A1a.8 Marine mammals and otter

A1a.8.1 Introduction and key sources of information

The sections below describe the occurrence of cetaceans (porpoises, dolphins, and whales), seals and otters in UK waters. A summary is provided of the current understanding of their distribution, abundance, ecological importance, and the main environmental issues of concern. Where possible, information is provided on any known or likely trends in these characteristics. In addition, the various conservation frameworks in place to facilitate their management and conservation are described. A comprehensive baseline for marine mammals was compiled in contribution to the OESEA 3 Environmental Report (Appendix 1 in DECC 2016); here, we update and build upon the 2016 baseline to reflect new information where relevant.

Reviews of marine mammal distribution, ecology and sensitivities in UK waters have been carried out as supporting studies to previous oil and gas SEAs (e.g. Hammond *et al.* 2001, 2004, 2006, 2008) and the first Offshore Energy SEA (Murphy *et al.* 2008). Further reviews of available information on marine mammals and assessments of species' status have taken place as part of several UK initiatives, including Charting Progress 2 (UKMMAS 2010), the UK Government reporting for Article 17 of the Habitats Directive (JNCC 2007, 2013, 2019) and for the Marine Strategy Framework Directive (DEFRA 2012). Species-specific assessments in the recent Fourth Report under Article 17 of the Habitat Directive each include a bibliography of relevant references (JNCC 2019). Hague *et al*. (2020) provide a comprehensive and up-to-date review of information on the distribution and abundance of cetaceans and seals in Scottish waters, with a focus on areas identified for offshore wind development under the 'ScotWind' leasing round. The contribution of Evans & Waggitt (2020) to the Marine Climate Change Impacts Partnership has provided up-to-date information on impacts of climate change on marine mammals around the UK.

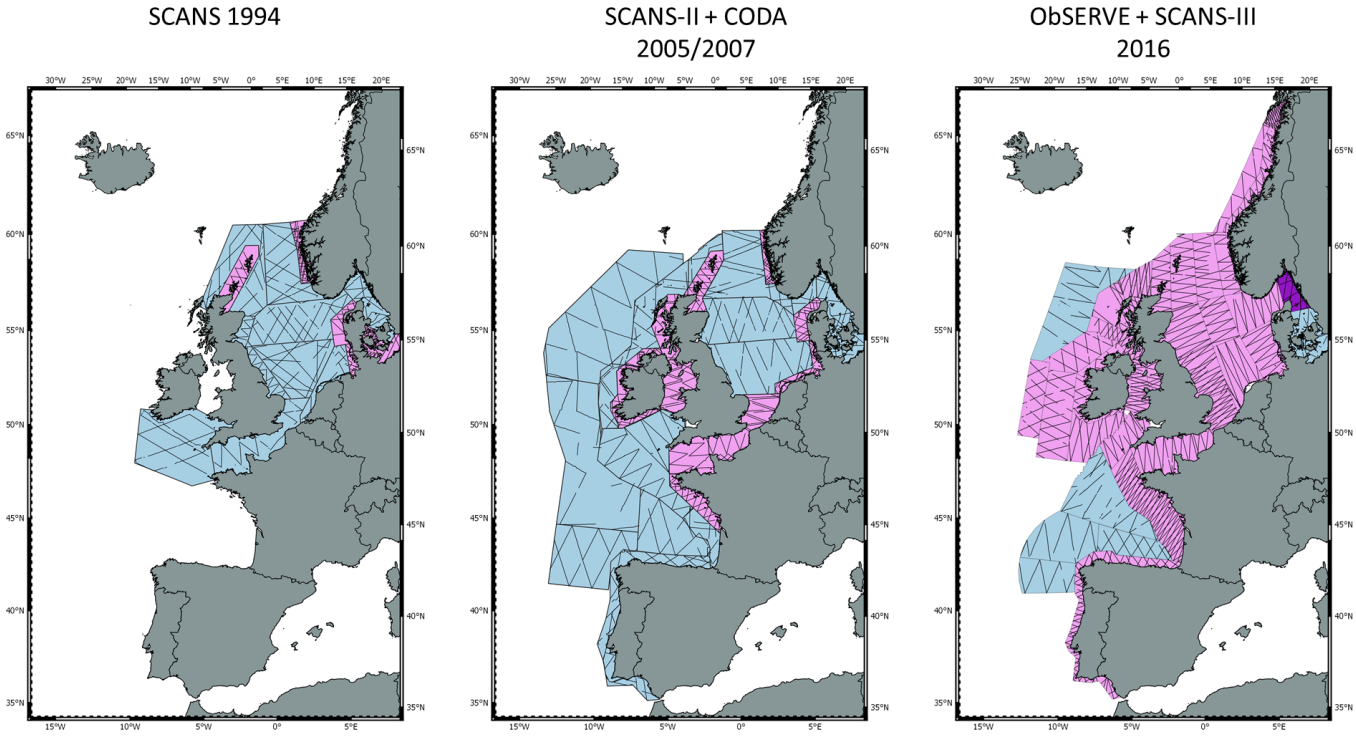
Broad-scale, dedicated cetacean surveys

Large-scale surveillance of cetacean population abundance has been carried out through wide-ranging internationally coordinated ship-based and aerial surveys such as the Small Cetacean Abundance in the European Atlantic and North Seas (SCANS) and Cetaceans Offshore Distribution and Abundance in the European Atlantic (CODA); these surveys have been instrumental in estimating abundance of more common species in UK and adjacent waters of the north-east Atlantic. SCANS I, II and III took place in the summers of 1994, 2005 and 2016 respectively (Hammond *et al.* 2013, 2017). CODA covered waters along the shelf edge and beyond, in waters of the UK, Ireland, France and Spain in 2007 (Hammond *et al.* 2009). While the SCANS I and II surveys were restricted to shelf waters, SCANS-III included areas off the shelf to the west of Scotland, and also west of France and north-west of the Iberian Peninsula (Hammond *et al*. 2021).

The majority of Irish waters were not included in the SCANS-III survey area; this area, including Irish and Celtic Seas and the Irish continental margin, were surveyed for cetaceans (and seabirds) under the ObSERVE programme. This included summer and winter aerial surveys from 2015-2016 (Rogan *et al*. 2018), complemented by ship-based visual and acoustic surveys and a series of bottom-mounted acoustic loggers deployed along the Irish shelf edge (Berrow *et al*. 2018; Kowarski *et al*. 2018). Survey coverage is illustrated in Figure A1a.8.1. Work is currently underway to generate abundance estimates and modelled distributions for the combined ObSERVE and SCANS-III survey data.

The SCANS-III report also provides a reanalysis of shipboard data for some species/years from the previous SCANS surveys, where appropriate, using a more robust approach to estimating detection probability. This reduces the probability of bias in abundance estimates due to responsive movement of animals and creates a comparable time series of estimates from 1994, 2005 and 2016 for harbour porpoise, white-beaked dolphin, bottlenose dolphin and minke whale. Additionally, the 2016 survey provided, for the first time, estimates of g(0): the proportion of animals on the trackline which were detected by aerial observers. g(0) was estimated for harbour porpoise, dolphins (all species) and minke whale, and applied to aerial survey data for 2016 and 2005, providing further refinements to abundance estimates for those species from 2005. Revised abundance estimates from ship surveys were similar for minke whale but 20-50% larger for harbour porpoise and three times larger for white-beaked dolphin. These results confirm that abundance was previously underestimated for harbour porpoise and, especially, for white-beaked dolphin. Revised abundance estimates for aerial surveys using the SCANS-III estimates of g(0) were similar for dolphin species but smaller for minke whale.

