OSPAR CEMP Guideline

QSR23 Common Indicator Assessment: M6 Marine Mammal By-catch (harbour porpoise; common dolphin; grey seal) Region II, III and IV

QSR23 Candidate Indicator Assessment: M6 Marine Mammal By-catch (harbour porpoise; grey seal) OSPAR Region I

(OSPAR Agreement 2022-03)[1]

This OSPAR biodiversity indicator is still in the early stages of implementation and as a result of iteration and learning, it is anticipated that there will be evolution of the methods and approaches documented in the CEMP guidelines. Version updates will be clearly indicated and be managed in a phased approach via ICG-COBAM through its expert groups and with the oversight and steer of BDC.

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[1] This document exists in English only

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1 Introduction

The primary human-induced cause of mortality of marine mammals in the OSPAR Maritime Area is incidental capture and entanglement in fishing gears, widely known as by-catch (Wade et al. 2021). There are existing legal requirements to monitor by-catch of marine mammals and to apply relevant measures to ensure it does not have a significant negative impact on marine mammal populations.

This indicator assesses by-catch of harbour porpoise *Phocoena phocoena* (including the subspecies *P. p. meridionalis* found in the MSFD subregion Bay of Biscay and Iberian Coast), short-beaked common dolphin *Delphinus delphis*, and grey seal *Halichoerus grypus*. Of the marine mammal species reported as by-caught in the OSPAR Maritime Area, these three species are the most commonly observed. These species are also amongst the most abundant marine mammals in the OSPAR area and consequently, are potentially prone to more interactions with fishing gear compared to other species given increase probability of encountering fishing activity.
Furthermore, harbour porpoise has been included in the OSPAR List of Threatened and / or Declining Species and Habitats for the Greater North Sea and Celtic Seas MSFD subregions owing to evidence of a decline in populations, their sensitivity and the threat of incidental capture and drowning in fishing nets.

The importance of cetaceans and seals as a component of marine biodiversity has been recognised in that they are included in the Indicative list of characteristics for assessing Good Environmental Status in the Marine Strategy Framework Directive. They are also listed in Annex II of the Habitats Directive and so are species which are the subject of additional Community legislation. This indicator would serve to trigger the investigation of possible cause-effect relationships as a basis for measures.

The OSPAR M6 Marine Mammal By-catch Indicator will contribute to assessments of the state of marine mammals and assessments of Good Environmental Status under the Marine Strategy Framework Directive criteria:

D1C1 – The mortality rate per species from incidental by-catch is below levels which threaten the species, such that its long-term viability is ensured.

D1C2 – The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.

D1C3 – The population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity, and survival rates) of the species are indicative of a healthy population which is not adversely affected due to anthropogenic pressures.

From the Quality Status Report 2023, this indicator will assess by-catch against calculated thresholds across OSPAR Regions I (candidate indicator), II, III and IV (Arctic Waters, the Celtic Seas, the Greater North Sea and the Bay of Biscay and Iberian Coast).

This indicator uses abundance figures and by-catch rates to estimate actual by-catch of the three species (harbour porpoise, common dolphin and grey seal). These rates are then compared against the calculated thresholds to establish whether the Assessment Unit is achieving the threshold (by-catch rates are below the threshold), or not achieving the threshold (by-catch rates are exceeding the threshold).

2 Monitoring

2.1 Purpose

As top predators, marine mammals are often used as a sentinel to reflect the state of the wider marine ecosystem. They have varied diets and are highly mobile to varying degrees depending on the species, so their abundance and distribution would be expected to respond to significant natural and manmade changes in the marine environment or at haul out sites for seal species. Natural causes as well as events with anthropogenic (human) drivers, including disease outbreaks, competition with other species, shifts in resource availability, disturbance, and fisheries interactions are likely to influence distribution and abundance of the species. Fisheries interactions resulting in by-catch may play a particular role in the abundance of a species given the anthropogenic removal from a population resulting from by-catch mortality. These CEMP guidelines provide a framework to monitor marine mammal by-catch within the OSPAR region applying three species as the examples, as included in the M6 indicator assessment: harbour porpoise (*Phocoena phocoena*); common dolphin (*Delphinus delphis*); and grey seal (*Halichoerus grypus*).

Although abundance and distribution data play a key role in calculating the by-catch thresholds, the M6 indicator and consequently these CEMP guidelines do not go into detail on monitoring of abundance and distribution. The M4 indicator on cetacean abundance and distribution, and the M3 indicator on seal abundance and distribution, with associated CEMP guidelines lay the foundations for this evidence.

2.2 Assessment Units

Harbour porpoise

The Assessment Units (AU) for harbour porpoise have been updated since the Intermediate Assessment 2017[2] taking into account the recommendation from a joint OSPAR-HELCOM workshop (OSPAR-HELCOM, 2019) that the revised NAMMCO-NIMR AUs (NAMMCO 2019) be used for harbour porpoise by-catch assessments, as the most biologically accurate units (Figure 1).

