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8–11 February 2016

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Executive Summary

WGMME met in Madrid in February 2016 to work on five Term of Reference. Two of these related to a request for OSPAR. The first was a review the draft OSPAR assessments of (a) the abundance and distribution of harbour seals and grey seals and (b) grey seal pup production in the Northeast Atlantic. In general, the ICES WGMME found that the assessments produced were of a high quality, clear and scientifically robust, although some specific revisions to the text were suggested. The second part of the request involved collation of data and assessment of status for cetaceans in the OSPAR area.

In relation to coastal bottlenose dolphins and killer whales, most time-series of abundance data are rather short in relation to the generation time of these long-lived animals. Assessment was only possible for five populations, with an indicative assessment provided for another. The time-series of monitoring data were too short to undertake the assessment for the remaining AUs. In many locations around the eastern North Atlantic Ocean, coastal bottlenose dolphin populations declined or disappeared before or during the 20th century, but most of the current populations seem to be stable. Human pressures include disturbance (mainly from recreational activities), direct and indirect fisheries impacts, and pollution. The population consequences of human activities remain to be elucidated and the difficulty of doing so is compounded by the ephemeral nature of some coastal populations. In addition, the relationships between coastal bottlenose dolphins and wider ranging offshore populations remain unclear.

For most other cetacean species there is only one robust estimate of abundance. For those species for which there are multiple estimates of abundance, the time-series are short relative to the life cycle of the species and the precision of the estimates is generally low leading to poor power to detect trends from these data. It is therefore not possible to infer with any confidence whether populations are decreasing, stable or increasing. However, there has been a clear shift in harbour porpoise distribution from north to south in the North Sea. Notwithstanding the inability to detect trends, recent estimates of abundance are either similar to or larger than comparable earlier estimates. Despite the multiple pressures and threats facing cetaceans in this region, with the data available, there is currently no evidence of an impact of anthropogenic activity on either distribution or abundance of cetacean species in OSPAR Regions II, III and IV. More data are needed to make an informed assessment; results from a large-scale survey in summer 2016 will aid this process.

In addition, WGMME reviewed and reported on (a) new information on population abundance, population/stock structure and management frameworks for marine mammals and (b) information on negative and positive ecological interactions between grey seal (*Halichoerus grypus*) and other marine mammals. In relation to the latter topic, a Workshop is proposed for 2017. WGMME also reported on the status of the ICES seal database, suggesting that it could be merged with a new database on seals and seabirds being developed for OSPAR.

1 Introduction

The Working Group on Marine Mammal Ecology (WGMME) met at the headquarters of Instituto Español de Oceanografía (IEO) in Madrid, Spain, during 8–11 February 2016. The list of participants and contact details are given in Annex 1. On behalf of the working group, the chairs would like to thank the IEO for hosting the meeting.

The Chairs also acknowledge the diligence and hard work of all the participants before, during and after the meeting, which ensured that the Terms of Reference were addressed.

In addition to work on the current Terms of Reference, during the drafting of the report, there was some discussion of the work described in recent WGMME reports, following questions received from OSPAR and ASCOBANS.

Further to questions about the risk matrix in the WGMME 2015 report, specifically why habitat degradation in the Baltic Sea was classified as a "high risk" to harbour porpoises, the group has sought further expert opinion on this point. Since no consensus could be reached WGMME agrees that it will review the threat matrix at its 2017 meeting.

The wording of the text about threshold values for abundance of coastal bottlenose dolphins (which appeared in the 2014 WGMME report and 2014 ICES advice) has been revised[*] to improve clarity and for consistency with thresholds for other cetaceans and some additional explanatory text generated for other cetaceans (see Section 7 and Annexes 7 and 8).

Finally, the group notes that it would be useful to revisit a previously planned CRR on monitoring methods for marine mammals, which could potentially provide a practical guide to monitoring methods for use in the ongoing implantation of the EU Marine Strategy Framework Directive.

[*] Revised after the information was sent to the Review Group for the common marine mammal indicator assessments request.

2 ToRs

The Terms of Reference were as listed below. The meeting Agenda followed the ToRs, essentially in reverse order, with work focused initially on ToRs d and e, required for submission to the Advice Drafting Group during the week following the meeting, and subsequently on ToRs a, b and c.

a) Review and report on any new information on population abundance, population/stock structure and management frameworks for marine mammals;

b) Update North Atlantic information on negative and positive ecological interactions between grey seal (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*)/other marine mammals;

c) Update the database for seals;

d) OSPAR requests to review the draft OSPAR assessment of the abundance and distribution of harbour seals and grey seals and an assessment of grey seal pup production in the Northeast Atlantic. ICES is requested to assess the validity of the data analysis that underpins the assessments and if necessary, to recommend any changes that should be implemented in future assessments.

e) To support OSPAR in the delivery of common indicator assessment of Cetaceans through:

- i) the collation of estimates of coastal bottlenose dolphin abundance in the assessment units identified, over an appropriate time frame;
- ii) To assess trends in abundance (and where possible distribution within range) of coastal bottlenose dolphins in the assessment units identified, against targets proposed;
- iii) To present an overview of data on cetacean species other than coastal bottlenose dolphins that may be available to make a regional assessment in the frame of indicator M-4;
- iv) To collate and assess the data identified in (i) against the targets proposed.

3 ToR a: Review and report on any new information on population abundance, population/stock structure and management frameworks for marine mammals

The available information on cetacean abundance, distribution (and population structure) has been compiled to form the basis of the common OSPAR indicator assessments for MT3 (Grey and harbour seal abundance and distribution) and MT4 (Cetacean abundance and distribution); see ToRs d and e. Therefore only short summaries of new information not presented in previous years´ reports are given here. No new information on management frameworks was available.

3.1 Seals

3.1.1 Ireland

There are not enough data to robustly assess harbour and grey seal population trajectories in Ireland. However monitoring data support emerging evidence of some population growth in Ireland since the mid-1990s and possibly dating to the early 1980s (O Cadhla *et al.*, 2013). Between 2003 and 2012 there was an overall increase of 18.1% in the minimum population estimate for harbour seals (Duck and Morris, 2013). The current monitoring program for harbour seals consists of a national coordinated aerial survey occurring within the six year Habitats Directive Article 17 reporting cycle, with each survey conducted over two consecutive years in order to produce an updated minimum estimate of the population size. Additionally, multiple annual ground counts are conducted during the moult period at key regional haul-out sites covering approximately 40–50% of the national population.

The grey seal breeding population is estimated by conducting pup counts at breeding colonies and estimating pup production (PEST model) and population size (using a scaler). The current programme for grey seals aims to cover one region a year (there are three main regions), so that each region is surveyed twice within the six year reporting period under the Habitats Directive.

3.2 Cetaceans

3.2.1 Minke whales in the Northeast Atlantic

A new abundance estimate for minke whales in the Northeast Atlantic based on the Norwegian surveys in the period 2008–2013 is now available (Solvang *et al.*, 2015; see Figure 3.1). This estimate of 100 615 minke whales (CV = 0.11 or CV = 0.17 when the additional variance due to multiyear survey design is accounted for) includes an estimate of 89 623 (CV 0.12) for the Eastern Medium Area (*E*), which is composed of four Small Management Areas (*SMA*) as identified by IWC. The total abundance in the Eastern Medium Area in the period 2007–2013 is slightly higher than the estimates in the previous survey periods: 80 487 (CV = 0.15) in 1996–2001 and 81 401 (CV = 0.23) in 2002–2007.

The Norwegian surveys in 2008–2013 also covered two *SMA*s of the Central Medium Area (*C*) and the combined abundance estimate for these two small areas is 10 991 (CV = 0.26). This is lower than the abundance estimates for the previous survey periods: 26 718 (CV = 0.14) in 1996–2001 and 26 739 (CV = 0.39) in 2002–2006. These small areas in the Central Medium Area are surveyed by Norway because they can yield a harvest quota for the Jan Mayen area that has been subject to earlier Norwegian whaling activities. However, there has been no Norwegian whaling in the Jan Mayen area in recent years.

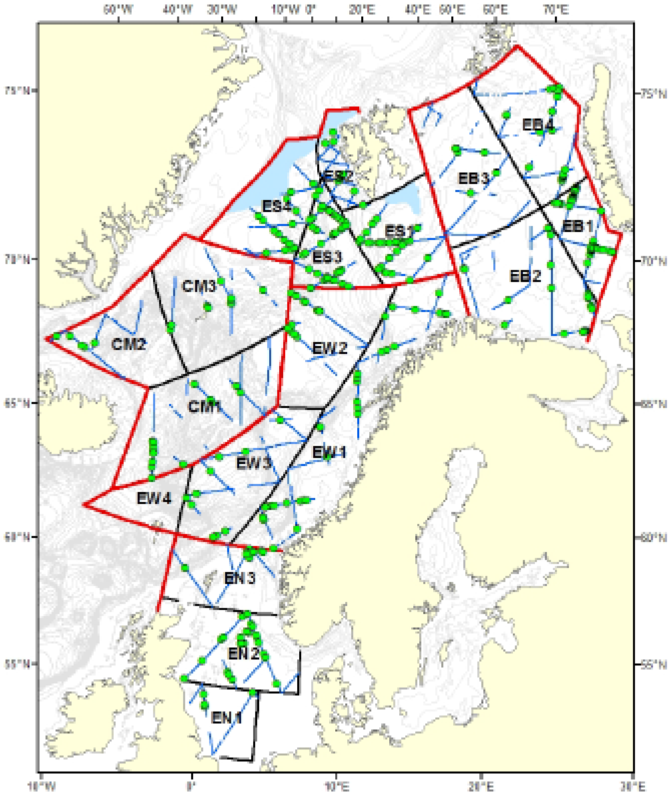

Figure 3.1. Surveyed area for the Norwegian surveys in 2008–2013. The Small Management Areas (SMA) are indicated by codes with two letters and one number. Also shown are the transect lines covered in primary search mode (realised survey effort) and primary minke whale sightings (green dots) made from platform A. Taken from Solvang *et al.* (2015).

3.2.2 Abundance of white beaked dolphins and white sided dolphins in the Northeast Atlantic

Fernandez *et al.* (2015) undertook a new population genomic study of the two *Lagenorhynchus* species in the NE Atlantic. Based on their overall estimates of nucleotide diversity, the authors calculated long-term effective population sizes of 61 253–88 963 for white-beaked dolphins and 100 775–146 363 for white-sided dolphins.

3.2.3 Harbour porpoise distribution and abundance in German waters

A synoptic survey of the German North and Baltic was carried out between June and August 2015. Using an aerial line-transect survey in the German EEZ of the North and Baltic, a total of 211 harbour porpoise groups were recorded on effort in the North Sea and 73 in the Baltic Sea, comprising a total of 246 (North Sea) and 80 individuals (Baltic Sea) (see Figure 3.2). Due to adverse weather conditions and additional logistic reasons, spatial coverage of “Sylt Outer Reef” (CN) and D was not complete, while the German Part of the Doggerbank (area A) could not be surveyed at all. The survey area in the Baltic Sea comprised an area up to a longitude of 13.5°E.

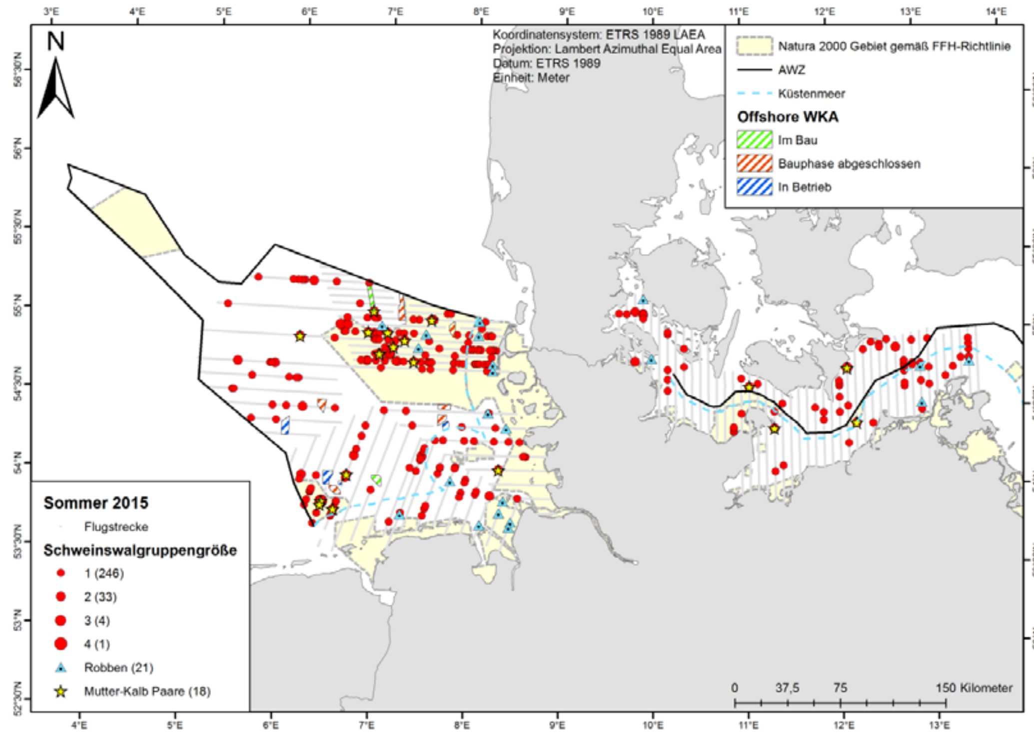

Figure 3.2. Survey effort and harbour porpoise sightings during aerial surveys in the German North and Baltic Seas during summer 2015. Group sizes are represented by circles of different sizes, sightings of calves are indicated by stars and sightings of seals are represented by triangles.

Effort-corrected density and abundance estimates for harbour porpoises were generated (cell based aggregations of sighting in Figure 3.3) using a bootstrapping method. The estimated abundance was 17 609 individuals (95% CI: 11 905–36 152) in the German North Sea, resulting in an estimated density of 0.55 individuals per km^2 (95% CI: 0.32–0.97 Ind./km^2). Density values are within the range found in previous years, but lower than the estimates in 2009 (1.05 (0.57–2.03) ind./km^2 (Gilles *et al.*, 2010)) and 2012 (0.71 (0.39–1.40) ind./km^2 (Gilles *et al.*, 2013)).

In the German Baltic Sea an abundance of 3,834 harbour porpoises was estimated (95% CI: 2237–6796 Ind.). This results in an estimated average density of 0.23 ind./km^2 (95% CI: 0.13–0.41 ind./km^2).

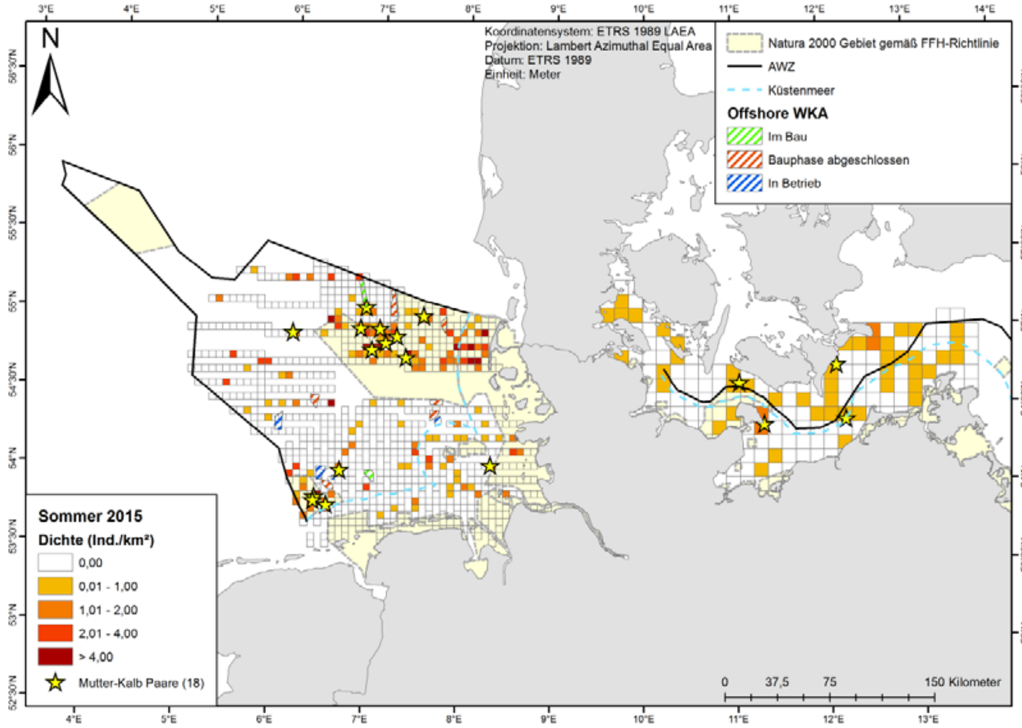

Figure 3.3. Raster map of harbour porpoise densities in the German North and Baltic Seas based on aerial surveys during summer 2015. Pairs of mother and calf are represented by stars.

3.2.4 Harbour porpoise abundance in Dutch waters

Aerial surveys to estimate the abundance of harbour porpoise along the entire Dutch continental shelf have continued to be conducted in July with the shelf being stratified into four areas: A - Dogger Bank, B - Offshore, C - Frisian Front and D - Delta (Figure 3.4). In 2015, the total number of porpoises on the Dutch continental shelf was estimated at 41 299 (21 194–79 256), which falls between the estimates for July 2010 (25 998; 13 988–53 623) and July 2014 (76 773; 43 414–154 265). Note that the confidence intervals of the new estimate overlap with those of both previous estimates (Geelhoed *et al.*, 2015).

Land-based observations during systematic sea watches and records of beached animals showed smaller numbers in Dutch coastal waters in 2015 (including July) compared to previous years. The numbers recorded during sea watches (from the shore) were the lowest since the late 1990s. This caused concern about a potential reduction in abundance of porpoises in Dutch waters. However, the results of the abundance estimates per area show that a majority of porpoises (58.9%) were present in the northernmost areas A (Dogger Bank) and B (Offshore) (Geelhoed *et al.*, 2015). The decline in strandings and sightings from the shore in 2015 is thus probably due to harbour porpoises occurring on average further offshore than the years before (Figures 3.5 and 3.6).

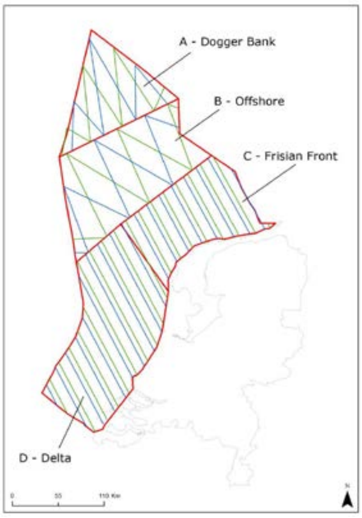

Figure 3.4. Map of the Dutch continental shelf with the planned track lines in areas A - Dogger Bank, B - Offshore, C - Frisian Front and D - Delta. Colours indicate sets of track lines.

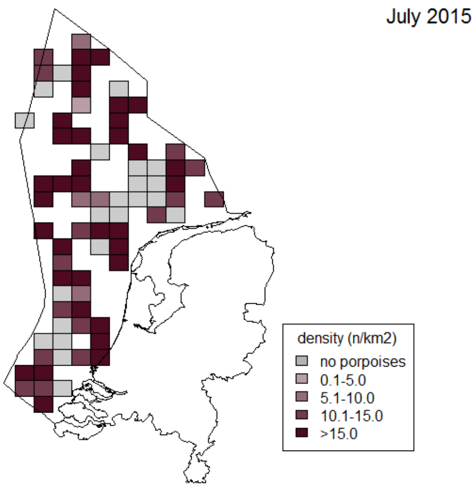

Figure 3.5. Distribution and density by grid cell of harbour porpoise in Dutch waters in July 2015.

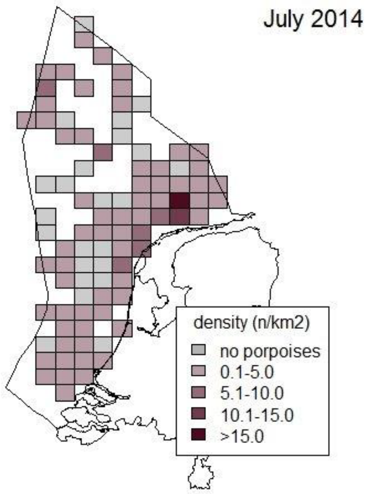

Figure 3.6. Distribution and density by grid cell of harbour porpoise in Dutch waters in July 2014.

3.2.5 Harbour porpoise in Belgian waters

Strandings of harbour porpoises in Belgium (Figure 3.7) and The Netherlands showed a steep decline in 2015 (Haelters and Geelhoed, 2015).

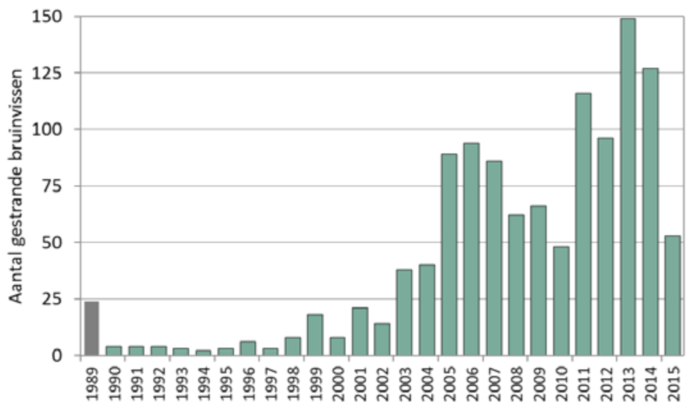

Figure 3.7. Strandings of harbour porpoises in Belgium recorded annually between 1990 and 2015 (plus total for 1970–1989. Data from RBINS, unpublished).

3.2.6 Cetacean distribution and abundance in French waters

The recurrent cetacean and seabird sighting programmes conducted on board RV Thalassa during the fish stock assessment surveys PELGAS, IBTS, CGFS and EVHOE have continued during 2015 and will do so in 2016. No specific survey dedicated to estimating cetacean abundance and distribution was conducted in 2015, although preparatory work was undertaken for the SCANS-III survey that will take place in summer 2016. Analyses of cetacean relative densities and habitat preference reported at WGMME 2015 have been submitted for publication as part of a special issue of Deep-Sea Research-Part II, dedicated to European Marine Megafauna. It is expected that this issue will be published in late 2016 A total of 28 manuscripts, including ten papers related to cetaceans in the Northwest Atlantic, are being reviewed. Of those, five papers deal with cetaceans in French waters of the Northeastern Atlantic.

3.2.6.1 Bottlenose dolphins in the Gulf of Saint Malo

As reported in WGMME (2015), the Gulf of Saint Malo population of bottlenose dolphins was estimated to comprise 420 animals (95% CI: 331–521) using mark–recapture analyses on photo-identification data in summer 2010 (Louis, 2014). Genetic analysis from biopsy samples indicates the presence of a single genetic population although some ecological differentiation was corroborated by the results of a stable isotopes analyses (Louis, 2014). New annual estimates for the following years (2011–2014), also based on photo-identification studies, are detailed in ToR e and show a stable population (Couet, unpublished data).

3.2.7 Cetaceans in Spanish waters

In northern Spain, sightings data collected each year by a team of observers on board the spring fish acoustic survey (PELACUS) were analysed by Saavedra *et al.* (2015a) with Distance software to estimate relative population size. The authors also used Bayesian methods to remove the effect of attraction to the vessel on the estimates, by combining previous data on attraction collected during SCANS-II with the data collected during the acoustic fish surveys. Dolphin density estimated with both methods (correcting for attraction or not) was <0.3 dolphins/km^2.

3.2.8 Cetacean abundance in Portuguese waters

3.2.8.1 Coastal bottlenose dolphins

A total of 31 bottlenose dolphin sightings (Table 3.1.) was obtained from opportunistic and dedicated surveys, undertaken during 2008–2014 in the area between Nazaré and Setúbal (Figure 3.8.). Photo-ID data were collected during 20 of those sightings events, generating a catalogue to cover a total of 270 individuals (Martinho *et al.*, 2015). However, due to photographic quality and dorsal fin distinctiveness criteria, only 173 of these dolphins were used in the following analysis.

Table3.1. Survey effort in the area between Nazaré and Setúbal between 2008 and 2014.

Year	Surveys (n)	Effort (h)	Effort (Km)	Sightings (n)	Photo-ID sightings (n)	sightings /h	Km/sig h
2008	38	76	861	7	2	0.27	22.6
2009	12	33	714	4	2	0.3	59.5
2010	16	31	500	5	2	0.42	31.2
2011	28	106	1 692	7	6	0.2	60.4
2012	16	50	1 033	1	1	0.24	64.6
2013	12	54	1 274	5	5	0.24	106.2
2014	2	11	210	2	2	0.09	105.1
Total	124	361	2285	31	20	0.08	73.78

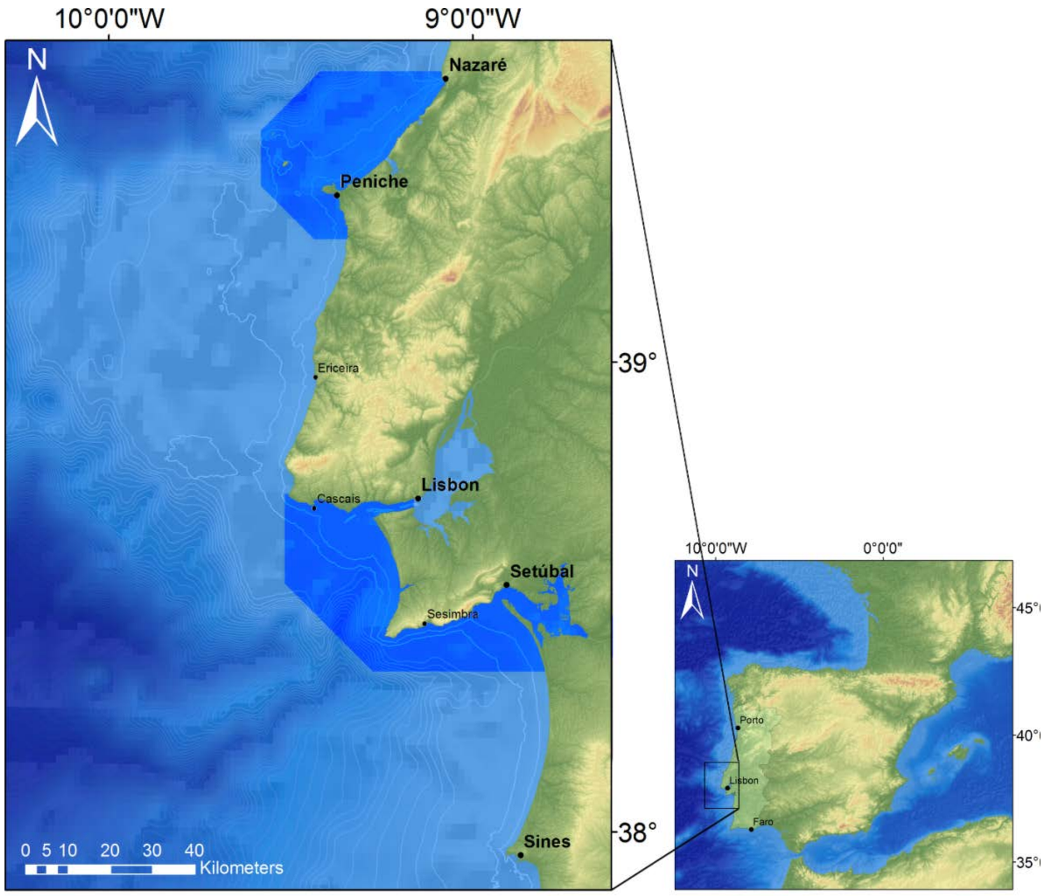

Figure 3.8. Survey are off central Portugal, between Nazaré and Setúbal Bay.

An estimate of the population size between 2008 and 2014 was obtained using Mark 8.0 (White and Burnham, 1999). Because of the short sampling period, the population was considered to be 'closed' and only two simple models of mark–recapture were considered: 1) Darroch and 2) Null. The first model assumes an equal probability of capture and recapture in each sample. However, the probability changes from sample to sample. This allows us to account for the variability of samples due to effects such as group, weather and sea state. The second model assumes an equal and constant probability of capture and recapture throughout samples. Based on the lowest value of Akaike Information Criterion (AIC), the best-fit model for the population of coastal bottlenose dolphins off central Portugal is the Darroch (Table 3.2) although both model estimates were very similar, suggesting a low effect of external variables on the probabilities of capture and recapture. Between 2008 and 2014, the population of coastal bottlenose dolphins was estimated to comprise 352 individuals (95% CI = 294–437).

Table 3.2. MARK results for abundance estimates of the bottlenose dolphins off central Portugal between 2008 and 2014 using photo-ID data.

	N	SE	CV (%)	95% CI Low	95% CI Upper	AIC	ΔAIC
Darroch	352	36	10	294	437	132.53	0.00
Null	358	37	10	299	446	187.22	54.69

3.2.8.2 Sado bottlenose dolphins

The population of bottlenose dolphins in the Sado estuary is well documented and has been studied at a regular basis since the 1980s. High-residency levels in this small area and consistent numbers of individuals throughout the years strongly suggest that this population is closed. Based on this, absolute values for population size were obtained through an extensive review of published and grey literature (Martinho, 2012) and, for more recent years (2012–2015), using the data that were collected by Associação para as Ciências do Mar (APCM) during a current genetics project (Inês Carvalho, personal communication). The final estimates refer to the number of individuals present at the end of each year or during the last count for that year. Currently, this population has a total of 28 dolphins (Figure 3.9). Two of individuals were apparently born elsewhere and were at least three years old at the time of immigration. These two immigration events occurred in 2012 and 2015.

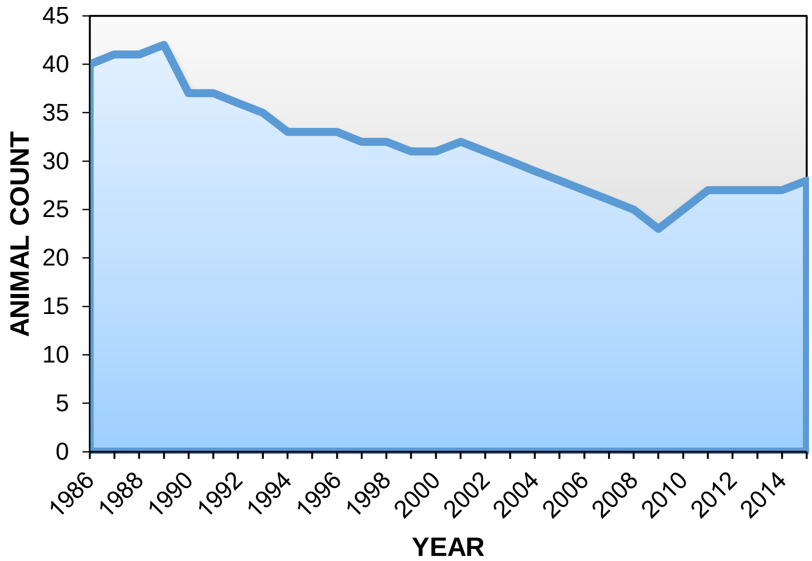

Figure 3.9. Absolute population count of the bottlenose dolphin population of Sado estuary between 1986 and 2015.

Cetacean sightings in the Portuguese Exclusive Economic Zone have been collected using cargo ships from the company TRANSINSULAR (www.transinsular.pt) as platforms of opportunity since 2012. The routes between Continental Portugal and Madeira Island, the Azores Archipelago and the Canary and Cape Verde Islands are being covered (Correia *et al.*, 2015). This project, run by CIIMAR (Interdisciplinary Centre of Marine and Environmental Research) and the University of Porto, aims to provide new information on distribution, abundance and habitat hot spots for cetaceans, and to model and predict habitat use.

An analysis of the data collected between 2012–2013 on the route to Madeira Island has been published (Correia *et al.*, 2015). Surveys are still running, and a total of 103 sea surveys were completed during 2012 to 2014, with most of the effort in offshore waters, and twelve species, being identified to date. All twelve species were seen along the route to Madeira, with 336 sightings in 14 619 nautical miles of effort, resulting in an overall encounter rate of 2.30 sightings/100 nm (July to October, 2012–2014) while eight species were recorded along the route to the Azores, with 130 sightings in 5577 nautical miles of effort (2.33 sightings/100 nm; July–September, 2014) (Figures 3.10 and 3.11).

Data processing from the 2015 survey season is ongoing, including a new route from Continental Portugal to the Canary and Cape Verde Islands, and seasonal surveys are starting this year (2016).

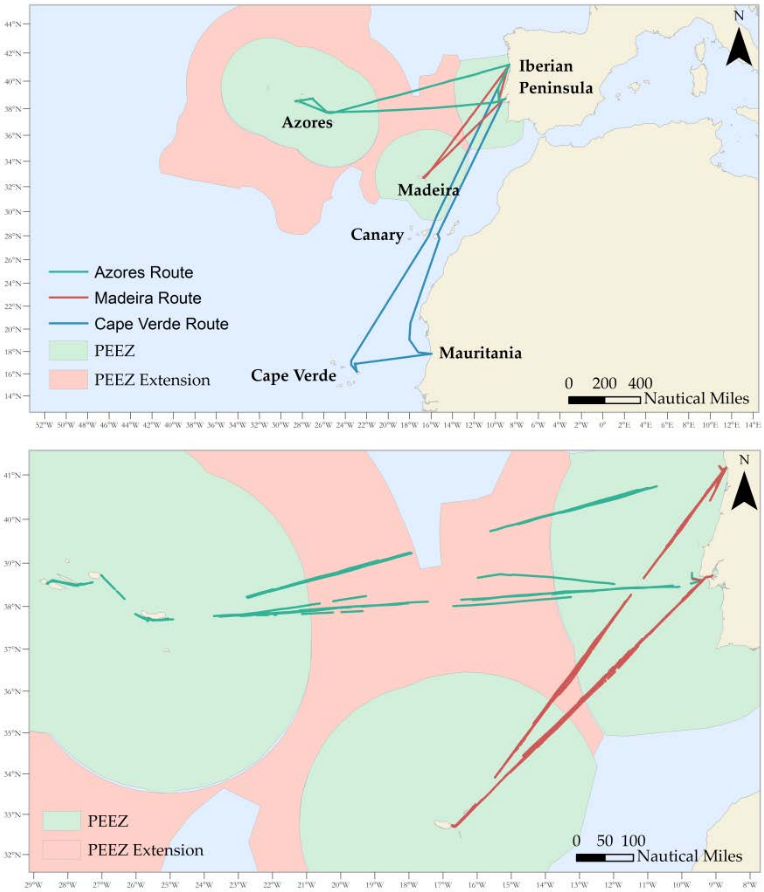

Figure 3.10. Routes being surveyed within the study area and the Portuguese Exclusive Economic Zone (PEEZ). A) Routes surveyed; B) Survey effort tracks from 2012 to 2014.

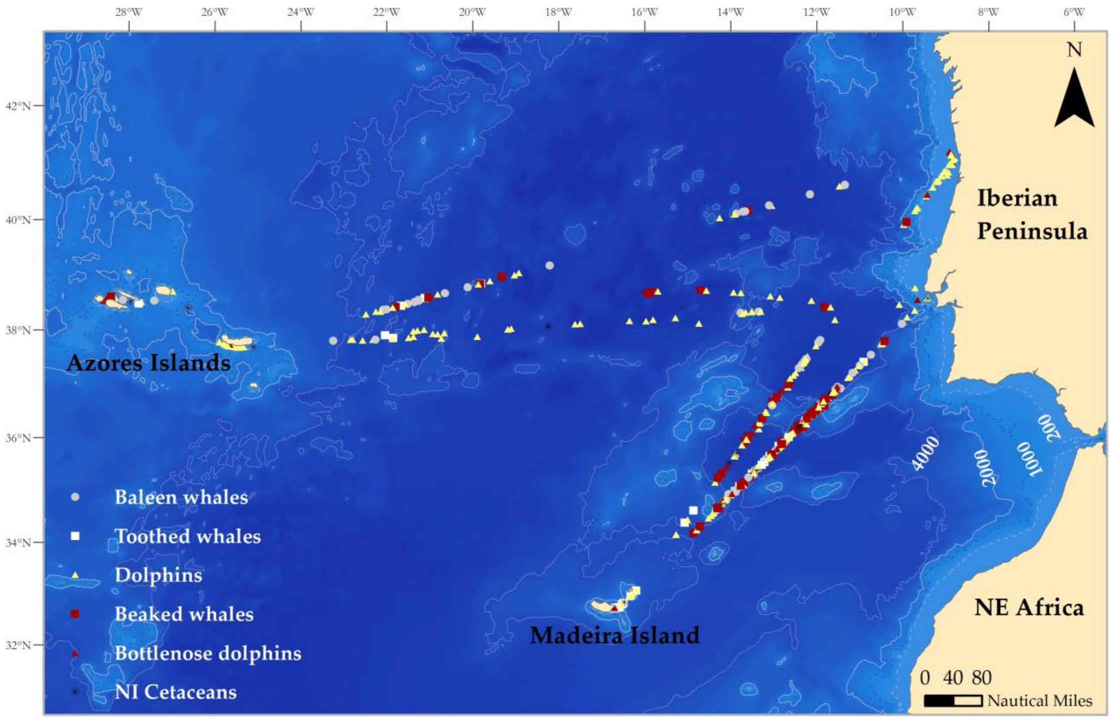

Figure 3.11. Recorded sightings, on effort, by groups for the routes of Madeira (July to October, 2012–2014) and Azores (July–September, 2014). Beaked whales and bottlenose dolphins are marked in dark red.