Figure A1a.8.1: SCANS, CODA and ObSERVE survey coverage



Notes: Pink areas are those surveyed by aircraft; blue areas by vessel. The single purple block was surveyed by vessel and aircraft due to poor conditions during vessel surveys. Source: Hammond *et al*. (2019).

Compilations and analyses of existing data

Reid *et al.* (2003) compiled cetacean sighting records from a variety of systematic surveys and opportunistic sightings, incorporating some 2,500 days of observation carried out from 1979-1997 to produce an atlas of cetacean distribution in north-west European waters. Many of these sightings came from the European Seabirds at Sea (ESAS) database, the Sea Watch Foundation database and SCANS-I. The Atlas has been cited extensively and maps have been regularly reproduced. The Atlas was updated for Welsh waters to include data from 1990-2009 (Baines & Evans 2012), and a similar resource is available specifically for Irish waters using data from 2005-2011 (Wall *et al*. 2013). While not effort-corrected, maps of sightings recorded during seismic surveys in UK and adjacent waters from 1994-2010 provide

useful information on the distribution of marine mammals, particularly for the central-northern North Sea and waters north and west of Scotland (Stone 2015).

Substantial new data have been collected since publication of Reid *et al*. (2003) through NGOs, industry, academic and government-funded projects. Two subsequent data collation exercises included the JNCC-led Joint Cetacean Protocol ('JCP', Thomas 2009, Paxton & Thomas 2010, Paxton *et al.* 2010) and the Marine Ecosystems Research Project ('MERP', Waggitt *et al*. 2020). The JCP provided a platform for the integration of effort-linked cetacean sightings across NW Europe, and collated 38 data sources representing 1.05 million km of ship and aircraft survey effort from 1994-2010. From this resource, species distribution modelling resulted in maps that provide an indicative illustration of the average distribution and abundance of seven of the most common cetacean species occurring in NW European waters from 1994-2010 (Paxton *et al*. 2016). It is recognised that these maps can add value to industry impact assessments and marine spatial planning efforts by providing density estimates at medium to large spatial scales that are likely to be more realistic than what could be obtained from small scale surveys during one or two years. However, it is also important to recognise its limitations; the validity of some assumptions made in standardising data from multiple sources and other potential sources of bias have not been examined in detail. Further, the temporal and spatial paucity of the data has meant abundance estimates for many areas and time periods have wide confidence intervals, and the power to detect trends in population size remains low even for species with reasonably good time-series of data (Paxton *et al*. 2016). An key application of the JCP data resource was an analysis to identify of areas of persistently high relative density of harbour porpoise (Heinänen & Skov 2015), to inform the selection of SACs.

The MERP exercise collated and standardised 2.68 million km of effort-linked aerial and vessel survey data, collected between 1980 and 2018, therefore including SCANS-III and ObSERVE data. Species distribution models were developed for 12 species of cetacean (using data from 1985-2017) to provide average monthly predicted density surfaces at 10 x 10 km resolution. Acknowledged limitations included: the limited influence of small sub-populations on models (noting that bottlenose dolphin predictions are limited to the offshore ecotype); that substantive changes in distributions over time have occurred for some species (e.g. harbour porpoise in the North Sea) and therefore uncertainty over how predictive maps are to current distribution patterns; and, evidence of limited ability to detect seasonal changes in distribution (Waggitt *et al*. 2020).

Work is currently underway (led by JNCC) towards establishing a functional Joint Cetacean Data Programme (JCDP)[1] to coordinate how cetacean data are collected, stored, accessed and analysed. Potential applications of the collated data include reporting and assessments of conservation status, trend analyses, and various spatio-temporal analyses of distribution (JNCC 2021). Phase 1 of the JCDP was recently completed, establishing a draft data standard and draft data policy, along with scoping options for developing and maintaining the data resource in the long-term. The next stage includes the development of a database and portal.

The JCP and MERP exercises have compiled more comprehensive and recent data and performed more rigorous analyses than those presented in Reid *et al*. (2003). However, the simpler atlas outputs of Reid *et al*. (2003), along with those of Baines & Evans (2012) and Wall *et al*. (2013), provide a more transparent and easily-interpretable resource, which relies on

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

fewer assumptions. Therefore, while data are old, and must be used in the context of known broad-scale changes distribution (e.g. North Sea harbour porpoise, Hammond *et al*. 2013), these atlas outputs remain a valuable resource in terms of understanding the distribution of cetaceans in UK and adjacent waters.

Deep-diving cetaceans, particularly beaked whales, continue to remain poorly understood due to the challenges associated with their typically offshore distribution and limited time spent at the surface for observation. Using data from SCANS-II (2005), CODA (2007) and North Atlantic Sightings Surveys (NASS) (2007), Rogan *et al*. (2017) investigated the distribution, abundance and habitat use of deep-diving cetaceans (beaked whales, sperm whale, pilot whale) in the NE Atlantic, including deep waters west of the UK and Ireland. Following on from this study, a BEIS-funded project by SMRU (Lacey & Hammond in prep.) has compiled and analysed a newer and more comprehensive data on deep-diving species, including: the 2005 and 2016 SCANS surveys; CODA (2007, including previously unanalysed acoustic detections); Faroes blocks of the 2015 NASS, ObSERVE surveys in Irish waters (2015-2016); and, previously unanalysed sightings from the European Seabirds at Sea Database (ESAS, managed by JNCC). These have added several hundred data points for each of beaked, sperm and pilot whales to those that were already available; outputs include more robust estimates of species distribution and abundance in deep water of the European Atlantic, including species-specific beaked whale estimates where possible.

Seal distribution, abundance and habitat use

Extensive information on the distribution and abundance of grey and harbour seals is drawn from the results of the UK seals monitoring programme, run by SMRU, and reported yearly to the Special Committee on Seals (e.g. SCOS 2019). For grey seals, this involves counts of pups born during the autumn breeding season; the principal Scottish breeding sites are surveyed biennially by air, while ground counts take place annually at the main sites in eastern England. Smaller colonies are surveyed less frequently. Harbour seals are counted while on land during their August moult, using aerial surveys with either thermographic imagery (most regions) or conventional photography (estuaries of English and Scottish east coasts). These moult counts of harbour seals provide a minimum population size which can be scaled by the estimated proportion hauled out. Hauled-out grey seals are also counted during the August moult counts.

Information on seals' at-sea movement and behaviour has been obtained from several hundred individuals fitted with satellite tags, many as part of studies funded by BEIS and its forerunner departments (e.g. Jones *et al.* 2015, Russell *et al.* 2013). Combining telemetry data with haul-out-specific population estimates has been used to generate at-sea abundance maps ('usage' maps) around the British Isles at a resolution of 5 x 5km grid cells; these usage maps have undergone several iterations as new telemetry data and population estimates became available (e.g. Jones *et al*. 2015, Jones & Russell 2016, Russell *et al*. 2017).

Recently, usage maps have been superseded by predicted distribution estimates using habitat preference models (Carter *et al*. 2020). In this BEIS-funded project, existing high-resolution GPS telemetry data were supplemented with additional tag deployments, followed by an analysis of data from a total of 114 grey and 239 harbour seals. Telemetry data were combined with the most recently-available haul-out counts in a use-availability habitat preference modelling framework to estimate the predicted at-sea density for grey and harbour seals. The resultant layers provide predicted relative density estimates (proportion of at-sea population during the main foraging season) and their 95% confidence intervals at a 5 x 5km spatial scale.

Other sources of information

Information on the distribution of large whales (fin, humpback and blue) in deep waters to the west of Britain and Ireland was provided by acoustic monitoring using US Navy-operated hydrophone arrays mounted to the seabed in this area; data collected from 1996-2005 were presented in Charif & Clark (2009). While limited to Irish waters, results from static acoustic monitoring in the ObSERVE Acoustic project provide further, more recent, broad-scale information on the occurrence of vocalising cetaceans (including baleen whales) along the Atlantic margin (Berrow *et al*. 2018).