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2 https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/biodiversity-status/marine-mammals/harbour-porpoise-bycatch/

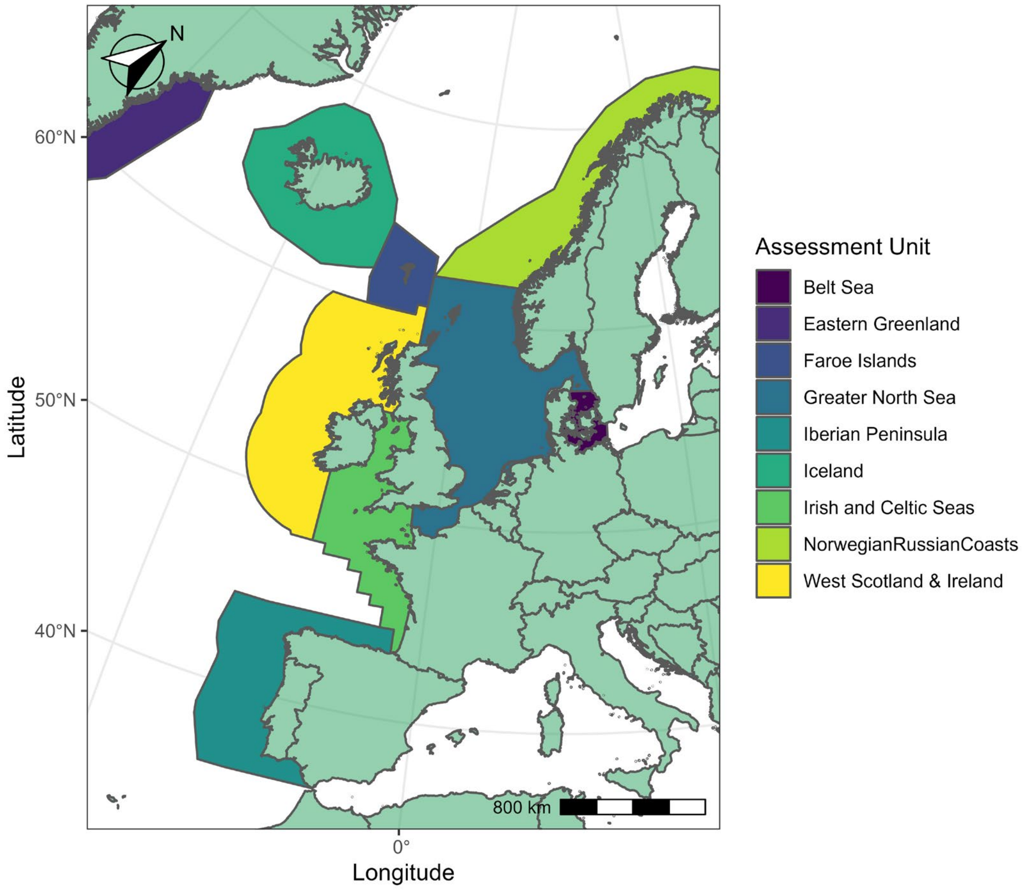

Figure 1: M6 assessment units for harbour porpoise by-catch

Uncertainty remains regarding the Irish and Celtic Seas boundaries. In the NAMMCO (2019) report, there is consideration of splitting out the Irish Sea as an AU with a boundary from the south of Wales across to Ireland. However, the data considered by NAMMCO noted this was based on limited sampling and justification for this boundary was not clear. Analysis published by Fontaine et al. (2017) suggests porpoise in the Irish Sea were genetically closer to the Celtic Sea and Bay of Biscay populations than the West of Scotland and Ireland animals. As a result, it was decided that the evidence suggested mixing of the more southerly animals with the Irish Sea animals and therefore to maintain that area as a single AU.

Common Dolphin

One AU is currently recognised for common dolphins (Figure 2). Murphy et al. (2021) proposed to join OSPAR Regions II, III and IV for this species. The AU used in the assessment encompasses this proposal and extend it to the boundaries of the MSFD subregion Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast (Figure c) given the wide-ranging nature and lack of evidence of finer-scale population structure within the North-East Atlantic.