3.2.9 Population structure of white beaked and white sided dolphin in the Northeast Atlantic

Fernández *et al.* (2015) used restriction-site-associated DNA sequencing (RADSeq) to recover genome wide genotypes from a total of 70 white-beaked (*Lagenorhynchus albirostris*) and 43 Atlantic white-sided dolphins (*L. acutus*) sampled across the Northeast Atlantic. Their results indicate a higher diversity and lower population structuring in white-sided dolphins than in white-beaked dolphins The authors relate these differences with the different habitat of each species, with white-sided dolphins inhabiting pelagic waters while white-beaked dolphins showing a more patchy distribution, mainly across continental shelves.

3.2.10 Population structure of long-finned pilot whales (*Globicephala melas*) in the Northeast Atlantic

Monteiro *et al.* (2015a) used biogeochemical (fatty acids and stable isotopes) and genetic (mitochondrial DNA) markers to identify long-finned pilot whale (*Globicephala melas*) population diversity and structure in the North Atlantic. The authors analysed samples from the northwest Iberian Peninsula, the United Kingdom, the Faroe Islands and the United States of America. Genetic data revealed strong regional levels of divergence, although analysis of molecular variance revealed no differentiation between the Northeast and Northwest Atlantic. On the other hand, results from the fatty acids analyses indicate an ecological differentiation between all regions analysed, while stable isotopes showed an overlap between some sampling regions. The authors suggest that both ecological and genetic factors may drive the levels of pilot whale differentiation in the North Atlantic. Results from the fatty acid and stable isotope analyses (Monteiro *et al.*, 2015b) support the geographic and ontogenetic dietary variation in pilot whales already revealed by the analysis of stomach contents (Santos *et al.*, 2014).

3.3 Future large-scale surveys

WGMME (2015) recommended that ICES, OSPAR and Member States should support the SCANS-III initiative, noting the urgent need for a new large-scale absolute abundance survey for cetaceans in European Atlantic waters, following those carried out in 1994 and 2005–2007, to fulfil EU Member State (MS) obligations under the MSFD and Habitats Directive. WGMME (2015) also noted the need for surveys in other European Seas covered by the MSFD where no large-scale cetacean abundance surveys have been undertaken to date (e.g. Mediterranean and Black Seas).

A North Atlantic Sightings Survey (NASS), coordinated through the North Atlantic Marine Mammal Commission (NAMMCO), took place in summer 2015 as the latest in a series of such surveys previously conducted in 1987, 1989, 1995, 2001 and 2007. The survey covered a large proportion of central and eastern North Atlantic waters off Norway, Iceland, the Faroe Islands and Greenland. The SCANS-III project will survey European Atlantic waters in summer 2016 after securing funds for European Atlantic range states.

3.4 References

Correia, A.M. 2013. Cetacean monitoring in Northeastern Atlantic Ocean: Occurrence and distribution of cetacean species in the Canary Basin. Master thesis (MSc) in Ecology, Environment and Territory. Sciences Faculty of Porto University, Porto, Portugal. 93 pp.

Correia, A.M., Tepsich, P., Rosso, M., Caldeira, R. and Sousa-Pinto, I. 2015. Cetacean occurrence and spatial distribution: Habitat modelling for offshore waters in the Portuguese EEZ (NE Atlantic). Journal of Marine Systems 143, 73–85.

Correia A., Rosso, M., Pierce G. and Sousa Pinto I. 2015. Cetacean Monitoring in Macaronesia - contributing to the MSFD goals. International Council for the Exploration of the Sea CM 2015/P:07. ICES Annual Science Conference, Copenhagen, Denmark, 21–25 September.

Cosgrove, R. Cronin, M., Reid D., Gosch M., Sheridan M., Chopin N. and Jessop M. 2013. Seal depredation and bycatch in set net fisheries in Irish waters. Fisheries Resource Series Vol. 10, 37 pp.

Duck, C. and Morris, C. 2013. An aerial survey of harbour seals in Ireland: Part 2: Galway Bay to Carlingford Lough. August-September 2012. Unpublished report to the National Parks & Wildlife Service, Department of Arts, Heritage & the Gaeltacht, Dublin.

Geelhoed, S.C.V., Lagerveld, S. and Verdaat, J.P. 2015. Marine mammal surveys in Dutch North Sea waters in 2015. IMARES, WAGENINGEN UR, Institute for Marine Resources & Ecosystem Studies, Report number C189/15, The Netherlands.

Gilles, A., Peschko, V. and Siebert, U. 2013. Monitoring bericht 2012. Marine Säugetiere und Seevögel in der deutschen AWZ von Nord- und Ostsee. Teilbericht marine Säugetiere - Visuelle Erfassung von Schweinswalen. Endbericht für das Bundesamt für Naturschutz.

Haelters, J. and Geelhoed, S. 2015. Minder bruinvissen in de zuidelijke Noordzee. Zoogdier 26(4): 1–3.

Gilles, A. and Siebert, U. 2010. Monitoringbericht 2009. Marine Säugetiere und Seevögel in der deutschen AWZ von Nord- und Ostsee. Teilbericht marine Säugetiere - Visuelle Erfassung von Schweinswalen. Endbericht für das Bundesamt für Naturschutz.

Martinho F. 2012. Residency and behavioural patterns of coastal bottlenose dolphins (*Tursiops truncatus*) in the Arrábida and Tróia shores (Portugal). Master thesis, Faculdade de Ciências da Universidade de Lisboa, Portugal. 80 pp.

Martinho, F, Pereira A, Brito C, Gaspar R, Carvalho I. 2015. Structure and abundance of bottlenose dolphins (*Tursiops truncatus*) in coastal Setúbal bay, Portugal. *Marine Biology Research,* 11(2): 144–156 (DOI: 10.1080/17451000.2014.894244).

Monteiro, S.S., Ferreira, M., Vingada, J.V., López, A., Brownlow, A. and Méndez-Fernandez, P. 2015b. Application of stable isotopes to assess the feeding ecology of long-finned pilot whale (*Globicephala melas*) in the Northeast Atlantic Ocean. Journal of Experimental Marine Biology and Ecology 465, 56–63.

Monteiro, S.S., Piertney, S., Moffat, C.F., Ferreira, M., Vingada, J.V., López, A., Brownlow, A., Jepson, P., Mikkelsen, B., Niemeyer, M., Carvalho, J.C., and Pierce, G.J. 2015a. Population diversity and structure of long-finned pilot whale (*Globicephala melas*) in Atlantic waters assessed through biogeochemical and genetic markers. Marine Ecology Progress Series 536, 243–257

Ó Cadhla, O., Keena, T., Strong, D., Duck, C. and Hiby, L. 2013. Monitoring of the breeding population of grey seals in Ireland, 2009–2012. Irish Wildlife Manuals, No. 74. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Dublin, Ireland.

Saavedra, C., Gerrodette, T., Louzao, M., Valeiras, J., García, S., Murcia, J.L., Cerviño, S., Pierce, G.J. and Santos, M.B. 2015a. Abundance and distribution of the Common dolphin (*Delphinus delphis*) in the north of the Iberian Peninsula. Proceedings of the 29th Conference of the European Cetacean Society (ECS). St Julian's Bay, Malta: 63.

Solvang, H.K., Skaug, H.J. and Oien, N. 2015. Abundance estimates of common minke whales in the Northeast Atlantic based on survey data collected over the period 2008–2013. Working Document presented to the International Whaling Commission Scientific Committee, SC/66a/RMP/8, 10 pp.

White, G.C. and K. P. Burnham. 1999. Program MARK: Survival estimation from populations of marked animals. Bird Study 46 Suppl., 120–138.

4 ToR b: Update of North Atlantic information on ecological interactions between grey seals (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*)/other marine mammals

4.1 Predation by grey seals on marine mammals

It has long been recognised that the diet of grey seals does not consist exclusively of fish and cephalopods, e.g. various published accounts of predation on waterfowl/seabirds (Grant and Bourne, 1971; Lucas and McLaren, 1988). Predation on porpoises by grey seals, at the time thought to be unusual, was observed in British waters by Vodden (1995). As reviewed by WGMME in 2015, evidence collected over the last few years demonstrates predation and scavenging by grey seals on both harbour seals and harbour porpoises (e.g. Bouveroux *et al.*, 2014; Haelters *et al.*, 2012; Jauniaux *et al.*, 2014; van Bleijswijk *et al.*, 2014; Leopold *et al.*, 2015a,b; Stringell *et al.*, 2015; van Neer *et al.*, 2015a).

Cannibalism in grey seals has been known since at least the early 1990s from the western North Atlantic when Bédard *et al.* (1993) described a number of cases and included a description of a predation event and a picture of a grey seal that had been predated. This early report fits well with the more recent reports of adult male grey seals cannibalizing grey seal pups in the eastern North Atlantic (Thompson *et al.*, 2015; Bishop *et al.*, 2016) and with the description of grey seal predation on harbour seals by van Neer (2015a). Additional cases of cannibalism have been described by Kovacs *et al.* (1996) and Smith (2000).

Predation of grey seals on other marine mammal species may not be a recent phenomenon, as such mortalities could previously have been undiagnosed or misdiagnosed (see also Leopold *et al.*, 2014). At least some of the "corkscrew" injuries seen in harbour seals in the UK may have been caused by grey seals rather than by ducted propellers (Thompson *et al.*, 2015). A review of historical necropsy reports suggests that many cases of corkscrew lesions reported in both harbour and grey seals in Scotland are consistent with grey seal predation (Brownlow and Onoufriou, accepted). In a retrospective analysis of data on porpoises stranded on the island of Helgoland (1990–2014) 19% of the juveniles and 17% of the adults found dead were classified as having been preyed on by grey seals (van Neer *et al.*, 2015b). As proposed by Haelters *et al.* (2015), several cases of mortality of harbour seals, harp seals, hooded seals and ringed seals in the western North Atlantic could also be consistent with grey seal predation.

Recent information on grey seal predation on other marine mammals is summarized here:

In Belgium, predation by grey seals was suspected in 28% of harbour porpoises washed ashore in 2014 (eleven out of 40 animals for which a cause of death could be identified; Haelters *et al.*, 2016).

In France, ten to 15 stranded harbour porpoises per year show indications of grey seal predation, although these have not been confirmed by genetics or morphometric measurements (PELAGIS, unpublished data). No suspected attack of grey seals on harbour seals has been reported to date. More recently, two young grey seals were found dead with suspicion of adult grey seal attack. These cases are under further assessment.

In Germany, local seal rangers have witnessed grey seals preying on harbour seals, involving several individual grey seals, distinguished by their fur colour and because one seal had a green roto flipper tag from Helgoland. Some carcasses of harbour seals as well as grey seals have been retrieved in the immediate vicinity of these observations, usually not longer than one or two hours after the event. These carcasses are the subject of further research with the aim of creating a set of diagnostic tools for future assessment of carcasses where no observations have been made. Additionally, eye-witness reports with associated photographs show a grey seal estimated to be five to seven years of age preying on a subadult female grey seal (estimated by the seal ranger to be two to three years old) and other grey seal carcasses showing similar lesions have been found. Carcasses of harbour porpoises showing lesions as described in Leopold *et al.* (2015) have been retrieved in different areas of the German Wadden Sea (Abbo van Neer, personal communication, partly based on observations communicated by seal rangers).

Mutilated carcasses of harbour porpoises and harbour seals, consistent with grey seal predation on these species, continue to wash up on Dutch North Sea beaches and in the Dutch Wadden Sea, but no further analysis on the frequency of such cases has been carried out (Mardik Leopold, personal communication).

4.2 Interspecific competition for habitat and prey

Russell *et al.* (2015) assessed differences in activity budgets of sympatric grey and harbour seals around the UK from a long-term telemetry study, in the context of the increasing grey seal population but locally declining harbour seal populations. They found no evidence that regional variation in foraging effort was linked to regional population trajectories in harbour seals. They found some evidence of temporal separation between the two species in terms of when they hauled out. However, while diurnal segregation in time spent foraging could play a role in the coexistence of these two sympatric species (Monterroso *et al.*, 2014), Russell *et al.* (2015) found no evidence of such segregation. Thus, these results do not provide evidence of negative ecological interactions between grey and harbour seals around the UK in terms of their activity budgets.

The apparently increasing predation by grey seals on other marine mammals may be a consequence of a growing population and expanded distribution of grey seals, and increased overlap of grey seal occurrence with the presence of potential prey such as harbour porpoises. However, increased awareness of seal predation and increased reporting of dead stranded marine mammals, together with the submission of images, could influence this perception. The following questions deserve attention:

- Does increased grey seal abundance lead to increased competition for prey with other marine mammals in the areas where they co-occur, as their diets overlap (e.g. Thompson *et al.*, 1996; Santos and Pierce, 2003; Méheust *et al.*, 2015)?
- Have fishery-induced ecosystem changes, including shifts from dominance of large demersal fish to a predominance of small pelagic fish and invertebrates, as seen in the Northwest Atlantic (Pauly *et al.*, 1998; Bundy *et al.*, 2009), led to a need for grey seals to change prey and/or to change foraging areas? What is the impact of climate change (e.g. Cheung *et al.*, 2012)?
- Does the risk from grey seal predation result in other marine fauna moving to safer but less profitable habitats with potential adverse health effects? Leopold *et al.* (2014) speculated that porpoises may decrease the risk of

predation by losing weight (becoming leaner) in order to become more agile, while on the other hand being exposed to an increased risk of emaciation (as also proposed by Macleod *et al.* (2014) in relation to bottlenose dolphin attacks). Swain *et al.* (2015) demonstrated that distributions of cod, hake and skate were strongly related to risk of predation by grey seals, with distribution shifting into lower risk areas as predation risk increased.

- What ecosystem changes occur as a consequence of fluctuations of population sizes of marine mammals (e.g. Hammill *et al.*, 2015; Swain *et al.*, 2015)?

4.3 Grey seal predation on fish and associated ecosystem effects

In 2015, WGMME reviewed marine ecosystem models that included marine mammals. Grey seals were included in several Ecopath with Ecosim (EwE) models, including those for the Barents Sea, Baltic Sea, North Sea, west coast of Scotland, and northern and southern Gulf of St Lawrence. In addition, grey seals are a component of the MSVPA model for the North Sea, a Stochastic Multispecies model for the North Sea and a TSA model for the west coast of Scotland (see ICES, 2015 and references therein).

In 2016, WGMME received information (four published papers) on grey seals' potential impact on depleted demersal fish populations (e.g. Atlantic cod, white hake and thorny skate) in the southern Gulf of St Lawrence (sGSL), Canada. Twenty years ago, these fish populations collapsed due to overexploitation. Despite negligible levels of fishing mortality and strong rates of production of small juvenile fish, these populations have shown no sign of recovery and some continue to decline. Lack of recovery is due to dramatic increases in the natural mortality of larger individuals in these populations. Predation by grey seals has been proposed as an important cause of this high mortality. Note however that Mackenzie *et al.* (2008), using an EwE model, showed that grey seal predation had a relatively small influence on the likelihood of cod stock recovery in the Baltic, compared to fishing and the expected reduction in salinity due to climate change.

The Canadian papers include studies on the population dynamics of the above-mentioned fish species and others based on stratified-random bottom-trawl surveys conducted by the Canadian Department of Fisheries and Oceans (DFO) in the sGSL each September since 1971; on habitat use by demersal fish in relation to predation risk (grey seals) at large spatial and temporal scales in the southern Gulf of St Lawrence ecosystem; telemetry studies of grey seals in relation to distribution of these fish species (and others) during late autumn and winter; and diet studies of grey seals taken in overwintering areas in deeper waters where these fish live.

Swain *et al.* (2015) showed that distributions of cod, hake and skate were strongly related to risk of predation by seals, with distribution shifting into lower risk areas as predation risk increased. Non-prey species did not show similar changes in habitat use. Spatial variation in fish condition suggests that these low-risk areas are also less profitable for cod and skate in terms of food availability. The effects of density-dependence and water temperature were also important in models, but did not account for the changes in habitat use as the risk of predation increased.

In Harvey *et al.* (2012), data from satellite transmitters deployed on grey seals (between 1993 and 2005) and winter bottom-trawl survey data (1994 to 1997) showed that the distribution of searching effort by male grey seals varied throughout winter. In early winter, males concentrated their movements around St Paul's Island. In late winter, they were found to the southeast of this area, where females also occurred.

The fish community differed between apparent foraging and non-foraging areas. Densities of small plaice, hake and redfish, large herring and cod of all sizes were relatively high in the male grey seal foraging zones; female foraging zones were characterized by higher densities of small plaice and redfish and large cod. Areas that were not a focus of grey seal foraging were characterized by high densities of medium and large redfish as well as large turbot and witch flounder.

Hammill *et al.* (2014) showed that in the Cabot Strait, where overwintering aggregations of cod were present, cod accounted for 68% (range 57–80%) of the male diet based on stomach contents, and 46% (range: 31–64%) of the diet determined from intestines. The mean length of cod consumed by seals was in the range from 28 cm to 39 cm in different areas. Cod and hake were more important to the diet of males than that of females. The contribution of cod to the diet of grey seals foraging in the cod overwintering area was much greater than has been reported elsewhere.

The WGMME did not have time to discuss or evaluate the information above but it was suggested that seal-fish interactions should be on the agenda for a subsequent meeting.

4.4 Predation on seals by killer whales

Prey switching, between herring and harbour seals, by groups of killer whales has been documented along the Norwegian coast (Vongraven and Bisther, 2014). During the last 3–4 years there have been some observations in northern Norway (during coastal seal research surveys) of killer whales taking harbour seal pups and adult grey seals from pupping areas. Killer whales aggregate during late autumn and winter in overwintering areas for the Norwegian spring-spawning Atlantic herring stock. In the 1990s and early 2000s, the herring stock overwintered in the inner parts of Lofoten and Tysfjord in Nordland County, where few coastal seals occur. The herring stock has shifted gradually to overwinter in outer coastal areas and has been followed by large numbers of humpback and killer whales. In these areas harbour and grey seals are more abundant, which may explain the increased frequency of interactions between killer whales and seals.

Killer whale predation on seals has recently been observed in East Greenland waters. Six killer whales taken by aboriginal hunters off Ammasalik, East Greenland, had the remains of harp and hooded seals in their stomachs. Based on microsatellite allele frequencies, the killer whale individuals were genetically assigned to populations that had previously been biopsy sampled or captured while feeding on herring off Norway and Iceland, or feeding on mackerel in the North Sea (Foote *et al.*, 2013).

4.5 A future workshop?

In 2015, WGMME considered that it would be useful to hold a Workshop on the topic of grey seal predation on marine mammals. There have been three relevant developments since the 2015 meeting. First, two related workshops were held at the European Cetacean Society conferences in 2015 and 2016 (St Julian's, Malta, 22 March 2015 and Funchal, Madeira, 17 March 2016: Marine mammal pathology: update of the necropsy protocol on dissection techniques and tissue sampling). A conclusion of these workshops was that existing necropsy protocols would be updated to identify specific pathological and morphological lesions associated with predation by grey seals on other marine mammals.

Second, WGMME member Abbo van Neer has recently received funding to work on grey seal predation on marine mammals. The project aims to gather further knowledge in order to answer the following questions:

1) Since when has predation of grey seals on marine mammals occurred?

 1.1) Is it a recently developed or an established but rare behaviour? The project will compare and collate data of the different stranding networks around the North Sea and check grey and white literature (also historical reports and descriptions) for any evidence indicating the presence of such behaviour in former times and to assess ecological relevance for marine mammal populations.

 1.2) If it is a recently developed behaviour, are there any obvious changes in the ecosystem that could lead to such behaviour? The project will compare seal predation information with fisheries data or similar sources.

2) Assessment of the behaviour on an individual level.

 2.1) Are only single specialised individuals preying on marine mammals or does a larger part of the population follow this strategy? The project will collate and compare data for the different observations in order to identify individual seals. It will extract genetic information (fingerprint) from seals showing this behaviour (based on biopsy and/or faeces) and get background information on origins.

 2.2) Which sex and age classes are showing this behaviour? The project will extract information from any recordings that are available.

 2.3) Are there seasonal and/or regional patterns of predation and/or prey type? The project will extract information from available reports, check for correlation with specific times such as pupping and mating and consider implications for effects on population level. It will also consider species, age, (health) condition, etc. of the prey animals.

3) Assess specific details of predatory behaviour

 3.1) Evaluate available reports on the behaviour as well as collect new high resolution data. The project will evaluate available reports for detailed descriptions as well as check video and photographic records. If possible a camera and satellite tag including accelerometer will be mounted on a grey seal that shows the specific behaviour.

 3.2) Assess prey composition of seals that prey on marine mammals. This will involve genetic screening of faeces.

4) Which diagnostic tools are available to assess retrieved carcasses?

 4.1) Pathology tools. The project will further develop diagnostic tools available and create a necropsy and sampling protocol.

 4.2) Genetic tools. The project will further develop genetic tools to assess predator of cetaceans and seals and to distinguish between marine and terrestrial predators/scavengers.

Finally, a resolution has been proposed for the organization of an ICES workshop on Predator–prey Interactions between Grey Seals and other marine mammals (WKPIGS). The timing and location of the workshop have not yet been decided (see Annex 5), but its aims and outcomes will be coordinated in conjunction with the above project led by Abbo van Neer.

4.6 References

Bédard, C., Kovacs, K. and Hammill, M. 1993. Cannibalism by grey seals, *Halichoerus grypus*, on Amet Island, Nova Scotia. Marine Mammal Science, 9, 421–424. http://dx.doi.org/10.1111/j.1748-7692.1993.tb00474.x.

Bishop, A. M., Onoufriou, J., Moss, S., Pomeroy, P. P., and Twiss, S. D. 2016. Cannibalism by a male grey seal (*Halichoerus grypus*) in the North Sea. Aquatic Mammals, 42(2), 137–143. http://dx.doi.org/ 10.1578/ AM.42.2.2016.137.

Bouveroux, T., Kiszka, J. J., Heithaus, M. R., Jauniaux, T. and Pezeril, S. 2014. Direct evidence for gray seal (*Halichoerus grypus*) predation and scavenging on harbor porpoises (*Phocoena phocoena*).Marine Mammal Science. http://doi.wiley.com/10.1111/mms.12111.

Bundy, A., Heymans, J.J., Morissette, L. and Savenkoff, C. 2009. Seals, cod and forage fish: a comparative exploration of variations in the theme of stock collapse and ecosystem change in four Northwest Atlantic ecosystems. Progress in Oceanography 81: 188–206.

Cheung, W., W. L., Sarmiento, J. L., Dunne, J., Frölicher, T.L., Lam, V.W.Y., Palomares, M.L.D., Watson, R. and Pauly, D. 2012. Shrinking of fishes exacerbates impacts of global ocean changes on marine ecosystems Nature Climate Change Letters, doi 10.1038/nclimate1691.

Engelhard, G.H., Peck, M.A., Rindorf, A., Smout, S.C., van Deurs, M., Raab, K., Andersen, K.H., Garthe, S., Lauerburg, R.A.M., Scott, F., Brunel, T., Aarts, G., van Kooten, T. and Dickey-Collas, M. 2014. Forage fish, their fisheries, and their predators: who drives whom? ICES Journal of Marine Science 71(1): 90–104. doi:10.1093/icesjms/fst087.

Foote, A., Newton, J., Ávila-Arcos, M., Kampmann, M., Samaniego, J., Post, K., Rosing-Arvid, A., Sinding M. and Gilbert, M. 2013. Tracking niche variation over millennial timescales in sympatric killer whale lineages. Proc. R. Soc. B (280) 20131481; DOI: 10.1098/rspb.2013.1481.

Grant, D. R., and Bourne, W. R. P. 1971. Grey seals and sea- birds. In W. R. P. Bourne (Ed.), Seabird report 1971 (pp. 52–53). Aberdeen, UK: Zoology Department, Aberdeen University.

Haelters, J., Kerckhof, F., Janiaux, T. and Degraer, S. 2012. The grey seal (*Halichoerus grypus*) as a predator of harbour porpoises (*Phocoena phocoena*)? Aquatic Mammals 38(4):343–353. http://dx.doi.org/10.1578/AM38.4.2012.343.

Haelters, J., Kerckhof, F., van Neer, A. and Leopold, M. 2015. Exposing Grey Seals as Horses and Scientists as Human. Aquatic Mammals 41(3), 351–353. DOI 10.1578/AM.41.3.2015.351.

Haelters, J., Kerckhof, F., Jauniaux, T., Potin, M., Rumes, B. and Degraer, S. 2016. Zeezoogdieren in België in 2014 [Marine mammals in Belgium in 2014].Royal Belgian Institute of Natural Sciences, MARECO rapport 16/01.29 pp.

Hammill, M. O., Stenson, G. B., Swain, D. P. and Benoît, H. P. 2014. Feeding by grey seals on endangered stocks of Atlantic cod and white hake. ICES Journal of Marine Science; doi:10.1093/icesjms/fsu123.

Jauniaux, T., Garigliany, M. -M., Loos, P., Bourgain, J. -L., Bouveroux, T., Coignoul, F., Haelters, J., Karpouzopoulos, J., Pezeril, S. and Desmecht, D. 2014. Bite injuries of grey seals (*Halichoerus grypus*) on harbour porpoises (*Phocoena phocoena*). PlosOne 1–9, DOI:10.1371/journal.pone.0108993.

Kovacs, K. M., Lydersen, C. And Hammill, M. 1996. Grey seal cannibalism. Marine Mammal Science 12:161. http://dx.doi.org/10.1111/j.1748-7692.1996.tb00316.x.

Leopold, M. F., Begeman, L., Heße, E., van der Hiele, J., Hiemstra, S., Keijl, G., Meesters, E. H., Mielke, L., Verheyen, D. and Gröne, A. 2015. Porpoises: from predators to prey. Journal of Sea Research 97:14–23.

Leopold, M. F., Begeman, L., van Bleijswijk, J. D. L., IJsseldijk, L. L., Witte, H. J. and Gröne, A. 2014. Exposing the grey seal as a major predator of harbour porpoises. Proceedings of the Royal Society B 282(1798):20142429. doi: 10.1098/rspb.2014.2429.

Lucas, Z., and McLaren, I. A. 1988. Apparent predation by grey seals, *Halichoerus grypus*, on seabirds around Sable Island, Nova Scotia. The Canadian Field-Naturalist, 102, 675–678.

MacKenzie, B. R., Eero, M. and Ojaveer, H. 2011. Could seals prevent cod recovery in the Baltic Sea? Plos One 6(5):e18998.

MacLeod, C.D., MacLeod, R., Learmonth, J.A., Cresswell, W. and Pierce, G.J. 2014. Predicting population level risk effects of predation from the responses of individuals. Ecology 95, 2006–2015.

Méheust, E., Alfonsi, E., Le Ménec, P., Hassani, S. and Jung, J.-L. 2015. DNA barcoding for the identification of soft remains of prey in the stomach contents of grey seals (*Halichoerus grypus*) and harbour porpoises (*Phocoena phocoena*). Marine Biology Research 11(4): 385–395.

Monterroso, P., Alves, P.C., Ferreras, P. 2014. Plasticity in circadian activity patterns of mesocarnivores in Southwestern Europe: implications for species coexistence. Behav. Ecol. Sociobiol. 68: 1403–1417.

Pauly, D., Christensen, V., Dalsgaard, J., Froese, R. and Torres Jr., F. 1998. Fishing down marine food webs. Science 279: 860–863.

Russell, D., B. McClintock, J. Matthiopoulos, P. Thompson, D. Thompson, P. Hammond, E. Jones, M. MacKenzie, S. Moss and B. McConnell. 2015. Intrinsic and extrinsic drivers of activity budgets in sympatric grey and harbour seals. Oikos 000: 001–011.

Santos, M. B. and Pierce, G. J. 2003. The diet of the harbour porpoise (*Phocoena phocoena*) in the Northeast Atlantic. Oceanography and Marine Biology: in Annual Review 41: 355–390.

Smith, N. 2000. Battle of the seals: Marine life around Skye 2000. Retrieved 2 February 2015 from www. glaucus.org.uk/Skye.htm.

Stringell, T., Hill, D., Rees, D., Rees, F., Rees, P., Morgan, G., Morgan, L. and Morris, C. 2015. Predation of harbour porpoises (*Phocoena phocoena*) by grey seals (*Halichoerus grypus*) in Wales. Aquatic Mammals 41(2):188–191.

Thompson, D., Onoufriou, J., Brownlow, A. and Bishop, A. 2015. Preliminary report on predation by adult grey seals on grey seal pups as a possible explanation for corkscrew injury patterns seen in the unexplained seal deaths. Marine Mammal Scientific Support Research Programme MMSS/001/11, 15 pp.

Swain, D.P., Benoît, H.P. and Hammill, M. O. 2015.Spatial distribution of fishes in a Northwest Atlantic ecosystem in relation to risk of predation by a marine mammal. Journal of Animal Ecology 84: 1286–1298. doi: 10.1111/1365-2656.12391.

Thompson, P. M., McConnell, B. J., Tollit, D. J., Mackay, A., Hunter, C. and Racey, P. A. 1996. Comparative distribution, movements and diet of harbour and grey seals from Moray Firth, N. E. Scotland. Journal of Applied Ecology 33 (6), pp. 1572–1584.

Van Bleijswijk, J. D. L., Begeman, L., Witte, H. J., IJsseldijk, L. L., Brasseur, S. M. J. M., Gröne, A. and Leopold, M. F. 2014. Detection of grey seal *Halichoerus grypus* DNA in attack wounds on stranded harbour porpoises *Phocoena phocoena*. *Marine Ecology Progress Series* 513:277–281.

Van Neer, A., Jensen, L. F., Siebert, U. 2015a. Grey seal (*Halichoerus grypus*) predation on harbour seals (*Phoca vitulina*) on the island of Helgoland, Germany. Journal of Sea Research 97:1–4. http://dx.doi.org/10.1016/j. seares.2014.11.006.

van Neer, A., Wohlsein, P., Siebert, U. 2015b. Shedding light on the phenomenon of grey seal predation on marine mammals. In: 29th Conference of the European Cetacean Society, 23–25 March 2015, St Julian's, Malta.

Vodden P. 1995.Predation on harbour porpoises by grey seals and bottlenose dolphins. Soundings (newsletter for Seawatch Foundation) 2(4): 5–6.

Vongraven, D. and Bisther, A. 2014. Prey switching by killer whales in the north-east Atlantic: observational evidence and experimental insights. Journal of the Marine Biological Association of the United Kingdom 94, 1357–1365.

5 ToR c: Update the database for seals

5.1 Requirement

There is a standing request that WGMME collate information on seal population monitoring across the ICES area. In the past, a member of the WGMME held any collated information on seal monitoring and abundance in the form of a simple Excel workbook.

Contracting Parties have been working cooperatively through OSPAR to report on grey and harbour seals for the Marine Strategy Framework Directive (MSFD). To this end, OSPAR have been developing seal common indicators M3 (grey and harbour seal abundance and distribution) and M5 (grey seal pup production). As part of this process OSPAR issued a data call in 2015 and the data provided were held by the Sea Mammal Research Unit at the University of St Andrews.

As the development of these indicators has progressed, it seems more than likely that they will be used to inform the OSPAR Intermediate Assessment in 2017 and the MSFD reporting in 2018 as well as future assessments. To assist this process, OSPAR has contracted ICES to build and manage a biodiversity database for both seal and seabird data.

Expert group members that attended a workshop on MSFD seal indicators in March 2015 informed the data specifications. For assessments of OSPAR MSFD Indicators M3 and M5 a shared data structure is convenient and for some parameters a necessity.

5.2 Area of relevance

While the assessments for M3 and M5 are restricted to OSPAR regions II and III (Greater North Sea and Celtic Seas), the database itself should continue to be updated with any relevant information from the wider ICES area (e.g. northern Norway, North America, the Baltic).

Almost all Member States in the Greater North Sea and Celtic Seas regions have already contributed to the existing OSPAR database hosted at St Andrews (with exceptions e.g. Ireland).

5.3 Current status

At present the OSPAR database includes the following parameters: Species ID, Country, MSFD Assessment Unit (not applicable to areas outside OSPAR regions II and III), Year, Count, Survey method, Source (data provider), Season (e.g. moulting, breeding), Latitude/Longitude (where available), Location name. The database contains far more comprehensive information and at a finer scale, than the previous WG collated dataset (which was limited to harbour seal moult counts and grey seal pup production estimates). The database now includes the information needed to assess grey and harbour seal distribution as well as abundance.

5.4 Issues

It is noted that the database is currently incomplete as not all countries have contributed data.

The WGMME stresses that robust assessments of changes in pinniped distribution from surveys that are designed primarily to estimate abundance are problematic (see ToR d for further information).

As the seal surveys are designed for assessing abundance, the data produced carry some inherent limitations regarding their use for assessment of distribution. First, the surveys only cover distribution on land and do not address the distribution at sea. Second, the surveys do not cover potential haulout sites or breeding colonies in a systematic way. Haulouts and breeding sites are sampled preferentially based on past experience of seal occurrence. This means that the surveys are not designed to detect expansions of ranges; new haulouts are only added to the survey coverage as anecdotal data on seal occurrence accumulate. Third, most surveys only cover narrow windows during key parts of the life cycle of the seals, namely peak moulting and pupping seasons.

Survey data may be used to detect contractions in range in terms of reduced use or abandonment of haulouts or areas, depending on the spatial resolution with which data are reported. Temporal shifts in distribution density within the area covered by the surveys can be described at the spatial resolution provided in the data. This spatial resolution needs to be at least at the level of the MSFD seal Assessment Units and preferably at smaller scales for both harbour and grey seals.

5.5 Recommendation

The WGMME strongly recommends that all ICES Member Countries regularly contribute data to the OSPAR database.

To improve the database additional data could include CVs and number of replicate counts to assist with power analyses of the data.

6 Review of OSPAR assessments M3 and M5

d) OSPAR requests to review the draft OSPAR assessment of the abundance and distribution of harbour seals and grey seals and an assessment of grey seal pup production in the Northeast Atlantic. ICES is requested to assess the validity of the data analysis that underpins the assessments and if necessary, to recommend any changes that should be implemented in future assessments.

ICES WGMME members undertook a review of the draft OSPAR assessments of common indicators describing changes in grey seal and harbour seal abundance and distribution (M-3) and changes in grey seal pup production (M-5).

In general, the ICES WGMME found that the assessments produced were of a high quality, clear and scientifically robust. The work to share, collate and analyse seal survey data from across the Greater North Seas and Celtic Seas is novel and is a step forward for collaborative seal research.

Below ICES WGMME presents a general critique of the assessments; specific comments, additions or deletions of an editorial nature were recorded directly in the Word files provided and should be referred to in context (see Annexes 5 and 6).

6.1 M-3: Seal abundance and distribution

The WGMME suggests that:

- Assessments should be updated to include the most recently available quality-controlled survey data up to 2014. It was noted that 2015 survey data are still being processed in many instances and would not be available until late 2016.
- References to 'total European' grey seal population should be changed to reflect the fact that large parts of northern Europe are not included in the assessment (e.g. Norway north of 62°N, Russia, Iceland, Faroe Islands). Suggested revisions are 'OSPAR regions II and III' or 'Greater North Sea and Celtic Seas'.
- Sections on power analyses should be removed due to there being insufficient detail available to assess power to detect threshold trends. A comprehensive assessment of the retrospective power of survey data to detect threshold trends would require details of all replicate surveys conducted in every Assessment Unit (AU) so as to be able to calculate the between- and within-year variance in counts. At present, it appears there is neither the detailed data available, nor the resources to conduct such an assessment of power. The inclusion of, and justification for, 80% confidence intervals on all quantitative assessments should be retained. It should be noted that for some areas power analyses have already been conducted and these are duly referenced in the assessments (Meesters *et al.*, 2007; Teilman *et al.*, 2010).
- The 'Knowledge Gaps' section should be revised to highlight the fact that the '1% decline per annum in the last reporting round' threshold is not detectable with 80% power in many AUs. The case for aiming for 80% power, rather than the more typical 95%, was made by WGMME 2014. However, 80% statistical power may not be achievable in regions where annual, repeated surveys are not undertaken. Assuming that the relevant details

were provided to allow for a comprehensive assessment of power, this gap between the thresholds and power could be addressed in one or more ways, either across all AUs or in each individually where applicable: first, survey effort could be increased to a level that would allow detection of thresholds with 80% power (note that this level of resource investment would be high in areas with long, convoluted coastlines where multiple survey team deployments would be required to cover the area within the survey window). Second, periods over which trends are investigated could be extended to match what would be achievable with maximum power in each AU. In order to keep this period within an acceptable length of time, annual monitoring efforts may need to be increased. Third, a comprehensive assessment of retrospective power in each AU could be undertaken to present a realistic estimate of confidence in the statistical power to detect the threshold trends (i.e. providing an estimate of confidence in the assessment).

