CEMP Guideline M4

Common indicator: Abundance and distribution at the relevant spatio-temporal scale of cetacean species regularly present (M4) – version March 2022

(OSPAR Agreement 2018-09)[1] [2]

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, approaches and values 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

[2] Update 2022

1 Introduction

Cetaceans are widely distributed in a range of habitats and are present throughout the OSPAR Maritime Area. A total of 35 cetacean species have been recorded within OSPAR Regions II, III and IV, although only around a dozen occur commonly: In the Greater North Sea, Celtic Seas, Bay of Biscay and Iberian Coast, it is estimated that more than 1.5 million individuals occur, with their distribution extending beyond the OSPAR area.

Many of the less common species have their main ranges outside the OSPAR Regions and therefore are impossible to monitor systematically within the OSPAR Maritime Area.

The M4 indicator for cetaceans has the potential to address two relevant criteria of the EU Commission Decision on GES (2017/848):

- D1C2 "The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured" (primary criterion).
- D1C4 "The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions" (primary criterion).
- D1C5 "The habitat for the species has the necessary extent and condition to support the different stages in the life history of the species" (primary criterion).

This CEMP guideline describes monitoring methods for M4 Abundance and distribution of cetaceans, including coastal bottlenose dolphins.

Monitoring effort and assessments are made at the relevant species-specific temporal and spatial scale.

These guidelines are mainly based on the current M4-indicator. Following the OSPAR Marine Mammal Expert Group (OMMEG) advise to BDC2019 the three M4-assessments in the Intermediate Assessment 2017 are combined into one in order to facilitate a more comprehensive assessment towards QSR2023.

2 Monitoring

2.1 Purpose

As top predators, cetaceans can indicate the state of the marine ecosystem. Their abundance and distribution would be expected to respond to changes in human activities and environmental changes, including climate change. Natural factors and factors due to anthropogenic activities including disease, competition with other species, resource depletion, pollution, (acoustic) disturbance, and fisheries interactions are likely to have an effect on distribution and abundance. Although no straightforward causal relationships between abundance and distribution of cetaceans, and anthropogenic activities have been established in the OSPAR regions, a number of anthropogenic activities may, at least in part, be drivers of numerical and distributional changes. These CEMP guidelines provide a framework to monitor cetacean abundance and distribution within the OSPAR regions. The M4-indicator and consequently these CEMP guidelines do not explicitly link abundance and distribution to anthropogenic activities. The monitoring of anthropogenic activities and their effects on abundance and distribution of cetaceans requires further work, not currently included in the M4-indicator.

2.2 Quantitative Objectives

The geographical scope of the indicator is species dependent. With the exception of some coastal bottlenose dolphins, cetacean populations extend over large spatial scales beyond national boundaries and often beyond European North Atlantic waters.

Monitoring of cetaceans should be undertaken at the appropriate species-specific spatial and temporal scale to detect a decline or increase in population size. A good understanding of natural variability and patterns of movement is required prior to concluding that a decline or increase in population size has taken place, and further knowledge is needed prior to linking such changes to anthropogenic activities.

2.3 Monitoring Strategy

For cetaceans, there is currently no internationally coordinated monitoring scheme at the relevant spatial scales[3] needed for the assessment of these wide-ranging species. Large-scale international surveys such as SCANS (Small Cetaceans in European Atlantic waters and the North Sea) and CODA (Cetacean Offshore Distribution and Abundance in the European Atlantic) are regarded as the most suitable for the monitoring of those populations that have a wide range, while photo identification and capture–mark–recapture methods are most suitable for small local coastal/resident populations. The SCANS surveys were conducted in 1994, 2005 and 2016 (Hammond et al., 2002; 2013; 2021), and CODA in 2007 (CODA, 2009). These surveys were organized bottom-up, coordinated by the University St Andrews (UK) and were not initiated by an overarching body like OSPAR. Results of these surveys, complemented with results from national surveys, were used for the OSPAR Intermediate Assessment 2017[4] (OSPAR IA 2017) and for the Indicator Assessment for QSR 2023.

There is a general lack of data to fulfil the six-yearly reporting requirements under the Habitats Directive and the Marine Strategy Framework Directive for most species/assessment units. The SCANS-surveys have historically been conducted with an 11 years interval. Ideally this frequency should be increased to one survey every six years to match reporting cycles under the Habitats Directive and the Marine Strategy Framework Directive. Statistical power analysis showed that the statistical power to detect trends over short time periods with data typical of cetacean surveys is low but will increase with a higher survey frequency. The more frequently conducted national surveys are currently restricted to parts of OSPAR Regions II, III and IV. Ideally, an increase in the frequency of the large-scale SCANS survey to at least once every six years, preferably complemented with more frequent regional monitoring using the same methods as SCANS[5], would improve assessments. Alongside regular coordinated large-scale surveys, integration of the results from national and other small-scale surveys using standardized line-transect methods with distance sampling data acquisition can provide assessment of distributional change and the identification of potential drivers.