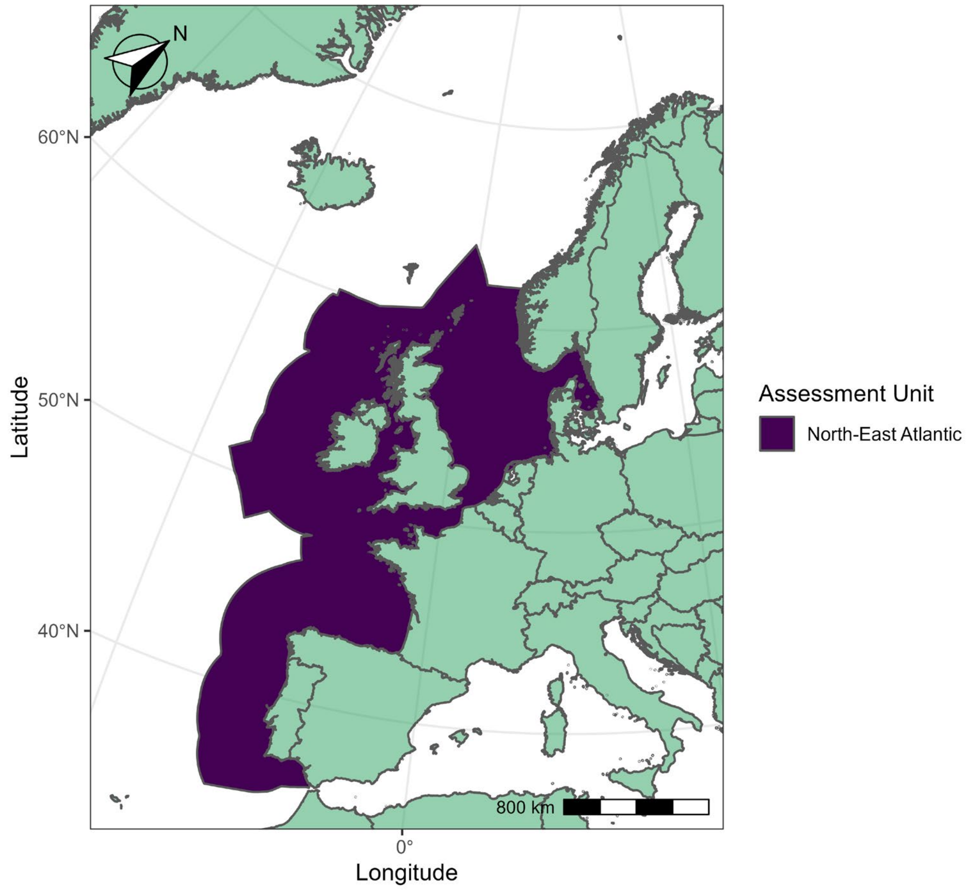

Figure 2: M6 assessment unit for common dolphin by-catch

Grey seal

Grey seals are highly mobile and range over large distances so their abundance is assessed at a large scale. As a result, by-catch is also assessed at relative scales, resulting in three Assessment Units for grey seal by-catch, covering three OSPAR Regions (Figure 3).

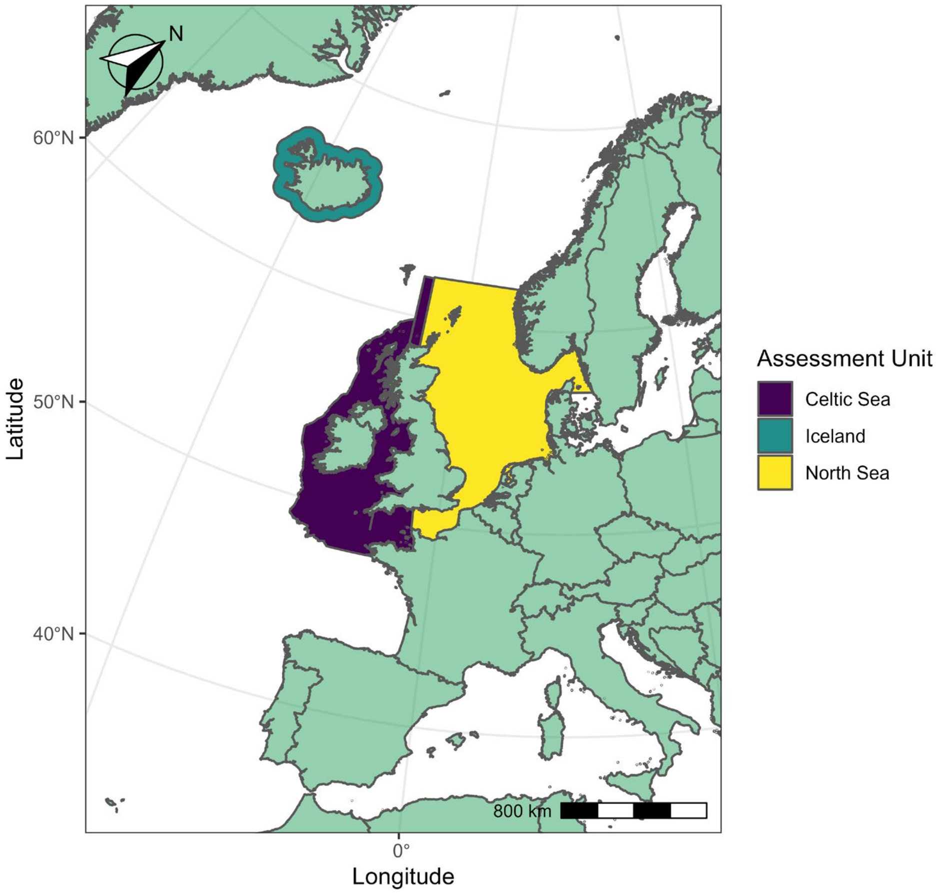

Figure 3: M6 assessment units for grey seal by-catch, including the Iceland AU within Region I.

The North Sea and Celtic Sea AUs align broadly with Region II and III respectively. The Iceland AU, however, only overlaps with a proportion of Region I. These units differ from the M5 pup production and M3 seal abundance and distribution AUs as the basis for the population estimates differs for M6 given the focus on by-catch as opposed to identifying trends in abundance. Further work is required to refine the AUs for M6, particularly in Region III, to better account for the regional picture in terms of abundance, and fishing effort resulting in mortality through by-catch.