- The difference between the two 'total grey seal population size' models should be better explained and justification for the integration of the 2008 independent estimate made clearer. The working group recognises that this model is a large step forward in attempting to understand the demographics of grey seals as one unit in the Greater North Sea and Celtics Seas, and would like to applaud the efforts of those responsible. However, as noted in the comments the fact that the population trajectory estimated by the model incorporating the independent summer estimate is much lower than the population trajectory using pup production alone means that the former must be too low, pup production estimates too high or that there is a problem with the methodology. Work to refine this model should continue. In particular, the group noted that analysis of telemetry data from other regions around Europe could be undertaken to produce estimates of the proportion of time grey seals spend hauled out during the survey window. This proportion is critical to rescaling the summer grey seal counts to the independent estimate. Information on any regional variation in key demographic parameters such as fecundity, pup survival and density-dependence could be included in future model runs.
- The assessments should highlight the fact that counts of grey seals during their moult throughout the assessment area would increase the accuracy of estimates of total grey seal population sizes. While grey seal moult surveys are already regularly undertaken by some CPs (e.g. the Netherlands, Germany, Denmark, France) the WGMME recognise that this may not be feasible in all areas.

6.2 M-5: Grey seal pup production

The WGMME suggests that:

- The assessments should recognise the fact that pup production when used on its own is not a meaningful indicator of population *condition* per se because the total population size also needs to be considered. However, local abundance estimates – to the extent that they are available – may not necessarily be representative of the number of potentially breeding females in those areas during the breeding season. Furthermore, the population size estimates are themselves derived from the same pup counts that are used in indicator M5 to assess population condition; thus, there is no independent abundance estimate to use as context for pup production as an indicator of population condition. Rather than being a condition indicator, M5, as it stands, is an index of population size. An ideal measure of population condition would include information on female fecundity and pup survival; however, these demographic parameters are only available where long-term and detailed monitoring of colonies exits (e.g. Isle of May in Scotland). Another good indicator of population condition would be changes in body condition (e.g. blubber thickness or condition indices). Again, the group is not aware of many instances where such data exist with sufficient quality to conduct an analysis of trends. Notwithstanding these caveats, the WGMME is of the opinion that assessment of pup production on the level of smaller AUs is useful and could provide an early and local warning of major changes in the population as a result of changes in local conditions (e.g. food availability, disturbance, depredation, bycatch).

- Assessments should be updated to include the most recently available quality-controlled survey data up to 2014. It was noted that 2015 survey data are still being processed in many instances and would not be available until late 2016.
- References to 'total European' grey seal population should be changed to reflect the fact that large parts of northern Europe are not included in the assessment (e.g. Norway north of 62°N, Russia, Iceland, Faroe Islands). Suggested revisions are 'OSPAR regions II and III' or 'Greater North Sea and Celtic Seas'.
- Sections on power analyses should be removed due to there being insufficient detail available to assess power to detect threshold trends. A comprehensive assessment of the retrospective power of survey data to detect threshold trends would require details of all replicate surveys conducted in every AU to be able to calculate the between and within year variance in counts. At present, it appears there is neither the detailed data available, nor the resources to conduct such an assessment of power. The inclusion of, and justification for, 80% confidence intervals on all quantitative assessments should be retained. It should be noted that for some areas power analyses have already been conducted and these are duly referenced in the assessments (Meesters *et al.*, 2007; Teilman *et al.*, 2010).
- The 'Knowledge Gaps' section should be revised to highlight the fact that the '1% decline per annum in the last reporting round' threshold is not detectable with 80% power in many AUs. The case for aiming for 80% power, rather than the more typical 95%, was made by WGMME 2014. However, 80% statistical power may not be achievable in regions where annual, repeated surveys are not undertaken. Assuming that the relevant details were provided to allow for a comprehensive assessment of power, this gap between the thresholds and power could be addressed in one or more ways either across all AUs or in each individually where applicable: first, survey effort could be increased to a level that would allow detection of thresholds with 80% power (note that this level of resource investment would be high in areas with long, convoluted coastlines where multiple survey team deployments would be required to cover the area within the survey window). Second, periods over which trends are investigated could be extended to match what would be achievable with maximum power in each AU. In order to keep this period within an acceptable length

of time, annual monitoring efforts may need to be increased. Third, a comprehensive assessment of retrospective power in each AU could be undertaken to present a realistic estimate of confidence in the statistical power to detect the threshold trends (i.e. providing an estimate of confidence in the assessment).

7 ToR e: To support OSPAR in the delivery of common indicator assessment of Cetaceans through

1) The collation on estimates of coastal bottlenose dolphin abundance in the assessment units identified, over an appropriate time frame;

2) To assess trends in abundance (and where possible distribution within range) of coastal bottlenose dolphins in the assessment units identified, against targets proposed;

3) To present an overview of data on cetacean species other than coastal bottlenose dolphins that may be available to make a regional assessment in the frame of indicator M-4;

4) To collate and assess the data identified in (i) against the targets proposed.

In order to respond to this OSPAR request, and taking into consideration the complexity of assessments required, WGMME agreed that two separate assessments would be compiled. These were:

1) Abundance and distribution of coastal bottlenose dolphins and killer whales.

2) Abundance and distribution of cetaceans other than coastal bottlenose dolphins and killer whales.

This division was agreed on the basis of the monitoring methodologies generally used (localised mark–recapture studies vs. large-scale population surveys) and the importance of the anthropogenic pressure of persistent organic pollutants (identified as potentially a more significant issue for coastal bottlenose dolphins and killer whales than for the majority of the other species). Prior to the meeting, available data were collated and preliminary drafts were produced which were further developed during the meeting.

The assessments focus mainly on abundance, considering evidence of negative changes that exceed previously proposed threshold values (see WGMME (2014); note however that, following questions from OSPAR, the text about the threshold value for coastal bottlenose dolphins has been revised[†] and some clarification also added in relation to threshold values for other cetaceans (see Annexes 7 and 8). Full details for each species/assessment unit are included in the assessment sheets.

7.1 Coastal bottlenose dolphins and killer whales

In relation to coastal bottlenose dolphins and killer whales, most time-series of abundance data are rather short in relation to the generation time of these long-lived animals. Assessment was only possible for five populations, with an indicative assessment provided for another. The time-series of monitoring data were too short to undertake the assessment for the remaining AUs. In many locations around the eastern North Atlantic Ocean, coastal bottlenose dolphin populations declined or dis-

[†] Revised after the information was sent to the Review Group for the common marine mammal indicator assessments request.

appeared before or during the 20th century, but most of the current populations seem to be stable.

Human pressures include disturbance (mainly from recreational activities), direct and indirect fisheries impacts, and pollution. The population consequences of human activities remain to be elucidated and the difficulty of doing so is compounded by the ephemeral nature of some coastal populations. In addition, the relationships between coastal bottlenose dolphins and wider ranging offshore populations remain unclear.

7.2 Other cetaceans

For other cetaceans (harbour porpoise *Phocoena phocoena*, offshore common bottlenose dolphin *Tursiops truncatus* (inshore bottlenose dolphins are considered in a separate document),white-beaked dolphin, *Lagenorhynchus albirostris*, short-beaked common dolphin *Delphinus delphis*, striped dolphin *Stenella coeruleoalba*, minke whale *Balaenoptera acutorostrata,* fin whale *Balaenoptera physalus*, long-finned pilot whale *Globicephala melas*, sperm whale, *Physeter macrocephalus* and beaked/bottlenose whales as a combined species group (Ziphiidae)), most populations/Assessment Units occupy large areas and large-scale sightings surveys are necessary to obtain robust estimates of abundance. There are multiple anthropogenic pressures and threats facing all cetaceans in this region, including fishery bycatch and pollution.

Large-scale surveys in the OSPAR area took place in 1994 and in 2005–2007, with the latter covering a larger area. Consequently for most species there is only one robust estimate of abundance. For those species for which there are multiple estimates, the time-series are short relative to the life cycle of the species and the precision of the estimates is generally low leading to low power to detect trends. It is therefore not possible to infer with any confidence whether populations are decreasing, stable or increasing. Results from a large-scale survey in summer 2016 will aid this process and smaller-scale surveys, some also sampling different seasons, could provide some additional evidence although usually they do so at a sub-Management Unit scale. Notwithstanding the difficulty of detecting trends, recent estimates of abundance are either similar to or larger than comparable earlier estimates. In relation to distribution, there has been a clear shift in harbour porpoise distribution from north to south in the North Sea.

Annex 1: Participants list

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Annex 2: Draft ToRs for WGMME 2017

The **Working Group on Marine Mammal Ecology** (WGMME), chaired by Begoña Santos (Spain) and Graham Pierce (UK), will meet in St Andrews, UK 6–9 February 2017 to:

a) Review and report on any new information on population abundance, population/stock structure, management frameworks (including indicators and targets for MSFD assessments), and anthropogenic threats to individual health and population status (e.g. plastics);

b) Review and update the criteria for assessment of cetaceans in the context of the MSFD;

c) Review current issues in relation to direct seal–fisheries interactions, including developments in mitigation measures;

d) Update the database for seals;

e) Update assessments of offshore cetaceans based on new results from the SCANS III survey.

WGMME will report by 4 April 2017 for the attention of the Advisory Committee.

Justification

ToR a is a standing term of reference. However, the group proposes to expand its scope since it would be useful to include information on threats to population status. This is relevant to the assessment of population status. Ingestion of plastic debris by marine mammals is currently something of a hot topic. In addition, questions have arisen concerning the boundaries of Assessment Units for coastal bottlenose dolphins and these will be reviewed.

Tor b relates to questions arising from the cetacean assessments undertaken in 2016. Specifically, there is a need to revise the criteria for determination of whether abundance for an Assessment Unit has fallen below the baseline level. The IUCN criteria provide insufficient detail to fully define the process. It is suggested that all criteria used in the assessments are reviewed and updated as necessary.

ToR c aims to address current issues in direct (operational) seal–fisheries interactions in the context of (in some cases increasing) seal population abundance and distribution. In some areas there is increasing concern from fisheries organisations regarding the survival of coastal passive fishing gear and pressure for economic compensation and/or targeted removal of 'rogue' individuals. Another major aspect of seal–fisheries interactions includes competition for shared resources; however, in 2017 the group would aim to review only those direct interactions such as depredation, bycatch, and mitigation. Indirect interactions (e.g. competition for food, transmission of codworm) could be reviewed in 2018.

ToR d is a standing term of reference.

ToR e aims to update current offshore cetacean assessments following the SCANS III survey (due to take place in summer 2016). This will be the first large-scale survey since the mid-2000s and will thus provide a much needed update on cetacean abundance, and provide the first opportunity to determine trends for several cetacean species.

Annex 3: Bird seal database requirement

The document "OSPAR Convention for the Protection of the Marine Environment of the Northeast Atlantic" from the Meeting of the Biodiversity Committee (BDC) held in Gothenburg on 29 February–4 March 2016 is presented in full on the next pages.

ANNEX 6
(Ref. 3.22)

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

Meeting of the Biodiversity Committee (BDC)

Gothenburg: 29 February – 4 March 2016

Specification for the ICES hosted OSPAR biodiversity Database for seabird and seal data

It is the purpose of this document to articulate the requirements for the biodiversity databases being built by ICES for the management of data associated with the common biodiveristy indicators B1, B3, M3 and M5.

Overview:

1. The OSPAR/HELCOM/ICES JWGBird had previously expressed the need for a central regional database to feed regional assessments of OSPAR Common Indicators on birds. JNCC, UK had temporarily been collating data and temporarily storing it, however a longer term solution was needed; ICES Data Centre has been identified as a suitable host.
2. A similar need was also expressed by the OSPAR marine mammal expert group for the management of data to support seal indicators.
3. This specification relates to the requirements for both the seabird and seal data management requirements, except where otherwise specified
4. The purpose of an OSPAR database should be:
    a. To collate and store data to be used for regional biodiversity indicator assessments;
    b. To provide a snapshot of data that can be used in each assessment (as required by OSPAR and HELCOM data strategies and assessment processes, and to ensure accessibility to the data underlying MSFD assessments as required of each Member State by MSFD Art. 19);
    c. To provide an audit trail for each assessment;
    d. The database should not replace national databases or be a repository for primary data.

Details relating to the OSPAR database on seabirds:

5. The database should hold data collected by land-based observers of marine birds when the data are:
    a. counts of adult birds and estimates of breeding success that are conducted on land at breeding colonies or sites, nesting close to the coast and using marine environment (e.g. for food);
    b. in intertidal areas or close to the shore and counted from land during migration or over-winter.
6. The database could be constructed to accommodate land-based data (described in §2-3 above) from OSPAR in the first instance for the North East Atlantic, but with the ambition that it should, in future also hold this data for HELCOM areas i.e. Baltic Sea.

7. The database should be updated annually by online data from Contracting Parties, submitted as the result of OSPAR data calls.
8. JWG Bird highlighted concerns that data providers might have over free access to data held in the database and the need in the first instance to restrict access until these concerns can be addressed to move towards the requirements of the OSPAR data policy and MSFD data access requirements; these concerns are detailed below under "data access".

Requirements for the database:

Data submission format:

- The current format for bird and seal data submitted by Contracting Parties has been provided to ICES;
- Data will be submitted each year in response to an annual data call initiated by OSPAR Secretariat;
- Contracting Parties should submit their data through a web based application to be developed as part of the database;
- The web application should show the status of data that has been provided, i.e. submission (accessions) overview;
- The data should be subject to QC checks against the required reporting format specification (Annex 1);
- The database should provide a data feed to the OSPAR Data and Information Management System (ODIMS) via compatible web services. The database will be made accessible through ODIMS as the primary access point. Only data cleared for release are to be made available via the webservices. Any data that has access restrictions must be flagged by the data provider and excluded from the webservice feed to ODIMS;
- Cleared data that can be made publically accessible can also be made available via the ICES Data Portal http://ecosystemdata.ices.dk
- The database should have corresponding INSPIRE compliant metadata at the level of the dataset.
- According to the OSPAR data policy, the database should allow for the approval through OSPAR processes (this is likely to be JWG BIRD advising BDC and formal approval by BDC) before it is used for assessment or, where appropriate, published through ODIMS.

Data access

- OSPAR data policies require that OSPAR data is made publically accessible. However there are some issues that have not yet been resolved with regards to access and sharing of some of the data sets from certain providers (e.g. NGOs, individuals, commercial organisations, academic institutions). As such the database will need to be able to provide solutions that will enable the data to be protected in some cases, until such time as the issues can be resolved.

Timeframe for delivery

Agree specification	10 January 2016
Presentation of draft database	1 March 2016 (BDC 2016)
Finalisation of database	30 March 2016

Cost for development:

The agreed cost for the development of the database EUR 12 374

The ongoing database management costs for subsequent years, starting 2017 should be agreed as part of the OSPAR/ICES annual work programme.

Contacts:

- The contacts for all correspondence regarding the establishment and development of the OSPAR Bird Database should be:
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    - Chris Moulton (OSPAR Secretariat) - chris.moulton@ospar.org
    - Cc to Morten Frederiksen (ICES co-chair of JWGBIRD) - mfr@bios.au.dk

Background on data to be included for seabirds

Land-based counts – our understanding

- Each row of data consists of one value per species per site per year.
- The data can include both observed counts that may have missing values in some years; or a complete time series of values in which missing observed counts have been interpolated. The provision of observed or interpolated counts is the decision of each Contracting Party;
- The International Waterbird Census database currently holds observed counts only of wintering waterbirds and waders. The proposed OSPAR data base is required because the indicator assessments used data products from certain contracting parties (i.e. post-interpolated values) and we need an alternative database in which to store them.
- There is a need separate tables for breeding counts and non-breeding counts.

Breeding success data

- Ideally, each data row should contain two values per species per site per year: a count of nests monitored, and a count chicks fledged from those nests.
- The above are difficult to collect for remote sites and for other sites that are visited for a short period. JWGBird will aim to develop an alternative method for recording breeding success/failure at these sites. These alternative parameters could be included in the same database.

Annex 4: WKPIGS Expert Group Meeting Resolution

The ACOM/SCICOM Workshop on Predator–prey Interactions between Grey Seals and other marine mammals (WKPIGS), chaired by Andrew Brownlow (UK), Nora Hanson (UK), Jan Haelters (Belgium) and Abbo van Neer (Germany), will meet in May, 2017 in Middelfart, Denmark, alongside the European Cetacean Society annual conference to:

a) Define and harmonise the pathological indicators of a grey seal predation event in marine mammal carcasses;

b) Describe the known prevalence and spatio-temporal trends of grey seal predation on other seals and harbour porpoises across the North Atlantic;

c) Identify potential environmental or demographic drivers of the behaviour and trends;

d) Discuss potential methods to quantify the impact of grey seal predation on harbour seal and harbour porpoise populations and to quantify the importance of cannibalism in grey seals;

e) Identify knowledge gaps and develop a collaborative program of research to address these.

WGMME_Project will report by June 1, 2017 for the attention of the WGMME (Working Group on Marine Mammal Ecology), SCICOM and ACOM.

Supporting information

Priority	This activity will contribute towards the science base underpinning ICES advice in relation to the management of marine mammals. The group will summarise current knowledge, identify knowledge gaps and describe research priorities to address the direct impact of grey seals on harbour seal and harbour porpoise populations in the ICES area, some of which are declining. It will also consider the importance of cannibalism in grey seals. Consequently, the workshop is considered to have a high priority.
Scientific justification	Grey seals (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*) are sympatric predators throughout much of their distribution in the Northeast Atlantic. In some areas of Scotland, where ~30% of the European harbour seal population is found, harbour seals are in steep decline. Over the past two decades, there has been an increase in the number of seals reported, at both sides of the North Atlantic, dead stranded with characteristic spiral lesions. Until recently, the causes were hypothesized to be predation by sharks, and/or mortality resulting from collision with ducted propellers. However, direct observations have now been made in Germany and in the UK of adult male grey seals causing similar injuries while catching, killing and preying upon young grey and harbour seals. Additionally, grey seals have been shown to kill and predate upon harbour porpoises (*Phocoena phocoena*) in Belgium, The Netherlands, France and the UK. In the Netherlands, grey seals were identified as one of the main causes of death in harbour porpoises found dead there. Clearly this behaviour is not restricted to a few 'rogue' individuals; it appears to be widespread and possibly increasing in some areas. Predation on harbour seals and porpoises by grey seals is an example of asymmetric intraguild predation whereby one predator species kills and perhaps eats another predator with which it competes for prey resources. In the case that individuals of the second species are eaten, their value as a food resource may also be relevant. Interactions between sympatric predators can be modulated by resource limitations, habitat availability / space use, and the dynamics of other intraguild competitive interactions. Understanding the prevalence, and potential drivers, of intraguild predation in these protected marine predators will be an important aspect of the work carried out by WGMME and critical to provide sound scientific evidence about the ecological interactions between marine mammal species in the Northeast Atlantic. National agencies responsible for the management of seals and harbour porpoises under the MSFD will also benefit from a concerted effort to collate and disseminate all available information and to develop a coordinated and coherent research plan. At present, the behaviour has been documented in several countries within the Northeast Atlantic (UK, Germany, The Netherlands, Belgium, France), wherein stranding networks resources are being used to identify causes of mortality in stranded marine mammals, including of those, with evidence of grey seal predation. In the Northwestern Atlantic, possible interactions between grey seals and other seal species exist, with similar lesions having been reported, though with an unknown or different origin. WKPIGS will provide a space for marine mammal biologists to meet face-to-face to discuss the aims presented above. The workshop deliverables will be a report summarising the main findings, and an outline of research plans going forward; the workshop will also help to foster international collaboration on this topic.

Resource requirements	The research programmes which provide the main data input to this group have already started, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible. However, additional support (e.g. via the ICES Science Fund) could help assure wider participation in the meeting, e.g. from scientists from the western Atlantic. The assistance of ICES to publicize the workshop and to publish the proceedings would also be welcomed.
Participants	The workshop will be attended by 20–25 experts in seal and harbour porpoise biology and management including representatives from marine mammal strandings networks.
Secretariat facilities	None.
Financial	To minimise the need for financial support, the workshop will be run alongside the European Cetacean Society conference in 2017. Nevertheless, additional funding will be sought.
Linkages to advisory committees	The workshop outcomes will be relevant to provision of advice on marine mammals by ACOM.
Linkages to other committees or groups	The workshop contributes directly to WGMME objectives and activities as well as being of interest to SCICOM (e.g. to Expert Groups within SSGEPD).
Linkages to other organizations	None, although we expect the work to be of interest to the European Cetacean Society (which despite its name also has an interest in seals).

Annex 5: M-4 Abundance and distribution of cetaceans 2: coastal bottlenose dolphins (and killer whales) (D1.2-Population Size, D1.1-Population distribution)

Key message

In many locations around the eastern North Atlantic Ocean, coastal bottlenose dolphin populations have declined or disappeared before or during the 20th century, but most of the current populations seem to be stable. Human pressures include disturbance (mainly from recreational activities), both direct and indirect fisheries impacts, and pollution.

Background (brief)

Bottlenose dolphins in European waters are subdivided into coastal populations, which live in relatively small areas close to shore, and a much larger offshore population. The eleven assessment units for bottlenose dolphin reflect the different populations; ten of these are small, resident or semi-resident coastal groups, while the other consists of a large wide-ranging offshore group (which is covered in a separate assessment). The coastal populations are potentially exposed to a greater level of human activity due to their proximity to humans and their residency. Human activities can negatively affect coastal bottlenose dolphins, and contribute to declines in numbers and changes in distribution.

Since the 19th century a number of coastal bottlenose dolphin populations have declined or disappeared altogether. As coastal bottlenose dolphins, and cetaceans in general, are long-lived top predators and charismatic species of public concern, changes in distribution and abundance are important, and should be assessed against changes in human activities and climate change. This indicator assesses trends in the numbers of animals in the different coastal populations, and this report includes some information on populations that have disappeared. Monitoring in a few populations has been ongoing for decades, but for most populations it is recent, or consists only of anecdotal information. The indicator is linked to Descriptor 8 which considers pollutants. For some coastal populations, persistent organic pollutants such as PCBs have been implicated in their decline and even local disappearance.

Background (extended)

Marine mammals, including cetaceans, are top predators, and comprise an important part of biodiversity. Bottlenose dolphins are long-lived and are probably the most iconic of the cetacean species and the most recognisable by the public. As cetaceans are included under the Habitats Directive (Annex IV), their abundance (criterion 1.2) and distribution (criterion 1.1) comprise a key aspect for securing and achieving GES according to the MSFD. Bottlenose dolphins are also listed in Annex II of the Habitats Directive, which requires the designation of Special Areas of Conservation in order to contribute to their favourable conservation status.

While the high mobility of the species facilitates interaction and gene flow over large distances (Hoelzel, 1998; Querouil *et al.*, 2007), bottlenose dolphins can also display fine-scale genetic population structure resulting from localized adaptations over small spatial scales (Ansmann *et al.*, 2012). Genetic differentiation between neighbouring populations regularly occurs and may be related to habitat borders (Natoli *et al.*, 2005; Bilgmann *et al.*, 2007; Wiszniewski *et al.*, 2009), sex-biased linked dispersal (Möller *et al.*, 2004; Bilgmann *et al.*, 2007; Wiszniewski *et al.*, 2010), niche specialisation (Louis *et al.*, 2014a), anthropogenic activities (Chilvers and Corkeron, 2001), and through isolation by distance without apparent boundaries separating populations (Krützen *et al.*, 2004; Rosel *et al.*, 2009). Consequently, bottlenose dolphins are subdivided into small discrete coastal populations residing relatively close to shore and a much larger wide-ranging offshore population. This is reflected in the large number of assessment units for this species. The relationships both within and between those coastal and offshore populations remain unclear (Rosel *et al.*, 2009; Toth *et al.*, 2012; Richards *et al.*, 2013; Louis *et al.*, 2014b). A similar situation may occur in Europe. This report covers the coastal populations, while the offshore population is considered in a separate assessment. The coastal populations are potentially exposed to a greater level of human activity due to their proximity to humans and their residency. Since the 19th century a number of coastal bottlenose dolphin populations have declined or have disappeared altogether.

Human pressures

A number of human activities may affect bottlenose dolphins. The most obvious human pressure in coastal areas is human disturbance mainly from recreational activities (including commercial dolphin watching), with both short- and long-term impacts noted in several populations around the world (Bejder and Samuels, 2003; Bejder *et al.*, 2006) including West Wales (Feingold and Evans, 2014a; Norrman *et al.*, 2015) and East Scotland (Pirotta *et al.*, 2014; 2015). Incidental catches of bottlenose dolphins through entanglement in fishing gear (mainly gillnets and pelagic trawls) also occur (ICES, 2015a). Within the OSPAR region, bottlenose dolphin bycatch appears to be highest (and potentially unsustainable) off the coasts of northern Spain (Galicia, Asturias, Cantabria and Basque Country), west Portugal, and SW Spain (Andalucia) (López *et al.*, 2003; 2012; Goetz *et al.*, 2014; Vázquez *et al.*, 2014; Vélez, 2014; ICES, 2015a). Fishing activities can also indirectly affect populations through depletion of the prey resource (ICES, 2015b). Habitat disturbance as a result of fishing activities causing damage to the seabed and its benthic faunas is also a potential human pressure in some areas (Feingold and Evans, 2014a; Norman *et al.*, 2015). Habitat loss will also affect coastal populations (Camphuysen and Peet, 2006; Camphuysen and Smeenk, 2016). Research has demonstrated high pollutant loads in most coastal bottlenose dolphin populations investigated, possibly leading to health problems and reproductive failure (Jepson *et al.*, 2013, 2016). Exposure to high pollutant levels has been suggested as one reason for past declines in and disappearance of some populations. Climate change may also affect bottlenose dolphins either by altering human activities and thus pressures or by affecting the stock sizes and distribution of their prey.

The indicator‡

Following criteria adopted for other cetaceans and based on the IUCN criterion for abundance changes which would identify a population as vulnerable, it is recommended that, for each assessment unit of inshore bottlenose dolphins, population sizes should be maintained at or above baseline levels, with no decrease from this

‡ Revised after the information was sent to the Review Group for the common marine mammal indicator assessments request.

level of ≥30% over a three generation period. Applying an estimated generation time of 23 years (Taylor *et al.*, 2007), this implies a period of 69 years. A decline of 30% over 69 years is equivalent to a decline of approximately 5% over ten years or 0.5% per year. An important caveat is that power analysis indicates that, for such populations, the minimum detectable (i.e. statistically demonstrable) rate of decline is likely to be closer to 5% per year (e.g. Thompson *et al.*, 2004; Englund *et al.*, 2007). In addition, the assessment should be carried over a reasonable time-period. Evidently an assessment cannot be delayed until 69 years have passed but very short time-series may give misleading results. In small resident populations, local movement may account for apparent changes in abundance over short-time-scales. The recommendation is to base the assessment on a time-series covering at least the last ten years, with a minimum of four counts during that period. Thus the target is no decline from the baseline of more than 5% over ten years.

Monitoring in a number of populations has been ongoing over a sufficiently long period to enable an assessment against the target, while in others there are currently insufficient data over a suitable time period available (see Table A for a summary of monitoring programmes). Current estimates of numbers of animals in a population are usually obtained by photo-ID (either mark–recapture or in the case of small populations, by direct census), although in their absence, abundance estimates are derived from line-transect surveys. Where possible, annual data on estimated number of animals by population are provided. In addition, this interim assessment includes consideration of those populations that are known to have disappeared from their former range.

Table A. Summary of current and known coastal bottlenose dolphin monitoring programmes (with at least four population estimates).

AU	Country	Years	Method	References
East Coast Scotland	UK	1990–present (initially only Moray Firth)	Mark–Recapture	Cheney *et al.*, 2013, 2014; Corkrey *et al.*, 2008
West Coast Scotland	UK	1995/1998,	Mark–Recapture	Grellier and Wilson, 2003; Cheney *et al.*, 2013
Coastal Wales	UK	2001–present (until 2005, only Cardigan Bay SAC)	Mark–Recapture	Pesante *et al.*, 2008; Feingold and Evans, 2014; Norrman *et al.*, 2015
Coastal Ireland	Ireland	NW Connemara only: 2009	Mark–Recapture	Ingram *et al.*, 2009, Nykanen *et al.*, 2015
Coastal Ireland: Shannon Estuary	Ireland	1997, 2003, 2006, 2008, 2010, 2015	Mark–Recapture	Ingram and Rogan, 2003; Ingram *et al.*, 2009; Berrow *et al.*, 2010; Rogan *et al.*, 2015
Coastal Southwest England	UK	2008/2013	Mark–Recapture	Brereton *et al.*, in review
Coast of Normandy and Brittany: Gulf of St Malo / Channel Islands	France	2010, 2011, 2012, 2013, 2014	Mark–Recapture	Louis *et al.*, 2015; Couet 2015a, b
Coast of Normandy and Brittany: Ile de Sein	France	1992–2001, 2014	Census	Le Berre and Liret, 2001; Liret, 2001; Liret *et al.*, 2006
Northern Spain	Spain	2003/2011	Line-transect	Lopez *et al.*, 2013
Southern Galician Rias	Spain	2006/2009	Mark–Recapture	Garcia *et al.*, 2011
Coastal Portugal	Portugal	1998/2001, 2007/2022	Mark–Recapture	Martinho, 2012; Martinho *et al.*, 2015
Coastal Portugal: Sado Estuary	Portugal	1986–present	Census	Gaspar, 2003; Lacey, 2015
Gulf of Cadiz	Spain	2005/2006 and 2009/2010	Mark–Recapture	MAGRAMA, 2012

Thresholds and baselines

Although the baseline ideally should be derived from historical data obtained prior to major human impacts, these are not available. Moreover, the historical abundance and distribution is unknown and cannot realistically be restored (where it is known to have declined) as today's marine environment is very different. Climatic change may also have important consequences. A modern baseline therefore has had to be utilised. In the assessment, the start of the data time-series for each assessment unit could be used as the baseline, with indicator assessment thresholds set as a deviation from that baseline value.

Since abundance estimates typically have wide confidence values, they may not have the power to detect even relatively strong trends. Bottlenose dolphins are relatively long-lived slow reproducing species, so that, for example, problems in reproduction may show significant time-lags before being detected.

Abundance data should always be considered separately for each assessment unit, along with any available data on distributional changes, causes of death in stranded animals, and possible links to human activities.

Assessment method

Assessment units

Assessment Units (AU) have been determined on the basis of a combination of spatial separation, lack of photo-ID matches, and genetic differences (Evans and Teilmann, 2009; ICES, 2013) as outlined in ICES (2014) (Figure A).

Abundance

Abundance has been calculated for each Assessment Unit where sufficient data exist. Abundance estimates were made largely using Photo-ID capture–recapture methods, and an indication is given about the trend in the population since the start of monitoring: stable, declining, increasing or unknown. At least four abundance estimates from different years were required before the population trend was assessed based on previous power analysis exercises (WGMME, 2014). On occasions, pooled estimates have been calculated from a period of years. Some small discrete populations were assessed by a full census of individuals.

Distribution

Records of both sightings and strandings were used to identify where populations existed historically.

Results (brief)

Coastal bottlenose dolphins occur along the Atlantic seaboard of Europe from Scotland in the north to Spain in the south. Small resident populations remain in the Sound of Barra (West Coast of Scotland AU), Shannon estuary (West Coast of Ireland AU), the Iroise Sea (Brittany/Normandy AU, NW France) and in the Sado Estuary (Coast of Portugal AU), but a number of estuaries or semi-enclosed bay systems in the southern North Sea (Area II) and Bay of Biscay (Area IV) no longer hold regular bottlenose dolphin populations.

The overall population size of coastal bottlenose dolphins in the area considered is at least 2700 animals, and probably in the region of 3000–4000, considering gaps in coverage. Few localities have been monitored on an annual basis. The most extensive annual counts come from the Sado Estuary, dating from the mid-1980s, and indicate the population is in decline. Annual mark–recapture estimates in the Moray Firth region dating back to 1990 indicate that the population is stable or increasing. In the Cardigan Bay SAC and the wider Cardigan Bay, annual estimates available from 2001 and 2005, respectively indicate broadly stable populations. Estimates for the Gulf of St Malo (including the Channel Islands) indicate the population has been stable since 2010. Less frequent assessments have been made at Ile de Sein (France) and in the Shannon Estuary (Ireland) indicating both are stable populations. Bottlenose dolphin abundance has been estimated in other locations but there are insufficient data to establish a population trend at this time.

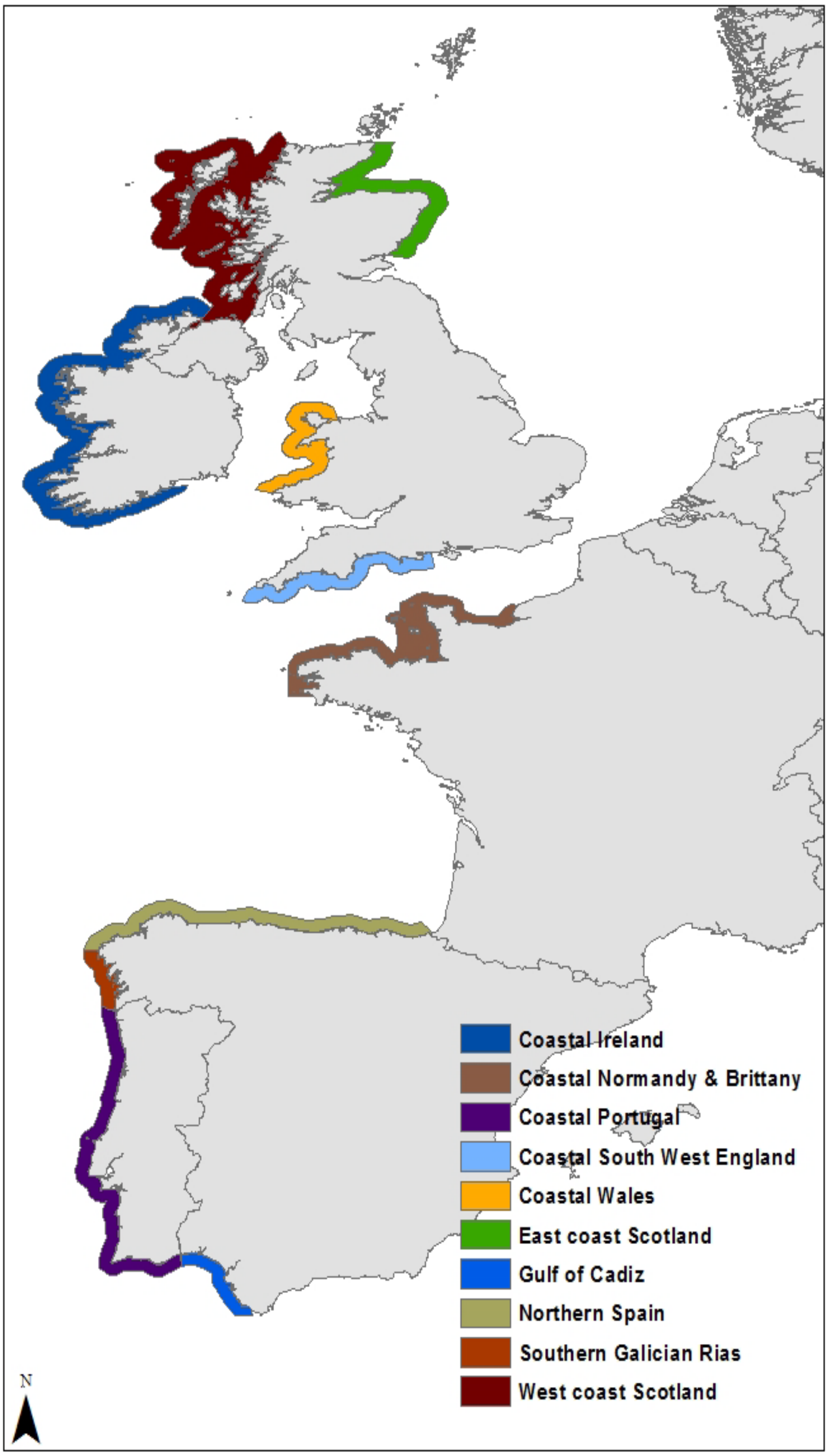


Figure A. Assessment Units for coastal bottlenose dolphins proposed by ICES.

Populations with an unknown size disappeared from estuaries in the Severn Estuary and eastern England as well as Elbe and Weser Estuaries in Germany towards the end of the 19th century. More recently, a population in the southern North Sea (which ranged from northern French and along the Dutch coast) disappeared around the end of the 1960s. Other discrete populations (e.g. Arcachon in France and the Tagus Estuary in Portugal) have also disappeared in recent decades. Bottlenose dolphins appear to have used some coastal areas for limited periods of time, possibly forming ephemeral populations. Declines due to disturbance have been demonstrated in other parts of the world and high pollutant loads leading to health problems and reproductive failure may also have resulted in declines and the disappearance of some populations.

Results (extended)

Coastal bottlenose dolphin populations occur along the Atlantic seaboard of Europe from Scotland in the north to Spain in the south. Bottlenose dolphins occur in coastal waters of Spain, Portugal, Northwest France, West and South Ireland (including a genetically distinct population in the Shannon estuary and a more widely ranging coastal population, moving along the west coast), Northeast Scotland (particularly the Moray Firth south to the Firth of Forth), West Scotland, North and West Wales (including all of Cardigan Bay), and parts of the English Channel. In past centuries, the species appears to have regularly occupied the southern North Sea and a number of estuaries where they are now an uncommon visitor.

