Region IV);
- low relative intensity of Transport and Shipping sector activity in Wider Atlantic (Region V);
- moderate relative intensity of Transport and Shipping sector activity in Arctic Waters (Region I);
- high relative intensity of Transport and Shipping sector activity in Greater North Sea (Region II), Celtic Seas (Region III) and Bay of Biscay and Iberian Coast (Region IV).

Regional evidence for trends in the intensity of other human activities or for Climate Change and Ocean Acidification were not available in sufficient detail to be utilised in this assessment.

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Climate Change

The impacts of climate change on marine mammals are not fully understood but will be multifarious

Key messages:

- Changes in environmental conditions driven by climate change and ocean acidification are likely to impact marine mammals by influencing the availability of suitable habitats and the timing and distribution of primary production, increasing the prevalence of and susceptibility to disease, and shifting the phenological timing of key life history events.
- Increasing evidence indicates that geographic range shifts in marine mammals are largely driven by changes in sea surface temperature, since species track changing environmental conditions as well as the abundance and distribution of prey. Climate change impacts are expected to be more pronounced in Arctic Waters, where species are more restricted in their ability to adapt and move further north.
- Observed environmental changes as a result of climate change, such as storm frequency, suspended sediment and sea ice coverage, can impact the acoustic properties of seawater, influencing social communication, predation risk and both inter- and intraspecific competition across marine mammal species.
- As sea-ice cover declines in the Arctic, the increased commercial interest in the region (for example, increased shipping activity) afforded by the longer ice-free season exposes polar marine species to higher risk of both collision and incidental by-catch as well as noise disturbance. Similarly, changes in the distribution of prey may shift the location of fishing activity, thereby affecting the impact of underwater noise across different parts of the environment.
- As marine renewable energy developments increase in an to attempt to minimise future climate change effects, the risk of marine mammal exposure to underwater noise throughout all stages of the development also rises. Impulsive and continuous noise can result in disturbance and injury to marine mammals, inhibiting foraging and feeding behaviours.
- Arctic environmental changes can alter exchange processes between atmospheric, terrestrial and aquatic reservoirs of persistent chemicals like polychlorinated biphenyls (PCBs) and mercury, and the

rates of their bioaccumulation in marine mammals. Most of the available data derive from studies conducted in Arctic waters. They show how the polluting impact of climate change on marine mammals' varies greatly across the Arctic region. For example, significantly decreasing trends of mercury were found in ringed seals from the Canadian Arctic (-2,4 to –8% / year), whereas no trend was observed in Greenland ringed seals. Shifts in food web structure and prey abundance due to climate-driven environmental changes seem to be most important drivers of such changes.

The impacts of climate change on marine mammals are driven by a multitude of factors including sea temperature, sea ice availability, salinity, prey availability and distribution, exposure to disease and toxins, among many others. Observed geographical range shifts in some cetacean species across the North-East Atlantic are driven, at least in part, by increased sea temperatures and associated range shifts in both primary production and prey species (zooplankton, fish, cephalopods or crustaceans) (Williamson *et al.,* 2021) as well as by physical thermal tolerances and habitat availability (Moore et al., 2019; Gulland *et al.*, 2022; Orgeret *et al.,* 2021). Corroborating this, northward shifts in commercial fish species have been well documented in recent years; several of these species overlap with the diet of marine mammals across seas in OSPAR Regions II-IV (Evans and Waggitt, 2020; Williamson *et al.*, 2021; Coombs *et al.,* 2019; Strand *et al.*, 2020; Evans, 2020; Ashlock *et al.,* 2021; Sanderson and Alexander, 2020; Tracy *et al.*, 2019; Byers, 2021; Montero-Serra *et al.,* 2015; Edwards *et al.,* 2016). The impacts are predicted to be most pronounced in Arctic Waters, where marine mammal species are physically restricted in their responses to change (e.g., ice-obligate species and those reaching, or already at, their thermal tolerances; Biuw *et al.,* 2022; Kovacs *et al.*, 2020; Vacquie-Garcia *et al.*, 2017; Bestley *et al.,* 2020; Orgeret *et al.*, 2021; Albouy *et al.,* 2020).

Increased storm frequency and sea level rises leave those seal species which breed or haul out along low-lying coastal areas particularly vulnerable to storm surges (Evans and Bjorge, 2013; Zicos *et al.*, 2018). Approximately 35% of the global population of grey seals breed in the United Kingdom (SCOS, 2020). Severe storms in 2017 led to particularly high levels of grey seal pup mortality in the United Kingdom, with 75% of grey seal pups around all major breeding sites in Wales reported lost (SCOS, 2018). Similarly, in 2021 at least 225 pups were found washed up along the Scottish east coast after a storm event. Increased intensity and frequency of storms may also impact the foraging behaviours of marine mammals (Smith *et al.*, 2013; Fandel *et al.*, 2020). Encounters of coastal bottlenose dolphin populations in both the US Middle Atlantic Bight and the Mississippi Sound decreased significantly during storms, with individuals thought to be travelling further to forage (Smith *et al.*, 2013; Fandel *et al.*, 2020). Conversely, the number of foraging encounters was significantly higher after the storm than before (Smith *et al.,* 2013; Fandel *et al.*, 2020). These changes in foraging have been linked to changes in the distribution and behaviour of prey species and can have impacts on population dynamics and key life history events such as reproduction (Smith *et al.,* 2013; Fandel *et al.,* 2020).