2.3 Monitoring Strategy

Currently, data collection feeding into this indicator are primarily funded through widescale international collaborative survey and national monitoring schemes. Given their highly mobile and widespread nature, monitoring of abundance and distribution of cetaceans primarily occurs at a large scale with collaboration between countries to run concurrent survey to gain a snapshot of the distribution and estimate abundances, such as the Small Cetaceans in European Atlantic Waters and the North Sea (SCANS) surveys. These surveys utilise ship-based and aerial transect methods to record animals at sea.

Seal species are more commonly recorded during periods spent on land hauled out, combining a mixture of techniques to overcome obstacles such as estimating the proportion of the population not hauled out during a count.

Contracting Parties have an obligation to monitor by-catch under various legal instruments. Through the Working Group on By-catch of Protected Species (WGBYC), the International Council for the Exploration of the Sea (ICES) collates and reviews data reported by Member States to the European Commission (formerly under EC Regulation 812 / 2004 and now under Regulation EU 2019 / 1241), annually. These data are most commonly linked to at-sea dedicated and non-dedicated observations carried out for the purposes of fisheries monitoring in accordance with the EU Data Collection Framework Regulation 2017 / 1004 (DCF). One of the objectives of the EU Common Fisheries Policy (EU1380/2013) is to ensure that negative impacts of fishing activities on the marine ecosystem are minimized. This includes, amongst others, avoiding and reducing unwanted catches of commercial and protected species (including all marine mammal species). The obligation to monitor and to collect data lies with the EU Member States, who should cooperate with each other and with the Commission to coordinate data collection activities within the same region (in regional Member State groups, i.e. through Regional Coordination Groups on data collection that identify and prioritize the fishery/species combinations to be sampled for incidental by-catch under the revised EU DCF; ICES 2022). The aspiration for efficient by-catch monitoring is for ICES to ensure cooperation for data/information sharing, by-catch assessments, and risk evaluations with relevant organizations (2020d), including:

- Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS)
- Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS)
- General Fisheries Commission for the Mediterranean (GFCM)
- Baltic Marine Environment Protection Commission (HELCOM)
- North Atlantic Marine Mammal Commission (NAMMCO)
- North-East Atlantic Fisheries Commission (NEAFC)
- OSPAR Commission
- Regional Fisheries Management Organizations (RFMOs)

A workflow has been outlined by ICES (2020d) and should be implemented but hurdles remain that must be overcome to build an effective EU-wide by-catch monitoring programme (ICES 2022).

2.4 Monitoring Methods

Marine mammal abundance

Abundance estimates are of paramount importance for by-catch management: all threshold setting methods for setting removals limits require a recent estimate of abundance and a measure of its uncertainty in order to enact a precautionary approach. The most recent estimate of abundance for a marine mammal species in an assessment unit is often denoted N_{best} as it represents the best available evidence on abundance. However, management decisions should be precautionary and factor in the uncertainty around any abundance estimates: in practice a minimum estimate of abundance $N_{\min}$ (incorporating estimation uncertainty) is derived from N_{best} in management procedures (Wade 1998; Taylor et al., 1997; Moore et al. 2013).

Cetaceans

Estimates of cetacean abundance in the OSPAR Maritime Area (Regions II, III and IV primarily) are available from the large-scale multinational surveys such as the Small Cetaceans in European Atlantic Waters and the North Sea (SCANS) surveys. This was initiated in 1994 with SCANS-I (Hammond et al.,

2002) and then followed by SCANS-II and CODA surveys in summer 2005 and 2007 (Hammond et al., 2013), and the SCANS-III and ObSERVE surveys in summer 2016 (Hammond et al., 2021; Rogan et al., 2018). Estimates derived for Region I have been developed from regional aerial survey effort.

These surveys apply robust methodologies based of conventional distance sampling to collect data on cetaceans over large spatial scales. Dedicated line-transect surveys (Buckland et al., 2001) using ships and/or aircraft to cover the survey area, are the most effective method to provide abundance estimates for species that range widely over large areas (ICES, 2014). The data used to estimate abundance so far mostly have derived from large-scale aerial and shipboard surveys: SCANS (Hammond et al., 2002), SCANS-II (Hammond et al., 2013), CODA (Cetacean Offshore Distribution and Abundance in the European Atlantic; CODA, 2009) and SCANS-III (Hammond et al., 2021). Shipboard survey methods have mostly used a double platform set up to account for animals missed on the transect line and for the responsive movement of animals with respect to the observation platform. Several aerial surveys used tandem aircraft or the circle-back procedure for harbour porpoises to correct for animals missed on the transect line (Hiby, 1999); this was extended to dolphin species (Common dolphin) during SCANS-III in 2016 (Hammond et al., 2021).

Absolute abundance estimates of cetaceans were obtained from conventional distance sampling analyses (hereafter, design-based estimates). These design-based estimates are robust in the sense that they rely on sound principles of survey design to ensure representativeness and unbiasedness in sampling.