Inshore bottlenose dolphin populations, for which Special Areas of Conservation (SACs) have been established, remain the focus of continued visual and acoustic monitoring efforts to inform SAC condition assessments (e.g. Cheney *et al.* 2018, Lohrengel *et al*. 2018).

Information of UK stranded marine mammals has been routinely collected since 1913. In 1990, the UK Cetacean Strandings Investigation Programme (CSIP) was initiated; CSIP was a long-term monitoring programme to collect, analyse and report strandings around the UK and to carry out systematic *post-mortem* examinations to determine the causes of death, undertake surveillance on the incidence of disease and maintain a national tissue archive for chemical analyses. In addition to annual reports of the CSIP, results over the period 2011-2017 were reported in Deaville *et al*. (2018). The Scottish Marine Animal Strandings Scheme, results of which feed into the CSIP, also reports annually (e.g. Brownlow *et al*. 2020).

Knowledge of the distribution of otters relies on national surveys which were undertaken at regular intervals (approximately every 7 years) since 1979. The most recent were the 2009-10 survey of England (Crawford 2010), the 2010 survey of Northern Ireland (Preston & Reid 2011), the 2003-04 survey of Scotland (Strachan 2007) and the 2009 survey of Wales (Strachan 2015). Where relevant, information on the ecology of these species is drawn from a wide range of other publicly available reports and peer-reviewed studies.

A1a.8.2 UK context: Cetacean distribution and abundance

Twenty eight cetacean species have been recorded in UK waters from sightings and strandings. Of these, eleven species are known to occur regularly, while seventeen are considered rare or vagrant (UKMMAS 2010). This distinction has formed the basis for reporting conservation status as part of the implementation of the EU Habitat Directive under Article 17 (JNCC 2013). Among the regular species, there are some for which distribution and abundance are reasonably well known: harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), white-beaked dolphin (*Lagenorhyncus albirostris*), minke whale (*Balaenoptera acutorostrata*) and fin whale (*Balaenoptera physalus*). Fewer data are available for the other six regular species: Atlantic white-sided dolphin (*Lagenorhyncus acutus*), short-beaked common dolphin (*Delphinus delphi*), Risso's dolphin (*Grampus griseus*), killer whale (*Orcinus orca*), long-finned pilot whale (*Globicephala melas*), and sperm whale (*Physeter macrocephalus*). Each of these species is given a separate section below; the remaining species are grouped under 'beaked whales', 'other odonotocetes' and 'other mysticetes'.

Most cetaceans are wide-ranging and individuals encountered within the UKCS form part of a much larger biological population whose range extends well beyond UK waters. Following advice by SMRU and ICES, management units (MUs) for seven of the more common regularly occurring species were agreed by the UK Statutory Nature Conservation Bodies (SNCBs) and are described in the relevant sections below. The geographical extent of each MU is based on the presence of known populations and any evidence of ecological differentiation within these

populations. These MUs provide an indication of the spatial scales at which impacts of anthropogenic activities may best be taken into consideration (IAMMWG 2015). The boundaries and supporting evidence on population structure of each MU are subject to a review every five years (this is currently on-going (January 2022)), abundance estimates will also be updated using data from the most recent dedicated surveys (most recently updated, IAMMWG, 2021).

A1a.8.2.1 Harbour porpoise

The global distribution of the harbour porpoise (*Phocoena phocoena*) is restricted to the Northern Hemisphere, primarily within temperate and sub-arctic (primarily 5-14ºC) seas. In the eastern Atlantic, it is common and widely distributed on the continental shelf (mainly at depths of 20-200m) from the Barents Sea and Iceland in the north, to the waters off the African coast of Senegal and east across the North Sea to the Baltic Sea (Reid *et al.* 2003, Jefferson *et al*. 2015). The harbour porpoise is the most common cetacean in UK waters; it is wide-ranging and abundant throughout the UK shelf seas, both coastally and offshore. It is also the smallest and most inconspicuous cetacean within UK waters with sighting rate strongly affected by sea state. Typically, it occurs in small groups of 1-3 animals; larger aggregations have been reported, probably where many smaller groups are concentrated in the same area rather than coordinated schools (Reid *et al.* 2003). The mating/calving periods for the harbour porpoise ranges from May to August in the north east Atlantic (Learmonth 2006, Learmonth *et al.* 2014). An analysis of strandings from the North Sea coast showed a high density of neonatal strandings in the eastern North Sea, particularly the coasts of Germany and Denmark, indicative of areas important for calving (Ijsseldijk *et al*. 2020).

In coastal waters, they are often encountered close to islands and headlands with strong tidal currents (e.g. Pierpoint 2008). Sightings become increasingly rare close to the continental shelf edge, with relatively few records in deeper waters beyond the shelf edge. Individuals across the UKCS are part of the north east Atlantic population which is mainly considered to be a single 'continuous' population, even though some degree of genetic differentiation has been observed (Andersen *et al.* 1997, 2001, Tolley *et al.* 2001, Fontaine *et al.* 2007). However, for management and conservation purposes, three distinct UK Management Units have been proposed (Figure A1a.8.2) and abundance estimates have been calculated for the UK portion of each (IAMMWG 2021); the North Sea (NS) with 346,601 individuals (95% CI 289,498 – 419,967), West Scotland (WS) with 28,936 individuals (95% CI 21,140 – 39,608) and the Celtic & Irish Seas (CIS) with 62,517 individuals (95% CI 18,321 – 80,877).

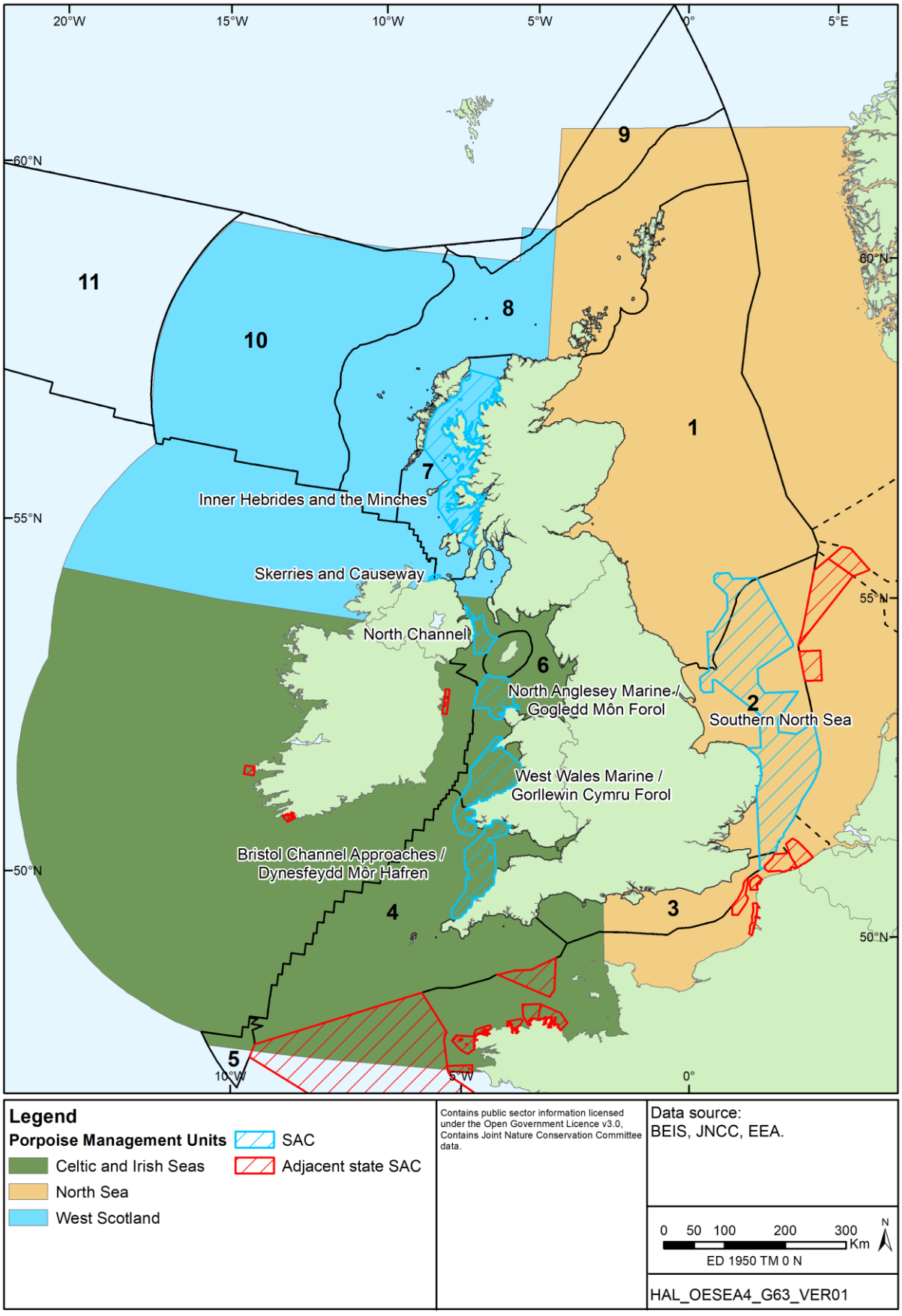
The population of harbour porpoise in UK waters has been estimated as 197,579 individuals (95% CI 163,294-239,063); this estimate is based on results of SCANS-III pro-rated by area across UK waters (JNCC 2019).