For small coastal populations annual photo-ID mark recapture methods have shown adequate power to assess trends in abundance, and, in addition, allow the gathering of other useful data (i.e. reproduction, mortality and age-structure). Passive acoustic monitoring can be the most efficient method to monitor harbour porpoises in areas with low densities or low visibility (e.g. the Wadden Sea). The minimum requirements to obtain the necessary temporal coverage and to enable the assessment of changes, are summarised in Table 1.

Table 1: Suggested minimum requirements for monitoring of abundance and distribution of all species under indicator M4.

	Regional monitoring	**SCANS type surveys**
Frequency of data collection	Annually to fill in gaps between SCANS type surveys	Ideally, at least every 6 years
Monitoring method	Line transect distance sampling methods: shipboard or aerial. Mark-recapture Photo-ID Passive acoustic monitoring (PAM)	Line transect distance sampling methods: shipboard and aerial
Who is responsible for monitoring?*	CP for national monitoring schemes, CP cooperation needed	CP cooperation, coordination body to be determined (OSPAR/lead CP?)
Frequency of indicator update and assessment	6 years (MSFD/HD reporting cycle)	6 years (MSFD/HD reporting cycle)
Minimal amount of monitoring locations	Monitoring must cover representative parts of CP's waters in the OSPAR subregions.	Monitoring should ideally cover all OSPAR regions

[3] An advice from OMMEG about a structural international strategy on a relevant temporal (frequency to be decided) and spatial scale (dependent per species) was presented to BDC in March 2019. The SCANS-IV survey, planned for summer 2022, includes a work package on setting a governance framework for large-scale surveys.

[4] https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/

[5] Frequency to be determined based on power analyses

	Photo-ID for relevant coastal populations PAM stations dependent on area	
Current data availability	National monitoring in national databases and can be versed to the Joint Cetacean Data Protocol (JCDP)	3x SCANS/CODA, not yet available in ODIMS but in OBIS Seamap and can be versed to the Joint Cetacean Data Protocol (JCDP)

* All member states have a legal obligation to monitor cetaceans for the implementation of the EU Habitats Directive (HD), Marine Strategy Framework Directive (MSFD) and other agreements.

2.4 Sampling Strategy

The abundance of cetaceans can be monitored using a variety of techniques; which method is most appropriate depends on the species or population (Evans & Hammond 2004; Hammond 2010). For M4 assessment, the objective of the monitoring is to detect trends in abundance. Frequencies of surveys should be such to allow appropriate estimation of trends and ensure continuous adequate information for MSFD (and HD) 6-yearly reporting cycles.

Dedicated line-transect surveys (Buckland *et al.,* 2001; Buckland et al., 2015) using ships and/or aircraft to cover the survey area, are expected to be the most effective method to provide abundance estimates for species that range widely over large areas (ICES, 2014a). These design-based estimates can be supplemented with model-based approaches integrating data from more frequent but smaller-scale surveys (e.g. Gilles *et al.*, 2016; Paxton *et al.*, 2016) to assess cetacean distribution at large scales.

The data used to infer distribution and to estimate abundance so far mostly have derived from large-scale aerial and shipboard surveys that used line-transect methodology to generate robust estimates of abundance: 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 (*Phocoena phocoena*) to correct for animals missed on the transect line (Hiby, 1999); this was extended to dolphin species (Common dolphin *Delphinus delphis* and Striped dolphin *Stenela coeruleoalba*) and minke whales (*Balaenoptera acutorostrata*) during SCANS-III in 2016 (Hammond et al., 2021). In other cases, conventional aerial survey methods were used, corrected for availability and observer bias where possible (Hammond et al., 2013). Where possible, information on species distribution has been obtained from modelled density surfaces fitted to data collected during large-scale and national surveys (*e.g.* Scheidat *et al.,* 2008; Haelters *et al.*, 2011; Viquerat *et al.,* 2014; Gilles et al., 2016; Laran et al. 2017; Rogan et al., 2017; Saavedra et al. 2018). Where this was not possible, distribution was derived from the distribution of animals seen on these and other surveys.

Mark-recapture analysis of photo-identification data is more appropriate for coastal populations of naturally well-marked species with a limited range, such as the bottlenose dolphins and killer whales. This method is based on individual distinctiveness (Urian *et al.,* 2017).