Seals

Grey seal abundance estimates are produced using a variety of data collection methods. All Contraction Parties are required to monitor harbour seals which is generally carried out during their annual summer moulting period (August), when the probability that animals will haul out and be detectable during a survey is higher. These surveys are conducted either using ground-based surveys or various aerial imagery techniques. During the harbour seal moult surveys, grey seals are also often present at the haul-outs although the probability of these animals hauling out during this time of year is highly variable (Russell et al. 2016). However, the opportunity is generally taken to also count grey seals and the data are then modelled using a scaler to account for the proportion not hauled out during the count to enable an abundance estimate. Some countries in continental Europe also survey grey seals during their annual moulting period in the early spring but these data are limited.

Although variable in nature, the summer grey seal counts provide an index of abundance that is independent from pup production estimates, which are derived from data collected via aerial photography and ground counting methods in late Autumn when grey seal pupping season peaks. These counts act as a proxy for the status of the population but have limited application in isolation in terms of abundance assessments.

Grey seals can form large breeding colonies in the late autumn. In many continental Europe AU’s, repeated surveys of the regions are utilised to generate peak counts of hauled out grey seals during the moult. This metric can then be used to examine trends in abundance over time. Counts of pups produced during the breeding season can also be used alongside other parameters to estimate total population size (Thomas et al., 2019).

The metrics used to estimate N_{min} are dependent on data available for each AU; August or moult counts are used preferentially, but if not available then breeding counts are substituted. Grey seals exhibit partial migration; some individuals breed and forage in different areas (Russell *et al.* 2013). Given that the majority of by-catch occurs at sea during the foraging season it is the distribution and abundance (at AU scale) during that time that should be used for estimation of N_{min}. Potential Biological Removal (PBR) estimates for Scotland are based on August counts for that reason.

Although grey seals also form aggregations to moult, the limited evidence suggests that, for the most part, individuals aggregate within the area in which they forage (Russell *et al*. 2013). Thus, both August and moult counts should be indicative of the distribution during the foraging season. Pup counts or production estimates are used if no August or moult data are available.

Substantial seasonal movements are unlikely to be a significant issue at the scale of OSPAR Regions. However, within a region it is important to use the same monitoring metric whenever possible to avoid double counting. Mixing of N_{min} estimates derived from the foraging distribution (August and moult counts) and breeding distribution should be avoided or at least minimised. For many AUs, there are more spatially comprehensive and comparable counts from the foraging and/or moult seasons than the breeding season.

There are caveats associated with the scalars derived for estimating N_{min} from both August haul out counts and pup production estimates. However, there are also uncertainties in estimating pup production; methods vary within and between AUs and, for example, a change in aerial survey methods in Scotland has been coincident with an apparent jump in pup production (Russell *et al.* 2021).

By-catch

Monitoring by-catch of marine mammals is notoriously difficult (ICES 2020a, 2020b, 2020c, 2020d; Moore et al. 2021; Wade et al. 2021; ICES 2022). This is primarily due to the volume of fishing effort and vessels using gears that are susceptible to by-catch on marine mammals, making it highly costly and challenging to provide adequate monitoring coverage.

The Data Collection Framework (DCF) provides a common framework in the European Union to collect, manage, and share data within the fisheries sector (Anonymous, 2019). Sampling programmes under the EU-Multi-Annual Programme are designed primarily to support fisheries management and should also allow the assessment of fisheries' impact on marine ecosystems. With respect to cetaceans, the collection of high-quality data usually requires a dedicated sampling scheme and methodology, usually different from those applied under the DCF (Stransky & Sala, 2019). In practice, the introduction of any programme on monitoring the by-catch of Protected, Endangered or Threatened Species (PETS; including cetaceans) is met with caution because of its perceived potential to disrupt data collection for fisheries management under the DCF (Stransky & Sala, 2019). This may explain the usually poor quality of by-catch data on PETS in the North-East Atlantic (ICES 2020a).

This poor quality complicates the analysis of by-catch data from non-dedicated schemes as biases in the sampling increases the number of caveats applied, and reduces confidence in outputs (ICES 2020a, 2020d). By-catch management, however, requires at least one estimate of by-catch to compare to a threshold in order to carry out an assessment. Generating those by-catch estimates from biased samples is no small endeavour and may require involved modelling depending on the data and on how they have been collected. Traditionally, ratio-estimators have been used (ICES 2020; Moore et al. 2021), but recent developments to generate by-catch estimates includes using alternative data sources including Remote Electronic Monitoring (Kindt-Larsen et al. 2012; Course 2021), strandings monitoring data (Peltier et al. 2016); or leveraging advanced statistical methodologies (Martin et al. 2015; Siders et al. 2020; Authier et al. 2021).

Although a general framework to estimate by-catch has been outlined (Moore et al., 2021), there is no one-size-fits-all analysis for obtaining marine mammal by-catch estimates from samples given the current state of monitoring and the heterogeneity of sampling schemes both within and between countries in the OSPAR Maritime Area (ICES 2020d).

2.5 Quality assurance/ Quality Control

The assessment requires data on marine mammal abundance with a spatial coverage and temporal extent commensurate with the area assessed. There is moderate to high confidence in the data and methodology used for estimating marine mammal abundance. Distance sampling is the state-of-the-art methodology to estimate cetacean abundance from line-transect survey (Buckland et al., 2015). A minimum abundance of grey seal abundance can be obtained from counts at haul-out sites using a variety of methods.