Several studies have looked at spatial patterns in the distribution of this species across UKCS at varying spatial and temporal scales. Notably, a large southerly shift in distribution was reported across the North Sea during the 10 years between 1994 and 2005 when the two SCANS surveys took place (Hammond *et al.* 2013), shown in Figure A1a.8.3. Density surface modelling from SCANS-I in 1994 suggested high densities of animals north of Scotland and in the western central and northern North Sea but that animals were almost absent from the southern North Sea. Repeat surveys for SCANS-II in 2005 showed considerable differences; densities in the central North Sea and Moray Firth were lower and considerably so around Orkney and Shetland, while high densities were observed throughout much of the UK southern North Sea. In addition, elevated densities were observed in the Celtic Sea, where very few individuals were observed in 1994. The southerly shift in distribution in the North Sea was also

reported from land-based observations (Evans *et al.* 2015), and reflected by an increase in stranded porpoise on the southern North Sea coasts of England and continental Europe since the late 1990s (Camphuysen *et al*. 2008, Leeney *et* al. 2008, Jung *et al*. 2009). A recent study of porpoise stranding records from 1990-2017 across the majority of the North Sea coast from Orkney to northern Denmark highlighted an overall increase in the annual incidence of strandings over time, with a notably steeper rise in the southern North Sea since 2005 (Ijsseldijk *et al*. 2020). There is no evidence from sightings surveys of further major shifts in harbour porpoise distribution since 2005, with the SCANS-III survey in 2016 also reporting higher densities in the southern North Sea than areas further north (Hammond *et al*. 2021).

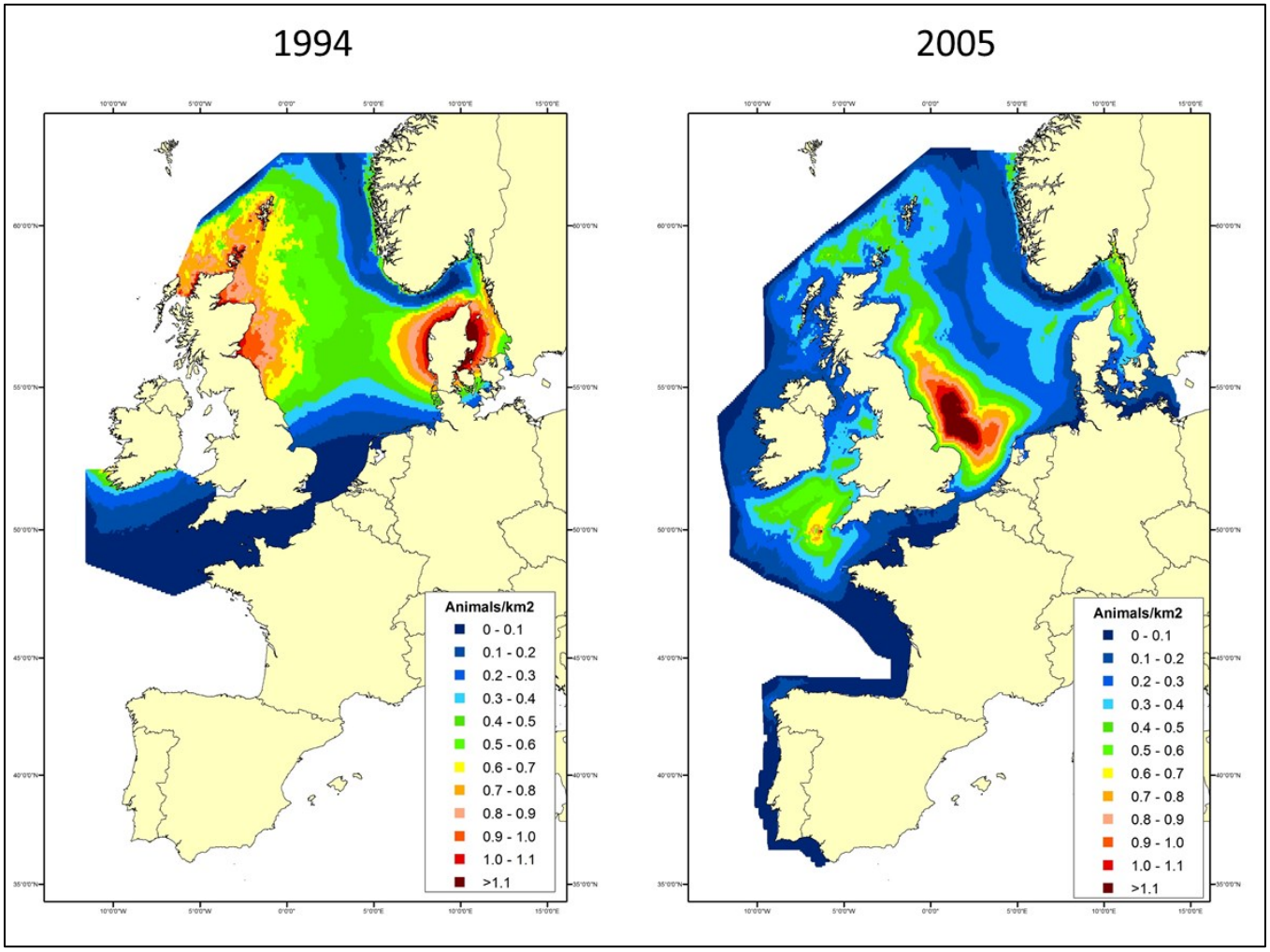
Aggregated harbour porpoise sightings data from the UK (SCANS-II, Dogger Bank), Belgium, the Netherlands, Germany, and Denmark informed the development of seasonal habitat-based density models for the central and southern North Sea (Figure A1a.8.4, Gilles *et al*. 2016). Seasonal model-based predictions of harbour porpoise abundance in the whole North Sea study area were similar in both spring and summer (372,167 95% CI 260,658-531,380 and 361,416 95% CI 243,827-534,913 respectively), but predicted abundance in the autumn months (228,913 95% CI 159,264-329,022) was approximately one third lower than the spring/summer abundances. Highest densities in UK waters were during the spring months at the Dogger Bank extending to the northwest up to the Firth of Tay, and in area of the southwest North Sea offshore from the Thames Estuary. Other areas of high predicted densities in spring were located in inshore areas close to the Belgian, Dutch, German and Danish coasts. Slightly lower densities were observed in summer months as harbour porpoise distribution moved offshore in the North Sea. Highest predicted densities for the summer season were over Dogger Bank, to the northwest of the Bank, and off the German and Danish west coastline. Predicted densities were lowest during the winter, when the highest predicted densities were to the northwest of the Dogger Bank and off the German and Danish coasts.