The overall population size for coastal bottlenose dolphin in the area considered is at least 2700 animals, and probably in the region of 3000–4000, although separating coastal from offshore populations remains challenging in some areas. Recent population estimates and trends for coastal populations are summarised below by assessment unit (see Table B):

West Coast Scotland AU

A small resident bottlenose dolphin population numbering around 15 animals inhabits the vicinity of the Sound of Barra in the Outer Hebrides (Grellier and Wilson, 2003; Cheney *et al.*, 2013) while an estimated 30 bottlenose dolphins range around the Inner Hebrides spending periods of time around Islay, the Small Isles, Skye, and occasionally the Minch north of Skye (Cheney *et al.*, 2013). There are insufficient data to determine the population trends at this time, although the Barra population appears to be stable.

East Coast Scotland AU

Monitoring of bottlenose dolphins in the inner Moray Firth started in 1990, and was later extended to a wider part of the Firth. Although during the 1990s, bottlenose dolphins ranged all along the north and south coasts of the Moray Firth, it was not until the mid-1990s that the species started extending its range around the Grampian coast (Evans *et al.*, 2003; Wilson *et al.*, 2004). It is now regular particularly off Aberdeen, the coast of Fife and in St Andrews Bay (Weir and Stockin, 2001; Cheney *et al.*, 2013). Bottlenose dolphins, some of which have been photo-identified as from the Moray Firth population, are now seen annually along the coast of NE England as far south as Yorkshire (SeaWatch Foundation, unpublished data).

Mark–recapture Bayesian methods applied to the East coast Scotland population provided estimates of population size that vary from 87–208, with the latest estimate

(2014) being 170 (95% HPD: 139–200). Despite interannual variability, the population is considered to be stable or increasing, with no decline over the available time-series of >5% in ten years (Figure B; Cheney *et al.*, 2014).

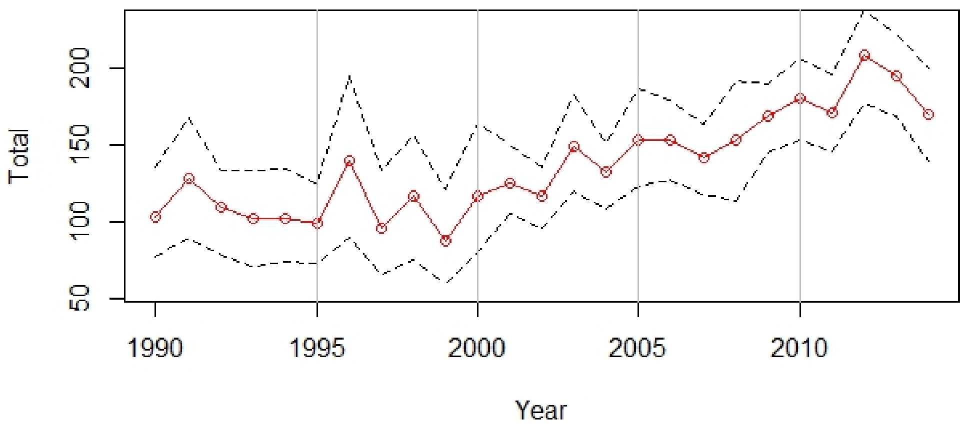


Figure B. East coast of Scotland population trend for BND (Cheney *et al.*, 2014).

Although bottlenose dolphins are occasionally recorded offshore in the North Sea and in coastal waters off SE England, northern France, Belgium, The Netherlands and Germany, there is no evidence that these are anything but transient animals, most likely from the East Coast of Scotland population or transient animals from further afield (Evans *et al.*, 2003; Camphuysen and Peet, 2006; Evans and Teilmann, 2009; ICES WGMME, 2013).

Coastal Wales AU

Annual monitoring of bottlenose dolphins in Cardigan Bay SAC, West Wales, began in 2001. This was extended to incorporate the wider Cardigan Bay area from 2005. In addition, since 2007, there have been opportunistic photo-ID surveys in the coastal waters of North Wales, and occasionally around the Isle of Man and in Liverpool Bay (Pesante *et al.*, 2008; Feingold and Evans, 2014a; Norman *et al.*, 2015). A proportion of the population inhabiting Cardigan Bay in summer ranges more widely between November and April, occurring particularly off the north coast of Anglesey, the mainland coast of North Wales and further north around the Isle of Man (Feingold and Evans, 2014b). Summer mark-recapture estimates for Cardigan Bay SAC have varied from 116–260. The latest estimate (2015) is 159 (95% CI = 130–228). For the wider Cardigan Bay (including both SACs), summer mark-recapture estimates have varied from 152–342, with the 2015 estimate being 222 (95% CI: 184–300). The Coastal Wales AU population is considered to be stable, with no decline over the available time-series of >5% over a ten year period (Figures C, D). It is noted that between 2013 and 2015, the population estimates have been among the lowest recorded but due to variability of the estimates it is too early to determine whether this represents the beginning of a decline.

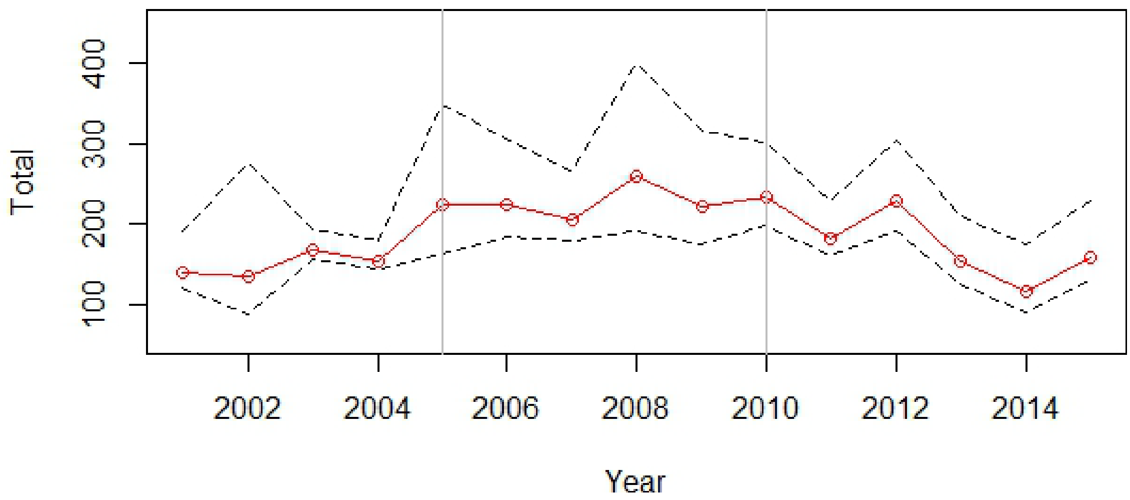


Figure C. Population trend, Cardigan SAC.

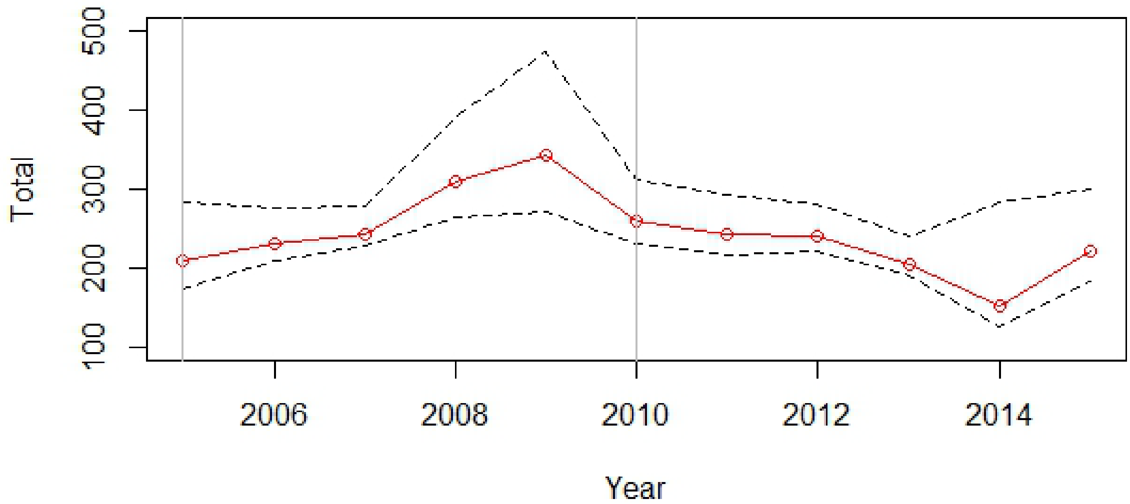


Figure D. Population trend, Wider Cardigan area.

Coastal Ireland AU

Bottlenose dolphins are regularly recorded in several bays along the west coast of Ireland, notably Kenmare River and Brandon Bay (Co. Kerry), Clew Bay and adjacent coastal areas of Connemara (Co Galway), Broadhaven Bay (Co Mayo), and Donegal Bay (Co Donegal) (Ingram *et al.*, 2001; 2003; Ó Cadhla *et al.*, 2003; Evans *et al.*, 2003). They have also been recorded all along the south coast of Ireland, but with sightings mainly around Cork Harbour (Co Cork) and Rosslare Harbour (Co Wexford) (Evans *et al.*, 2003; O'Brien *et al.*, 2009). Photo-ID matches indicate that individual bottlenose dolphins may range all around the coast of Ireland, and although there is a more or less continuous distribution from inshore to offshore, there is both photo-ID and genetic evidence of an offshore ecotype west of Ireland (O'Brien *et al.*, 2009; Mirimin *et al.*, 2011; Oudejans *et al.*, 2015). There are a number of mark–recapture population estimates for animals using the west coast of Ireland, but at different spatial scales. One estimate for NW Connemara is 171 individuals (95% CI: 100–294) in 2009 (Ingram *et al.*, 2009) and a second multi-site model averaged Bayesian assessment for a much larger area, including Connemara, Mayo and Donegal of 151 (95% CI: 140–190) for the year 2014 (Nykanen *et al.*, 2015). This mobile population appears to range widely, with seasonal and patchy habitat use. There is no information to indicate population trends.

Bottlenose dolphins inhabit the Shannon Estuary year-round, and genetic studies indicate that they form a discrete population separate from those occurring elsewhere along the west coast of Ireland (Mirimin *et al.*, 2011). Six mark–recapture population estimates have been made between 1997 and 2015, and range from 107 to 140 individuals (Ingram, 2000; Ingram *et al.*, 2008; Berrow *et al.*, 2012). The latest population estimate (2015) is 114 (95% CI: 90–143) (Rogan *et al.*, 2015) indicating that the population is stable, with no decline over the available time-series of >5% over ten years. (Figure E).

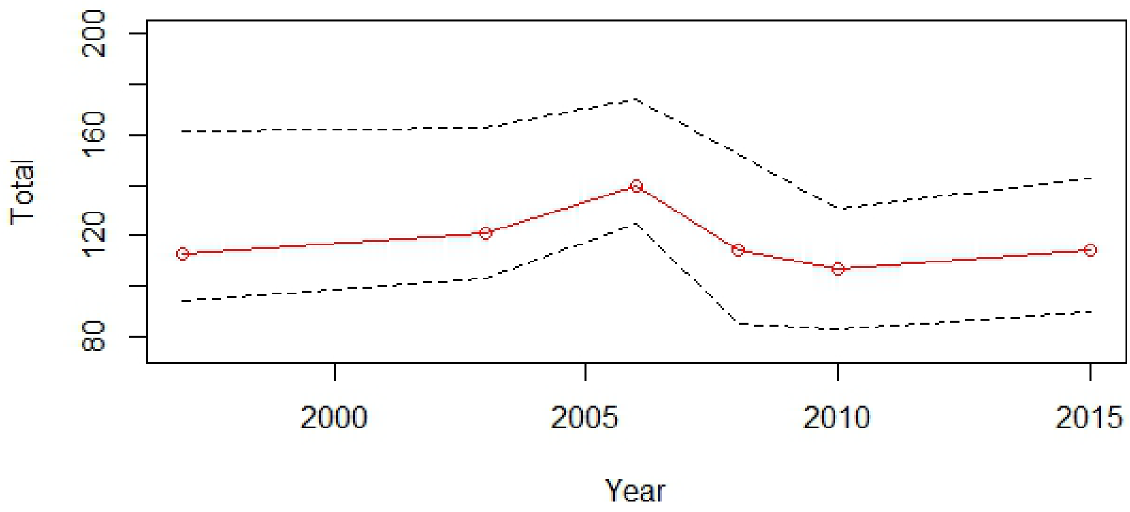


Figure E. Population trend, Shannon estuary.

Coastal Southwest England AU

Bottlenose dolphins have regularly inhabited the south and southwest coasts of England since the 1990s, being commonest around Cornwall but rare east of Dorset (Williams *et al.*, 1998; Evans *et al.*, 2003; Brereton *et al.*, in review). No systematic photo-ID surveys have been undertaken, but Brereton *et al.* (in review) have reported maximum abundance estimates for southwest England coastal waters, using two mark–recapture methods, ranging between 102 and 113 (95% CI: 87–142) over the combined period 2008–2013. There are insufficient data to assess trends against the indicator.

Coastal Normandy and Brittany AU

A resident population inhabits the Gulf of St Malo, ranging between the French coast of Normandy and the Channel Islands (Couet *et al.*, 2015a, b; Louis *et al.*, 2015). Mark–recapture estimates of this population in 2010 indicated it numbering between 372 (95% CI = 347–405) animals, with a 2014 estimate of 340 (95% CI = 290–380) (Couet *et al.*, 2015a, b; Louis *et al.*, 2015), thus indicating a stable population (Figure F).

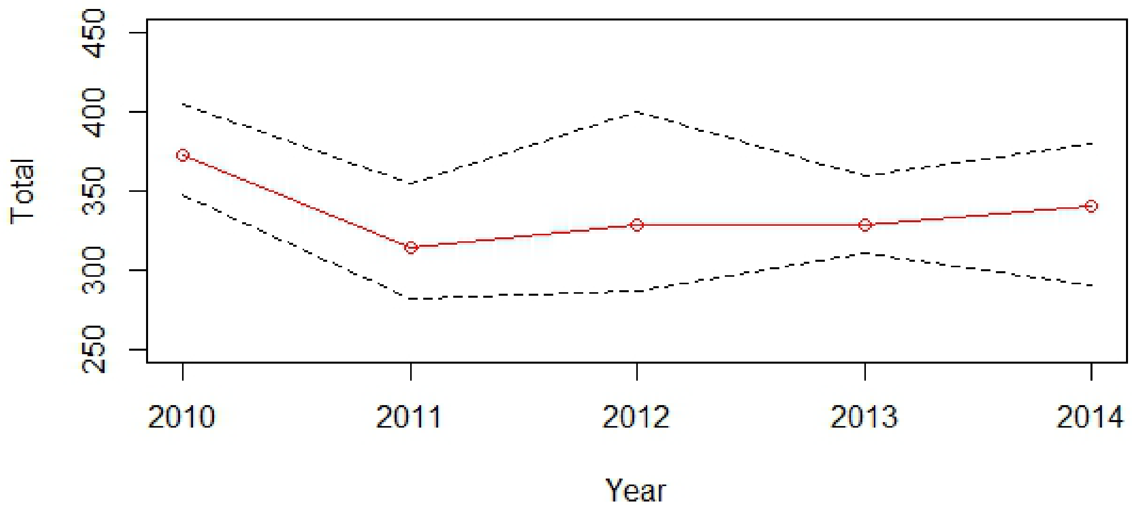


Figure F. Population trend, St Malo.

Two small populations exist in the Iroise Sea, one around Ile de Sein and the other around the Molene Archipelago which appear to be distinct. Photo-ID surveys have been undertaken in the vicinity of Ile de Sein since 2001, with at least five separate counts, ranging from 14 individuals in 2001 to 29 in 2014. An earlier estimate for this population was 14 animals in 1992, thus indicating a steady increase, with no decline over the available time-series of >5% over ten years (Figure G: Liret, 2001; Liret *et al.*, 2006).

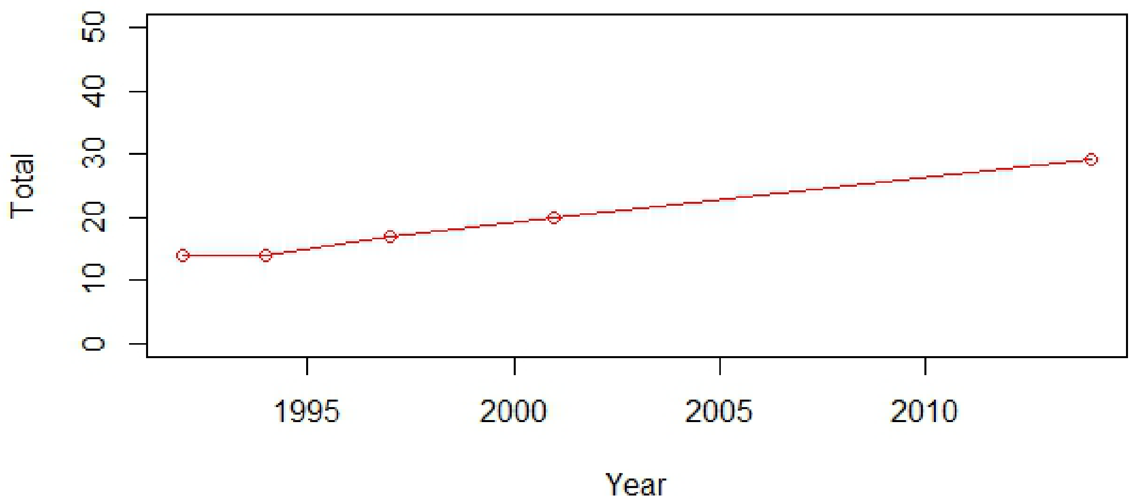


Figure G. Population trend for the Seine (Liret, 2001; Liret *et al.*, 2006).

Around the Molene Archipelago, a mark–recapture estimate of 29 individuals (95% CI = 28–42) was made from photographs taken between 1999 and 2001 (Le Berre and Liret, 2001; Liret *et al.*, 2006; Louis and Ridoux, 2015). A new photo-ID analysis is currently being undertaken (V. Ridoux, pers. comm.). It is therefore currently not possible to assess this population.

Northern Spain AU

In northern Spanish waters, only model-based abundance estimates exist, derived from line-transect surveys conducted between 2003 and 2011. These encompass both coastal and offshore animals (López *et al.*, 2013). The annual uncorrected abundance estimate in the study area is of 10 687 individuals (95% CI of 4094–18 132). Estimated abundances for the different areas are: (1) Euskadi = 1931, (2) Cantabria = 744, (3) Asturias = 1214, (4) Galicia = 703, (5) Galician Bank = 108 and (6) Aviles = 234. Although the distribution is homogeneous throughout the northern peninsula, there is a clear gradient in density, this being higher in eastern areas of Bay of Biscay where the largest groups have been recorded (López *et al.*, 2013). There are insufficient data at this time to make an assessment for this AU.

Southern Galician Rias AU (Spain)

Along the Galician coast, photo-ID surveys have been conducted between 2006 and 2009, resulting in the identification of 255 individuals (García *et al.*, 2011). A third of these photo-identified individuals (n=76) were considered to form the resident population inhabiting the Southern Galician Rias, as revealed by recapture histories, genetics and stable isotope analysis (Fernández *et al.*, 2011a, b; García *et al.*, 2011). Movements of individuals were recorded between Galicia and Euskadi in the Bay of Biscay (García *et al.*, 2011). It is not possible to make an assessment of this population at this time.

Coastal Portugal AU

Bottlenose dolphins occur widely along the coast of Portugal as well as offshore. Photo-ID surveys undertaken over two time periods have been used to derive mark–recapture population estimates of bottlenose dolphins in coastal Setúbal Bay (Martinho, 2012; Martinho *et al.*, 2015). Bottlenose dolphins identified from 1998–2001 were considered a closed and a more cohesive group than those from 2007–2011, with stable associations and an abundance of 106 (95% CI: 69–192) individuals. The more recent animals sampled seemed to be composed of an open group of 108 (95% CI: 83–177) animals, with a migration rate of 19% per year and low association values.

A wider-scale analysis of animals photographed in central west coastal Portugal from Nazaré and Sétubal Bay between 2008 and 2014 resulted in an estimate of 352 individuals (95% CI: 294–437) (Martinho, 2012; Martinho *et al.*, 2015).

The longest sequence of counts for a coastal bottlenose dolphin population in Europe is associated with the resident population in the Sado Estuary, where an annual census has been undertaken since 1986 (Gaspar, 2003; Lacey, 2015). Over this period, the population has shown a long-term decline from 39 individuals in 1986 to 27 individuals in 2014 (Figure H; Lacey, 2015). This population fails to meet the target, with a decline of over the available time-series of >5% over ten years.

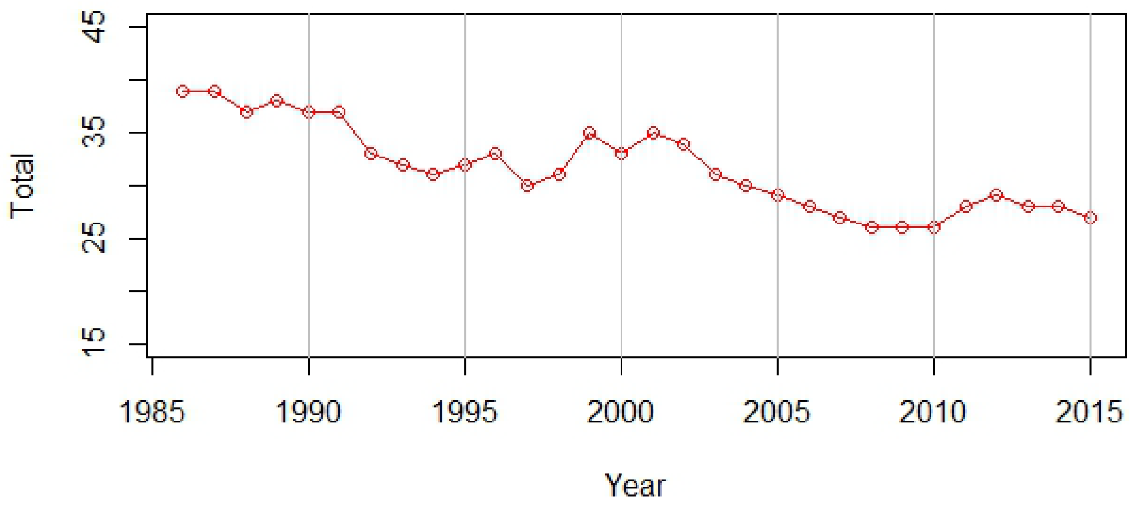


Figure H. Population trend, Sado estuary (Lacey, 2015).

Gulf of Cadiz AU

Mark–recapture estimates for bottlenose dolphins in the coastal Gulf of Cadiz have been determined for two periods: 2005–2006 and 2009–2010 (MAGRAMA, 2012). These gave estimates of 347 individuals (95% CI: 264–503) for 2005–2006, and 397 (95% CI: 300–562) for 2009–2010 suggesting a stable or increasing population. A much larger population apparently occupies the offshore Gulf of Cadiz, estimated to be 4391 (95% CI: 2373–8356) during 2009–2010 (MAGRAMA, 2012). It is not possible to make an assessment of this AU at this time.

A bottlenose dolphin population also inhabits the area around the Strait of Gibraltar, on the edge of Area IV. Photo-ID surveys in 2010 resulted in a mark–recapture population estimate of 297 individuals (95% CI: 276–332) (Portillo *et al.*, 2011). It is not possible to make an assessment of this population at this time.

Historic population losses

Since the 19th century a number of coastal bottlenose dolphin populations have declined or have disappeared altogether, such as the one that occurred until the end of the 1960s in the southern North Sea, along the shores of northern France up to The Netherlands. Bottlenose dolphins appear to have used some coastal areas for only limited periods of time. The best example is use of the Marsdiep area and the area east of Texel (The Netherlands). The species was recorded there regularly, and in relatively large numbers (up to 30–40 at a time), between 1933 and 1939 by Verwey (1975), mainly between February and May, coinciding with the migration and spawning period of the Zuiderzee herring. After the closure of the Zuiderzee Bay in 1932, the Zuiderzee herring gradually disappeared from the area, and in the late 1930s the regular occurrence of relatively large numbers of bottlenose dolphins ceased. Observations outside the Marsdiep area between the 1930s and 1970 are anecdotal, but the species was regarded as common in all Dutch waters and estuaries, second only to the harbour porpoise (Camphuysen and Peet, 2006; Camphuysen and Smeenk, 2016). After 1970, the species became scarce in Dutch waters, with strandings also declining rapidly (Figure I; Kompanje, 2001; Camphuysen and Peet, 2006; Camphuysen and Smeenk, 2016), at a similar time as a reduction in stranding records from SE England, as well as further west in SW England (Evans, 1980; Tregenza, 1992).

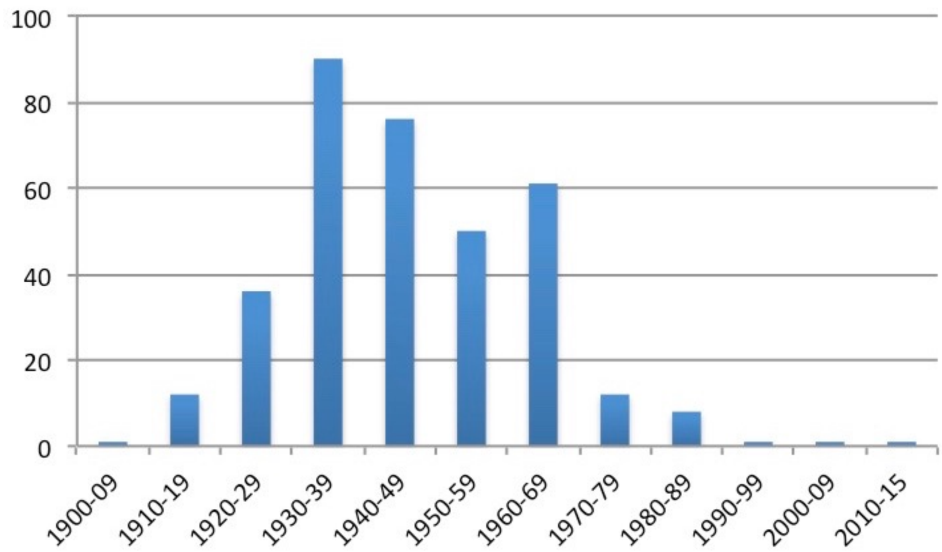


Figure I. BND strandings in the Netherlands, 1900–2015; Kompanje, 2001; Camphuysen and Peet, 2006; Camphuysen and Smeenk, 2016).

Earlier status changes are difficult to ascertain but historical accounts indicate that bottlenose dolphins occurred in the Severn Estuary, Thames Estuary, Humber Estuary, and Firth of Forth until the late 19th century (Evans and Scanlan, 1990; Nichols *et al.*, 2007). Along the coast of Germany, bottlenose dolphins occurred in the Elbe (Goethe, 1983) and Weser estuaries (Mohr, 1935; Goethe, 1983; Kölmel and Wurche, 1998) until the late 19th century. Further south, in Portuguese waters, bottlenose dolphins were reported in the Tagus estuary until 1960 (Teixeira, 1979). More recently, a coastal group persisted at Arcachon (France) between the late 1980s until it disappeared in the early 2000s, and a group of six animals occurred at Pertuis Charentais, between Ré and Oléron Islands and the French mainland, for a period in the late 1990s (V. Ridoux, O. van Canneyt and W. Dabin, personal communication).

Bottlenose dolphins appear to have used some coastal areas for limited periods of time, possibly forming ephemeral populations. For example, a group of dolphins utilized the Noirmourtier area (France) in the 1950–1960s and similar reports have been made for the Quiberon-Houat-Hoedic area (France). It is unclear whether these were truly resident coastal populations or offshore visitors that remained in the areas for a limited period of time.

Table B. Bottlenose dolphin population estimates.

	East Coast Scotland BND population				Cardigan Bay SAC BND population				Wider Cardigan Bay BND population	
	Total	95% HPDI			Total	95% CI			Total	95% CI	
1986				1986				1986			
1987				1987				1987			
1988				1988				1988			
1989				1989				1989			
1990	103	77	135	1990				1990			
1991	128	89	167	1991				1991			
1992	109	78	133	1992				1992			
1993	102	71	133	1993				1993			
1994	102	74	134	1994				1994			
1995	99	73	125	1995				1995			
1996	139	89	195	1996				1996			
1997	96	65	133	1997				1997			
1998	116	75	156	1998				1998			
1999	87	59	121	1999				1999			
2000	116	80	164	2000				2000			
2001	125	105	150	2001	140	121	192	2001			
2002	116	95	135	2002	135	88	275	2002			
2003	149	119	182	2003	167	155	194	2003			
2004	132	108	151	2004	153	143	180	2004			
2005	153	123	186	2005	223	164	349	2005	210	174	284
2006	153	127	179	2006	223	184	307	2006	230	210	275
2007	141	117	163	2007	206	179	266	2007	243	228	279
2008	153	113	191	2008	260	192	401	2008	310	264	391
2009	168	144	189	2009	221	175	315	2009	342	271	474
2010	180	153	206	2010	234	199	302	2010	259	231	311
2011	171	146	196	2011	182	160	228	2011	243	217	292
2012	208	177	237	2012	229	191	305	2012	240	220	280
2013	194	168	222	2013	153	126	211	2013	205	189	241
2014	170	139	200	2014	116	91	175	2014	152	126	282
2015				2015	159	130	228	2015	222	184	300
METHOD	M-R				M-R				M-R		
REFERENCES	2, 3				4, 5, 6				4, 5, 6		

HPDI = Highest Posterior Density Interval (Bayesian estimate) CI = Confidence Interval

	Shannon SAC BND population				NW Connemara BND population				Gulf of Saint Malo BND population		
	Total	95% CI			Total	95% CII			Total	95% CI	
1986				1986				1986			
1987				1987				1987			

1988				1988				1988			
1989				1989				1989			
1990				1990				1990			
1991				1991				1991			
1992				1992				1992			
1993				1993				1993			
1994				1994				1994			
1995				1995				1995			
1996				1996				1996			
1997	113	94	161	1997				1997			
1998				1998				1998			
1999				1999				1999			
2000				2000				2000			
2001				2001				2001			
2002				2002				2002			
2003	121	103	163	2003				2003			
2004				2004				2004			
2005				2005				2005			
2006	140	125	174	2006				2006			
2007				2007				2007			
2008	114	85	152	2008				2008			
2009				2009	171	100	294	2009			
2010	107	83	131	2010				2010	319	310	327
2011				2011				2011	337	324	349
2012				2012				2012	369	343	431
2013				2013				2013	378	365	385
2014				2014				2014	391	372	413
2015	114	90	143	2015				2015			
	M-R				M-R				M-R		
	8, 9				10				11, 12		

	GULF OF SAINT MALO BND POPULATION				ILE DE SEIN		MOLENE ARCHIPELAGO BND POPULATION		
	Total	95% CI			Total		Total	95% CI	
1986				1986		1986			
1987				1987		1987			
1988				1988		1988			
1989				1989		1989			
1990				1990		1990			
1991				1991		1991			
1992				1992	14	1992			
1993				1993		1993			
1994				1994	14	1994			
1995				1995		1995			
1996				1996		1996			
1997				1997	17	1997			
1998				1998		1998			
1999				1999					
2000				2000					
2001				2001	20	1999-2001	29	28	42
2002				2002		2002			
2003				2003		2003			
2004				2004		2004			
2005				2005		2005			
2006				2006		2006			
2007				2007		2007			
2008				2008		2008			
2009				2009		2009			
2010	420	331	521	2010		2010			
2011				2011		2011			
2012				2012		2012			
2013				2013		2013			
2014				2014	29	2014			
2015				2015		2015			
	M-R				CENSUS		M-R		
	16				14, 15		13, 15, 17		

SADO ESTUARY			SETUBAL BAY BND POPULATION				COASTAL GULF OF CADIZ BND POPULATION			
	Total	Popn Estimate		Total	95% CI			Total	95% CI	
1986	39	N/A	1986				1986			
1987	39	42 (0.5)	1987				1987			
1988	37	41 (0.7)	1988				1988			
1989	38	39 (0.3)	1989				1989			
1990	37	41 (0.7)	1990				1990			
1991	37	38 (0.2)	1991				1991			
1992	33	38 (0.4)	1992				1992			
1993	32	35 (0.5)	1993				1993			
1994	31	33 (0.0)	1994				1994			
1995	32	32 (0.0)	1995				1995			
1996	33	34 (0.3)	1996				1996			
1997	30	34 (0.3)	1997				1997			
1998	31	33 (0.3)					1998			
1999	35	37 (0.4)					1999			
2000	33	38 (0.5)					2000			
2001	35	37 (0.3)	1998-2001	106	69	192	2001			
2002	34	39 (0.6)	2002				2002			
2003	31	36 (0.4)	2003				2003			
2004	30	32 (0.0)	2004				2004			
2005	29	34 (0.7)	2005							
2006	28	33 (0.7)	2006				2005-06	347	264	503
2007	27	30 (0.2)					2007			
2008	26	28 (0.0)					2008			
2009	26	27 (0.0)								
2010	26	29 (0.4)					2009-10	397	300	562
2011	28	29 (0.0)	2007-2011	108	83	177	2011			
2012	29	30 (0.0)	2012				2012			
2013	28	30 (0.0)	2013				2013			
2014	28	29 (0.0)	2014				2014			
2015	27		2015				2015			
	CENSUS	M-R (SE)		M-R				M-R		
	23, 24	24		25, 26				21		

	STRAIT OF GIBRALTAR BND POPULATION		
	Total	95% CI	
1986			
1987			
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
1996			
1997			
1998			
1999			
2000			
2001			
2002			
2003			
2004			
2005			
2006			
2007			
2008			
2009			
2010	297	276	332
2011			
2012			
2013			
2014			
2015			
	M-R		
	20		

Other BND abundance estimates

UK - BARRA: 15 (ref 1); INNER HEBRIDES: 30 (ref 1); SW ENGLAND: max. 102 / 113 for 2008–2013 (ref 7) - MARK–RECAPTURE ESTIMATES.

NORTHEN SPANISH WATERS: 10 687 (95% CI: 4094–18 132) pooled estimate for 2003–2011 from line transect vessel surveys: regional estimates - Euskadi (1931), Cantabria (744), Asturias (1,214), Galicia (703), Bank (108), Aviles (234) (ref 19).

SOUTHERN GALICIAN RIAS, SPAIN: 76+ for 2000–2010 (cumulative number of identified individuals from photo-ID from vessel surveys) (ref 18).

REST OF GALICIA, SPAIN: 179+ for 2000–2010 (cumulative number of identified individuals from photo ID from vessel surveys) (ref 18).

CENTRAL WEST COASTAL PORTUGAL (BETWEEN NAZARE AND SETUBAL including SETUBAL BAY): 352 (95% CI: 294–437) for 2008–2014 (ref 25, 26) – MARK–RECAPTURE ESTIMATE.

WEST PORTUGAL: 2306 (34.7% CV) pooled estimate for 2010–2014 from aerial surveys; 3798 (87.6% CV) for 2011 from vessel surveys (ref 22, 27).

OFFSHORE GULF OF CADIZ: 4391 (33% CV) pooled estimate for 2009–2010 from vessel surveys (ref 21).

EASTERN MOROCCO: 737 (11% CV) in 2014 from vessel surveys (ref R. de Stephanis pers. comm.).

Conclusion (brief)

Overall population size for coastal bottlenose dolphin is estimated to comprise at least 2700 animals, and probably in the region of 3000–4000. In many locations around the eastern North Atlantic Ocean, coastal bottlenose dolphin populations have declined or disappeared during the 19th or 20th century. Where assessments could be made against the target set for the indicator, the existing populations show little long-term change with the exception of the Sado Estuary (Portugal) which is declining (i.e. failed the target set for the indicator).

Conclusion (extended)

The current bottlenose dolphin population occupying coastal waters of Western Europe probably numbers somewhere between 3000 and 4000 individuals. The majority of populations for which there are sufficient data to estimate trends show little change (i.e. met the target set for the indicator), with the exception of the Sado Estuary population in Portugal, which continues to decline (i.e. failed the target set for the indicator). A number of estuaries and enclosed bays that once held bottlenose dolphin populations no longer do so. Some of these losses occurred over a century ago, while some are more recent. Coastal bottlenose dolphins disappeared from the southern North Sea around the end of the 1960s. Local populations number 200–400 individuals, although some have less than 50 individuals. The Sado Estuary population is particularly vulnerable to local extinction given both its small population size and continued decline.

The population consequences of human activities, particularly fisheries bycatch, prey depletion, habitat deterioration (including pollutants), and disturbance from recreational activities (including commercial dolphin watching) are unclear. In addition, coastal bottlenose dolphin populations can have an ephemeral nature, probably related to prey availability. It is unknown what the consequences will be of habitat alterations due to climate change. This will depend largely upon changes in human activity and to changes in the status of bottlenose dolphin prey.

Knowledge gaps (brief)

Assessment was only possible for five populations, with an indicative assessment provided for another. The time-series of monitoring data was too short to undertake the assessment for the remaining AUs.

Historical data on abundance and distribution are either scarce or lacking.