Passive acoustic monitoring (Marques *et al.,* 2012; Sousa-Lima *et al.,* 2013) is the most efficient method to detect changes in smaller areas or in areas with low densities of acoustically active species like the harbour porpoise: e.g in the Baltic Sea (Amundin et al. 2022).

2.5 Quality assurance/ Quality Control

Quality assurance of the data from large- and small-scale surveys is maintained following the SCANS protocols (Hammond *et al.,* 2017) for data collection, validation and analysis. 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 surveys (Buckland et al., 2015).

The qualitative approach and control of data collected by photo ID follows the guidelines described in Urian *et al.* (2017). OMMEG collated national monitoring efforts for the QSR 2023 assessment.

There is **high** confidence in the abundance estimates for cetaceans which follow the conventional peer-reviewed distance sampling analyses (Hammond et al. 2021) or capture-recapture methods.

There is **moderate to high** confidence in the methods used for setting thresholds: these methods have been devised in international fora such as the International Union for the Conservation of Nature (ICES 2014b, 2016).

OMMEG collated national monitoring efforts for the QSR 2023 assessment. Future assessments may access data through the Joint Cetacean Data Programme[6] (JCDP). The JCDP was a development of the Joint Cetacean Protocol which was established to respond to the limited spatial and temporal nature of cetacean survey data (Paxton et al. 2016). The JCDP comprises (i) an international platform to collate and host cetacean survey datasets from the North-East Atlantic and (ii) a data standard to guide data collection and storage to enable a high-quality collation of data for analysis. The JCDP Data Portal launched in 2022 and is hosted by ICES. The JCDP aims to streamline the process of accessing and utilising cetacean survey data for a wide range of applications including reporting by Member States under the Habitats Directive and the Marine Strategy Framework Directive. Data can be filtered based on need and downloaded from the portal. The patchiness in time, space, scale and protocol of cetacean survey data make collation a challenging task but the result is mobilisation of a large amount of information to support analyses at a range of spatial and temporal scales.

2.6 Data reporting, handling and management

Each Contracting Party has its own data storage framework for national monitoring data. Within each assessment unit, M4 indicator is assessed using available data from CPs. National data need to be submitted to OSPAR (following a dedicated data call, as for the QSR 2023), or to a central data custodian (to be decided), that disseminates the data to the body responsible for data analysis and subsequent assessment. Which body this will be, needs to be agreed upon and the existing Joint Cetacean Data Protocol hosted by ICES could be a pragmatic option.

3 Assessment

This indicator is generated using time series of cetacean abundance and distribution across the entire OSPAR region.

3.1 Data acquisition

Approximately 698 500 km of line-transect survey effort were collated as part of the OSPAR data call for the assessing abundance and distribution of cetaceans in the North-East Atlantic for the QSR 2023. Both ship-based and aerial survey data were collated with approximatively 195 000 km ship-based and approximately 500 000 km aerial survey effort. These data span the period between 2005 and 2020, and cover a wide geographical range. The effort is not evenly distributed: a lot of effort is concentrated in the Greater North Sea, and comparatively less effort is deployed in offshore areas of the Celtic Seas, and Bay of Biscay and Iberian Coast. Geographic coverage is thus uneven across the OSPAR Maritime Area.

For most coastal populations of bottlenose dolphin, monitoring is only performed recently, or consists of largely unpublished information. Within the identified AUs, most of the available data relating to abundance are from photo-identification studies of small localized resident groups. These studies are often conducted on animals in protected areas and monitor numbers of individuals in these groups. Available literature was collated to examine abundance information relating to bottlenose dolphins in OSPAR regions II, III, and IV. In addition, researchers were contacted directly via email to enquire about recent relevant but unpublished analyses of abundance in these regions.

3.2 Preparation of data

Visual survey data are needed to be processed using standardized methods to provide quantitative data for an indicator assessment. In general, distance sampling data will be used to generate robust estimates of abundance which are corrected for bias in the observation survey process.

For coastal populations of bottlenose dolphins and killer whales, photo-ID data need to be processed using standardized capture-recapture methods to provide quantitative data for an indicator assessment.

A time series of estimates is required to assess trends.

3.3 Assessment criteria, values and units

OSPAR ICG–COBAM has proposed an assessment value for cetacean abundance, to "*Maintain populations in a healthy state, with no decrease in population size with regard to the baseline (beyond natural variability) and restore populations, where deteriorated due to anthropogenic influences, to a healthy state*".