Figure A1a.8.2: Harbour porpoise management units and Special Areas of Conservation



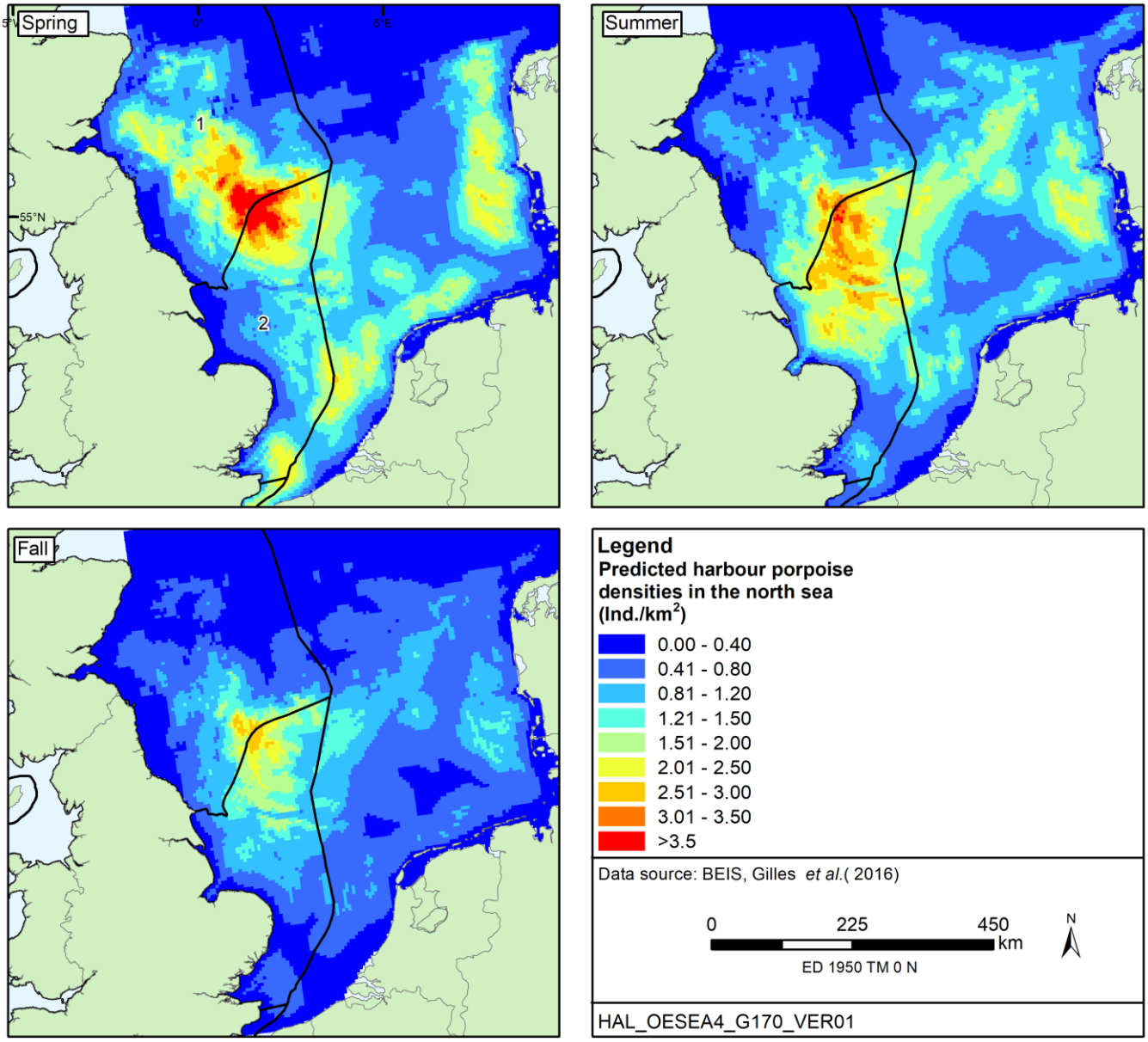
Note: Sites from adjacent states include those with a global assessment for harbour porpoise of A or B.

Figure A1a.8.3: Predicted density surface for harbour porpoise in 1994 and 2005



Notes: Density values are predictions based on the observed distributions and their relationships with habitat variables (longitude and latitude, distance from coast, depth or aspect of seabed slope if selected). Source: Hammond (Pers. Comm.)

Figure A1a.8.4: Predicted seasonal harbour porpoise densities in the North Sea



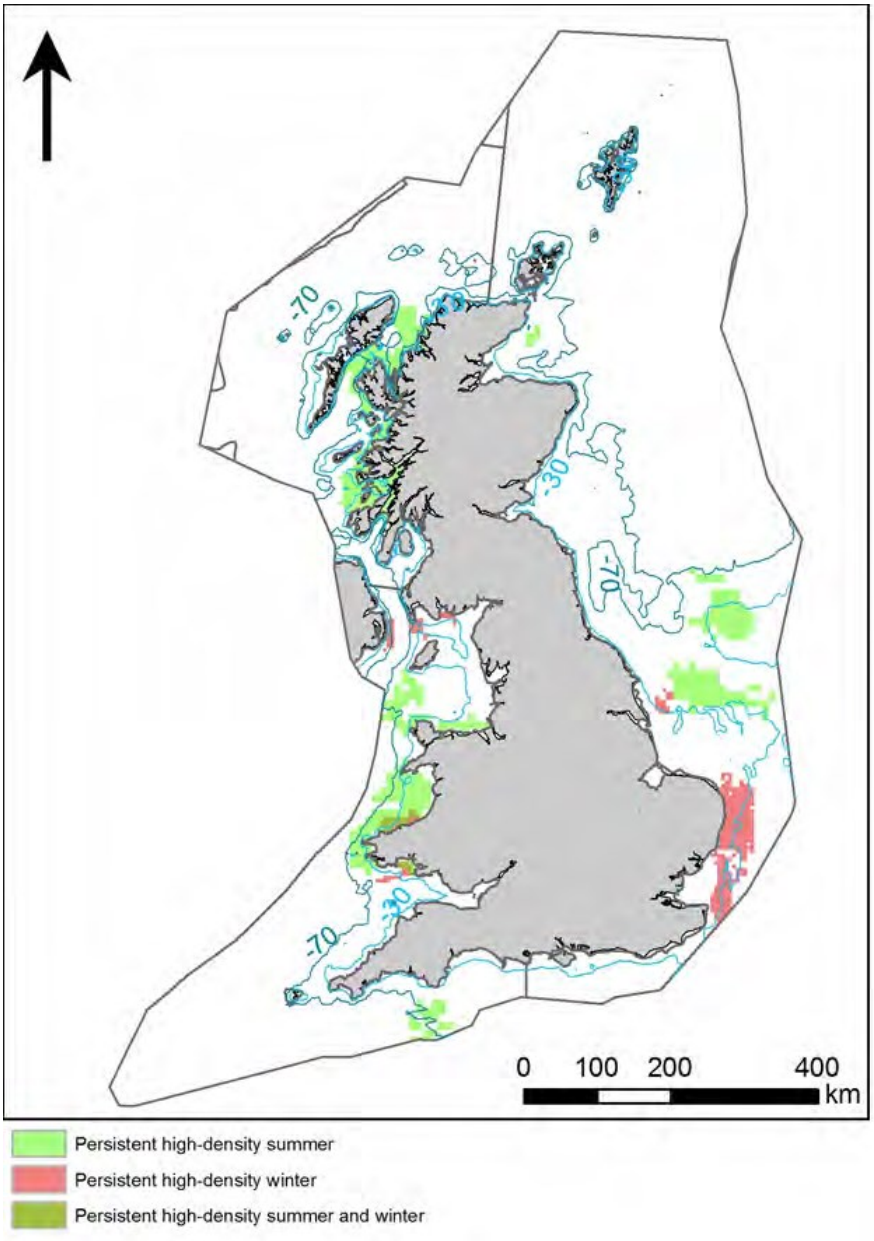
Source: Gilles *et al.* (2016)