The relationships between coastal bottlenose dolphins and wider ranging offshore populations remain unclear.

The population consequence of human activities remains to be elucidated and is compounded by the ephemeral nature of some coastal populations.

Knowledge gaps (extended)

Assessments can only be made for five coastal populations against the target set for the indicator as the monitoring in many AUs has not been undertaken for a sufficiently long period of time and several population abundance estimates are not available (i.e. at least ten years, with a minimum of four assessments during that period).An indicative assessment was made for another population where there had been four abundance estimates, but over less than ten years.

Information on historical distribution and, particularly, abundance is scarce or lacking. There are some published accounts, but much of the information is based on anecdotal accounts. Although historical reviews are currently being undertaken in some areas, it is unlikely that such information will become available in sufficient detail to quality baselines.

Defining AUs at an appropriate scale for bottlenose dolphin is challenging. Broadly, bottlenose dolphins can be divided into three types or groups related to their patterns of mobility and habitat use. These are resident, coastal and oceanic. The connectivity between these different groups is poorly understood, although they are considered to be distinct populations. As a result, within the AUs identified for coastal bottlenose dolphins, the smaller resident populations have often been included. Additionally where the coastal and offshore populations mix, it is often difficult to identify which population is being surveyed.

Human activities clearly have the ability to affect coastal bottlenose dolphins. However, the cause–effect relationships between human activities such as disturbance, pollutant loads, overfishing, and habitat alteration, and their population consequences remain to be elucidated.

Killer whale

Assessment

Additional information has been incorporated here with respect to killer whales. Although killer whales are widespread, much of the information on population structure comes from the inshore groups utilising similar monitoring methodologies to those for coastal bottlenose dolphin. The key anthropogenic pressure identified is pollution.

Killer whales are the most widely distributed of all cetacean species, and occur throughout the North Atlantic. Killer whales are regularly encountered in Icelandic and Norwegian waters (OSPAR area I) to the north of the assessment area. Within OSPAR areas II, III and IV, killer whales are most commonly sighted along the shelf edge, especially north of Shetland (OSPAR area II), in inshore Scottish waters around the Northern and Western Isles (Evans, 1988; Bolt *et al.*, 2009; Foote *et al.*, 2009) (OSPAR area III), and near the Strait of Gibraltar in OSPAR Area IV (e.g. Esteban *et al.*, 2013).

There is no overall estimate for the size of the killer whale population within OSPAR areas II, III and IV, and the information available comes from a selection of regional estimates. The Strait of Gibraltar killer whales have been shown to be a genetically distinct population to those of the northern North Atlantic (Foote *et al.*, 2011). These animals are seasonally resident in the Gulf of Cadiz (spring) and Strait of Gibraltar (summer) in association with the Atlantic bluefin tuna (*Thunnus thynnus*) on which they extensively feed (Esteban *et al.*, 2016a). This population was estimated at 39 individuals using data collected from 1999–2011. (Esteban *et al.*, 2016b). The population comprises five pods, of which two interact directly with the tuna fishery through predating fish from drop-lines (Esteban *et al.*, 2016a). Survival parameters estimated for these animals have shown a marked difference, with adult survival rates being higher in tuna fishing interacting pods (0.991, SE = 0.011) than non-interacting pods (0.901, SE= 0.050). Calving rates are also higher for the interacting pods (0.22, SE=0.02) than the non-interacting pods (0.02, SE=0.01). Only one juvenile and calf were observed among the non-interactive pods during the study period (Esteban *et al.*, 2016b).

The killer whale populations of OSPAR areas II and III have not been as extensively studied as the Gibraltar population, and equivalent information on survival parameters is not available. Killer whales around the north of the UK are known to be part of a wider population of animals utilising Icelandic and Norwegian waters as well as the area around the UK (Foote *et al.*, 2011). There is not a population estimate for this population as a whole. The NASS surveys (primarily in OSPAR area I) yielded sufficient information to estimate population size in killer whales in 1987, 1989, 1995 and 2001. However, the survey areas are not directly comparable and so these numbers cannot be used to inform a trend. The most recent estimate, for 2001, was for a population of 15 041 (CV=0.42). This population is primarily found to the north of the assessment region (OSPAR Areas II, III, and IV) in the waters of Iceland, Norway and the Faroe Islands (Figure J).

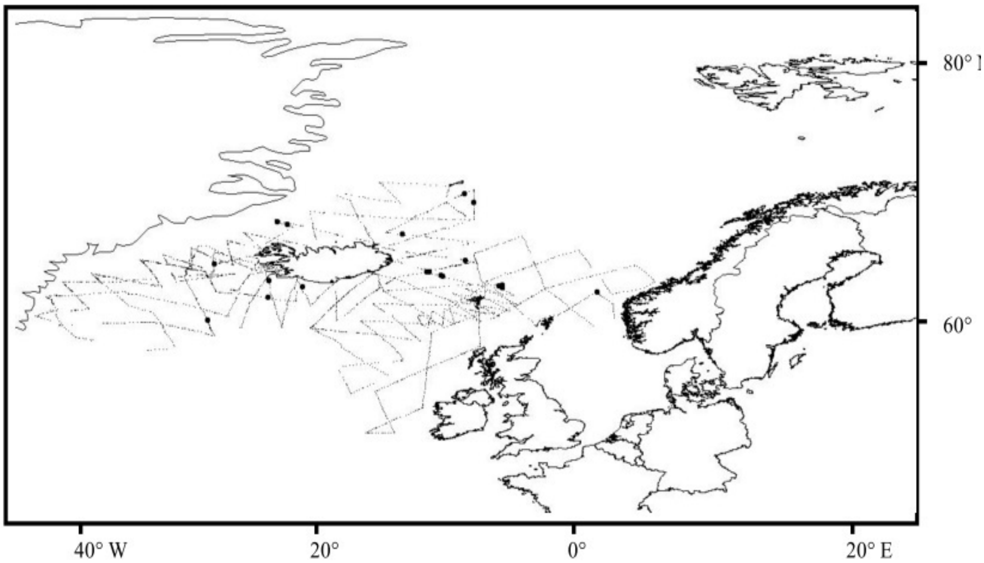


Figure J: Killer whale sightings from NASS 01 (Foote, 2007).

Within OSPAR area III, photo identification studies have identified ten individuals regularly seen around the Hebrides, as well as off the Welsh and Irish coasts. This population is genetically distinct to the other North Atlantic killer whales and this population is thought to number rather few individuals (Foote *et al.*, 2009; 2010).

Within OSPAR area II, photo identification studies have identified 24 animals around the Shetland Islands and 21 individuals elsewhere in the North Sea. These are part of a larger population of herring eating individuals numbering at least 200 animals, but primarily found out-with OSPAR area II. A subset of these animals is also known to prey on harbour seals around Shetland (Foote *et al.*, 2010).

Human pressures

ICES (2015b) reviewed and prioritised the key anthropogenic pressures on cetacean species in OSPAR areas II, III and IV. For killer whales these were identified as pollutants in all three areas, with military activity identified for areas II and III.

Killer whales, along with other odontocete species, are top predators and consequently vulnerable to bioaccumulation of pollutants. A recent study has shown that blubber samples for stranded or biopsied killer whales and bottlenose dolphins from within OSPAR areas II, III and IV contain very high levels of polychlorinated biphenyls (PCBs) (Jepson *et al.*, 2016). PCB "hot spots" included the Gulf of Cadiz and Southwest Iberia (bottlenose dolphins) and the Strait of Gibraltar (bottlenose dolphin and killer whale). Known to cause pathological changes to reproductive parameters, it has been hypothesised that high levels of PCBs in small and declining communities of coastal cetaceans may be inhibiting reproduction.

Feeding specialisation: The Gulf of Cadiz population of killer whales comprises two types of killer whales, those who interact with the drop-line tuna fishery, and those who do not. The individuals who do interact with the drop-line fishery have been shown to have higher survival rates and higher calving rates than those who do not, suggesting access to the line-caught tuna improves the success of individuals via reducing energy requirements compared to active hunting, and providing access to larger prey items (Esteban *et al.*, 2016b). As these two sets of individuals are not regularly seen intermixing, it is possible that this specialisation can lead to fragmentation of an already small population (Esteban *et al.*, 2016a). In addition, the "interacting" population is highly dependent on the drop-line fishery. No calves survived between 2005 and 2011, a period noted to coincide with a drop in tuna catches (Esteban *et al.*, 2016b).

References

Ansmann, I.C., Parra, G. J., Lanyon, J. M. and Seddon, J. M. 2012. Fine-scale genetic population structure in a mobile marine mammal: inshore bottlenose dolphins in Moreton Bay, Australia. Molecular Ecology, 21: 4472–4485.

Araújo, H., Santos, J., Rodrigues, P., Vingada, J., Eira, C., Raínho, A., Arriegas, I., Leonardo, T., Nunes, M., and Sequeira, M. 2014. First technical proposal of new SCI sites dedicated to the conservation of cetaceans in Portugal for inclusion in the National List of Sites. Annex to the 2014 Report of project LIFE MArPro NAT/PT/00038.

Bejder, L. and Samuels, A. 2003. Evaluating the effects of nature based tourism on cetaceans. In: Gales, N., Hindell, M., and Kirkwood, R. (eds.) Marine Mammals and Humans: Towards a Sustainable Balance. Collingwood, Australia: CSIRO Publishing, pp. 229–256.

Bejder, L., Samuels, A., Whitehead, H., Gales, N., Mann, J., Connor, R.C., Heithaus, M.R., Watson-Capps, J., Flaherty, C., and Krutzen, M. 2006. Decline in relative abundance of bottlenose dolphins exposed to long-term disturbance. Conservation Biology, 20: 1791–1798.

Berrow, S., O'Brien, S., Groth, L., Foley, A., and Voigt, K. 2010. Bottlenose Dolphin SAC Survey. Report to the National Parks and Wildlife Service, 1–24.

Bilgmann, K, Möller, L.M., Harcourt, R.G., Gibbs, S.E., and Beheregaray, L.B. 2007. Genetic differentiation in bottlenose dolphins from South Australia: association with local oceanography and coastal geography. Marine Ecology Progress Series, 341: 265–276.

Bolt, H. E., Harvey, P. V., Mandleberg, L. and Foote, A. D. 2009. Occurrence of killer whales in Scottish inshore waters: temporal and spatial patterns relative to the distribution of declining harbour seal populations. Aquatic Conservation: Marine and Freshwater Ecosystems, 19, pp.671–675.

Brereton, T., Jones, D., Leeves, K., Lewis, K., Davies, R., and Russell, T. In review. Population structure, mobility and conservation of Common Bottlenose Dolphin off southwest England from photo-identification studies. Journal of the Marine Biological Association of the United Kingdom.

Camphuysen C.J. and G. Peet. 2006. Whales and dolphins in the North Sea. Fontaine Uitgevers, Kortenhoef, The Netherlands.

Camphuysen C.J. and G. Peet. 2006. Whales and dolphins in the North Sea. Fontaine Uitgevers, ortenhoef, The Netherlands.

Camphuysen, C.J. and Smeenk, C. 2016. Tuimelaar *Tursiops truncatus*. In: S. Broekhuizen, J.B.M. Thissen, K.J. Canters and J.C. Buys (eds). Atlas van de Nederlandsezoogdieren. – Natuur van Nederland 12. Naturalis Biodiversity Center / European Invertebrate Survey, Leiden.

Cheney, B.J., Thompson, P.M., Ingram, S.N., Hammond, P.S., Stevick, P.T., Durban, J.W., Culloch, R.M., Elwen, S.H., Mandleberg, L., Janik, V.M., Quick, N.J., Islas-Villanueva, V., Robinson, K.P., Costa, M., Eisfeld, S.M., Walters, A., Philips, C., Weir, C.R., Evans, P.G.H., Anderwald, P., Reid, R.J., Reid, J.B., and Wilson, B. 2013. Integrating multiple data sources to assess the distribution and abundance of bottlenose dolphins (*Tursiops truncatus*) in Scottish waters. Mammal Review, 43: 71–88.

Cheney, B., Corkrey, R., Durban, J.W., Grellier, K., Hammond, P.S., Islas-Villanueva, V., Janik, V.M., Lusseau, S.M., Parsons, K.M., Quick, N.J., Wilson, B. and Thompson, P.M. 2014. Long-term trends in the use of a protected area by small cetaceans in relation to changes in population status. Global Ecology and Conservation, 2: 118-128.

Chilvers, B.L., and Corkeron, P.J. 2001. Trawling and bottlenose dolphins' social structure. Proceedings of the Royal Society of London, Series B, 268, 1901–1905.

Corkrey, R., Brooks, S., Lusseau, D., Parsons, K., Durban, J.W., Hammond, P.S., and Thompson, P.M. 2008. A Bayesian capture–recapture population model with simultaneous estimation of heterogeneity. Journal of the American Statistical Association, 103: 948–960.

Couet, P. 2015. From identification to models: reassessment of usual methods for populations monitoring. The case of bottlenose dolphin (*Tursiops truncatus*) inhabiting the English Channel. Poster presented at the international Workshop «Bottlenose dolphin conservation and monitoring in the North-western Mediterranean Sea» in Marseille, France.

Couet, P. 2015. De l'identification des animaux aux modèles mathématiques: une remise en question des méthodesusuelles de suivi des populations. Le cas de la population de grandsdauphins (*Tursiops truncatus*) en mer de la Manche. MSc thesis, Centre d'Ecologie Functionnelle & Evolutive.

Englund, A., Ingram, S. and Rogan, E. 2007. Population status report for bottlenose dolphins using the Lower River Shannon SAC, 2006–2007. Final report to the National Parks and Wildlife Service.

Esteban, R., Verborgh, P., Gauffier, P., Giménez, J., Afán, I., Cañadas, A., García, P., Murcia, J. L., Magalhães, S., Andreu, E. and de Stephanis, R. 2013. Identifying key habitat and seasonal patterns of a critically endangered population of killer whales. Journal of the Marine Biological Association of the United Kingdom, 1–9.

Esteban, R., Verborgh, P., Gauffier, P., Giménez, J., Foote, A. D. and de Stephanis, R. 2016a. Maternal kinship and fisheries interaction influence killer whale social structure. Behavioral Ecology and Sociobiology, 70, 111–122.

Esteban, R., Verborgh, P., Gauffier, P., Giménez, J., Guinet, C. and de Stephanis, R. 2016b. Dynamics of killer whale, blue fin tuna and human fisheries in the Strait of Gibraltar. Biological Conservation, 194, 31–38.

Evans, P.G.H. 1980. Cetaceans in British Waters. Mammal Review, 10: 1–52.

Evans, P.G.H. 1988. Killer whales (*Orcinus orca*) in British and Irish waters. RitFiskideildar, 11: 42–54.

Evans, P.G.H., Anderwald, P., and Baines, M.E. 2003. UK Cetacean Status Review. Report to English Nature and the Countryside Council for Wales. Sea Watch Foundation, Oxford. 160 pp.

Evans, P.G.H. and Scanlan, G. 1990. Historical Status Changes of Cetaceans in British and Irish waters. European Research on Cetaceans, 3: 51–57.

Evans, P.G.H. and Teilmann, J. Editors. 2009. Report of ASCOBANS/HELCOM Small Cetacean Population Structure Workshop. ASCOBANS/UNEP Secretariat, Bonn, Germany. 140 pp.

Feingold, D. and Evans, P.G.H. 2014a. Bottlenose Dolphin and Harbour Porpoise Monitoring in Cardigan Bay and Pen Llyna'rSarnau Special Areas of Conservation 2011–2013. Natural Resources Wales Evidence Report Series No. 4. 124 pp.

Feingold, D. and Evans, P.G.H. 2014b. Connectivity of Bottlenose Dolphins in Welsh Waters: North Wales Photo-Monitoring Report. Natural Resources Wales Research Report. 15 pp.

Fernández, R., Garcia-Tiscar, S., Santos, M.B., López, A., Martinez-Cedeira, J.A., Newton, J., and Pierce, G.J. 2011b. Stable isotope analysis in two sympatric populations of bottlenose dolphins *Tursiops truncatus*: evidence of resource partitioning? Marine Biology, 158: 1043–1055.

Fernández, R., Santos, M.B., Pierce, G.J., Llavona, A., López, A., Silva, M.A., Ferreira, M., Carrillo, M., Cermeño, P., Lens, S., and Piertney, S.B. 2011a. Fine-scale genetic structure of bottlenose dolphins, *Tursiops truncatus*, in Atlantic coastal waters of the Iberian Peninsula. Hydrobiologica 670: 111–125.

Foote, A. D., Newton, J., Piertney, S. B., Willerslev, E. and Gilbert, M. T. P. 2009. Ecological, morphological and genetic divergence of sympatric North Atlantic killer whale populations. Molecular Ecology, 18, 5207–5217.

Foote, A. D., Similä, T., Víkingsson, G. A. and Stevick, P. T. 2010.Movement, site fidelity and connectivity in a top marine predator, the killer whale. Evolutionary Ecology, 24, 803–814.

Foote, A.D., Vikingsson, G., Oien, N., Bloch, D., Davis, C.G., Dunn, T.E., Harvey, P., Mandelberg, L., Whooley, P. and Thompson, P.M. 2007. Distribution and abundance of killer whales in the North East Atlantic. Paper SC/59/SM5 presented to the Scientific Committee of the International Whaling Commission.

Foote, A. D., Vilstrup, J. T., De Stephanis, R., Verborgh, P., Abel Nielsen, S. C., Deaville, R., Kleivane, L., Martín, V., Miller, P. J. O., Øien, N., Pérez-Gil, M., Rasmussen, M., Reid, R. J., Robertson, K. M., Rogan, E., Similä, T., Tejedor, M. L., Vester, H., Víkingsson, G. A., Willerslev, E., Gilbert, M. T. P. and Piertney, S. B. 2011. Genetic differentiation among North Atlantic killer whale populations. Molecular Ecology, 20, 629–641.

García, N., Caldas, M., Palacios, G., Moldes, M., Leal, A., and López, A. 2011. Photo-identification and population movements of bottlenose dolphins *Tursiops truncatus*, along the Galician coast, NW Iberia. Poster, 25th Annual Conference of the European Cetacean Society, 21–23 March 2011, Cadiz, Spain.

Gaspar, R. 2003. Status of the Resident Bottlenose Dolphin Population in the Sado Estuary: Past, Present and Future. Doctoral Thesis. University of St Andrews, Scotland. 194 pp.

Goethe, F. 1983. Wale und Delphine in nieder sächsischen Küsten gewässern und Flüssen, Drosea, 1983: 49–68.

Goetz, S., Read, F.L., Santos, M.B., Pita, C., and Pierce, G.J. 2014. Cetacean-fishery interactions in Galicia (NW Spain): results and management implications of a face-to-face interview survey of local fishers. ICES Journal of Marine Science, 71(3): 604–617.

Grellier, K. and Wilson, B. 2003. Bottlenose dolphins using the Sound of Barra Scotland. Aquatic Mammals 29: 378–382.

Hoelzel, A.R. 1998. Genetic structure of cetacean populations in sympatry, parapatry and mixed assemblages; implications for conservation policy. Journal of Heredity, 89: 451–458.

ICES. 2013. Report of the Working Group on Marine Mammal Ecology (WGMME), 4–7 February 2013, Paris, France. ICES CM 2013/ACOM:26. 117pp.

ICES. 2014. OSPAR request on implementation of MSFD for marine mammals. Special request. Available from:

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/Special%20Requests/OSPAR_Implementation_of_MSFD_for_marine_mammals.pdf

ICES. 2015a. Report of the Working Group on Bycatch of Protected Species (WGBYC), 2–6 February 2015, ICES Headquarters, Copenhagen, Denmark. ICES CM 2015\ACOM:26. 82pp.

ICES. 2015b. Report of the Working Group on Marine Mammal Ecology (WGMME), 9–12 February 2015, London, UK. ICES CM 2015/ACOM:25. 114 pp.

Ingram, S.N. 2000. The ecology and conservation of bottlenose dolphins in the Shannon Estuary, Ireland. PhD thesis, University College Cork, Ireland. 213 pp.

Ingram, S. and Rogan, E. 2003. Estimating abundance, site fidelity and ranging patterns of bottlenose dolphins (*Tursiops truncatus*) in the Shannon Estuary and selected areas of the west-coast of Ireland. Report to the National Parks and Wildlife Service**,** 1–28.

Ingram, S.N., Englund, A., and Rogan, E. 2001. An extensive survey of bottlenose dolphins (*Tursiops truncatus*) on the west coast of Ireland. Heritage Council Report no. WLD/2001/42 17 pp.

Ingram, S.N., Englund, A., and Rogan, E. 2003. Habitat use, abundance and site-fidelity of bottlenose dolphins (*Tursiops truncatus*) in Connemara coastal waters, Co Galway. Heritage Council Wildlife Grant #12314. 27pp.

Ingram, S., Kavanagh, A., Englund, A., and Rogan, E. 2009. Site assessment of the waters of Northwest Connemara. A survey of bottlenose dolphins (*Tursiops truncatus*).Report to the National Parks and Wildlife Service, 1–33.

Jepson, P.D., Deaville, R., Barnett, J., Davison, N.I., Paterson, I.A.P., Penrose, R.S., Perkins, M.P., Reid, R.J., and Law, R.J. 2013. Persistent organic pollutants in UK stranded cetaceans (1990–2008): linking exposure with toxic effects. In: P.G.H. Evans (ed.) Chemical Pollution and Marine Mammals. European Cetacean Society Special Publication 55: 18–24.

Jepson, P. D., Deaville, R., Barber, J. L., Aguilar, À., Borrell, A., Murphy, S., Barry, J., Brownlow, A., Barnett, J., Berrow, S., Cunningham, A. A., Davison, N. J., Doeschate, M., Esteban, R., Penrose, R., Perkins, M. W., Smith, B., Stephanis, R. De, Tregenza, N., Verborgh, P., Fernández, A. and Law, R. J. 2016. PCB pollution continues to impact populations of orcas and other dolphins in European waters. Nature Scientific Reports, 6:18573. DOI: 10.1038/srep18573.

Keijl, G.O., Begeman, L., Camphuysen, C.J., Cremers, H.W.J.M., Hiemstra, S., IJsseldijk, L.L., Kamminga, P. and Osinga, N. In press. Cetaceans stranded in The Netherlands in 2008–2014. Lutra.

Kölmel, R. and Wurche, B. 1998. Wale aus der Elbe: Die Arten und ihre Fund- und Fangberichte. Schriften reihe Natureum Nieder elbe, 2: 10–35.

Kompanje, E.J.O. 2001. Review of strandings and catches of *Tursiops truncates* (Mammalia: Cetacea, Odontoceti) in the Netherlands between 1754 and 2000. Deinsea, 1(8): 169–224

Krützen, M., Sherwin, W.B., Berggren, P. and Gales, N. 2004. Population structure in an inshore cetacean revealed by microsatellite and mtDNA analysis: bottlenose dolphins (*Tursiops* spp.) in Shark Bay, Western Australia. Marine Mammal Science, 20: 28–47.

Lacey, C. 2015.Current status of the resident bottlenose dolphin population in the Sado Estuary, Portugal. Unpublished MSc dissertation, University of Edinburgh.

Liret, C. 2001. Domaine vital, utilization de l'espaceet des ressources: les grands dauphins, *Tursiops truncatus*, de l'île de Sein. Thèse de doctorat de l'Université de BretagneOccidentale, Brest. 155pp.

Liret, C., Baines, M.E., Evans, P.G.H., Hammond, P.S. and Wilson, B. 2006. Atlantic bottlenose dolphins: conservation and management. Oceanopolis, Brest, France. 56 pp.

Liret, C., Creton, P., Evans, P.G.H., Heimlich-Boran, J.R. and Ridoux, V. 1998. English and French coastal *Tursiops* from Cornwall to the Bay of Biscay, 1996. Photo-Identification Catalogue. Project sponsored by Ministère de L'Environnement, France and Sea Watch Foundation, UK. 100 pp.

López, A., Pierce, G.J., Santos, M.B., Gracia, J., and Guerra, A. 2003. Fishery bycatches of marine mammals in Galician waters: results from on-board observations and an interview survey of fishermen. Biological Conservation, 111: 25-40.

López, A., Vázquez, J.A., Martínez-Cedeira, J.A., Marcos-Ipiña, E., Laria, L., Maestre, I., Carbo, A., Llanova, A., Fernández, M., Díaz, J.L., Santos, L., Ruano, A., Fernández, R., y Méndez, P. 2012. Bases para el desarrollo de los planes de conservación de las espaceies de cétaceos protegidas en la Demarcación Marina Noratlantica. Volumen 2 Impactos. Ministerio de Agricultura, Alimentacíon y Medio Ambiente-Fundación Biodiversidad.

López, A., Vázquez, J. A., Martínez, J., Cañadas, A., Marcos, E., Maestre, I., Ruano, A., Laria, L., Llanova, A., Macleod, K. and Evans, P. 2013. New abundance estimates for harbour porpoise (*Phocoena phocoena*) and bottlenose dolphin (*Tursiops truncatus*) in Northern Spanish Cantabrian and adjacent waters of Bay of Biscay (2003–2011). Poster presented at the 27th European Cetacean Society Annual Conference, 8th–10th April, 2013, Setúbal, Portugal.

Louis, M., Fontaine, M.C., Spitz, J., Schlund, E., Dabin, W., Deaville, R., Caurant, F., Cherel, Y., Guinet, C. and Simon-Bouhet, B. 2014b. Ecological opportunities and specializations shaped genetic divergence in a highly mobile marine top predator. Proc. R. Soc. B 281: 20141558. http://dx.doi.org/10.1098/rspb 2014.1558.

Louis, M., Gally, F., Barbraud, C., Béesau, J., Tixier, P., Simon-Bouhet, B., Le Rest, K., and Guinet, C. 2015. Social structure and abundance of coastal bottlenose dolphins, *Tursiops truncatus*, in the Normano-Breton Gulf, English Channel. Journal of Mammalogy, DOI:10.1093/jmamma/gyv053.

Louis, M. and Ridoux, V. 2015. Suivi des grands dauphins et des petits cétacés dans le Parc naturel marind'Iroise. Rapport Convention n° 920/UMS 3462/PNMI.

Louis, M., Viricel, A., Lucas, T., Peltier, H., Alfonsi, E., Berrow, S., Brownlow, A., Covelo, P., Dabin, W., Deaville, R., de Stephanis, R., Gally, F., Gauffier, P., Penrose, R., Silva, M. A., Guinet, C. and Simon-Bouhet, B. 2014b.Habitat-driven population structure of bottlenose dolphins, *Tursiops truncatus*, in the North-East Atlantic. Molecular Ecology; 23, 857–874.

MAGRAMA. 2012. Estrategias Marinas. Grupo Mamíferos Marinos. Evaluación inicial y buen estado ambiental. Technical report.

Martinho F. 2012. Residency and behavioural patterns of coastal bottlenose dolphins (*Tursiops truncatus*) in the Arrábida and Tróia shores (Portugal).MSc thesis, Faculdade de Ciências da Universidade de Lisboa, Portugal. 80 pp.

Martinho, F., Pereira, A., Brito, C., Gaspar, R., and Carvalho, I. 2015. Structure and abundance of bottlenose dolphins (*Tursiops truncatus*) in coastal Setúbal Bay, Portugal. Marine Biology Research, 11(2): 144–156 (DOI: 10.1080/ 17451000.2014.894244).

Mirimin, L., Miller, R., Dillane, E., Berrow, S.D., Ingram, S., Cross, T.F., and Rogan, E. 2011. Fine-scale population genetic structuring of bottlenose dolphins in Irish coastal waters. Animal Conservation, 14: 342–353.

Mohr, E. 1935. Historisch-zoologische Walfischstudien. Nordelbingen, 11: 335–393.

Möller, L.M, and Beheregaray, L.B. 2004.Genetic evidence for sex-biased dispersal in resident bottlenose dolphins (*Tursiops aduncus*). Molecular Ecology, 13: 1607–1612.

Natoli, A., Birkun, A., Aguilar, A., López, A., and Hoelzel, A.R. 2005. Habitat structure and the dispersal of male and female bottlenose dolphins (*Tursiops truncatus*). Proceedings of the Royal Society B - *Biological Sciences*, 272: 1217–1226.

Nichols, C., Herman, J., Gaggiotti, O.E., Dobney, K.M., Parsons, K. and Hoelzel, A.R. 2007. Genetic isolation of a now extinct population of bottlenose dolphins (*Tursiops truncatus*). Proceedings of the Royal Society B, 274. DOI: 10.1098/rspb.2007.0176.

Norman, E.B., Dussan-Duque, S., and Evans, P.G.H. 2015. Bottlenose dolphins in Wales: Systematic mark–recapture surveys in Welsh waters. Natural Resources Wales Evidence Report Series No. 85. Natural Resources Wales, Bangor. 83 pp.

Nykanen, M., Ingram, S.D., and Rogan, E. 2015. West coast dolphins (*Tursiops truncatus*): abundance, distribution, ranging patterns and habitat use. Report to the National Parks and Wildlife Service, pp. 1–33.

O'Brien, J.M., Berrow, S.D., Ryan, C., McGrath, D., O'Connor, I., Pesante, G., Burrows, G., Massett, N., Klötzer, V., and Whooley, P. 2009. A note on long-distance matches of bottlenose dolphins (*Tursiops truncatus*) around the Irish coast using photo-identification. Journal of Cetacean Research and Management, 11: 69–74.

Ó Cadhla, O., Englund, A., Philpott, E., Mackey, M. and Ingram, S.N. 2003. Marine mammal monitoring in the waters of Broadhaven Bay and Northwest Mayo: 2001–2002. Report to Enterprise Energy Ireland Ltd, 74 pp.

Oudejans, M., Ingram, S., Englund, A., Visser, F. and Rogan, E. 2010. Bottlenose dolphins in Connemara and Mayo 2008–2009. Movement patterns between two coastal areas in the west of Ireland. Report to the National Parks and Wildlife Service Department of the Environment, Heritage and Local Government.

Oudejans, M., Visser, F., Englund, A., Rogan, E., and Ingram, S.N. 2015. Evidence for Distinct Coastal and Offshore Communities of Bottlenose Dolphins in the North East Atlantic. PLOS One, DOI:10.1371/journal.pone.0122668.

Pesante, G., Evans, P.G.H., Baines, M.E., and McMath, M. 2008. Abundance and Life History Parameters of Bottlenose Dolphin in Cardigan Bay: Monitoring 2005–2007. CCW Marine Monitoring Report No. 61: 75 pp.

Pirotta, E., Merchant, N.D., Thompson, P.M., Barton, T.R., and Lusseau, D. 2015. Quantifying the effect of boat disturbance on bottlenose dolphin foraging activity. Biological Conservation, 181: 82–89.

Pirotta, E., Thompson, P.M., Cheney, B., Donovan, C.R., and Lusseau, D. 2014. Estimating spatial, temporal and individual variability in dolphin cumulative exposure to boat traffic using spatially explicit capture–recapture methods. Animal Conservation, DOI: 10.1111/acv.12132.

Portillo, C., Jiménez-Torres, C., Pérez, S., Verborgh, P., Gauffier, P., Esteban, R., Giménez, J., Santos-Vegas, M., Cazalla, E., and de Stephanis, R. 2011. Survival rate, abundance and residency of bottlenose dolphins in the Strait of Gibraltar. Poster.25th Conference of the European Cetacean Society, 21–23 March 2011, Cádiz. Spain.

Quérouil, S., Silva, M.A., Freitas, L., Prieto, R., Magalhães, S., Dinis, A., Alves, F., Matos, J.A., Mendonça, D., Hammond, P., and Santos, R.S. 2007. High gene flow in oceanic bottlenose dolphins (*Tursiops truncatus*) of the North Atlantic. Conservation Genetics, 8: 1405–1419.

Richards, V.P., Greig, T.W., Fair, P.A., McCulloch, S.D., Politz, P., Natoli, A., Driscoll, C.A. Hoelzel, A.R., David, V., Bossart, G.D., and Lopez, J.V. 2013. Patterns of population structure for inshore bottlenose dolphins along the eastern United States. Journal of Heredity, 104(6): 765-778.

Rogan, E., Nykanen, M. Gkaragkouni, M., and Ingram, S.N. 2015. Bottlenose dolphin survey in the lower River Shannon SAC, 2015. Report to the National Parks and Wildlife Service, pp. 1–21.

Rosel, P. E., Hansen, L., and Hohn, A. A. 2009. Restricted dispersal in a continuously distributed marine species: common bottlenose dolphins *Tursiops truncatus* in coastal waters of the western North Atlantic. Molecular Ecology, 18: 5030–5045.

Santos, J., Araújo, H., Ferreira, M., Henriques, A., Miodonski, J., Monteiro, S., Oliveira, I., Rodrigues, P., Duro, G., Oliveira, F., Pinto, N., Sequeira, M., Eira, C. and Vingada, J. 2012. Chapter I: Baseline estimates of abundance and distribution of target species. Annex to the Midterm Report of Project LIFE MarPro NAT/PT/00038.

Teixeira, A.M.A.P. 1979. Marine mammals of the Portuguese coast. Z. Säugetierkunde, 44: pp. 221–238.

Thompson, P. M., Lusseau, D., Corkrey, R. and Hammond, P. S. 2004. Moray Firth bottlenose dolphin monitoring strategy options. Scottish Natural Heritage Commissioned Report No. 079 (ROAME No. F02AA409).

Toth, J. L. Hohn, A. A. Able, K. W., and Gorgone, A. M. 2012. Defining bottlenose dolphin (*Tursiops truncatus*) stocks based on environmental, physical, and behavioral characteristics. Marine Mammal Science, 28(3): 461–478.

Tregenza, N. J. C. 1992. Fifty years of cetacean sightings from the Cornish coast, SW England. Biological Conservation, 59: 65–70.

Vázquez, J. A., Cañadas, A., Martínez-Cedeira, J., López, A., Tejedor, M., Gauffier, P., Gazo, M., and Brotons, J. M. 2014. Docuemento técnico sobre la incidencia de la captura accidental de especies de cetáceo amenazadas en artes de pesca. Informe realizado para el Ministerio de Agricultura, Alimentacíon y Medio Ambiente. 95 pp.

Vélez, M. 2014. Interacciones entre cetáceos, Tortugas y pesquerías en el Golfo de Cádiz. MSc Thesis, University of Cádiz. 65 pp.

Verwey, J. 1975. The cetaceans *Phocoena phocoena* and *Tursiops truncatus* in the Marsdiep area (Dutch Waddensea) in the years 1931–1973. Nederlands Instituut voor Onderzoek der Zee, 17a, b: 1–153.

Weir, C.R. and Stockin, K.A. 2001. The occurrence and distribution of bottlenose dolphins (*Tursiops truncatus*) and other cetacean species in the coastal waters of Aberdeenshire, Scotland. Sea Watch Foundation, Aberdeen. 68 pp.

Williams, A. D., Williams, R., Heimlich-Boran., J. R., Evans, P. G. H., Tregenza, N. J. C., Ridoux, V., Liret, C. and Savage, S. 1997. A preliminary report on an investigation into bottlenose dolphins (*Tursiops truncatus*) of the English Channel: a collaborative approach. European Research on Cetaceans, 10: 217–220.

Wilson, B., Reid, R. J., Grellier, K., Thompson, P. M., and Hammond, P. S. 2004. Considering the temporal when managing the spatial: a population range expansion impacts protected areas-based management for bottlenose dolphins. Animal Conservation, 7: 331–338.

Wiszniewski, J., Allen, S. J., and Moeller, L. M. 2009. Social cohesion in a hierarchically structured embayment population of Indo-Pacific bottlenose dolphins. Animal Behaviour, 77: 1449–1457.

Wiszniewski, J., Beheregaray, L. B, Allen, S. J., and Möller, L. M. 2010. Environmental and social influences on the genetic structure of bottlenose dolphins (*Tursiops aduncus*) in Southeastern Australia. Conservation Genetics. 11:1405–1419.

Annex 6: M-4 Abundance and distribution of cetaceans other than coastal bottlenose dolphins (D1.1-Species Distribution, D1.2-Population Size)

Key message

Cetaceans are widely distributed, occur in a range of habitats and are overall abundant in OSPAR Regions II, III and IV. For most species there is only one robust estimate of abundance. For those species for which there are multiple estimates of abundance, the time-series are short relative to the life cycle of the species and the precision of the estimates is generally low leading to poor power to detect trends from these data. It is therefore not possible to infer with any confidence whether populations are decreasing, stable or increasing. However, there has been a clear shift in harbour porpoise distribution from north to south in the North Sea. Notwithstanding the inability to detect trends, recent estimates of abundance are either similar to or larger than comparable earlier estimates. Despite the multiple pressures and threats facing cetaceans in this region, with the data available, there is currently no evidence of an impact of anthropogenic activity on either distribution or abundance of cetacean species in OSPAR Regions II, III and IV. More data are needed to make an informed assessment; results from a large-scale survey in summer 2016 will aid this process.

Background (brief)

Cetaceans make up an important component of marine biodiversity (Figure A) and their abundance and distribution are key indicators of environmental status. A total of 35 different species of cetacean have been recorded within OSPAR areas II, III, and IV. Many are widely dispersed oceanic species that are rarely seen in European Atlantic waters and thus impossible to monitor systematically. Accordingly, this indicator is mainly restricted to assessing those species for which robust information on abundance and distribution is available. This information comes primarily from a small number of large-scale systematic surveys.