[6] https://jncc.gov.uk/our-work/joint-cetacean-data-programme/

The threshold for each species is defined as a trend in relation to a modern baseline. For each assessment unit, maintain [insert species name] population size at or above baseline levels (using the earliest reliable population estimate, e.g. from SCANS I or II; as the baseline provided that it is reasonable to assume that this represents GES, which may not be the case for very small populations or those subject to important known pressures), with no absolute decrease of >30% and a rate of decrease no greater than 30% over three generations. In practice, species-specific thresholds are converted to an annual scale (i.e., x% change per year; Table 2) instead of generation times: it is thus not necessary to wait for three generations to elapse in order to make an assessment. Generation times for cetacean species were taken from Taylor et al. (2007) and updated with the best available evidence by either OMMEG or ICES WGMME.
It must be kept in mind that most cetaceans are long-lived, slowly reproducing species, implying that problems affecting reproduction as well as effects from sub-lethal anthropogenic pressures may show significant time lags before being detected.

The most robust abundance data for offshore cetacean species are derived from the results of large-scale surveys designed with equiprobably coverage over the surveyed area. To quantify changes, a trend analysis relative to the best baseline estimates should be performed. These baselines should be kept under review as more information becomes available. OMMEG will provide species specific estimates when available.

Table 2: Agreed assessment values.

Functional Group	Species name	Threshold 1 (absolute decline, %)	Threshold 2 (yearly decline, %)
Baleen whale	Minke whale	-30	-0.5
	Fin whale	-30	-0.5
Deep-divers	Sperm whale	-30	-0.4
	Long-finned pilot whale	-30	-0.5
	Risso's dolphin	-30	-0.6
	Beaked whales	-30	NA
Small toothed cetaceans	Killer whale	-30	-0.5
	Bottlenose dolphin	-30	-0.5
	Striped dolphin	-30	-0.5
	White-sided dolphin	-30	-0.7
	White-beaked dolphin	-30	-0.7
	Common dolphin	-30	-0.9
	Harbour porpoise	-30	-1.6

NA: not available

Assessment Units for assessing abundance and distribution were defined for a number of species (ICES, 2014) in separate regions, or in the OSPAR Maritime Area. For harbour porpoise, several AUs have been reviewed and defined (IMR/NAMMCO 2019). For bottlenose dolphin, eleven AUs have been defined for the relatively small coastal populations on the basis of a combination of spatial separation, lack of photo-ID matches and genetic differences (Evans and Teilmann, 2009; ICES, 2013; ICES 2014; IAMMWG 2015). A single offshore AU for the relatively large and wide-ranging population(s) of bottlenose dolphin living offshore is currently defined. Likewise, a single AU covering all European Atlantic waters has been defined for minke whale, short-beaked common dolphin (Murphy et al., 2021), and white-beaked dolphin and white-sided dolphin. For fin whales, three AUs defined by the International Whaling Commission overlap with the OSPAR Maritime Area. No AUs have been defined for other species included in Table 2.

3.4 Spatial Analysis and / or trend analysis

A workflow for Indicator M4 (excluding coastal bottlenose dolphins because data sources are different) is outlined in Figure 1.