Discrete and persistent areas of relatively high porpoise density were identified by Heinänen & Skov (2015) following detailed analysis of the most complete dataset available for the UKCS at the time (18 years of survey data in the JCP). Statistical distribution models were used within each MU to address the challenge of highly variable survey coverage across space and time. Outputs include a set of discrete areas, mainly within Irish Sea and Welsh coastal waters, shelf waters of the North Sea and along the north-west Scottish coast (Figure A1a.8.5); some are persistent throughout the year, while others are valid in the winter or in the summer only. Despite the large quantity of data, effort coverage is very patchy both in time and space and differences in survey coverage may still influence the models. The authors warn that effort-related bias may result in predicted mean densities being largely a function of survey effort, particularly in areas of repeated surveys (e.g. areas subjected to baseline studies for offshore windfarm development) (Heinänen & Skov 2015).

The models identified several oceanographic variables and ship traffic as factors influencing the distribution of this species. The response to water depth in the Celtic and Irish Sea regions

showed a preference for shallower areas, while the responses in the North Sea region showed two peaks during summer; one at 40m and one at 200m depth. In the North Sea, surface salinity was influential in reflecting avoidance of estuarine water masses while the stability of the water column in terms of temperature differences was the most important determinant of porpoise density during summer. This response displayed similar patterns to water depth, with two peaks: one at the interface between mixed and stratified waters (tidal mixing front), and another peak at high values of stratification (typically found in deeper areas). In the Celtic/Irish Sea, eddy activity and current speed were also important predictors. The coarseness of surface sediments seemed to play a major role for the presence and density of porpoises in all three management units. The model results also indicated a negative relationship between the number of ships and the distribution of harbour porpoises in the Celtic/Irish Sea and the North Sea, but not in north-west Scottish waters.

Figure A1a.8.5: Map showing selected persistent high-density areas of harbour porpoise with survey effort from three or more years, as derived from statistical modelling by Heinänen & Skov (2015)



The persistent areas of relatively high porpoise density identified by Heinänen & Skov (2015) informed the selection of five SACs for harbour porpoise in Welsh, Northern Irish, English inshore and offshore waters, which were submitted in 2017 and fully designated in 2019. Similarly, the Inner Hebrides and the Minches SAC in Scottish territorial waters was submitted in 2016 and fully designated in 2018 (Figure A1a.8.2).

A1a.8.2.2 Bottlenose dolphin

The bottlenose dolphin (*Tursiops truncatus*) has a worldwide distribution across tropical and temperate seas of both hemispheres. They can be found in coastal, continental shelf and deeper waters but in most regions inshore and offshore 'sub-populations' or 'eco-types' tend to be distinct (e.g. Oudejans *et al.* 2015); the UKCS is no exception to this. In UK waters, inshore individuals are frequently reported off east and south-west Scotland, in the Irish Sea, and in the western English Channel, with limited interchange between them (references in IAMMWG 2021). Seven MUs are currently recognised for bottlenose dolphin comprising the four inshore populations and three MUs in offshore waters (IAMMWG 2015) as shown in Figure A1a.8.6 with abundance estimates for each MU reported in Table A1a.8.1.

The Coastal East Scotland (CES) MU primarily ranges from Orkney to the Forth of Firth with the highest frequency of sightings within the inner Moray Firth. The Coastal West Scotland and Hebrides (CWSH) MU includes animals sighted regularly around the Inner Hebrides (Mandleberg 2006), as well as more occasional reports from the Outer Hebrides and the northern entrance to the Minch. The Irish Sea (IS) MU shows high sightings rates in Cardigan Bay and off the north Wales coast, particularly around Anglesey (Evans *et al*. 2015). The Coastal West Channel (CWC) MU supports animals sighted year round from Cornwall along the Western Channel within 12nm of the coast, while animals occurring offshore of this coastal area are part of the Offshore Channel and SW England (OCSW) MU, ranging from Wales to the East Channel. In coastal waters, bottlenose dolphins favour river estuaries, headlands and sandbanks, mainly where there is uneven bottom relief and/or strong tidal currents (e.g. Wilson *et al.* 1997, Ingram & Rogan 2002). More detailed information for each of these MUs can be found in the relevant Regional Sea sections below.

With regard to offshore individuals, bottlenose dolphins are encountered along the shelf edge to the north and west of Scotland and beyond, including the Faroe-Shetland Channel and Rockall Trough and Bank. Here, they are often observed in mixed schools with long-finned pilot whales; these individuals are most likely part of a migratory wide-ranging offshore group (covered by the Oceanic Water (OW) MU). The Greater North Sea (GNS) MU is represented by ICES Area 4 excluding the CES area). Data obtained during the SCANS and ObSERVE surveys indicated that the western Celtic Sea is a relatively important area for bottlenose dolphins, with large numbers recorded offshore off the south and west coasts of Ireland in shelf waters as well as along the shelf edge and slope (Rogan *et al*. 2018).

Group size is commonly 2-25, although it may occasionally number tens or low hundreds of animals; larger schools tend to occur in deeper waters (Reid *et al.* 2003, Rogan *et al*. 2018).