A number of human activities may impact the abundance and distribution of cetaceans. In the past, direct removals from hunting had severe effects on populations, and fisheries bycatch today may also have a similar potential if not controlled. However, although other pressures and threats such as chemical and noise pollution are known to affect individual animals, the effects of these on populations are not well understood. Notwithstanding this, cetaceans are important top predators and charismatic species of general public concern. It is therefore important to monitor distribution and abundance, and to assess any changes in the context of human activities and broader climate change.

This indicator considers information on abundance and distribution in OSPAR Regions II, III and IV and assesses where possible the status of the following species: harbour porpoise *Phocoena phocoena*, offshore common bottlenose dolphin *Tursiops truncatus* (inshore bottlenose dolphins are considered in a separate document), white-beaked dolphin, *Lagenorhynchus albirostris*, short-beaked common dolphin *Delphinus delphis*, striped dolphin *Stenella coeruleoalba*, minke whale *Balaenoptera acutorostrata,* fin whale *B. physalus*, long-finned pilot whale *Globicephala melas*, sperm whale, *Physeter* *macrocephalus* and beaked/bottlenose whales as a combined species group (Ziphiidae). Killer whales are also considered in the separate document.

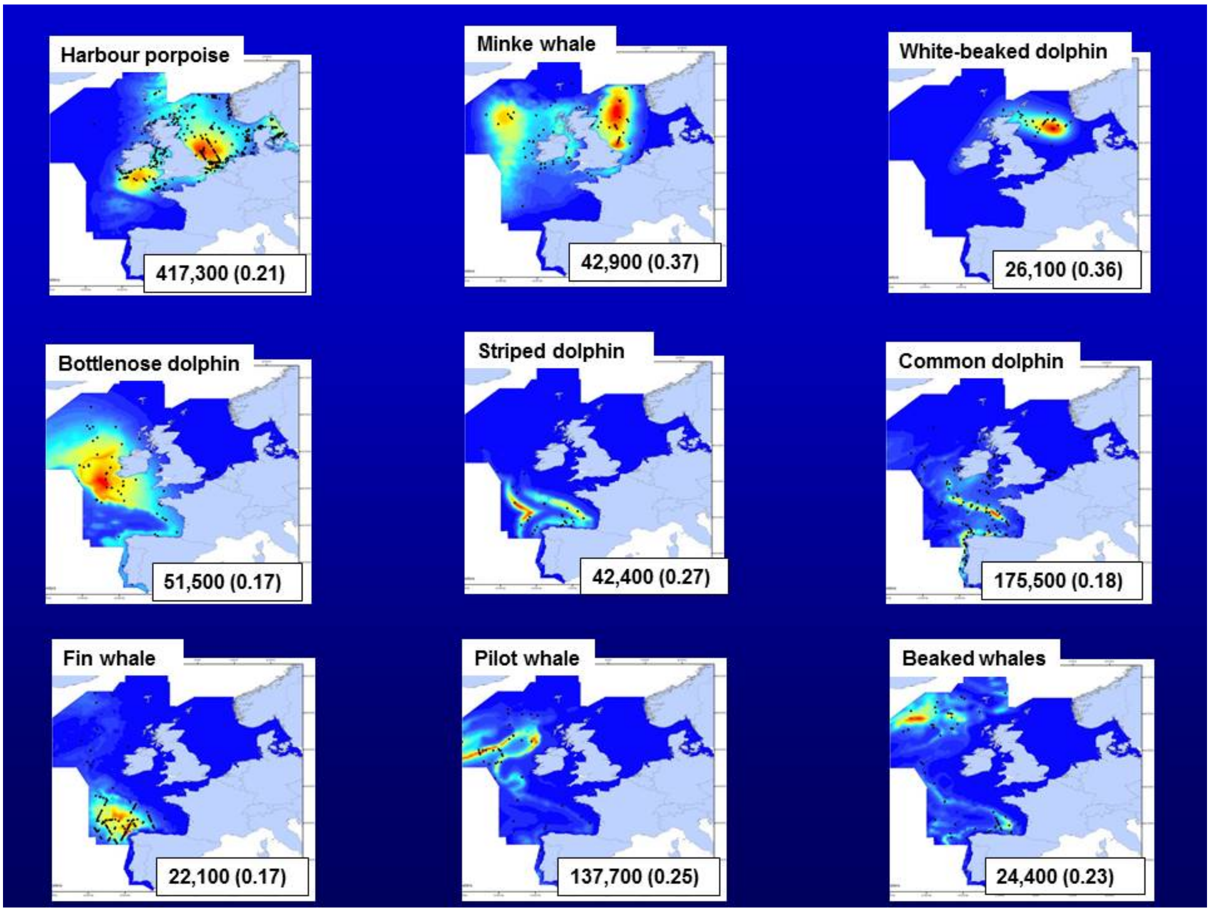


Figure A. Maps of model-predicted density of various cetacean species from analyses of combined SCANS-II, CODA and T-NASS data in summer 2005 and 2007 in the European Atlantic. Cetaceans are distributed widely across this area and the relatively small amount of overlap in predicted high-use areas highlights how the different species utilise the environment in different ways. SCANS-II = Small Cetacean Abundance in the European Atlantic and North Sea (Hammond *et al.*, 2013). CODA = Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA 2009). T-NASS = Trans North Atlantic Sightings Survey (http://www.nammco.no/)

Background (extended)

Introduction

Cetaceans make up an important component of marine biodiversity in European Atlantic waters, which is clearly shown by observation of their distribution and abundance.

Data from systematic large-scale surveys in 2005 and 2007 have been analysed using models that relate cetacean density to features of the habitat to produce maps of predicted distribution of various cetacean species in the European Atlantic (Figure A). These maps indicate that cetaceans are distributed widely across this area and the relatively small amount of overlap in predicted high-use areas highlights how the different species utilise the environment in different ways, at least in summer.

Analyses of these and other similar data also allow the abundance of these species to be estimated. Results of these analyses show that hundreds of thousands of individual whales, dolphins and porpoises live in European Atlantic waters. Although 35 different species of cetacean have been recorded within OSPAR Regions II, III, and IV (Waring *et al.*, 2009), many are widely dispersed oceanic species that are rarely seen in European Atlantic waters and thus impossible to monitor systematically. Accordingly, this indicator is mainly restricted to assessing those species for which robust information on abundance and distribution is available.

Cetaceans are subject to a range of anthropogenic pressures and threats, some of which have negative impacts at the individual level, ranging from increased stress and higher energetic costs, through sublethal effects on reproduction and immune function, to mortality. In more serious cases, effects may be manifest at population level (see JNCC, 2007; Hammond *et al.*, 2008; MAGRAMA, 2012). These pressures and threats include incidental bycatch in fishing gear (Silva *et al.*, 2011; Arbelo *et al.*, 2013; ICES, 2014a), collisions with ships (e.g. Laist *et al.*, 2001; Panigada *et al.*, 2006; Evans *et al.*, 2011; Arbelo *et al.*, 2013), underwater noise generated by shipping or seismic activities (e.g. Evans and Nice, 1996; Gordon *et al.*, 2003; David, 2006; Arbelo *et al.*, 2013; Jepson *et al.*, 2013), prey depletion caused by overfishing, habitat loss or degradation, pollution (e.g. Berggren *et al.*, 1999; Bennet *et al.*, 2001; Beineke *et al.*, 2005; Davison *et al.*, 2011; Law *et al.*, 2012; Méndez-Fernández *et al.*, 2014a,b; Murphy *et al.*, 2015; Jepson *et al.*, 2016), marine debris (e.g. Laist, 1987, 1997; WDCS, 2011; ASCOBANS, 2013; Baulch and Perry, 2014; Lusher *et al.*, 2015), offshore development of oil, gas and renewable energy, the effects of which include underwater noise as well as potential habitat loss or collision risk associated with installations (e.g. Wilson *et al.*, 2007; Bailey *et al.*, 2014), and climate change (Evans and Bjørge, 2013).

The threats/pressures listed (see Table A) represent those thought to have most relevance to marine mammals and were developed by WGMME in 2015 (ICES, 2015). They were extracted from the list of pressures (grouped by pressure themes) agreed by the Intersessional Correspondence Group on Biodiversity Assessment and Monitoring (ICG-COBAM, 2012). Threat levels are classified as high, medium or low (i.e. following a traffic light system), for each species-region combination, using the following criteria:

> High (red) = evidence or strong likelihood of negative population effects, mediated through effects on individual mortality, health and/or reproduction;
>
> Medium (yellow) = evidence or strong likelihood of impact at individual level on survival, health or reproduction but effect at population level is not clear;
>
> Low (green) = possible negative impact on individuals but evidence is weak and/or occurrences are infrequent.

The category "other" (no colour) was also defined for cases where there was little or no information on the impact of these pressures on marine mammals or the threat is absent or irrelevant (in this latter case it was indicated in the corresponding cell in the table) for a particular region-species combination. Results reflect both regional differences in pressures and differences in species biology or habitat. Thus squid/octopus-eating species are more likely to ingest plastic bags, beaked whales are particularly susceptible to mid-frequency sonar and coastal species are generally exposed to higher levels of pollutants.

This indicator considers information on abundance and distribution and assesses where possible the status of the following species: harbour porpoise *Phocoena*, offshore common bottlenose dolphin *Tursiops truncatus* (inshore bottlenose dolphins are considered in a separate form), white-beaked dolphin, *Lagenorhynchus albirostris*, short-beaked common dolphin *Delphinus delphis*, striped dolphin *Stenella coeruleoalba*, minke whale *Balaenoptera acutorostrata*, fin whale *B. physalus*, long-finned pilot whale *Globicephala melas*, sperm whale, *Physeter macrocephalus*, and beaked/bottlenose whales as a combined species group (Ziphiidae).

Metrics

D1.1–Species distribution

Density surface models have been used to predict the distribution of those species for which sufficient data are available. Data for these models come from large-scale and a combination of small-scale purpose-designed surveys.

D1.2–Population Size

Abundance of animals has mostly been estimated using data collected from large-scale purpose-designed aerial or shipboard surveys using line-transect (distance) sampling methods; these are known as design-based estimates (e.g. Hammond *et al.*, 2013). 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; Rogan *et al.*, in review).

Table A. 1. Threat matrix for the greater North Sea.

			Harbour porpoise	Common dolphin	White-beaked dolphin	Atlantic white-sided dolphin	Risso's dolphin	Minke whale	Long-finned pilot whale	Killer whale	Coastal bottlenose dolphin	Grey seal	Harbour seal
Pollution & other chemical changes	Contaminants		H	M	M	M	M	L	M	H	H	M	M
	Nutrient enrichment		L	L	L	L	L	L	L	L	L		
Physical loss	Habitat loss											M	M
Physical damage	Habitat degradation		L	L	L	L	L	L	L	L	L	M	M
Other physical pressures	Litter (including microplastics and discarded fishing gear)		L	L	L	L	L	M	L	L	L	M	M
	Underwater noise changes	Military activity	M	M	M	M	M	M	M	M	M	L	L
		Seismic surveys	M	M	M	M	M	M	M	L	M	L	L
		Pile-driving	M	M	M	M	M	M	M	L	M	L	M
		Shipping	M	M	M	M	M	M	M	L	M	L	L
	Barrier to species movement (offshore windfarm, wave or tidal device arrays)		L	L	L	L	L	L	L	L	L	L	L
	Death or injury by collision	Death or injury by collision (with ships)	M	M	L	L	L	M	L	L	M	L	L
		Death or injury by collision (with tidal devices)	Risk of collision leading to death or injury is considered possible, but no evidence of such an occurrence to date										

		Harbour porpoise	Common dolphin	White-beaked dolphin	Atlantic white-sided dolphin	Risso's dolphin	Minke whale	Long-finned pilot whale	Killer whale	Coastal bottlenose dolphin	Grey seal	Harbour seal
Biological pressures	Introduction of microbial pathogens	L	L	L	L	L	L	L	L	L	L	L
	Removal of target and non-target species (prey depletion)	M	L	L	L	L	M	L		L	L	L
	Removal of non-target species (marine mammal bycatch)	H	L	L	L	L	M	L	L	L	M	M
	Disturbance (e.g. wildlife watching)	L	L	L	L	L	L	L	L	M	L	M
	Deliberate killing + hunting	Does not occur						L	Does not occur		M	M

Table A. 2. Threat matrix for Celtic Seas including West Scotland.

		Harbour porpoise	Common dolphin	White-beaked dolphin	Atlantic white-sided dolphin	Risso's dolphin	Minke whale	Long-finned pilot whale	Killer whale	Fin whale	Sperm whale	Offshore bottlenose dolphin	Coastal bottlenose dolphin	Northern bottlenose whale	Grey seal	Harbour seal
Pollution & other chemical changes	Contaminants	H	M	M	M	M	M	M	H	L	M	M	H	L	M	M
	Nutrient enrichment	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Physical loss	Habitat loss	L	L	L	L	L	L	L	L	L	L	L	L	L	M	M
Physical damage	Habitat degradation	L	L	L	L	L	L	L	L	L	L	L	L	L	M	M

			Harbour porpoise	Common dolphin	White-beaked dolphin	Atlantic white-sided dolphin	Risso's dolphin	Minke whale	Long-finned pilot whale	Killer whale	Fin whale	Sperm whale	Offshore bottlenose dolphin	Coastal bottlenose dolphin	Northern bottlenose whale	Grey seal	Harbour seal
Other physical pressures	Litter (inc. microplastics and discarded fishing gear)		L	L	L	L	L	M	L	L	L	L	L	L	L	M	M
	Underwater noise changes	Military activity	M	M	M	M	M	M	M	M	M	M	M	M	M	L	L
		Seismic surveys	M	M	M	M	M	M	M	L	M	M	M	M	M	L	L
		Pile-driving	M	M	M	M	M	M	M	L	M	M	M	M	M	L	M
		Shipping	M	M	M	M	M	M	M	L	M	M	M	M	M	L	L
	Barrier to species movement (offshore windfarm, wave or tidal device arrays)		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

Table A. 3. Threat matrix for The Bay of Biscay and the Iberian Peninsula.

			Harbour porpoise	Common dolphin	Striped dolphin	Cuvier´s beaked whale	Risso's dolphin	Long-finned pilot whale	Killer whale	Fin whale	Sperm whale	Northern bottlenose whale	Sowerby's beaked whale	Offshore bottlenose dolphin	Coastal bottlenose dolphin
Pollution & other chemical changes	Contaminants		H	M	M	L	L	M	H	L	L	L	L	L	H
	Nutrient enrichment		L	L	L	L	L	L	L	L	L	L	L	L	L
Physical loss	Habitat loss		L	L	L	L	L	L	L	L	L	L	L	L	L
Physical damage	Habitat degradation		L	L	L	L	L	L	L	L	L	L	L	L	L
Other physical pressures	Litter (including microplastics and discarded fishing gear)		L	L	L	M	L	L	L	L	L	M	M	L	L
	Underwater noise changes	Sonar	L	L	L	H	L	L	L	L	L	M	M	L	L
		Seismic surveys	M	M	M	M	M	M	L	M	M	M	M	M	M
		Pile-driving	No current activity but potentially harmful												
		Shipping	L	L	L	L	L	L	L	M	L	L	L	L	L
	Barrier to species movement (offshore windfarm, wave or tidal device arrays)		L	L	L	L	L	L	L	L	L	L	L	L	L

			Harbour porpoise	Common dolphin	Striped dolphin	Cuvier´s beaked whale	Risso's dolphin	Long-finned pilot whale	Killer whale	Fin whale	Sperm whale	Northern bottlenose whale	Sowerby's beaked whale	Offshore bottlenose dolphin	Coastal bottlenose dolphin
	Death or injury by collision	With ships	L	L	L	L	L	L	L	H	H	L	L	L	L
		With tidal devices	No current activity but potentially harmful												
Biological pressures	Introduction of microbial pathogens		L	L	L	L	L	L	L	L	L	L	L	L	L
	Removal of target and non-target species (prey depletion)		L	L	L	L	L	L	L	L	L	L	L	L	L
	Removal of non-target species (marine mammal bycatch)		H	H	M	L	L	L	L	L	L	L	L	M	H
	Disturbance (e.g. wildlife watching)		L	L	L	L	L	L	L	L	L	L	L	L	M
	Deliberate killing + hunting		Does not occur	L	Does not occur										

Thresholds and baselines (See ICES WGMME advice to OSPAR (ICES, 2014b))

Although the baseline should derive from historical data, these are not available for any offshore cetacean species. Historical abundance is therefore unknown and, even if it is suspected to have declined, could probably not realistically be restored because today's marine environment is very different, including as a consequence of climate change. Consequently, a recent baseline must be utilized. The most useful baselines for offshore cetacean species derive from the results of large-scale surveys (e.g. CODA 2009; Hammond *et al.*, 2002; 2013).

For most species, only a single abundance estimate is currently available so no assessment involving change from a baseline is possible. For harbour porpoise, white-beaked dolphin and minke whale in the North Sea (OSPAR area II) there are two (SCANS and SCANS-II) or more (Norwegian surveys for minke whale) estimates so that such an assessment is possible [to be amended following the availability in early 2017 of the results from SCANS-III].

ICES (2014b) advice to OSPAR suggested a suitable indicator target for harbour porpoises could be 'For each Assessment Unit, maintain harbour porpoise population size at or above baseline levels, with no decrease of ≥30% over a three generation period' i.e. over between 22.5 and 36 years, depending on the source), equivalent to declines of no more than 1.0 to 1.6% to per year.

Regarding the above figures for harbour porpoise, and taking into consideration that WGMME has previously noted that 7.5 years is the most realistic figure for generation time of European porpoises, there is a need to detect a decline of 30% over 22.5 years (ICES, 2014b), i.e. a 1.6% decline per year.

ICES (2014b) advice to OSPAR suggested a suitable indicator target for white-beaked dolphins could be 'Maintain the white-beaked dolphin population size at or above the baseline levels, with no decrease of ≥30% over a three-generation period (54 years)′, i.e. a decline of no more than 0.66% per year.

ICES (2014b) advice to OSPAR suggested a suitable indicator target for minke whales could be 'Maintain the minke whale population size at or above the baseline levels, with no decrease of ≥30% over a three-generation period. Based on Taylor *et al.* (2007), generation time for this species may range between 13 and 22 years, so the decline should be assessed over anything from 39 to 66 years, i.e. a maximum decline of between 0.53% and 0.91% per year′.

It should be noted that, even with the best available monitoring methodology, there will obviously be limits to the minimum detectable rate of decline. While it is clearly not necessary to wait for three generations to assess whether a population is declining, in practice large-scale cetacean abundance surveys in the Northeast Atlantic have previously taken place at a frequency of six (NASS, Norway) to eleven (SCANS) years. It has been suggested that SCANS surveys occur every six years in future to match reporting under the Habitats Directive and MSFD; this sets a minimum limit to a viable assessment period.

Spatial scope

ICES WGMME has defined Assessment Units (AUs) to use when assessing Good Environmental Status for a number of species (ICES, 2014c). For harbour porpoise, six AUs have been defined (Figure B). For bottlenose dolphin, ten AUs have been defined for resident or semi-resident coastal/inshore populations of bottlenose dolphin, which are covered in a separate document. A single offshore "oceanic area" AU has been defined for bottlenose dolphins to cover all waters not covered by the coastal/inshore AUs. A single AU covering all European Atlantic waters has been defined for minke whale, white-beaked dolphin and short-beaked common dolphin.

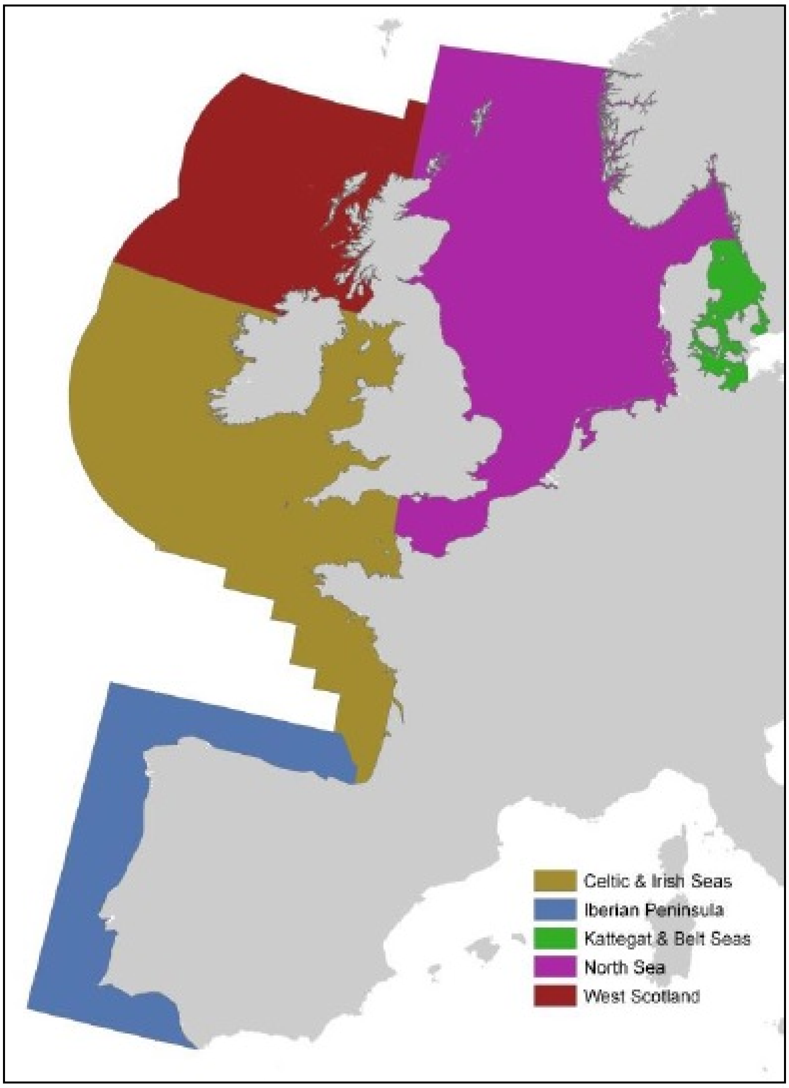


Figure B. Harbour porpoise Assessment Units defined by WGMME for MSFD assessments. Figure from ICES (2013).

Assessment method (extended)

The data used to infer distribution and to estimate abundance were mostly available from large-scale aerial and shipboard surveys that used line transect methodology to generate robust estimates of abundance; SCANS, SCANS-II and CODA (CODA, 2009; Hammond *et al.*, 2002; 2013). Other large-scale surveys using similar methods have also been used (North Atlantic Sightings Surveys, Norwegian surveys for minke whales). Smaller scale (mostly national) surveys have also been conducted using the same methodology (e.g. in Germany, the Netherlands, France; Scheidat *et al.*, 2008, 2012; Gilles *et al.*, 2009, 2011, 2016; Laran *et al.*, in review). The large-scale surveys provide information on distribution and abundance over a large area but infrequently and they have taken place only in summer. The smaller scale surveys provide information on distribution and abundance more frequently as well as potentially revealing intra-annual patterns.

D1.1–Species distribution

Where possible, information on species distribution has been obtained from modelled density surfaces fitted to data collected on large-scale or a combination of small-scale surveys (e.g. Gilles *et al.*, 2016; Rogan *et al.*, in review). Where this was not possible, distribution has been inferred from the distribution of animals seen on at-sea surveys.

D1.2–Population size

Abundance was estimated using line transect (distance) sampling methods, known as design-based estimates. The methodology used is described in detail in Hammond *et al.* (2013). Shipboard survey methods mostly used two observation teams on the same vessel so that animals missed on the transect line (and in some cases any responsive movement) could be accounted for in analysis. However, for some species, sufficient data were not available for such extended analytical methods to be used. Aerial surveys used tandem aircraft or the circle-back procedure for harbour porpoises to correct for animals missed on the transect line (Hiby and Lovell, 1998; Hiby, 1999). For other species, conventional aerial survey methods were used, corrected for availability bias where possible (Hammond *et al.*, 2013).

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 (Gillies *et al.*, 2016; Rogan *et al.*, in review).

The Disturbance Effects on the Harbour Porpoise Population in the North Sea (DEPONS)[4] project was setup by a collaborative working group of five offshore wind developers, funding research into the effects of windfarm construction on harbour porpoises in the North Sea. As part of this project survey data collected in UK, Belgium, the Netherlands, Germany and Denmark have been aggregated to develop seasonal habitat-based density surface models for the North Sea, using data collected between 2005 and 2013 (Gilles *et al.*, 2016).

Wide-scale surveys have also been conducted by France in 2011 and 2012 (see Laran *et al.*, in review).

The limited spatial and temporal nature of cetacean survey data led to the Joint Cetacean Protocol being established to collate and standardise all available Northwest European effort-related cetacean sightings data, with the aim of informing reporting by Member States under the Habitats Directive and Marine Strategy Framework Directive, but also Environmental Impact Assessments (EIA).

Results (brief)

Cetaceans are widely distributed across European Atlantic waters in a variety of coastal, shelf and offshore habitats. Of the more frequently encountered species, the harbour porpoise and white-beaked dolphin are mostly restricted to shelf waters in this region. Striped dolphin, and fin, sperm, bottlenose and pilot whales are primarily found in deep waters off-the-shelf. Bottlenose and common dolphins and minke

[4] http://depons.au.dk/currently/ Date accessed 10/01/16.

whales are found in both shelf and offshore waters. There is insufficient information to assess changes in distribution over time except for harbour porpoise in the North Sea, where distribution shifted markedly from primarily in the north to primarily in the south between 1994 and 2005, most likely because of shifts in prey availability.

Robust abundance estimates are available from purpose-designed large-scale surveys for ten cetacean species in European Atlantic waters: harbour porpoise, white-beaked, bottlenose, common and striped dolphins, and minke, fin, sperm, pilot and beaked (all species combined) whales. The most comprehensive estimates are from the combination of the SCANS-II and CODA surveys in 2005 and 2007, respectively, which cover almost all of OSPAR Regions II, III and IV. Together, these estimates show that in these three regions there are well over one million individual cetaceans living in these waters (Figure A). The most abundant species are the harbour porpoise with an estimated 375 000 animals, and common and striped dolphins with estimates for both species combined ranging from 220 000 to 700 000. Pilot whales are also abundant; approximately 150 000 animals have been estimated. Around 30 000 individuals of each of minke, fin and beaked whales have been estimated, together with 36 000 bottlenose dolphins, 17 000 white-beaked dolphins and 7000 sperm whales.

However, only for harbour porpoise, white-beaked dolphin and minke whale are there two or more comparable estimates of abundance. These time-series are currently short relative to the life cycle of the species and, given the precision of the estimates, there is generally poor power to detect trends from these data. It is therefore not possible to infer with any confidence whether populations are decreasing, stable or increasing. Notwithstanding this, recent estimates of abundance are either similar to or larger than comparable earlier estimates. Despite the multiple pressures and threats facing cetaceans in this region, there is currently no evidence, with the data available, of an impact of anthropogenic activity on either distribution or abundance of cetacean species in OSPAR Regions II, III and IV. More data are needed to make an informed assessment; results from a large-scale survey in summer 2016 will aid this process.

Results (extended)

D1.1–Species distribution

Harbour porpoise

Harbour porpoises are distributed throughout the shelf waters of OSPAR Regions II, III and IV. Their presence has variously been found to be strongly related to areas of low tidal current (Embling *et al.*, 2010), and with water depth between 50 and 150 m and strong seabed slope (Booth *et al.*, 2013) although these relationships depend on the area/habitat (Pierpoint, 2008; Marubini *et al.*, 2009; Gillies *et al.*, 2011; Isojunno *et al.*, 2012; Heinänen and Skov, 2015).

Comparisons of harbour porpoise distribution in between the SCANS and SCANS–II datasets show a marked difference in summer distribution, with a southwest shift in the main concentration of animals seen between 1994 and 2005 (Figure C). This shift in distribution is supported by other smaller scale surveys, with increasing numbers of porpoises occurring in French, Belgian, Dutch and German waters (e.g. Gilles *et al.*, 2009; 2011; Haelters *et al.*, 2011; Scheidat *et al.*, 2012; Peschko *et al.*, 2016) and decreasing numbers in the northern North Sea (Øien, 1999; 2005; 2010). The reason for this shift in distribution is believed to be a result of changes in prey availability (Hammond *et al.*, 2013).

Short-beaked common dolphin

Common dolphins appear to have a preference for upwelling-enriched waters, areas with steep seabed relief and extensive shelf areas (Jefferson *et al.*, 2008). A recent review of common dolphin in the northeast North Atlantic shows that this species is distributed widely in OSPAR Regions II, IV and V (Murphy *et al.*, 2013). The sightings made in Region II are thought to be associated with the North Atlantic Oscillation and incursion of warmer water into the northern North Sea (Murphy *et al.*, 2013). On the SCANS-II and CODA surveys there were no sightings in Region II but there were sightings throughout the southern part of Region III and throughout Region IV (Figure D).

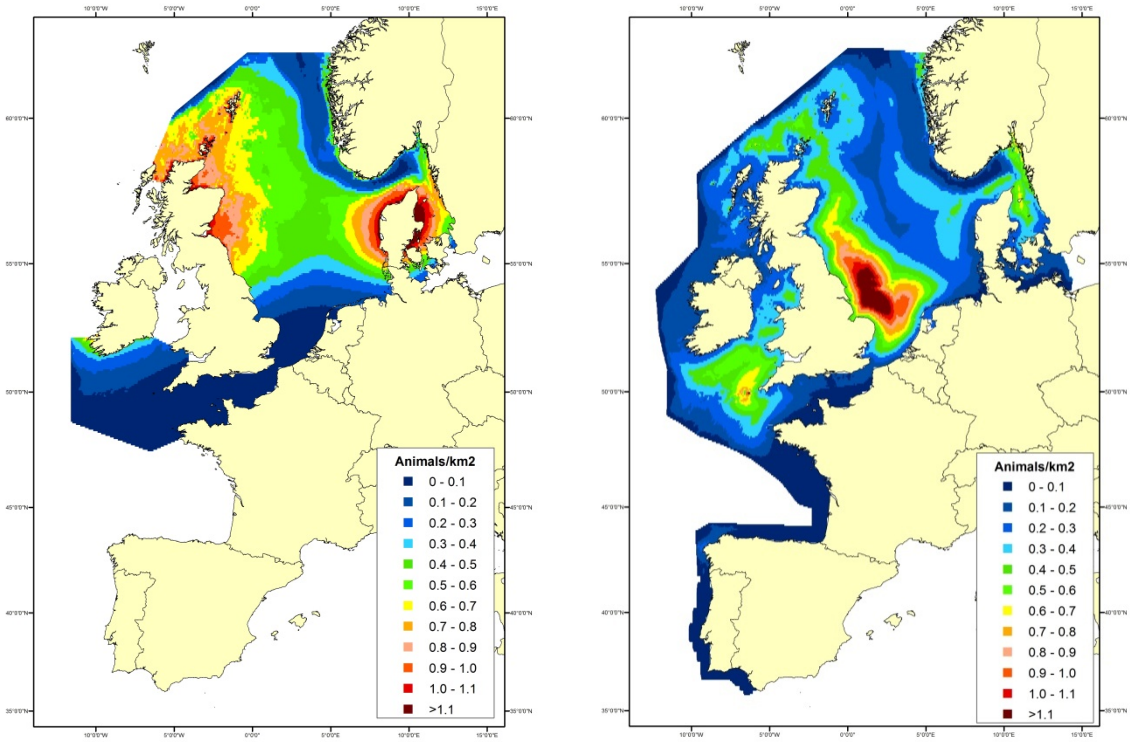


Figure C. Left: Density surface for harbour porpoises calculated using the SCANS data. Right: Density surface for harbour porpoises calculated using the SCANS-II data. (Hammond *et al.*, 2013).

White-beaked dolphin

White-beaked dolphins have been shown to prefer cooler water temperatures, of 13°C or less (Macleod *et al.*, 2008) and waters 50–100 m deep (Reid *et al.*, 2003). They are found predominantly in the northern part of OSPAR Region II and III and have only been recorded as vagrants in OSPAR Region IV (Figure E).

Offshore bottlenose dolphin

Bottlenose dolphins are widely distributed in offshore waters of the European Atlantic (Reid *et al.*, 2003), as confirmed by the SCANS-II and CODA surveys (Figure F). Little is known about this species in these offshore waters compared to the coastal/inshore populations (see separate document).

Striped dolphin

Striped dolphins have been found to prefer specific water temperatures (e.g. 21–24°C within the Mediterranean Sea (Panigada *et al.*, 2008). They are generally found only within the southern part of OSPAR Region III and in Region IV, primarily in waters off the continental shelf (CODA, 2009) (Figure G).

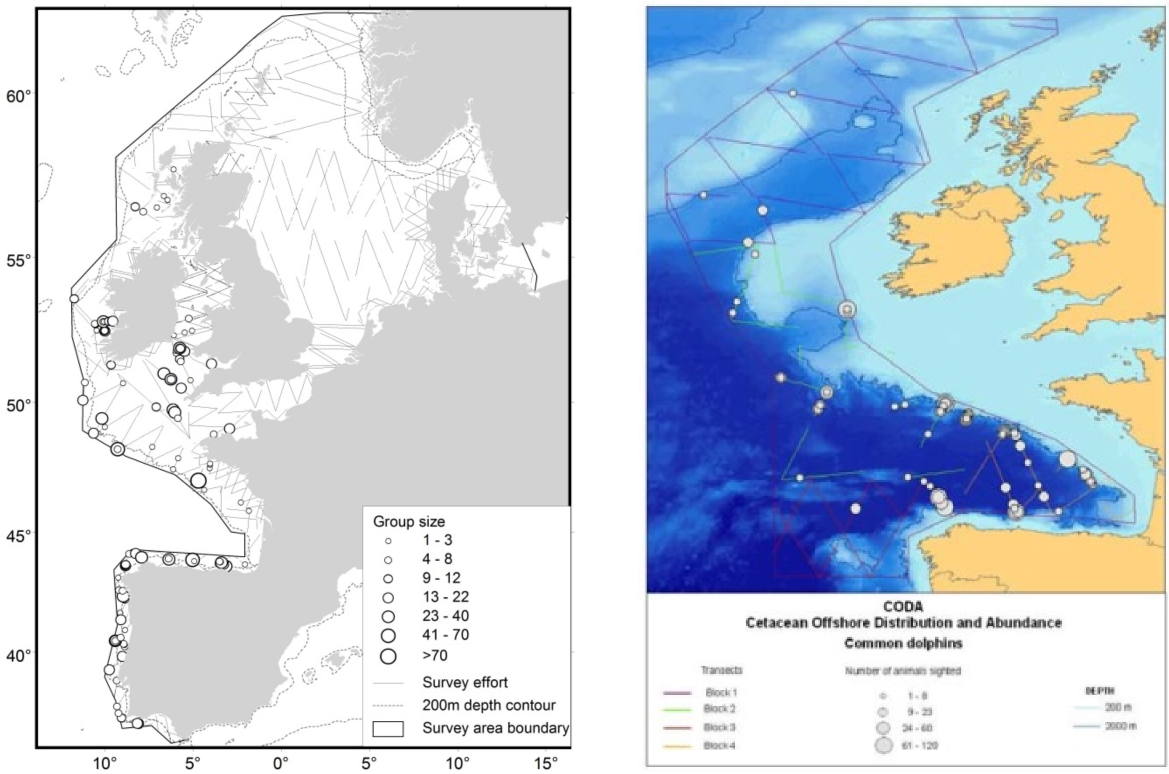
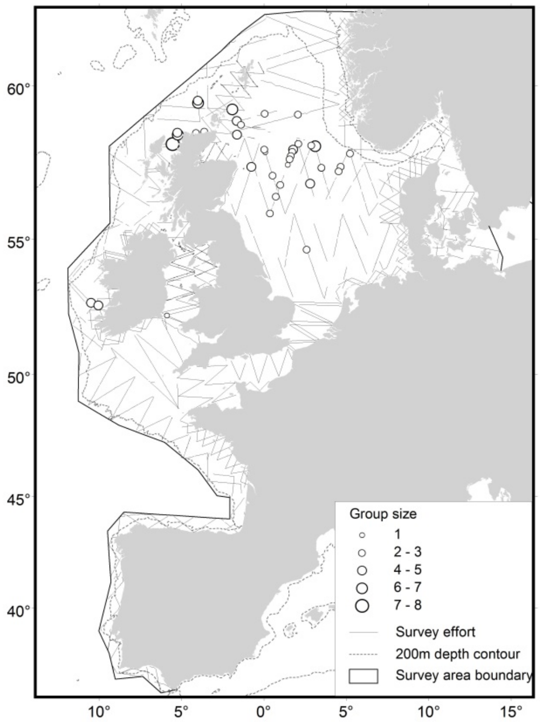
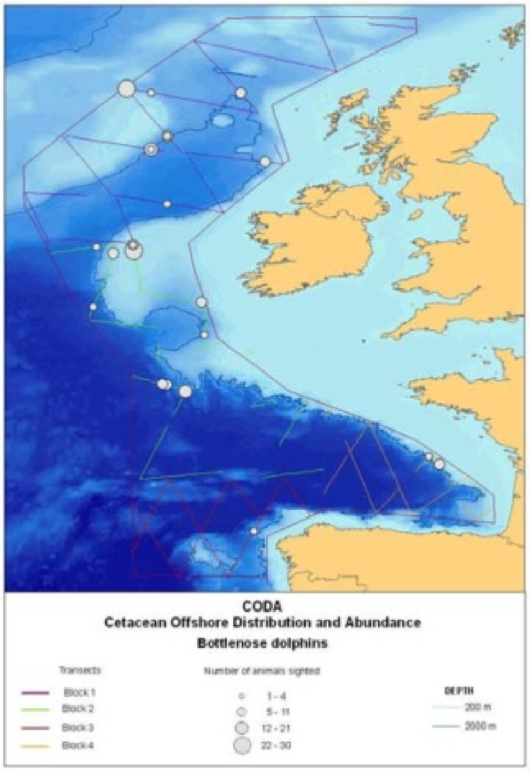


Figure D. Short-beaked common dolphin sightings from the SCANS II survey (left; Hammond *et al.*, 2013) and CODA survey (right; CODA, 2009).