Data management

Each Contracting Party has its own data storage mechanism for seal abundance and distribution data. For the QSR2023 assessments, national abundance and distribution data were submitted to an ICES data portal following a data call, which operated as the central data custodian. The data were then disseminated to the Sea Mammal Research Unit at St Andrews University (UK) for analysis. By-catch data for grey seal, harbour porpoise and common dolphin were also requested on a country-basis via the Working Group on By-catch (WGBYC) and stored in the WGBYC database for use in the QSR2023 assessments. These data were analysed through the specially convened Workshop on Estimation of Mortality of Marine Mammals (WKMOMA) and the outputs provided as ICES advice (2021).

Cetacean abundance and distribution data are managed through a combination of consortium databases such as SCANS III which is managed by St Andrews University, UK; or held in internal databases by the collecting country and disseminated to OSPAR as appropriate. Furthermore, some data are collected and stored independently to calculate values which are then provided to OSPAR (e.g. Iceland harbour porpoise abundance estimate). In future, there is an ambition for all cetacean abundance and distribution data to be collated via the Joint Cetacean Data Programme (JCDP)[3] to simplify access in completing analyses at international scales.

Data confidence

There is **low** confidence in the marine mammal by-catch data, and no centralized data holder has been designed. However, it is anticipated that a one single expert group in ICES (WGBYC) will evaluate all by-catch data/information from multiple sources and determine the primary sources (i.e. highest quality; best available science) to be utilized for advisory purposes (ICES 2020d). These data and results from their analyses can be leveraged for future assessment purposes. There is moderate / low confidence in the methodology used in the methods currently used to generate by-catch

There is **high** confidence in the abundance estimates for harbour porpoise and common dolphin which follow the conventional peer-reviewed distance sampling analyses (Hammond et al. 2021). Estimates for grey seal have **high to moderate** confidence driven by regional availability of data and type of data collection feeding into the estimates. Where large caveats exist, for example, application of a widescale standard scalar based on regional telemetry information, additional data have been applied such as repeated counts, to increase the confidence of the scaled outputs.

[3] https://jncc.gov.uk/our-work/joint-cetacean-data-programme; https://www.ices.dk/data/data-portals/Pages/Cetaceans.aspx

There is **high** confidence in the methods used for setting thresholds: these methods have been devised in international fora such as the International Whaling Commission where they have been extensively tested (Punt 1993), or have been used in legislations (e.g. the U.S. Marine Mammal Protection Act; Wade 1998). These methods enact sound management principles such as the precautionary principle and rewards data acquisition and efficient monitoring by allowing higher removals limits with high quality data.

3 Assessment

This indicator is generated using time series of seal abundance and distribution data from colonies and haul-out sites along the North Sea, the Celtic Seas and Arctic Waters.

3.1 Conservation Objectives

For the North-East Atlantic Environment Strategy (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 to work towards strengthening the evidence base concerning this interaction by 2025. The objective to “minimise and eliminate by-catch” aligns with ambitions set out under ASCOBANS (MOP 3, Resolution 3); Regulation (EU) 2019/1241 on the conservation of fisheries resources and the protection of marine ecosystems through technical measures; and was integral to the proposed conservation objective for OSPAR by the OSPAR-HELCOM “Workshop to examine possibilities for developing indicators for incidental by-catch of birds and marine mammals” (OSPAR-HELCOM 2019).

A critical gap currently hindering progress towards properly addressing marine mammal by-catch is the lack of legally binding conservation objectives (ICES 2020b). Bravington et al. (1997) and ICES (2010), among others, have stressed how management targets must be determined in the context of explicit conservation objectives. The ICES working group on Marine Mammal Ecology (ICES, 2010) recommended to "move […] towards the explicit definition and justification of target population sizes and management objectives". ICES (2010) advice to the European Commission (Section 1.5.1.2) stressed the need for these explicit conservation and management objectives for marine mammal populations. However, the advice to the European Commission was not acted upon (ICES, 2013; ICES 2020c). Lacking an unambiguous and explicit conservation objective, the OSPAR Marine Mammal Expert Group (OMMEG) interpreted the ASCOBANS conservation objective of restoring or maintaining marine mammal populations to at least 80% of carrying capacity[4] (Reijnders 1997).

Harbour porpoise

The conservation objective is the quantitative interpretation of OMMEG: “a population should [be able to] recover to or be maintained at 80% of carrying capacity, with 0.8 probability, within a 100-year period”. This objective is a quantitative interpretation of the ASCOBANS “short-term practical

4 https://www.ascobans.org/en/species/threats/bycatch

sub-objective" "to restore and/or maintain stocks/populations to 80% or more of the carrying capacity".

Common Dolphin

The conservation objective is the quantitative interpretation of OMMEG: "a population should [be able to] recover to or be maintained at 80% of carrying capacity, with 0.8 probability, within a 100-year period". This objective is a quantitative interpretation of the ASCOBANS "short-term practical sub-objective" "to restore and/or maintain stocks/populations to 80% or more of the carrying capacity".