Figure A1a.8.6: Bottlenose dolphin management units

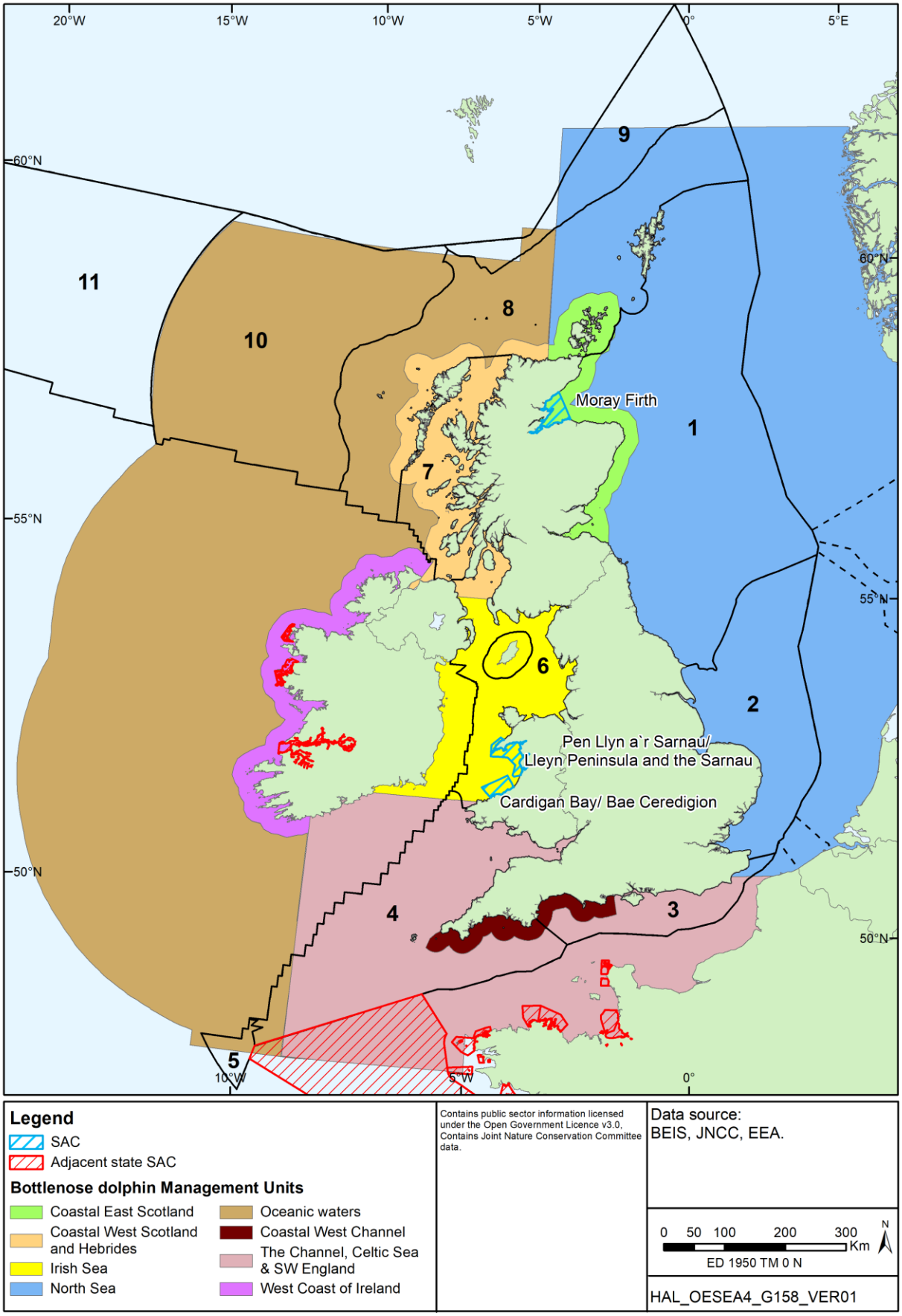


Table A1a.8.1: Estimates of abundance of bottlenose dolphin in defined Management Units (MUs)

MU	Abundance of animals in MU	95% Confidence Interval for MU	Abundance of animals in UK portion of MU	95% Confidence Interval for UK portion of MU
CWSH	-	-	45	33-66
CES	-	-	189	155-216
GNS	2,022	548-7,453	1,885	476-7,461
OCSW	10,947	6,727-14,814	3,866	1,974-7,572
CWC	-	-	40	30-59
IS	293	108-793	186	70-492
OW	70,249	49,720-99,255	1,299	597-2,826

Source: IAMMWG (2021)

The population of bottlenose dolphins in UK waters has been estimated as 10,610 individuals (95%CI 6,302-17,865); this estimate is based on results of SCANS-III pro-rated by area across UK waters (JNCC 2019).

A1a.8.2.3 White-beaked dolphin

White-beaked dolphins (*Lagenorhynchus albirostris*) are restricted to the cold temperate sub-polar waters of the north Atlantic. In the eastern Atlantic their range extends from the northern Bay of Biscay to Iceland and to northern Norway. They are the second most commonly occurring cetacean in UK shelf waters, regularly encountered in coastal and offshore waters while very rare in deeper waters beyond the shelf edge (Figure A1a.8.7). Their distribution is generally restricted to the northern half of UK waters, with greatest abundance in the central and northern North Sea, Orkney and Shetland and north-west Scotland. Analysis of summer sightings on shelf waters around the UK from 1983-1998 showed the vast majority of white-beaked dolphins to occur in waters below 13°C in temperature (MacLeod *et al.* 2008). Less numerous, but regular sightings occur into the southern and eastern North Sea in German, Dutch and Belgian waters (Jansen *et al.* 2010) but are very rare in the Channel and Irish and Celtic Seas. In UK waters, sightings occur throughout the year, but are slightly more frequent from July to October (Reid *et al*. 2003). Long-term stranding data from 1907-2003 show a seasonal peak in strandings of white-beaked dolphins from June to September, with the majority occurring around the Scottish coast and along the east coast of England (Canning *et al.* 2008).

A single MU has been deemed appropriate for the management and conservation of this species; this is called the Celtic & Greater North Seas (CGNS) MU, comprising all UK waters and extending to the seaward boundary used by the European Commission for Habitats Directive reporting (see Figure A1a.8.6, IAMMWG 2015). The abundance of white-beaked

dolphin in the MU was estimated[2] at 43,951 animals (95% CI=28,439-67,924), of which 34,025 (95% CI=20,026-57,807) were estimated to be in the UK EEZ (IAMWWG 2021).

The population of Atlantic white-beaked dolphins in UK waters has been estimated as 30,172 individuals, albeit with a high degree of uncertainty (95%CI 17,346-52,483); this estimate is based on results of SCANS-III pro-rated by area across UK waters (JNCC 2019).

Group size is typically less than 10, although schools of up to 50 are not uncommon and larger aggregations of 100-500 animals have been reported in northern parts of their range (Reid *et al.* 2003).

A1a.8.2.4 Atlantic white-sided dolphin

Atlantic white-sided dolphins (*Lagenorhynchus acutus*) are confined to the north Atlantic. They share most of their range with the white-beaked dolphin, but in the north-east Atlantic they are primarily an offshore, oceanic species. At sea, the two species can be difficult to distinguish and they are often recorded simply as *Lagenorhynchus* spp. They are regularly sighted in the waters north and west of Scotland, with greatest numbers observed along the shelf break and over deeper waters further offshore, including the Faroe-Shetland Channel to the north (Pollock *et al.* 2000, MacLeod *et al.* 2003, Stone 2015). While they have been observed throughout the year, greatest numbers are observed from May to November (Reid *et al.* 2003). The species is infrequently recorded in nearshore waters of Orkney and Shetland, often in large groups, and primarily during summer. They are also occasionally observed in offshore waters of the central and northern North Sea from July to September. In shelf waters, Atlantic white-sided dolphins have been reported as forming mixed schools with white-beaked dolphin. Over deeper waters, they are regularly recorded in association with long-finned pilot whales (*Globicephala melas*), and occasionally larger baleen whales.

The single CGNS MU (see Figure A1a.8.7), has been deemed appropriate for the management and conservation of this species (IAMMWG 2015). The abundance of white-sided dolphins across the entire CGNS MU was estimated at 18,128 (95% CI= 6,049-54,323) with the UK component estimated at 12,293 animals (95% CI -3,891-38,841) (IAMMWG 2021).

The population of Atlantic white-sided dolphins in UK waters has been estimated as 28,836 individuals, albeit with a high degree of uncertainty (95%CI 7,590-109,556); this estimate is based on results of SCANS-III pro-rated by area across UK waters (JNCC 2019).