Left: Figure E: White-beaked dolphin sightings from the SCANS II survey (Hammond *et al.*, 2013). Right: Figure F: Bottlenose dolphin sightings from the CODA survey (CODA, 2009).

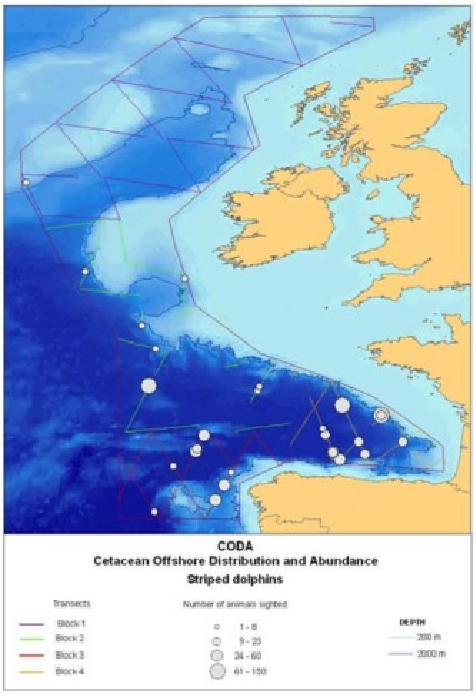


Figure G: Striped dolphin sightings from the CODA survey (CODA, 2009).

Minke whale

Minke whales occur both on and off the continental shelf of the European Atlantic. In summer, the southern/central North Sea (OSPAR Region II) and OSPAR Region III represent the southern limit of the summer range of minke whales for this region (Reid *et al.*, 2003; Evans *et al.*, 2003). Minke whales have rarely been recorded in OSPAR Region IV (Figures H and I).

Fin whale

Fin whales primarily inhabit deep waters (200–400 m) beyond the continental shelf (Reid *et al.*, 2003). They are not frequently encountered in OSPAR Region II but are commonly found in OSPAR Regions III and IV (Figure J). Data spanning the past 20 years do not indicate any changes in distribution over this time span (Macleod *et al.*, 2011).

Long-finned pilot whale

Long-finned pilot whales are deep divers and typically found only in waters around the continental slope and off the continental shelf. They occur throughout OSPAR Regions III and IV (Figures K and L). No pilot whales were seen in the SCANS and SCANS-II surveys in the North Sea (OSPAR Region II). Slope and distance to shelf edge have found to be important predictors for this species (Rogan *et al.*, in review).

Beaked whales (all species)

Beaked whales are deep-diving species found almost exclusively in deep waters. Sightings of beaked whales are relatively uncommon throughout the region and rare in the North Sea (OSPAR Region II). Sightings of northern bottlenose whales and Sowerby's beaked whales have been made primarily in the northern part of Region III, while Cuvier's beaked whales have been seen mostly in the southern part of Region III, and western part of Region IV (Figures M and N).

Sperm whale

The sperm whale is a deep-diving species found throughout deep waters of OSPAR Regions III and IV but rarely in OSPAR Region II, except the Faroe-Shetland Channel between Regions II and III (Figure O).

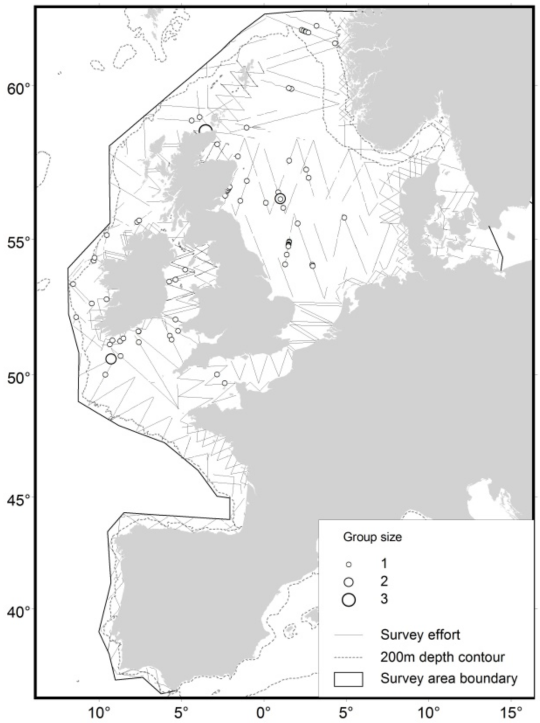


Figure H. Minke whale sightings from the SCANS-II survey (Hammond *et al.*, 2013).

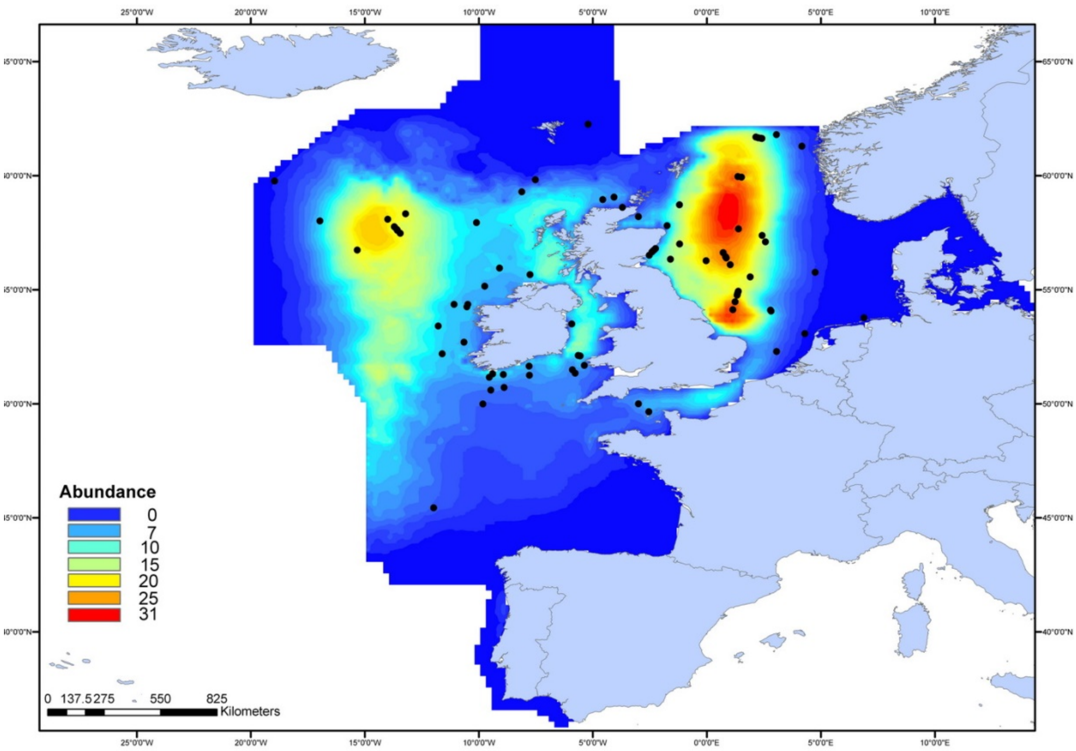


Figure I. Predicted density surface for minke whales from CODA, SCANS-II and NASS data (Macleod *et al.*, 2011).

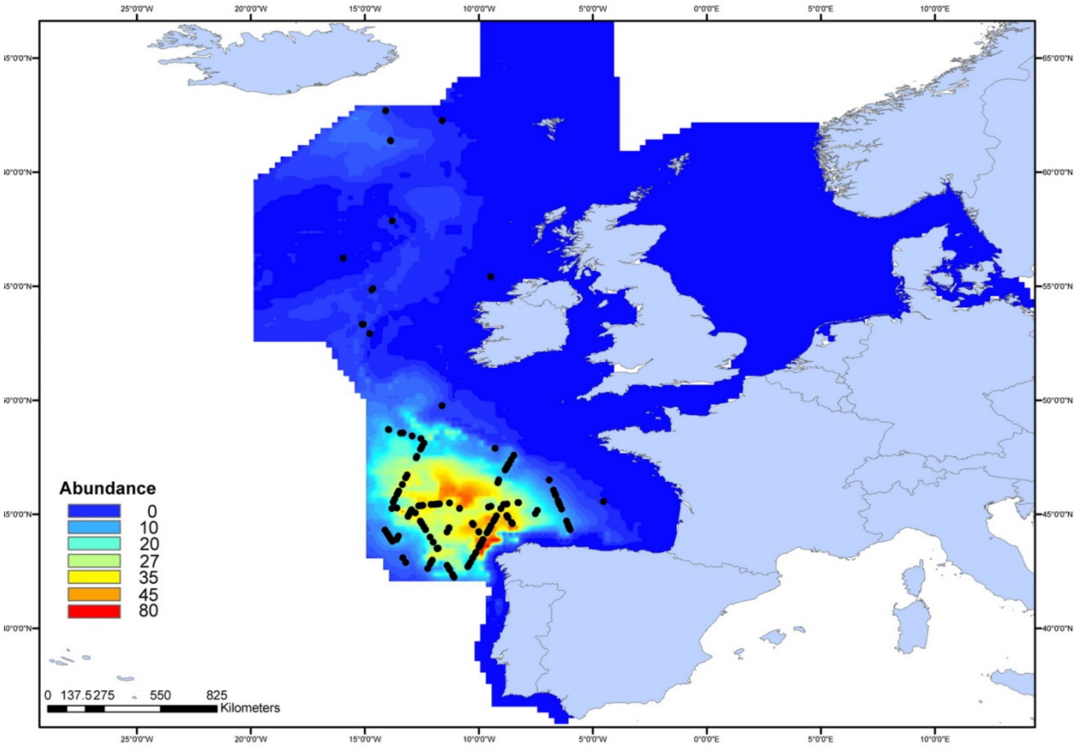


Figure J. Predicted density surface for fin whales from CODA data (Macleod *et al.*, 2011).

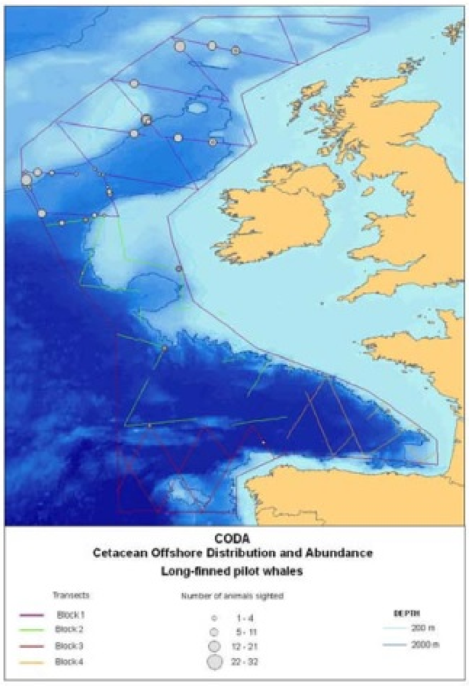


Figure K. Long-finned pilot whale sightings from the CODA survey (CODA, 2009).

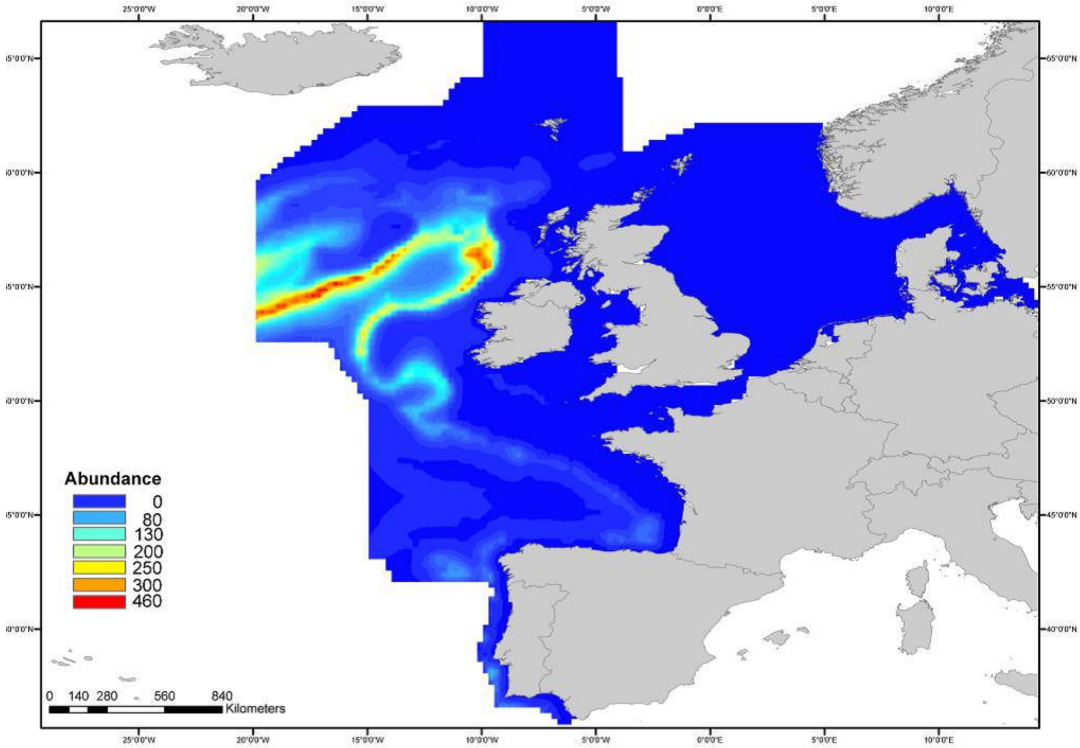


Figure L. Predicted density surface for long-finned pilot whales from CODA, SCANS-II and NASS data (Rogan *et al.*, in review).

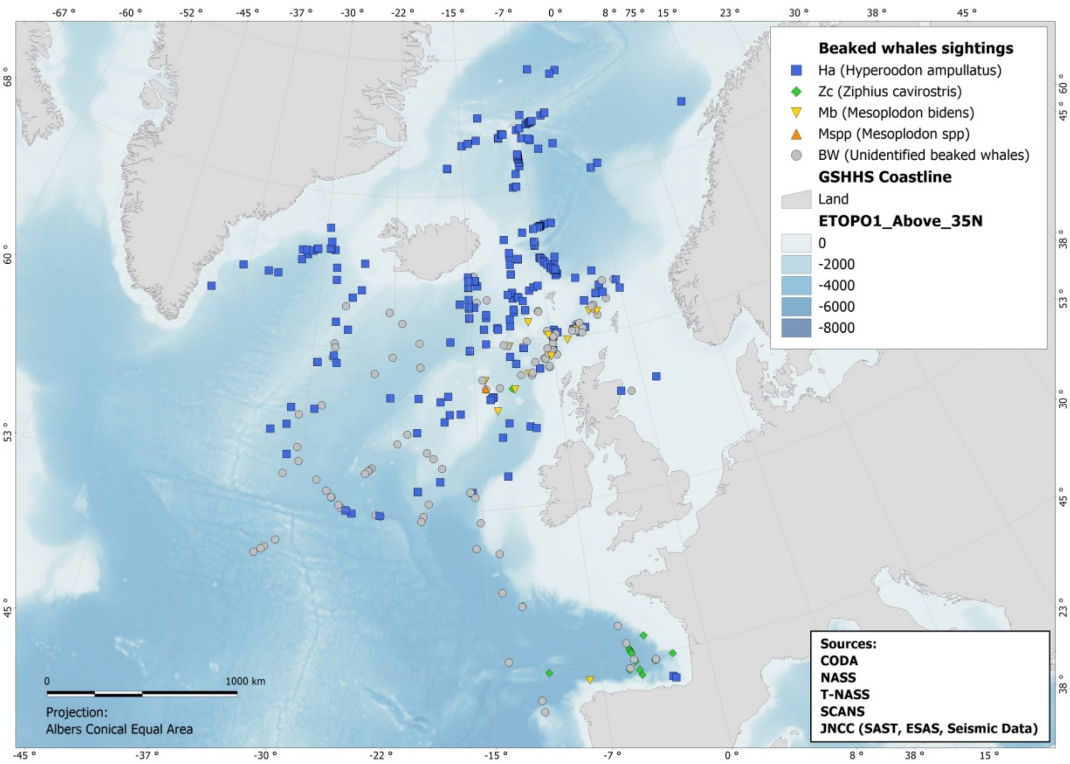


Figure M. Combined sightings of beaked whales from surveys across the region over multiple years. Data sources include NASS, CODA, ESAS, SAST and JNCC.

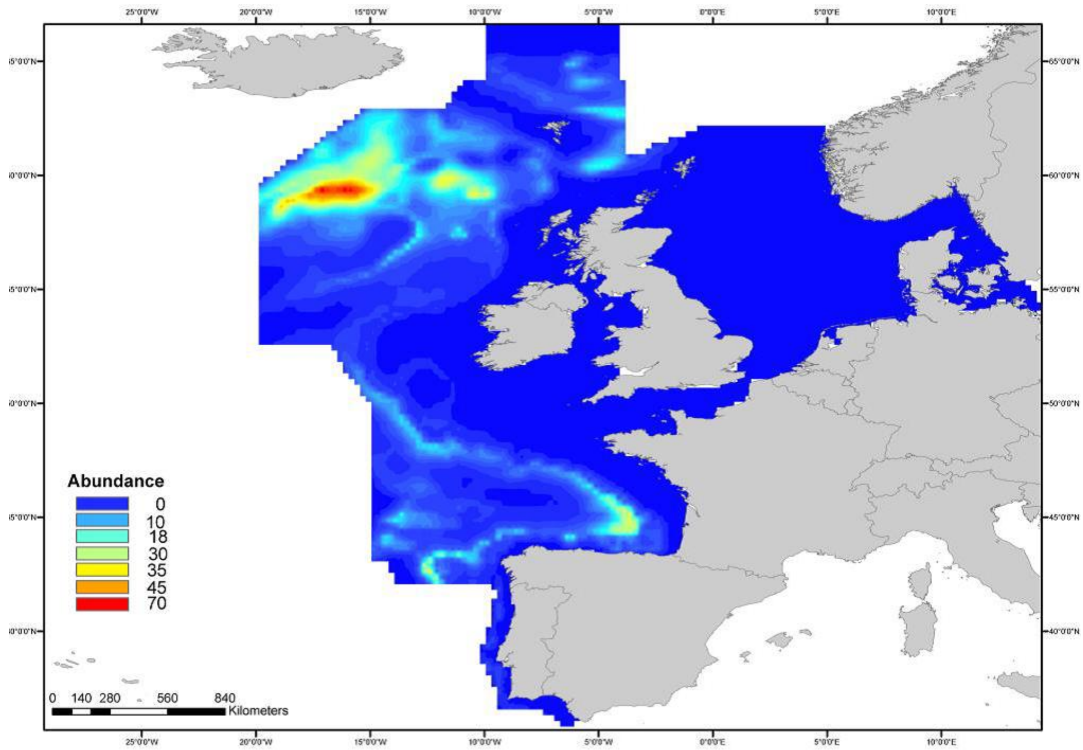


Figure N. Predicted density surface for beaked whales from CODA, SCANS-II and NASS data (Rogan *et al.*, in review).

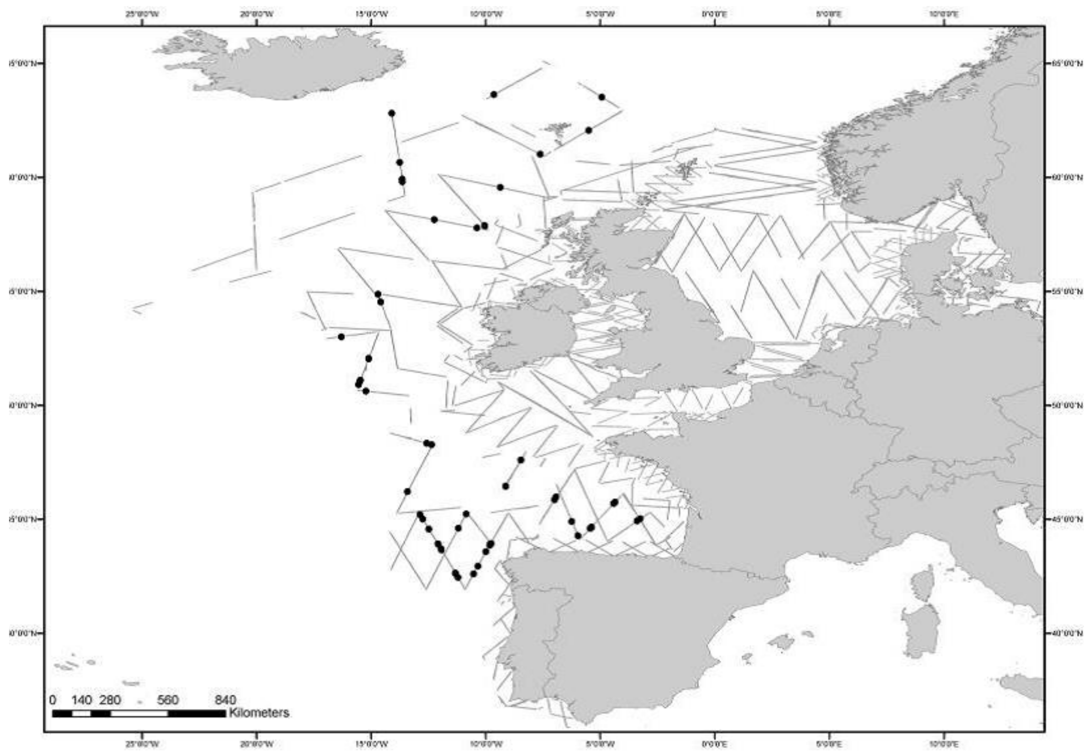


Figure O. Distribution of sperm whale sightings across the area of interest (Rogan *et al.*, in Review).

D1.2-Population size

Harbour porpoise

Abundance estimates for harbour porpoise are available for all five AUs in the region, but there is more than one estimate only for the North Sea and the Kattegat/Belt Seas AUs. The available estimates are for survey blocks that do not match exactly with the AUs as defined and attempts have not been made here to prorate block estimates into AUs. However, it is possible to make some inference about changes in abundance for these two AUs based on the block estimates.

The abundance of harbour porpoise from the 2005 SCANS-II survey for the whole region was estimated to be 375 358 (CV=0.20), with densities ranging mostly between 0.274–0.384 porpoises per km^2 among survey blocks. Animals were least common in the more offshore survey blocks to the west of Scotland and Ireland (Hammond *et al.*, 2013). Harbour porpoises were not recorded during the CODA (2009) survey, which covered deeper waters off-the-shelf. Estimated abundance in 1994 for the North Sea, the Skagerrak, Kattegat and Belt Seas and the Celtic Sea was 341 366 (CV=0.14) (Hammond *et al.*, 2002). Abundance in 2005 in an area equivalent to that surveyed in 1994 was 323 968 (CV=0.22). Estimates of abundance by survey block for SCANS and SCANS-II are given in Table B. Thus, in an area that comprises the North Sea and Kattegat/Belt Seas AUs (OSPAR Region II), there is no evidence of a change in abundance of harbour porpoise between 1994 and 2005.

Model-based abundance estimates have been calculated from data collected primarily in the southern and central North Sea in 2005–2013 for the majority of the North Sea AU (excluding the far northern part of the area) as part of the DEPONS project. Seasonal estimates have been made for spring (372 167, CV=0.18), summer (361 146, CV=0.20) and autumn (228 913, CV=0.19) (Gilles *et al.*, 2016). These estimates are consistent with those from SCANS and SCANS-II in 1994 and 2005.

There are three estimates of abundance that approximate the Kattegat/Belt Seas AU: 36 046 (CV=0.34) in 1994; 19 129 (CV=0.36) in 2005 and 40 475 (CV=0.24) in 2012. Although the 2005 estimate is considerably smaller, overall there is no evidence of a change in abundance in this AU between 1994 and 2012.

Short-beaked common dolphin

The most comprehensive estimates of abundance of common dolphins in the region are from SCANS-II in 2005 and CODA in 2007. The sum of these estimates for the single AU, covering OSPAR Regions II, III and IV, is 174 485 (CV=0.27) (Table B).

White-beaked dolphin

Estimates of abundance for the single AU for white-beaked dolphin are available for 1994 and 2005 (Table B). Estimated abundance in 2005 was 16 536 (CV=0.30). Highest estimated densities were found around western Scotland (0.105 animals/km^2) and in the northern North Sea (0.047 animals/km^2) (Hammond *et al.*, 2013). Estimated abundance in 1994 was 7856 (CV=0.30) (Hammond *et al.*, 2002). The 2005 estimate is considerably larger than the 1994 estimate but the latter did not cover the western part of the AU which showed high density in 2005; estimated abundance in 2005 in an equivalent area to 1994 was 11 000 (CV=0.29).

Table B. A summary of population abundance estimates from large-scale surveys covering all or part of OSPAR areas II, III and IV.

Species / Population	Survey / area	Estimate type	Estimate (CV)	Year	ICES WGMME AU	Notes	Reference
Beaked whales (all)	CODA, SCANS-II & T-NASS (F)	Model-based	29 205 (0.23)	2005/2007	No specified AU	OSPAR areas II, III, IV & V	Rogan *et al.* (in review)
Bottlenose dolphin	SAMM / Channel, Biscay	Design-based	Winter 19 106 (0.23); Summer 13 255 (0.35)	2011–2012	Channel / Oceanic Waters	Channel + part Bay of Biscay	Laran *et al.* (in prep)
Bottlenose dolphin	SCANS-II	Design-based	16 485 (0.42)	2005	Multiple	OSPAR areas II, III, IV & V	Hammond *et al.* (2013)
Bottlenose dolphin	CODA	Design-based	19 295 (0.25)	2007	Oceanic waters	OSPAR areas III, IV & V	CODA (2009)
Bottlenose dolphin	SCANS-II + CODA	Design-based	35 780 (0.24)	2005/2007	Oceanic waters	Part of AU, OSPAR area II, III, IV & V	CODA (2009)
Common + striped	CODA	Design-based	224 166 (0.48)	2007	Single AU	Part of AU, OSPAR area III, IV & V	CODA (2009)
Common + striped	SAMM / Channel, Biscay	Design-based	Winter 299 896 (0.11); Summer 696 013 (0.10)	2011–2012	Single AU	Channel + part Bay of Biscay	Laran *et al.* (in prep)
Common dolphin	SCANS-II	Design-based	56 221 (0.23)	2005	Single AU	Part of AU, OSPAR areas II, III, IV & V	Hammond *et al.* (2013)
Common dolphin	CODA	Design-based	118 264 (0.38)	2007	Single AU	Part of AU, OSPAR area III, IV & V	CODA (2009)
Common dolphin	SCANS-II + CODA	Design-based	174 485 (0.27)	2005/2007	Single AU	Part of AU, OSPAR area II, III, IV & V	Hammond *et al.* (2013); CODA (2009)
Fin whale	CODA, SCANS-II	Design-based	29 512 (0.26) including % of unidentified large whales	2005/2007	No specified AU	OSPAR areas II, III, IV & V	Macleod *et al.* (2011)
Fin whale	CODA, SCANS-II	Model-based	19 751 (0.17)	2005/2007	No specified AU	OSPAR areas II, III, IV & V	Macleod *et al.* (2011)
Harbour porpoise	SCANS / Block A	Design-based	36 286 (0.57)	1994	Celtic and Irish Seas	Part of AU	Hammond *et al.* (2002)
Harbour porpoise	SCANS-II / Block B	Design-based	40 927 (0.38)	2005	Celtic and Irish Seas	Block B spans two AUs (also North Sea)	Hammond *et al.* (2013)
Harbour porpoise	SCANS-II / Block Q	Design-based	11 011 (1.14)	2005	Celtic and Irish Seas	Block Q spans two AUs (also W Scotland / N Ireland)	Hammond *et al.* (2013)

Species / Population	Survey / area	Estimate type	Estimate (CV)	Year	ICES WGMME AU	Notes	Reference
Harbour porpoise	SCANS-II / Block O	Design-based	15 230 (0.35)	2005	Celtic and Irish Seas	Part of AU	Hammond *et al.* (2013)
Harbour porpoise	SCANS-II / Block P	Design-based	72 389 (0.53)	2005	Celtic and Irish Seas	Part of AU	Hammond *et al.* (2013)
Harbour porpoise	SCANS-II / Block R	Design-based	10 716 (0.37)	2005	Celtic and Irish Seas	Part of AU	Hammond *et al.* (2013)
Harbour porpoise	SCANS-II / Block W	Design-based	2357 (0.92)	2005	Celtic and Irish Seas	Part of AU	Hammond *et al.* (2013)
Harbour porpoise	SCANS-II / Block W	Design-based	2357 (0.92)	2005	Iberian Peninsula	Block W spans two AUs	Hammond *et al.* (2013)
Harbour porpoise	SCANS-II / Block Z	Design-based	0 (no sightings)	2005	Iberian Peninsula	Part of AU	Hammond *et al.* (2013)
Harbour porpoise	DEPONS	Model-based	Spring 372 167 (0.18); Summer 361 146 (0.20); Autumn 228 913 (0.19)	2005-2013	North Sea	Area of prediction slightly smaller than AU	Gilles *et al.* (2016)
Harbour porpoise	SAMM / Channel, Biscay	Design-based	Winter 31 199 (0.21); Summer 46 345 (0.12)	2011-12	North Sea / Biscay & Iberia	Small part North Sea; part Bay of Biscay	Laran *et al.* (in prep)
Harbour porpoise	SCANS-II / Block Q	Design-based	11 011 (1.14)	2005	W Scotland / N Ireland	Block Q spans two MUs (also Celtic and Irish Seas)	Hammond *et al.* (2013)
Harbour porpoise	SCANS-II / Block N	Design-based	12 076 (0.43)	2005	W Scotland / N Ireland	Part of MU	Hammond *et al.* (2013)
Harbour porpoise	SCANS / Block I	Design-based	36 046 (0·34)	1994	Kattegat / Belt Seas	Survey block extends north beyond MU	Hammond *et al.* (2002)
Harbour porpoise	SCANS / Block X	Design-based	392 (0·46)	1994	Kattegat / Belt Seas	Very small part of MU	Hammond *et al.* (2002)
Harbour porpoise	SCANS-II / Block S	Design-based	19 129 (0.36)	2005	Kattegat / Belt Seas	Survey block extends beyond MU	Hammond *et al.* (2013)
Harbour porpoise	Kattegat / Belt Seas	Design-based	40 475 (0.24)	2012	Kattegat / Belt Seas	All of MU	Viquerat *et al.* (2014)
Harbour porpoise	SCANS-II / Block H	Design-based	3891 (0.45)	2005	North Sea	Part of MU	Hammond *et al.* (2013)
Harbour porpoise	SCANS-II / Block J	Design-based	10 254 (0.36)	2005	North Sea	Part of MU	Hammond *et al.* (2013)
Harbour porpoise	SCANS-II / Block L	Design-based	11 575 (0.43)	2005	North Sea	Part of MU	Hammond *et al.* (2013)
Harbour porpoise	SCANS-II / Block B	Design-based	40 927 (0.38)	2005	North Sea	Block B spans two MUs (also Celtic and Irish Seas)	Hammond *et al.* (2013)

Species / Population	Survey / area	Estimate type	Estimate (CV)	Year	ICES WGMME AU	Notes	Reference
Harbour porpoise	SCANS-II / Block M	Design-based	3948 (0.38)	2005	North Sea	Part of MU	Hammond *et al*. (2013)
Harbour porpoise	SCANS-II / Block T	Design-based	19 369 (0.34)	2005	North Sea	Part of MU	Hammond *et al*. (2013)
Harbour porpoise	SCANS-II / Block U	Design-based	93 938 (0.28)	2005	North Sea	Part of MU	Hammond *et al*. (2013)
Harbour porpoise	SCANS-II / Block V	Design-based	47 048 (0.36)	2005	North Sea	Part of MU	Hammond *et al*. (2013)
Harbour porpoise	SCANS-II / Block Y	Design-based	1473 (0.47)	2005	North Sea	Part of MU	Hammond *et al*. (2013)
Harbour porpoise	SCANS / Block B	Design-based	0 (no sightings)	1994	North Sea	Part of MU	Hammond *et al*. (2002)
Harbour porpoise	SCANS / Block C	Design-based	16 939 (0.18)	1994	North Sea	Part of MU	Hammond *et al*. (2002)
Harbour porpoise	SCANS / Block D	Design-based	37 144 (0·25)	1994	North Sea	Part of MU	Hammond *et al*. (2002)
Harbour porpoise	SCANS / Block E	Design-based	31 419 (0.49)	1994	North Sea	Part of MU	Hammond *et al*. (2002)
Harbour porpoise	SCANS / Block F	Design-based	92 340 (0.25)	1994	North Sea	Part of MU	Hammond *et al*. (2002)
Harbour porpoise	SCANS / Block G	Design-based	38 616 (0.34)	1994	North Sea	Part of MU	Hammond *et al*. (2002)
Harbour porpoise	SCANS / Block H	Design-based	4211 (0.29)	1994	North Sea	Part of MU	Hammond *et al*. (2002)
Harbour porpoise	SCANS / Block J	Design-based	24 335 (0.34)	1994	North Sea	Part of MU	Hammond *et al*. (2002)
Harbour porpoise	SCANS / Block L	Design-based	11 870 (0.47)	1994	North Sea	Part of MU	Hammond *et al*. (2002)
Harbour porpoise	SCANS / Block M	Design-based	5666 (0.27)	1994	North Sea	Part of MU	Hammond *et al*. (2002)
Harbour porpoise	SCANS / Block Y	Design-based	4077 (0·26)	1994	North Sea	Part of MU	Hammond *et al*. (2002)
Minke whale	SCANS	Design-based	8445 (0.24)	1994	Single MU	Part of MU, OSPAR areas II & III	Hammond *et al*. (2002)
Minke whale	Norwegian / North Sea	Design-based	14 046 (0.28)	1995	Single MU	Part of OSPAR areas I, II & III	Solvang *et al*. (2015)
Minke whale	Norwegian / North Sea	Design-based	27 364 (0.21)	1996–2001	Single MU	Part of OSPAR areas I, II & III	Solvang *et al*. (2015)
Minke whale	Norwegian / North Sea	Design-based	6246 (0.48)	2002–2007	Single MU	Part of MU, mostly OSPAR area II	Solvang *et al*. (2015)
Minke whale	SCANS-II	Design-based	18 958 (0.35)	2005	Single MU	Part of MU, OSPAR areas II, III, IV & V	Hammond *et al*. (2013)
Minke whale	SCANS-II & CODA	Design-based	30 410 (0.34)	2005/2007	Single MU	OSPAR areas II, III, IV & V	Macleod *et al*. (2011)
Minke whale	Norwegian / North Sea	Design-based	6891 (0.31)	2008–2013	Single MU	Part of MU, mostly OSPAR area II	Solvang *et al*. (2015)
Minke whale	Norwegian / NE Atlantic	Design-based	89 623 (0.18)	2008–2013	Single MU	Larger than MU, OSPAR areas I, II & III	Solvang *et al*. (2015)

Species / Population	Survey / area	Estimate type	Estimate (CV)	Year	ICES WGMME AU	Notes	Reference
Minke whale	SAMM / Channel, Biscay	Design-based	Winter 363 (1.02); Summer 5223 (0.33)	2011–2012	Single MU	Channel + part Bay of Biscay	Laran *et al.* (in prep)
Pilot whale	CODA, SCANS-II & T-NASS (F)	Model-based	152 071 (0.25)	2005/2007	No specified MU	OSPAR areas II, III, IV & V	Rogan *et al.* (in review)
Sperm whale	CODA, SCANS-II & T-NASS (F)	Design-based	3267 (0.23) / 7035 (0.28) including % of unid large whales	2005/2007	No specified MU	OSPAR areas II, III, IV & V	Rogan *et al.* (in review)
Striped dolphin	CODA	Design-based	61 364 (0.93)	2007	Single MU	Part of MU, OSPAR areas III & IV	CODA (2009)
White-beaked dolphin	SCANS	Design-based	7856 (0.30)	1994	Single MU	Excluding western part of MU	Hammond *et al.* (2002)
White-beaked dolphin	SCANS-II	Design-based	16 536 (0.30)	2005	Single MU	OSPAR areas II, III & IV	Hammond *et al.* (2013)

Offshore bottlenose dolphin

The SCANS-II and CODA surveys in 2005 and 2007, respectively, covered all shelf waters and almost all offshore waters of the region. The estimates from these two surveys thus relate primarily to the Oceanic waters AU but also include AUs inhabited by coastal bottlenose dolphin populations, although little survey effort was conducted in any of these coastal/inshore AUs. The sum of the estimates is 35 780 (0.24) (Table B).