Grey Seal

The conservation objective is the that of the U.S. Marine Mammal Protection Act (MMPA) of 1994. The MMPA aims at achieving abundance equal to or greater than the Maximum Net Productivity Level (MNPL). A "stock" (or population) that is at /above the MNPL is referred to as being at "optimum sustainable population". The conservation objective for grey seal is thus: "a population will remain at, or recover to, its maximum net productivity level MNPL (typically 50% of the populations carrying capacity), with 0.95 probability, within a 100-year period".

3.2 Thresholds

Thresholds in the context of marine mammal by-catch represent upper limits to anthropogenic removals, whose exceedance will result in an unacceptably high risk of failing the conservation objective. Thresholds are thus not target but limits not be exceeded.

By-catch management requires both data on abundance and data on by-catch. However, both data sources may be plagued by (potentially large) uncertainties or biases which can prevent timely management decisions (Mangel et al., 1996; Taylor et al., 2000, Rayner 2012). These uncertainties are intrinsic to the data and cannot be reduced *ex post*. In order to take management actions that are robust against these uncertainties, threshold-setting methods that must allow accurate decisions despite these uncertainties and biases. Threshold-setting methods rely on extensive testing via simulations of virtual population dynamics under different management and monitoring actions (Moore et al., 2013). Simulations allow to select a threshold that can be robust against bias or uncertainty in abundance or by-catch estimate, and thereby to ensure that the conservation objective will be reached with a high probability (Wade 1998; Taylor et al. 2000; Moore et al., 2013; Genu et al., 2021). The general framework to set these thresholds is called a Management Strategy Evaluation and is routinely used in fisheries sciences to set limits to anthropogenic removals (Kaplan et al., 2021).

Selecting a threshold settings method is contingent on data requirements, especially with respect to by-catch estimates. If a time series of by-catch estimates is available, a Removals Limit Algorithm can be used. Otherwise, Potential Biological Removal can be used. Both these methods require at least one estimate of absolute abundance (and an estimate of its uncertainty).

Harbour porpoise

Greater North Sea AU

The agreed threshold-setting method for the harbour porpoise in the Greater North Sea AU is the Removals Limit Algorithm (RLA). the anthropogenic mortality limit is computed as:

$$\mathrm{RLA} = \widehat{N}_{best} \times \hat{r} \times max\left(0, \widehat{D}_t - \mathrm{IPL}\right) \quad (1)$$

where $\widehat{N}_{best}$ is the best available abundance estimate and IPL is the internal protection level set to 0.54 (i.e. 54% of carrying capacity K). If the estimated depletion level of the population is below the IPL, then the by-catch limit is set to 0. The remaining parameters $\hat{r}$ (growth rate) and $\widehat{D}_t$ (current depletion) are estimated in a Bayesian framework from time series of abundance and by-catch estimates (Hammond et al. 2019; Genu et al. 2021). The maximum net productivity level (MNPL) for marine mammal is thought to occur at 60% of K (MNPL; Taylor and de Master 1993, Wade 1998), and the IPL is set to 90% of the MNPL ($0.90 \times 0.60 = 0.54$; Punt 1993). The Management Strategy Evaluation carried out to set anthropogenic removals limits to harbour porpoises in the Greater North Sea AU is described in Genu et al. (2021).

Other AUs

The agreed threshold-setting method for the harbour porpoise in all its AUs save the Greater North Sea is the modified PBR (mPBR). The formula of the modified PBR (mPBR) tuned to the OMMEG interpretation of the ASCOBANS conservation objective for small cetaceans is:

$$\text{mPBR} = \begin{cases} N_{\text{min}} \times 0.5 \times R_{\text{max}} \times F_{\text{R}}, & \text{if there are more than 2,500 mature individuals,} \\ 0 \text{ otherwise} \end{cases} \quad (2)$$

where N_{min} is the minimum population estimate (i.e., the 20th percentile of the best available abundance estimate, usually the most recent one, assuming a lognormal distribution), R_{max} is the maximum theoretical or estimated productivity rate of the population and F_{R} is a recovery factor between 0.1 and 0.35. For small cetaceans, the maximum theoretical or estimated productivity rate R_{max}, is very difficult to estimate in practice but the value 4% is the consensus one[5] (Wade 1998). The recovery factor F_{R} is by default 0.1 and allows accounting for (i) the current depletion level of the population (the more depleted, the lower F_{R}), and (ii) for some protection against bias and uncertainties in the data. F_{R} is set to 0.1 by default but may be increased up to 0.35 when populations are well studied and biases in estimation of N_{min} and other parameters are thought to be negligible.

The mPBR sets a non-nil limit to anthropogenic removals for populations of small cetacean with more than 2,500 mature individuals. However, for small populations, *i.e.* with less than 2 500 mature individuals, no population decline should be allowed and thus mPBR is set to 0.

The Management Strategy Evaluation carried out to set anthropogenic removals limits to harbour porpoises in AUs other than the Greater North Sea AU is described in Genu et al. (2021).

Common dolphin

The agreed threshold-setting method for the common dolphin in the North-East Atlantic is the modified PBR (mPBR).