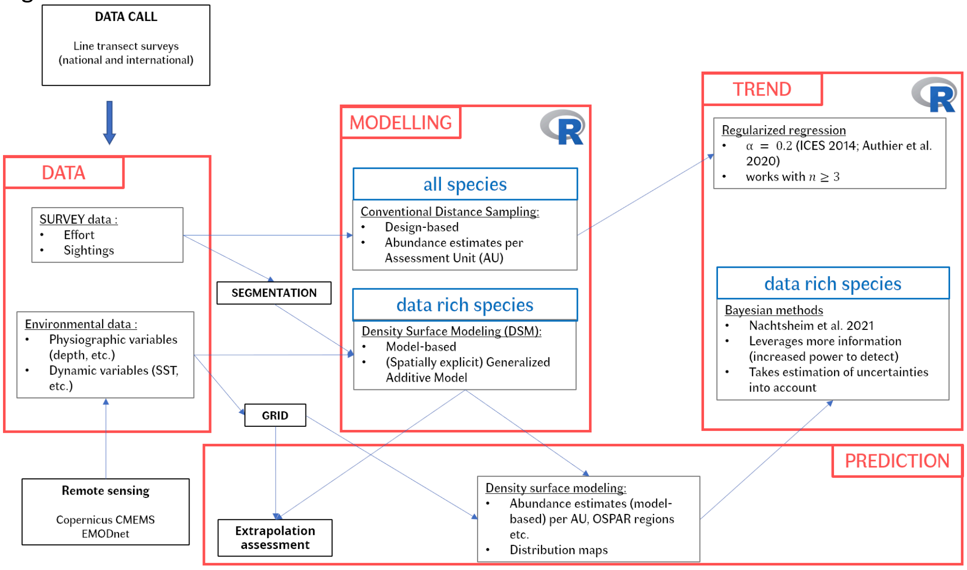

Figure 1: Workflow for Indicator Assessment M4. The workflow summarized data collation for large-scale international survey and smaller-scale national surveys, their formatting for modelling distribution using a density surface approach. Abundance is estimated for most species using conventional distance sampling methods (Hammond et al., 2021), and these estimates were used for trend analysis (Authier et al., 2020). In theory, more advanced methods could also be leveraged to evidence a trend (Nachtsheim et al., 2021) but were not used in the assessment.

Spatial analysis

Model-based density estimates have been used to predict the distribution and abundance of those species for which sufficient data are available from large-scale purpose-designed surveys. Such model-based results are not available for relatively rare species. Maps of observed sightings provide information on distribution based on recent data for which results from density surface models are not yet available. An analysis of changes in distribution for the most common cetacean species from collated survey datasets (2005-2020) was carried out using Density Surface Models (Miller et al. 2013).

Trend analysis

A trend is quantified as the percentage change (in abundance) over a specified time period (Link and Sauer 1997). For cetacean species, excluding coastal bottlenose dolphins, abundance of animals per species per assessment unit has mostly been estimated using data collected from large-scale purpose-designed surveys using line-transect distance sampling methods (Buckland et al., 2001; Buckland et al., 2015); these are known as design-based estimates (e.g. Hammond et al., 2013; Figure 1). Some abundance estimates come from models fitted to these data to generate a density surface from which abundance is derived; these are known as model-based estimates (e.g. Gilles et al., 2016; Figure 1). To assess trends, at least three design-based abundance estimates are required over a relevant time scale. Model-based estimates of abundance could be used to estimate a trend if an adequate model can be fitted to the available data (Figure 1). Finding an adequate model requires substantial care in model checking, but allow to combine several data sources with different spatial and temporal coverage (), and potentially to predict abundance over spatial and temporal gaps. However, a gap analysis must be performed in order to assess the robustness of model-based abundance estimates (Bouchet et al. 2019).

Abundance of coastal bottlenose dolphins per population in an AU was estimated using capture–recapture methods applied to photo-identification data, and ship-based surveys. To assess trends, at least four abundance estimates are required over a relevant time scale.

To assess trends, it is needed to consider the statistical power to detect changes (Authier et al. 2020). For coastal bottlenose dolphins, monitoring in several populations within AUs has been ongoing for long enough to enable an assessment of trends, while in others there are currently too few data available over a suitable time period. Current estimates of numbers of animals in a population are usually obtained by photo-ID, although in their absence, abundance estimates are derived from line-transect surveys. Where possible, annual data on the estimated number of animals per population are provided in this assessment. Consideration is also given to coastal bottlenose dolphin populations known to have disappeared from their former range.

Power Analysis

Prospective statistical power analyses (Hoenig and Heisey 2001) were performed for detecting a trend in short time series of abundance estimates for cetacean species using a statistical significance set to 0.2 (Authier et al. 2020). WGMME recommended to relax the threshold for statistical significance α from 0.05 to 0.20 so that smaller rates of decline can be more readily detected. This proposal was scientifically evaluated: the adjustment of the statistical significance level is both justifiable and acceptable from a statistical and scientific point of view (Authier et al. 2020). Power was increased with α = 0.2, yet statistical remained low to detect a small decline (Authier et al. 2020). The power to detect trends could be improved by increasing the frequency of the large-scale surveys.

3.5 Presentation of assessment results

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 threshold. These maps provide a 'quick look' overview of the AU outcomes for M4 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.

The monitoring strategy proposed by OMMEG, will be necessary in order to better assess cetacean abundance and trends on the spatial-temporal scale required within the OSPAR region to fulfil the six-yearly reporting cycles. Additionally, some suggestions for future work are included by OMMEG in their multi-year working plan:

- An agreement on the delimitation of assessment units (coordinated with assessment units from other relevant organisations)
- The definition of a baseline for each species in each assessment unit
- The development and implementation of a standardized monitoring methodology, and/or a mechanism for standardising data post collection. Although progress has been made, both effort-related monitoring of cetaceans and analytical procedures need further refinement and standardisation, both in methodology as well as frequency (preferably every 6 years large scale surveys) and organisation
- The development of an assessment tool and agreement on the body that makes the assessment

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