Increasing sea temperatures and changing prey distributions are predicted to impact the phenology and recruitment success of marine mammal species. The extent of harmful algal blooms is predicted to increase along with the temperatures and stratification in the water column. When combined with the geographic range shifts that introduce individuals to novel pathogens and thermal stress, lowering their immune system functioning, this may increase both the prevalence and susceptibility of disease in marine mammals (Cohen *et al.*, 2018; Mann *et al.,* 2013; Sanderson & Alexander, 2020; Fernandez *et al.*, 2022). Salinity changes and thermal stratification of the water column impact the seasonal timing of plankton production at the base of the food web. Changes to plankton blooms influence the recruitment success of marine mammal prey species, which time their life events to these cycles. In turn, the reproductive activities of marine mammals are similarly affected by the trophic mismatch (Holt *et al.,* 2010; Edwards *et al.,* 2020; Sharples *et al.*, 2020;

Sharples *et al.*, 2013; Frost *et al.*, 2016). Observed increases in instances of skipped breeding attempts as well as phenological shifts in the start of the breeding season of grey seals have been associated with increasing sea surface temperature and changing prey distributions. Sub-optimal environmental and body condition has been seen to increase the incidence of skipped breeding attempts and it is hypothesised that skipping a season may be a mechanism by which individuals prioritise survival and increase the likelihood of future reproductive success (Smout *et al.*, 2019; Bull *et al.*, 2021; Caillat *et al.*, 2019).

Shorter sea-ice seasons and reduced ice extent in Arctic Waters have substantially increased access and opportunity for marine traffic, whose predicted increase will alter the soundscape and increase the risk of ship strikes on slow moving species such as bowhead whales (Stephenson *et al.*, 2013; Hauser *et al.*, 2018). Increased human activities, either from climate change or government policy ambitions to mitigate and reduce carbon emissions, expose marine mammals to added pressures. The construction and operation of marine renewable developments, such as offshore windfarms, introduce increased levels of underwater noise into the marine environment. Both impulsive and continuous noise have the potential to injure or disturb species, mask communication, and restrict access to important breeding or feeding grounds by both cetaceans and pinnipeds.

Changes in all these factors have major consequences for the sources and fate of both naturally occurring and human-made chemicals entering the ocean. Sea-ice decrease, temperature and precipitation increase, current shifts and changes in the structure and biodiversity of local food webs are modifying the bioaccumulation rates of persistent chemicals (e.g., mercury or PCBs) by marine mammals. A shift in mercury levels in Greenland Sea ringed seals has been related to higher terrestrial/freshwater spring run-off (Pinzone, 2021), whereas an increase in Persistent Organic Pollutants (POPs) levels in North Atlantic whales (e.g., killer whales) was in part linked to a shift from a fish-dominated to a seal-dominated diet in new Arctic habitats (Remili *et al.*, 2021). At the same time, changes in the proportion of Arctic *versus* sub-Arctic seal species in Hudson Bay polar bears' diet has been associated with an increase in adipose concentrations of total poly-brominated diphenyl ethers (PBDEs) between 1990 and 2007 (Borgå *et al.*, 2022). Climate change impact on marine mammals' chemical pollution is therefore strongly variable in time and space, underlining the necessity for more species-specific case-studies. Moreover, the largest number of observations derive from Arctic Waters, as here the cause-effect relationships between environmental changes and pollution are easier to study. A greater effort of data acquisition is needed from the Greater North Sea (Region II) to the Wider Atlantic (Region V) in order to forecast future trends at the entire OSPAR scale.

To improve confidence in OSPAR's assessment of the impacts of climate change and ocean acidification on marine mammal species and the prediction of future impacts, numerous strands of evidence are required. Long-term monitoring of the abundance and distribution of cetacean species across the North-East Atlantic is already being undertaken using regionally coordinated aerial and ship surveys in a six-yearly cycle. However, the availability of fine-scale data in between these surveys limits the power of the assessments of seasonal trends. Robust information on abundance and distribution is even more limited for those offshore and deep-diving species which are particularly challenging to monitor using traditional methods. Research into the impact of cumulative human-induced and climate change pressures in the marine environment, as well as the responses of marine mammal species to these pressures, is necessary in order to better understand how marine mammal species will adapt to environmental changes and human activities in the marine environment.

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OSPAR's Quality Status Report 2023

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Our vision is a clean, healthy and biologically diverse North-East Atlantic Ocean, which is productive, used sustainably and resilient to climate change and ocean acidification.

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