The Management Strategy Evaluation carried out to set anthropogenic removals limits to common dolphins in the North-East Atlantic is described in Genu et al. (2021).

[5] R_{max} is difficult to estimate in practice. In the original PBR, Wade (1998) reviewed the available evidence for odontocetes and found “that 4% is probably a suitable default value for odontocetes, and that 2% represents a worst-case scenario” (page 34).

Grey seal

The agreed threshold-setting method for the grey seal is the PBR (PBR). The formula of the PBR is:

$$\mathrm{PBR} = N_{\min} \times 0.5 \times R_{\max} \times F_{\mathrm{R}} \quad (3)$$

where $N_{\min}$ is the minimum population estimate (i.e., the 20^{th} percentile of the best available abundance estimate, usually the most recent one, assuming a lognormal distribution), $R_{\max}$ is the maximum theoretical or estimated productivity rate of the population and F_{R} is a recovery factor between 0.1 and 1.0. For seals, the value 12% is the consensus one for $R_{\max}$ (Wade 1998). The recovery factor F_{R} is most often chosen to be between 0.1 and 0.5 and allows accounting for (i) the current depletion level of the population (the more depleted, the lower F_{R}), and (ii) for some protection against bias and uncertainties in the data. The use of $F_{\mathrm{R}} < 1.0$ buffers against uncertainties that might prevent population recovery, such as biases in the estimation of $N_{\min}$ and $R_{\max}$. Within the PBR context, the choice of $F_{\mathrm{R}} = 0.5$ as a default was determined by tuning, with simulations (Wade 1998). This value is used as a default for populations that are depleted, threatened, or of unknown status, with the value allowed to be increased up to 1.0 when populations are well studied and biases in estimation of $N_{\min}$ and other parameters are thought to be negligible (Punt et al., 2020).

Setting threshold limits, however robust they may be, is not enough to guarantee the conservation objective will be achieved. Without effective monitoring or enforcement of removal limits (and other provisions under instruments dealing with by-catch), conservation objectives run a high risk of being missed entirely.

3.3 Assessment

Carrying out an assessment is straightforward: it requires to gauge the latest available estimate of by-catch for a species in a given AU against its thresholds. The comparison is between the mean estimate against the threshold as the later takes into account uncertainties and possible biases in the data. If the by-catch estimate is lower than the threshold, then the threshold is achieved. If the by-catch estimate exceeds the threshold, then the threshold is not achieved.

Thresholds are adaptive: they are updated every time a new abundance estimate becomes available for the (modified) Potential Biological Removal, or they updated every time a new abundance estimate and new by-catch estimates become available for the Removals Limit Algorithm. As new information become available, this updating ensures that the best available evidence is used in decided management actions.

3.4 Presentation of assessment results

The outputs for the QSR2023 were collated into a table to illustrate the threshold setting method; abundance estimate; calculated threshold values; and estimate of by-catch against each AU that has been assessed (Table 1). This has been included in this CEMP to illustrate the methods of presenting the results. However, these values are subject to change for future iterations of this indicator assessment and this table should not define future methods where changes are required.

OSPAR Region	AU	Threshold setting approach	Abundance estimates	Threshold v alues (anthropo-genic removals)	By-catch estimates (2020) *Red = threshold not met
Harbour porpoise					
II	Greater North Sea	RLA	Nbest = 345 000 CV = 0,18 (239 000 - 483 000)	1622	5974
III / IV	Irish and Celtic Seas	mPBR	Nbest = 47 000 CV = 0,14 (35 300 - 60 800)	82	751
III	West Scotland and Ireland	mPBR	Nbest = 44 300 CV = 0,14 (33 400 - 57 700)	78	305
IV	Iberian Peninsula	mPBR	Nbest = 2 900 CV = 0,32 (1 500 - 5 100)	0	No estimate from observer data
I	Iceland*	PBR**	N(2007)*** = 43 200 CV = 0,45 (16 900 - 91 400)	3500	1713
Common dolphin					
II, III, IV	North-East Atlantic	mPBR	Nbest = 634 000 CV = 0,31 (336 000 - 1 092 000) Common dolphin and unidentified (common or striped) combined total	985	6406
Grey seal					
II	North Sea	PBR	Nmin = 119 519	7171	704
III	Celtic Sea	PBR	Nmin = 60 780	3647	1632
I	Iceland*	PBR	Nmin = 5 881	353	760

** Pilot assessment*

*** threshold set by IMR/NAMMCO (2019) from outputs of a model run on Icelandic harbour porpoises*

**** partial coverage of the AU*

Table 1: Summary table of QSR2023 M6 indicator assessment outcomes.

In addition to the summary table, map Illustrations are provided for each species, indicating the outcome of each AU in terms of whether they have reached (not exceeded) or not reached (exceeded) the calculated threshold. These maps provide a 'quick look' overview of the AU outcomes for M6 but the underlying information should be explored to understand the assessment outcomes in detail, taking into account the relevant caveats within each species AU. *[insert maps and update this text accordingly, depending on final decision on how to display outcomes]*

4 Change Management

The common indicator is maintained under ICG-COBAM which is under BDC.

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