Striped dolphin

The abundance of striped dolphins for the single AU in the region was estimated in 2007 as 67 414 (CV=0.38) for OSPAR areas III and IV (CODA, 2009) (Table B). However, common and striped dolphins can be difficult to distinguish in the field and there are also estimates for common and striped dolphins combined from CODA in 2007 and from the SAMM surveys in 2011/2012 (Laran *et al.*, in review). For CODA, the combined estimate is 224 166 (CV=0.48) compared to the estimate for common dolphins of 118 264 (CV=0.38), suggesting that there may be approximately 100 000 striped dolphins in this area (Table B). For the SAMM surveys in the Channel and part of the Bay of Biscay, there are combined common/striped dolphin estimates for winter (299 896; CV=0.11) and summer (696 013; CV=0.10) (Table B). Differences in methodology and timing of data collection preclude a comparison of the CODA and SAMM estimates.

Minke whale

A single AU has been described for minke whale in the region. Abundance has been estimated in parts of this area from the SCANS, SCANS-II and CODA surveys, and also from Norwegian surveys in the North Sea and SAMM surveys in the Channel and Bay of Biscay (Table B).

The most comprehensive estimate for the whole AU is for 2005/2007 from the SCANS-II/CODA surveys combined: 30 410 (CV=0.34) (Macleod *et al.*, 2011).

Information on variation in minke whale abundance over time is available for part of this region, focused on the North Sea. The SCANS and SCANS-II estimates of abundance in the North Sea in 1994 and 2005 were 7200 (CV=0.22) and 10 500 (CV=0.32), respectively. Norwegian North Sea estimates for 1995 and 1996–2001 were 14 046 (CV=0.28) and 27 364 (CV=0.21), respectively, but this area extended to 65°N into OSPAR area I. Norwegian North Sea estimates equivalent to the area covered by SCANS and SCANS-II were 6246 (CV=0.48) and 6891 (CV=0.31) in 2002–2007 and 2008–2013, respectively. The more recent Norwegian estimates had very little effort in the southern/central North Sea where around one-third of the abundance was estimated from SCANS-II. Thus, considering also the large CVs, there is considerable consistency in equivalent North Sea estimates from 1994 to 2013.

SAMM estimates in 2011/2012 for the Channel/Biscay area were 5223 (CV=0.33) in summer and 363 (CV=1.02) in winter.

Fin whale

An AU has not been described for the fin whale. The best estimate of abundance in the region is from the SCANS-II/CODA surveys in 2005/2007 (Macleod *et al.*, 2011; Table B). Almost all the sightings were from offshore waters covered by CODA 2007. The estimate of identified fin whales was 19 751 (CV=0.17). The estimate including a proportion of unidentified large whales, the large majority of which are likely to be fin whales, was 29 512 (CV=0.26).

Long-finned pilot whale

An AU has not been described for the pilot whale. The best estimate of abundance in the region is from the SCANS-II/CODA surveys plus the Faroes block of T-NASS in 2005/2007 (Rogan *et al.*, in review; Table B). Most of the sightings were from offshore waters covered by CODA 2007 (46 out of 59). The estimate of abundance was 152 071 (CV=0.25).

Beaked whales (all species)

AUs have not been described for beaked whales. The best estimate of abundance in the region is from the SCANS-II/CODA surveys plus the Faroes block of T-NASS in 2005/2007 (Rogan *et al.*, in review; Table B). The sightings of most species were mostly from offshore waters covered by CODA (38 out of 48) but most of the northern bottlenose whales were from T-NASS further west (12 out of 15). The estimate of abundance of all beaked whale species combined was 29 205 (CV=0.23).

Sperm whale

An AU has not been described for the sperm whale. The best estimate of abundance in the region is from the SCANS-II/CODA surveys plus the Faroes block of T-NASS in 2005/2007 (Rogan *et al.*, in review; Table B). Most of the sightings were from offshore waters covered by CODA 2007 (57 out of 65). The estimate of identified sperm whales was 3267 (CV=0.23). The estimate including a proportion of unidentified large whales, most of which are not likely to be sperm whales, was 7035 (CV=0.28).

[New estimates of abundance for all the above species for 2016 are scheduled to be available for OSPAR Regions II, III and IV from SCANS-III in early 2017].

Conclusion

Cetaceans are widely distributed in a range of habitats and are overall abundant throughout OSPAR Regions II, III and IV. For those species for which there is more than one estimate of abundance there is no evidence that numbers are declining or increasing. However, these time-series are currently short relative to the life cycle of the species and, given the precision of the estimates, there is generally poor power to detect trends from these data. Notwithstanding this, the most recent best estimates of abundance are either very similar or larger than earlier estimates. There has been a substantial shift in harbour porpoise distribution from north to south in the North Sea but this is most likely because of changes in prey availability. Consequently, despite the multiple pressures and threats facing cetaceans in this region, there is currently no evidence, with the data available, of a noticeable impact of anthropogenic activity on either distribution or abundance of cetacean species in OSPAR Regions II, III and IV.

Knowledge gaps (brief)

- Historical data on abundance and distribution are scarce or lacking.
- For most species, data are insufficient to assess status in relation to the selected thresholds.
- Lack of seasonal information at an appropriately large-scale.

- Lack of evidence of cause–effect relationships between human activities and population size/distribution.

Knowledge gaps (extended)

Historical data on abundance and distribution

There is very little information about historical distribution (pre-1980) for any species of cetacean in the region and no information about historical abundance. Methods to estimate the abundance of cetaceans were first developed in the 1980s (Hammond, 1986; Hiby and Hammond, 1989). Before that, information on cetacean population size was limited to the use of catch-per-unit-of-effort analyses to inform whaling.

Data on strandings have been recorded for more than 100 years but these can provide only very limited information on the distribution at sea of offshore species and it is not possible to use these data to infer population trends without additional information. This lack of historical information means that relatively recent data must be considered as a baseline. For no species can such recent data be considered to represent an unimpacted state.

Time-series of information to assess status

Many cetacean populations range over very large areas and, although some species are very abundant, these large ranges mean that densities are typically very low. In addition, all cetaceans spend the large majority of their lives underwater and are therefore difficult to observe. Surveys to obtain robust information over the large spatial scale required are thus both logistically challenging and expensive and, as a result, there have been few in the region. The large-scale SCANS/CODA surveys covering a large proportion of European Atlantic waters have happened only twice, although a third survey (SCANS-III) will take place in summer 2016. There have been valuable more frequent systematic aerial surveys generating robust information from the south/central North Sea that have been analysed as part of the DEPONS project (Gilles *et al.*, 2016). In general, however, there have been insufficient purpose-designed surveys for cetaceans to allow status to be assessed in relation to both indicators of abundance and distribution.

A potentially useful additional way to improve this situation is to pursue further the coordinated approach to collate and standardise all available effort-related cetacean sightings data across the region, a task currently being undertaken by the Joint Cetacean Protocol. The patchiness in time, space and scale of survey data make this a challenging task, but the large amount of information available means that this could be a productive exercise.

Lack of seasonal information at an appropriately large-scale

For logistical and practical reasons, large-scale surveys such as SCANS have been conducted during summer. Information is lacking about large-scale seasonal changes in distribution. Seasonal variation on distribution and abundance at a smaller spatial scale is, however, available from some national survey programmes (e.g. Belgium, Denmark, France, Netherlands, Germany and Sweden). In some cases, these surveys are coordinated. To obtain better information about seasonal variation in distribution and abundance, consideration needs to be given to the extension to wider areas and to the better coordination of smaller scale surveys in time and space.

It would be useful to establish a European Atlantic wide framework for conducting large-scale SCANS-type surveys at a frequency to match, at least, the Habitats Directive and MSFD reporting cycle of six years, as has been proposed elsewhere. For species with an offshore distribution that occur outside OSPAR Regions II, III and IV, coordination with other survey programmes such as NASS and the Norwegian "mosaic" surveys is desirable.

Anthropogenic influence on cetacean distribution and abundance

For human activities that have a direct negative impact on cetaceans (removals from hunting, fisheries bycatch and ship strikes) the impact on populations is, at least in theory, possible to assess. Hunting does not occur in the OSPAR Regions II, III and IV. Fisheries bycatch is considered in a separate indicator. Ship strikes of large cetaceans have been considered in a number of fora, including the particular problem of fast ferries (see Background for more detail). However, a lack of comprehensive data on, among other things, population abundance, makes even these direct impacts difficult to assess.

For indirect impacts, it is much more difficult to demonstrate cause and effect at a population level. As detailed in Background, cetaceans are at risk from the indirect effects of a variety of human activities, including underwater noise generated by shipping or seismic activities; prey depletion caused by overfishing, habitat loss or degradation; chemical pollution; marine debris; and the offshore development of oil, gas and renewable energy, the effects of which include underwater noise as well as potential habitat loss or collision risk associated with installations.

References

Arbelo, M., Los Monteros, A. E., Herráez, P., Andrada, M., Sierra, E., Rodríguez, F., Jepson, P. D., and Fernández, A. 2013.Pathology and causes of death of stranded cetaceans in the Canary Islands (1999–2005). Diseases of Aquatic Organisms 103: 87–99.

ASCOBANS. 2013. Report of the Marine Debris Working Group. 20th ASCOBANS Advisory Committee Meeting Document AC20/Doc.3.4.2. Available at: http://www.ascobans.org/sites/default/files/document/AC20_3.4.2_Report_MarineDebrisWG.pdf.

Bailey, H., Brookes, K. L., and Thompson, P. M. 2014. Assessing environmental impacts of offshore wind farms: lessons learned and recommendations for the future. Aquatic Biosystems 10: 1–13.

Baulch, S. and Perry, C. 2014. Evaluating impacts of marine debris ingestion and reporting interactions to the IWC. Working Document to the Scientific Committee of the IWC.SC/65b/E02, 19 pp.

Beineke, A., Siebert, U., McLachlan, M., Bruhn, R., Thron, K., Failing, K., Müller, G., and Baumgärtner, W. 2005. Investigations of the potential influence of environmental contaminants on the thymus and spleen of harbor porpoises (*Phocoena phocoena*). Environmental Science and Technology 39: 3933–3938.

Bennett, P. M., Jepson, P. D., Law, R. J. Jones, B. R., Kuiken, T., Baker, J. R., Rogan, E. and Kirkwood, J. K. 2001. Exposure to heavy metals and infectious disease mortality in harbour porpoises from England and Wales. Environmental Pollution 112: 33–40.

Berggren, P., Ishaq, R., Zebuhr, Y., Naf, C., Bandh, C., and Broman, D. 1999. Patterns and levels of organochlorines (DDTs, PCBs, non-ortho PCBs and PCDD/Fs) in male harbour porpoises (*Phocoena phocoena*) from the Baltic Sea, the Kattegat-Skagerrak Seas and the west coast of Norway. Marine Pollution Bulletin 38: 1070–1084.

CODA. 2009. Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA), 43 pp.

David, J. A. 2006. Likely sensitivity of bottlenose dolphins to pile-driving noise. Water and Environment Journal 20: 48–54.

Davison, N. J., Perrett, L. L., Law, R. J., Dawson, C. E., Stubberfield, E. J., Monies, R. J., Deaville, R., and Jepson, P. D. 2011. Infection with *Brucella ceti* and high levels of polychlorinated biphenyls in bottlenose dolphins (*Tursiops truncatus*) stranded in south-west England. Veterinary Record, 1–6. doi: 10.1136/vr.d2714.

Evans, P. G. H. and Bjørge A. 2013. Impacts of climate change on marine mammals. Marine Climate Change Impacts Partnership (MCCIP) Annual Report Card 2011–2012 Scientific Review 1–34.

Evans, P. G. H., Baines, M.E., and Anderwald, P. 2011. Risk Assessment of Potential Conflicts between Shipping and Cetaceans in the ASCOBANS Region. 18th ASCOBANS Advisory Committee Meeting Document AC18/Doc.6-04 (S) rev.1. Available at: http://www.ascobans.org/sites/default/files/basic_page_documents/AC18_6-04_rev1_ProjectReport_ShipStrikes.pdf.

Evans, P. G. H., and Nice, H. 1996. Review of the effects of underwater sound generated by seismic surveys on cetaceans. Sea Watch Foundation, Oxford. (Report commissioned by UKOOA).

Gilles, A., Scheidat, M., and Siebert, U. 2009. Seasonal distribution of harbour porpoises and possible interference of offshore wind farms in the German North Sea. Marine Ecology Progress Series 383: 295–307.

Gilles, A., Adler, S., Kaschner, K., Scheidat, M., and Siebert, U. 2011. Modelling harbour porpoise seasonal density as a function of the German Bight environment: implications for management. Endangered Species Research 14: 157–169.

Gilles, A., Viquerat, S., Becker, E.A., Forney, K.A., Geelhoed, S.C.V., Haelters, J., Nabe-Nielsen, J., Scheidat, M., Siebert, U., Sveegaard, S., van Beest, F., van Bemmelen, R. and Aarts, G. 2016. Seasonal habitat-based density models for a marine top predator, the harbour porpoise, in a dynamic environment. In press, Ecosphere.

Gordon, J. C. D., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M. P., Swift, R. and Thompson, D. 2003. A Review of The effects of seismic surveys on marine mammals. Journal of the Marine Technology Society 37:41–53.

Hammond, P. S. 1986. Estimating the size of naturally marked whale populations using capture–recapture techniques. Reports of the International Whaling Commission (Special Issue 8): 253–282.

Hammond, P.S. *et al.* 2002. Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology, 39(2): 361–376.

Hammond, P. S., Northridge, S. P., Thompson, D., Gordon, J. C. D., Hall, A. J., Murphy, S. N. and Embling, C. B. 2008. Background information on marine mammals for Strategic Environmental Assessment 8. Report to the Department for Business, Enterprise and Regulatory Reform. Sea Mammal Research Unit, St Andrews, Scotland, UK, 52 pp.

Hammond, P.S. *et al.* 2013. Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological Conservation, 164, pp.107–122.

Heinänen, S. and Skov, H. 2015. The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area. JNCC report number 544. http://jncc.defra.gov.uk/page-6991.

Hiby, A. R. and Hammond, P. S. 1989. Survey techniques for estimating abundance of cetaceans. Reports of the International Whaling Commission (Special Issue 11): 47–80.

Hiby, A. R. and Lovell, P. 1998.Using aircraft in tandem formation to estimate abundance of harbour porpoise. Biometrics 54: 1280–1289.

Hiby, L. 1999. The objective identification of duplicate sightings in aerial survey for porpoise, in: Garner, G.W., Amstrup, S.C., Laake, J.L., Manly, B.F.J., McDonald, L.L. and Robertson, D.G. (Eds.), Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam, pp. 179–189.

ICES. 2013. Report of the Working Group on Marine Mammal Ecology (WGMME), 4–7 February 2013, Paris, France. ICES CM 2013/ACOM:26. 117 pp.

ICES. 2014a. Bycatch of small cetaceans and other marine animals. Review of national reports under Council Regulation (EC) No. 812/2004 and other published documents. Advice April 2014.AC21/Inf.3.1.b.

ICES. 2014b. OSPAR request on implementation of MSFD for marine mammals. Special request. Available from: http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/Special%20Requests/OSPAR_Implementation_of_MSFD_for_marine_mammals.pdf .

ICES. 2014. Report of the Working Group on Marine Mammal Ecology (WGMME), 10–13 March 2014, Woods Hole, Massachusetts, USA. ICES CM 2014/ACOM:27. 234 pp.

ICES. 2015. Report of the Working Group on Marine Mammal Ecology (WGMME), 9–12 February 2015, London, UK. ICES CM 2015/ACOM:25. 114 pp.

ICG-COBAM. 2012. MSFD Advice Manual and Background Document on Biodiversity A living document - Version 3.2 of 5 March 2012. http://www.ospar.org/documents/dbase/publications/p00581/p00581_advice%20document%20d1_d2_d4_d6_biodiversity.pdf .

Jefferson, T. A., Webber, M. A., and Pitman, R. 2008. Marine Mammals of the World: A Comprehensive Guide to their Identification. Elsevier Science publishing. 592 pp.

Jepson, P. D., Deaville, R., Acevedo-Whitehouse, K., Barnett, J., Brownlow, A., Brownell Jr., R. L., Clare, F. C., Davison, N., Law, R. J., Loveridge, J., Macgregor, S. K., Morris, S., Murphy, S., Penrose, R., Perkins, M. W., Pinn, E., Seibel, H., Siebert, U., Sierra, U., Simpson, V., Tasker, M. L., Tregenza, N., Cunningham, A. A. and Fernández, A. 2013. What Caused the UK's Largest Common Dolphin (*Delphinus delphis*) Mass Stranding Event? PLoS One 8(4):e60953. doi:10.1371/journal.pone.0060953.

Jepson, P. D., Deaville, R., and Law, R. J. 2016. PCB pollution continues to impact populations of orcas and other dolphins in European waters. Scientific Reports 6: 18573.

JNCC (Joint Nature Conservation Committee). 2007. Second Report by the UK under Article 17 on the implementation of the Habitats Directive from January 2001 to December 2006. Peterborough: JNCC. Available from: www.jncc.gov.uk/article17.

Laist, D. W. 1987. Overview of the biological effects of lost and discarded plastic debris in the marine environment. Marine Pollution Bulletin 18: 319–326.

Laist, D. W. 1997. Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. In: Coe, J.M., Rogers, D.B. (Eds.), Marine Debris: Sources, Impacts and Solutions. Springer Verlag, New York, NY, pp. 99–140.

Laist, D. W., Knowlton, A. R., Mead, J. G., Collet, A. S., and Podesta, M. 2001. Collisions between ships and great whales. Marine Mammal Science 17: 35–75.

Laran, S., Authier, M., Blanck, A., Doremus, G., Falchetto, H., Monestiez, P., Pettex, E., Stephan, E., Van Canneyt, O., and Ridoux, V. In review. Seasonal distribution and abundance 1 of cetaceans within French waters: Part II: The Bay of Biscay and the English Channel. Deep Sea Research II.

Law, R. J., Barry, J., Barber, J. L., Bersuder, P., Deaville, R., Reid, R. J., Brownlow, A., Penrose, R., Barnett, J., Loveridge, J., Smith, B., and Jepson, P. D. 2012. Contaminants in cetaceans from UK waters: Status as assessed within the Cetacean Strandings Investigation Programme from 1990 to 2008. Marine Pollution Bulletin 64: 1485–1494.

Lusher, A. L., Hernandez-Milian, G., O'Brien, J., Berrow, S., O'Connor, I., and Officer, R. 2015. Microplastic and macroplastic ingestion by a deep diving, oceanic cetacean: The True's beaked whale *Mesoplodon mirus*. Environmental Pollution 199: 185–191.

Macleod, K., Hammond, P. S., Burt, L., Cañadas, A., Lens, S., Mikkelsen, B., Rogan, E., Santos, B., Uriarte, A., Van Canneyt, O., and Vazquez, J. A. 2011. Abundance of baleen whales in the European Atlantic. Paper SC/63/RMP24 presented to the Scientific Committee of the International Whaling Commission.

MAGRAMA. 2012. Estrategias Marinas: Evaluación Inicial, Buen Estado Ambiental y Objetivos Ambientales. Ministerio de Agricultura, Alimentación y Medio Ambiente, 287 pp. http://www.magrama.gob.es/es/costas/temas/estrategias-marinas/0_documento_marco_estrategias_marinas_tcm7-204388.pdf.

Méndez-Fernandez, P., Websterd, L., Chouvelon, T., Bustamante, P., Ferreira, M., González, A. F., López, A., Moffat, C. F., Pierce, G. J., Read, F. L., Russell, M., Santos, M. B., Spitz, J., Vingada, J. V., and Caurant, G. 2014a. An assessment of contaminant concentrations in toothed whale species on the NW Iberian Peninsula: Part I. Persistent organic pollutants. Science of the Total Environment 484: 196–205.

Méndez-Fernandez, P., Websterd, L., Chouvelon, T., Bustamante, P., Ferreira, M., González, A. F., López, A., Moffat, C. F., Pierce, G. J., Read, F. L., Russell, M., Santos, M. B., Spitz, J., Vingada, J. V., and Caurant, G. 2014b. An assessment of contaminant concentrations in toothed whale species on the NW Iberian Peninsula: Part II. Trace element concentrations. Science of the Total Environment 484: 206–217.

Murphy, S., Barber, J. L., Learmonth, J. A., Read, F. L., Deaville, R., Perkins, M. W., Brownlow, A., Davison, N., Pierce, G. J., Law, R. J., and Jepson, P. D. 2015. Reproductive Failure in UK Harbour Porpoises *Phocoena phocoena*: Legacy of Pollutant Exposure? PLoS ONE 10(7): e0131085.

Øien, N. 1999. Report of the Norwegian 1998 sighting survey for minke whales. Paper SC/51/RMP12 Submitted to the Scientific Committee of the International Whaling Commission. IWC, the Red House, 135 Station Road, Impington, Cambridge CB24 9NP, UK.

Øien, N. 2005. Report of the Norwegian 2004 survey for minke whales in the North Sea and southern Norwegian Sea. Paper SC/57/O10 Submitted to the Scientific Committee of the International Whaling Commission. IWC, the Red House, 135 Station Road, Impington, Cambridge CB24 9NP, UK.

Øien, N. 2010. Report of the Norwegian 2009 survey for minke whales within the Small Management Area EN- the North Sea. Paper SC/62/RMP7 Submitted to the Scientific Committee of the International Whaling Commission. IWC, the Red House, 135 Station Road, Impington, Cambridge CB24 9NP, UK.

OSPAR. 2012. MSFD Advice Manual and Background Document on Biodiversity. Version 3.2. OSPAR Biodiversity Series. Available from http://www.ospar.org/work-areas/cross-cutting-issues/msfd/msfd-advice-manuals.

Panigada, S., Pesante G., Zanardelli, M., Capoulade, F., Gannier, A., and Weinrich, M. T. 2006. Mediterranean Fin Whales at risk from fatal Ship Strikes. Marine Pollution Bulletin 52:1287–1289.

Pike, D., Gunnlaugsson, T., and Vikingsson, G. 2009.Estimates of the abundance of minke whales (*Balaenoptera acutorostrata*) from Faroese and Icelandic NASS shipboard surveys. NAMMCO Sci. Pub. 7: 81–94.

Peschko, V., K. Ronnenberg, U. Siebert, and Gilles, A. 2016. Trends of harbour porpoise (*Phocoena phocoena*) density in the southern North Sea. Ecological Indicators 60: 174–183. DOI 10.1016/j.ecolind.2015.06.030.

Pierpoint, C. 2008. Harbour porpoise (*Phocoena phocoena*) foraging strategy at a high energy, near-shore site in south-west Wales, UK. Journal of the Marine Biological Association of the United Kingdom 88: 1167–1173.

Rogan, E., Cañadas, A., Macleod, K., Santos, B., Mikkelsen, B., Uriarte, A., Van Canneyt, O., Antonio Vazquez, J., and Hammond, P. S. In Review. Distribution, abundance and habitat use of deep diving cetaceans in the North East Atlantic. Deep Sea Research II.

Scheidat, M., Gilles, A., Kock, K. H., and Siebert, U. 2008. Harbour porpoise *Phocoena phocoena* abundance in the southwestern Baltic Sea. Endangered Species Research, 5: 215–223.

Scheidat, M., Verdaat, H., and Aarts, G. 2012. Using aerial surveys to estimate density and distribution of harbour porpoises in Dutch waters. Journal of Sea Research 69: 1–7.

Silva, M. A., Machete, M., Reis, D., Santos, M., Prieto, R., Dâmaso, C., Pereira, J. G., and Santos, R. S. 2011. A review of interactions between cetaceans and fisheries in the Azores. Aquatic Conservation: Marine and Freshwater Ecosystems, 21(1): 17–27.

Taylor, B., Chivers, S. J., Larese, J. and Perrin, B. 2007. Generation length and percent mature estimates for IUCN assessments of cetaceans. Southwest Fisheries Science Center. Administrative report LJ-07-01, 18 pp.

Viquerat, S., Herr, H., Gilles, A., Peschko, V., Siebert, U., Sveegaard, S. and Teilmann, J. 2014. Abundance of harbour porpoises (*Phocoena phocoena*) in the western Baltic, Belt Seas and Kattegat. Marine Biology 161: 745–754.

Waring, G. T., Palka, D. L. and Evans, P. G. H. 2009. North Atlantic Marine Mammals. Pp. 763–771. In: Encyclopaedia of Marine Mammals (Editors W. F. Perrin, B. Würsig and J. G. M. Thewissen). 2nd edition. Academic Press, San Diego.

WDCS. 2011. Marine Debris and Cetaceans. Report of the Whale and Dolphin Conservation Society.

Wilson, B., Batty, R. S., Daunt, F. and Carter, C. 2007. Collision risks between marine renewable energy devices and mammals, fish and diving birds. Report to the Scottish Executive. Scottish Association for Marine Science, Oban, Scotland, PA37 1QA.

Annex 7: Technical minutes from the Review Group for the common marine mammal indicator assessments request

- RGMM;
- 18 February 2016;
- Participants: Simon Ingram (Chair), Garry Stenson and David Lusseau;
- Working Group: WGMME.

7.1 Review of ICES report IA2017 M4 Abundance and distribution of cetaceans other than coastal bottlenose dolphins and killer whales

On the whole the report is comprehensive and addresses the OSPAR request comprehensively using all the relevant published material available. The language is appropriate to a non-scientific audience although reviewers have made some small edits to the Indicator Assessment Sheet. There are a number of key points that should be considered by the advisory group as described below. Also comments and edits have been appended to the Indicator Assessment Sheet.

Threats

Table B ('threat matrix'): The reviewers are not confident with the evidence or validity of this Table of threats and cannot even think of a way to replicate the estimates in a standardised manner. The risk is that these are mostly guesswork, and therefore should be acknowledged as such and be used with caution at best. For example it seems likely that bottlenose dolphins living in coastal habitat (such as estuaries are indirectly exposed to threats resulting from habitat degradation, habitat loss, nutrient enrichment but these are classed as ‘low’. There is no source reference to the empirical evidence supporting the construction of this matrix.

Harbour porpoise use of tidal current

Our understanding from Embling *et al.* is that harbour porpoises are attracted to predictable small-scale high-current locations (e.g. Corryvreckan) but avoid large areas of high energy currents (e.g. North Channel). The report states that this paper demonstrated that porpoises ‘strongly avoid’ high current areas.

Lack of evidence vs. lack of change in status

The conclusion states that "Consequently, despite the multiple pressures and threats facing cetaceans in this region, there is currently no evidence, with the data available, of a noticeable impact of anthropogenic activity on either distribution or abundance of cetacean species in OSPAR Regions II, III and IV." Probably more accurate to state that (what would be a more appropriate conclusion) is that we currently lack the level of details needed to appraise whether the current multiple pressures and threats to which cetaceans are exposed are degrading the GES of cetaceans (with distribution or abundance metrics).

Appropriateness of assessment methods

Although this may be fundamentally related to the application of the MSFD rather than the details of this report we would like to highlight the problem that much of the current threats cause sublethal impacts and abundance estimation is likely not the best tool (or should not be the only tool) to inform management and additional approaches would be necessary (demographic rate estimations, health estimations) to develop appropriate, and more flexible, indicators that can provide managers the lead time needed to react to GES challenges before the problems are so large that they cannot be counter-acted.

7.2 Review of ICES report IA2017 M4 Abundance and distribution of cetaceans 2: coastal bottlenose dolphins

- Garry Stenson joined RGMM for Review 5.2

On the whole the report is comprehensive and addresses the OSPAR request comprehensively. The language is appropriate to a non-expert audience although we have made some small edits to the Indicator Assessment Sheet. There are a number of key points that should be considered by the advisory group as described below. Also comments and edits have been appended to the Indicator Assessment Sheet.

Key message. This states that populations are stable but overstates the role of recreational vessel (ecotourism) disturbance. These conclusions are revisited in further comments below.

Agreed targets/thresholds

Although this is probably beyond the scope of this OSPAR request and has been agreed at a previous WGMME meeting the reviewers have concerns regarding the decline thresholds set in the GES monitoring. 30% in ten years target does not seem to be biologically driven but perhaps a detectable level of decline give the power of the survey data (because that is the effect size we can detect with MR estimation?). Although this may be a wider comment about GES monitoring within the MSFD this issue points to the shortcoming of abundance as an indicator for the purpose of the ToR (as opposed to e.g. demographic rates), particularly when the populations are likely to be mainly affected by sublethal impacts.

Offshore population

In background (brief) section there is a reference to the 'offshore' population of *Tursiops*. We understand that this 'population' is included in IA2017 M4 assessment sheet for cetaceans other than coastal bottlenose dolphins and killer whales but we comment on this 'population' as it is referred to repeatedly in this document.

Very little is known about this 'offshore population' specifically there is no knowledge regarding the ranging behaviour and genetic/social structure of this population. The statement that this offshore group is 'large wide ranging' should perhaps be restated as 'large and widely distributed'.

As stated in the *background* there is an offshore population of bottlenose dolphins that is a separate genetic population from the coastal bottlenose dolphin populations. This appears to be supported by several genetic and photo-id studies. There is little or no information surrounding the finer scale genetic/social structure of offshore animals and the degree to which these animals visit or use coastal habitat.

Impacts

There should be a general statement that our coastal waters are host to an increasing number of competing human activities, both industrial and recreational and careful management is needed for integrated planning and management to minimise potential impacts of bottlenose dolphins using coastal waters.

Ocean noise

Lack of reference to ocean noise (OSPAR pollutant) throughout the document. Many of the coastal bottlenose dolphin populations use waters with high levels of shipping activity and the level of noise and impacts to population level has not been adequately assessed to date and needs to be promoted in the text (masking, etc.).

Disturbance

In Simon Ingram's opinion (although this is not shared by David Lusseau) there is too much emphasis on recreational disturbance throughout the document. The reviewers do agree that the report should focus more on cumulative impacts (and point on synergies and interactions which can compound them). Whilst recreation activities is an issue in itself (because it is prevalent, chronic and a big part of dolphin daily life in Europe), it becomes a big problem only when they can't compensate for these impacts (e.g. when habitat modification, fisheries pressure) and can itself compound other impacts (release of fat-trapped contaminants back in the body as dolphins have to use their stores to compensate the energetic costs of rec effects). Impacts such as recreational dolphin watching is easily controlled and it should be possible for this to be well managed and tends to be localised with seasonal and weather constraints. There are likely to be much more significant threats from combinations of insidious indirect impacts from food chain damage and pollutant loads especially in combination with disturbance pressure from recreation disturbance.

Status and monitoring issues

Baselines

The report recommends the use of current levels of abundance as baselines. Given the demographic dynamics of the species once we start looking at several generations and in the light of potential range shifts during this time, can we talk about a 'local' baseline at all? These concerns are expanded on below. Given how recent the first estimates are for most groups considered, I would have expected some comment about problems associated with the idea of using the first estimate for comparison. It may be the only option but it clearly has problems that should be explained to the reader.

Estimates of total abundance of coastal populations

There is repeated reference in the report about likely total abundance of bottlenose dolphins in coastal waters but it is not made clear how this total was derived, was this simply the sum of MR estimates?? Besides problems with summing Bayesian posterior estimates with frequentist estimates (without starting on the uncertainty appraisal hurdle); we have problems with the assumption of closed population you need to make particularly when the years vary. Hence summing population estimates of mobile populations from surveys conducted in different years is problematic. Perhaps there is an argument that the concept of a metapopulation is more appropriate to think about GES for *Tursiops* (see comments on AU below).

The method of photo-id is prone to biases and there is no attempt to qualify the quality of the various data sources incorporated into this review. In the light of this, the report should be cautious in the use of unpublished data risks including poor data, for example the reported numbers of dolphins using the waters of SW England are best used with caution as a minimum estimate of individuals recorded in this area rather than an estimate of abundance.

A significant conclusion from this review is that the status of majority of the 'populations' they examined cannot be assessed. Although they mention the fact that many cannot be 'assessed' this is usually one of the last statements. This should be highlighted, especially given how little is known about many of the groups they have commented on.

Overall, we would have like to have seen some general discussion that addressed issues such as the quality of the estimates, stock structure, difficulties in obtaining precise enough estimates to determine trends (perhaps a power analysis?)

Population stability

There is a reference to the lack of precision to detect even quite significant changes in population size, yet the report states that the coastal populations appear stable; the potential contradiction here needs clarifying. The statement 'most current populations seem to be stable' has to be considered within the relatively short time that these populations have been subject to monitoring surveys (maximum 25 years). While the population AUs do not appear to exceed the agreed decline threshold of <30% within ten years the precision and frequency of monitoring surveys are not sensitive to detect smaller but significant declines/increases.

AUs and populations

In the report there is some confusion as to whether we are treating AUs as a whole or considering status of individual communities/populations within the wider AU. The issue of how stock structure was determined and how independent each AU/population is, is highly relevant to how confident the trend estimates are. The understanding of stock structure of coastal dolphins should be explained early in the document, particularly to enable the reader to understand the relationship between their 'populations' and the AUs. Specifically there is a reference to the Sado estuary being in decline (defined as >30% within ten years) but this is not a separate AU and there is no evidence that the AU to which these animals belong (Portuguese coast) is in a similar decline given the AEs for other communities/populations within this AU. The use of the term 'population' is somewhat haphazard throughout with reference to the 15 animals using the Sound of Barra as a population.

I also have a concern with the issue of movements vs. their 'populations' (current or historical). The report discusses the possibility of 'ephermeral populations' and yet treats each of their groups as independent. Changes in local numbers may be due to declines (increases) in total abundance or movements which cannot be distinguished in many cases. Some discussion about these difficulties should be considered.

Additional minor comment; the authors often use the term 'can/cannot be assessed' when what they mean is that it cannot be assessed against the OSPAR criteria. This needs clarifying.

Monitoring distribution and changes in ranging behaviour

There is not enough focus on ranging behaviour and that (i.e. Wilson *et al.*, 2004) range shifts may be detected as an apparent decline, changes in the status of a population may be measured as range expansion and occupancy rather than a simple change in abundance at a number of fixed sites that are being condition monitored by Habs Directive SACs. We need to be aware that we have patchy data between sites with regular condition monitoring and more effort is probably needed here (see knowledge gaps). We have to disentangle local extirpation from displacement; which if we use abundance estimation at fixed sites; we can't. Due to the use of patchy survey data that have been collected for a different purpose (usually condition monitoring for the habitats directive) there is confusion between residency pattern estimation and sampling rate (do we not see dolphins in the middle of the North Sea because we don't look much?). This needs to be considered (and constitutes a knowledge gap).

Historic populations

It might be worth stating that it appears likely that *Tursiops* have been using the coastal waters of NE Europe since the last glacial retreat with radiocarbon dated specimens of approximately 8000 years found in the southern North Sea (Nykanen, unpublished data). From the work by Marie Louis *et al.*, what we know from MF and what we know of sublethal impacts (the problem of displacement vs. extirpation) mean we can't really talk about the historical data in the context of the modern data: have these historical populations really disappeared, or moved?

Miscellaneous minor points

- The charismatic argument is rather poor justification of conservation, there are plenty of good reasons why we need to keep an eye on cetaceans for GES appraisal, and for ecosystem services sustainability.
- More precise consideration of cetacean species trophic levels (and its variability) would be 'useful' and appropriate when trying to articulate arguments around the ToR.
- A somewhat minor point is that there are a very large number of place names used. All names used in the text should be shown on a map.
- The authors use a lot of statements that are not well support or explained (i.e. 'motherhood comments'). For example, they make statements such as "Habitat loss will also affect populations" - what do they mean by habitat loss? How does damage to the seabed result in lower populations? Climate change is raised and assumed to have only negative impacts. Is it not possible that changes in water temperatures may open up new resources or areas for BND?

Knowledge gaps

The report is reasonably comprehensive but *we* feel that a number of points could be strengthened/included.

- Imprecision of monitoring surveys to detect change - more frequent surveys (rather than limited to Habs Directive six year cycle) would provide better sensitivity.

- Gaps in data between monitored sites insufficient to detect range changes and occupancy of new sites in response to re-occupation of suitable habitat as water quality and prey stocks recover.
- Limited information relating to genetic stock structure especially where there have been no biopsy sampling - Cardigan Bay, MF, Cornwall, this would be useful for baseline data and monitoring any future change in the status and distribution of coastal bottlenose dolphins (and to test a hypothesis that coastal areas can be re-occupied by offshore animals.
- Understanding of long-term impact of exposure to noise levels is poor. Some modelling work has indicated that *Tursiops* may be resilient to relatively high levels of disturbance from vessels (New *et al.*, 2013) but this did not consider the cumulative impacts of disturbance together with elevated noise (associated disruption to communication, etc.).

Killer whales

This section appears to be rather brief. Although this is probably due to the smaller number of animals using the NE coastal waters and the lack of detailed research focus outside areas of regular occurrence (Straits of Gibraltar).

Interaction of killer whales in waters north of UK with the pelagic mackerel fleet is not mentioned. (Luque, 2006). There is insufficient information relating to the extent and impacts of the tuna fishery interaction around the Straits of Gibraltar.

Threats

While pollutants are included as a significant threat to reproductive success of coastal killer whales based on PCP loading in blubber, there should be mention of other coastal threats such as prey supply and habitat degradation from fishing over extended periods as likely contributors to decline.