A1a.8.2.5 Short-beaked common dolphin

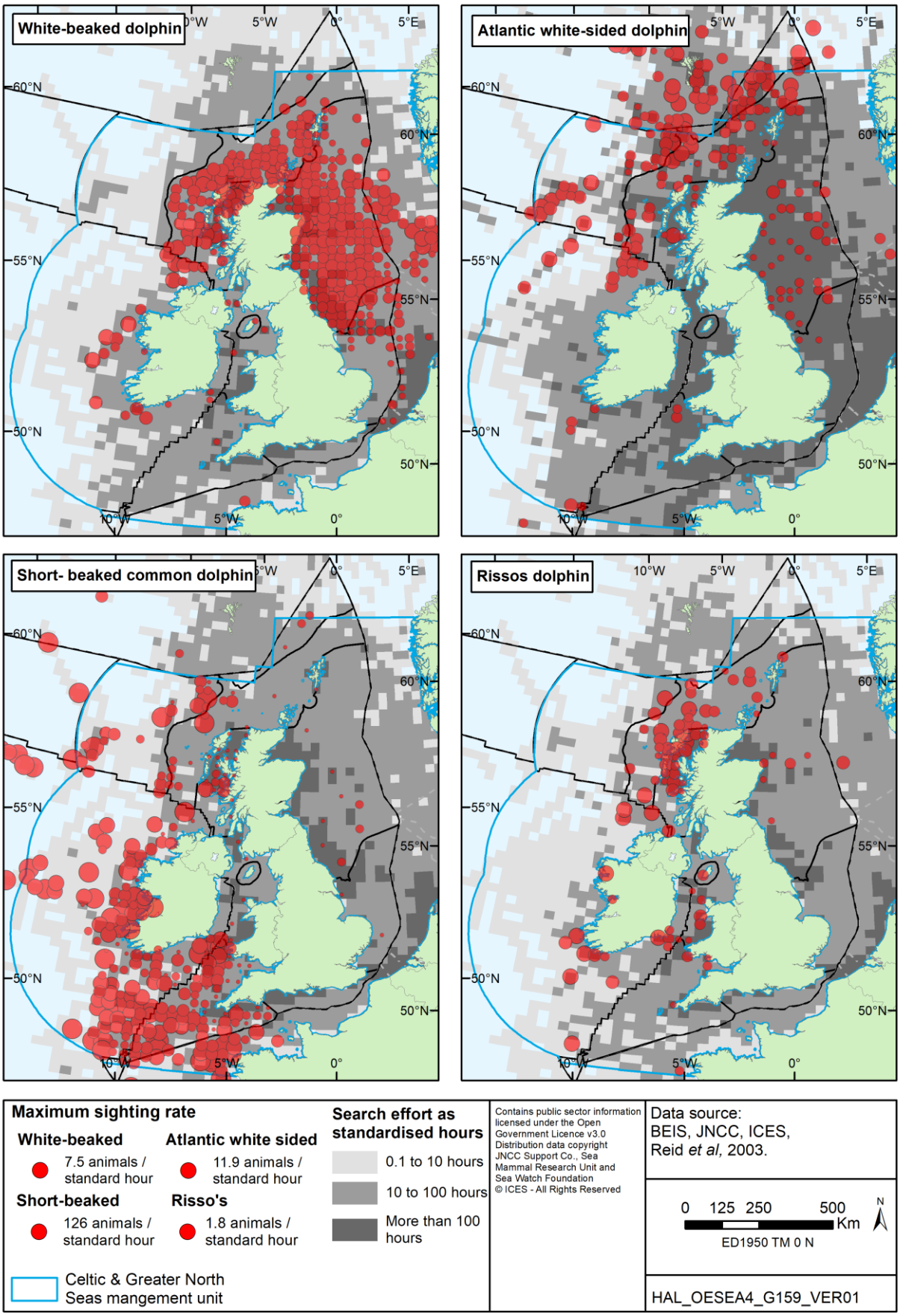
The common dolphin (*Delphinus delphis*) has a worldwide distribution and inhabits both oceanic and shelf-edge waters of tropical, subtropical and temperate seas of the Atlantic and Indo-Pacific. Large variability in morphological characters and pigmentation patterns has resulted in two distinct species being proposed (Rosel *et al.* 1994); *Delphinus delphis* is now referred to as short-beaked common dolphin, to distinguish it from the long-beaked common dolphin *Delphinus capensis*; only the short-beaked form has been recorded in the north Atlantic. Common dolphins are found in a wide range of group sizes from small schools to large concentrations of 1,000 to 5,000 individuals (e.g. Murphy 2004); average group size

[2] The estimate was derived from the SCANS-II abundance estimates for continental shelf waters (Hammond *et al.* 2013) which represent the core range for this species.

reported in Reid *et al.* (2003) was 14 individuals. In offshore waters south-west of the UK, they occasionally form mixed schools with striped dolphins (*Stenella coeruleoabla*).

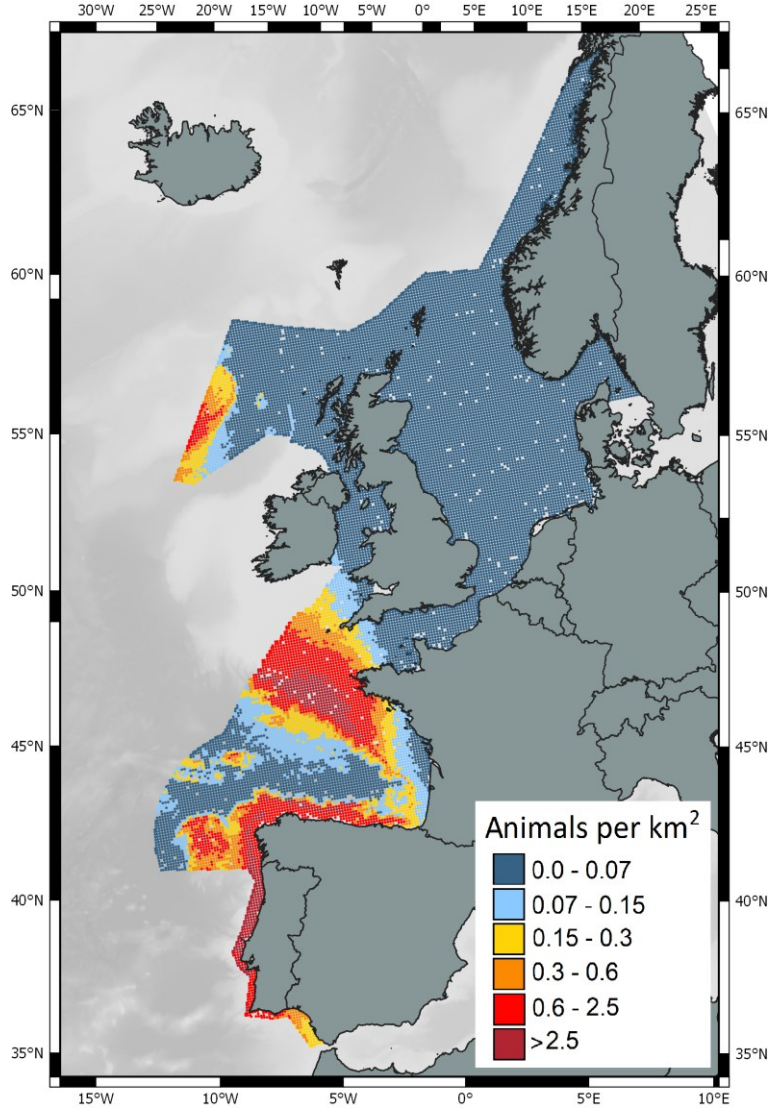
At least during summer, it is widely distributed throughout the north-east Atlantic, from coastal waters to the mid-Atlantic ridge, from the Azores and the Strait of Gibraltar to Norway, with the majority of sightings having been reported in waters south of 60°N (Murphy *et al.* 2013). Analysis of summer sightings on shelf waters around the UK and adjacent waters showed the vast majority of common dolphins to occur in waters above 14°C in temperature (MacLeod *et al.* 2008, Cañadas *et al.* 2009). Strong seasonal shifts in their distribution have been noted, with winter inshore movements onto the Celtic Shelf and into the western English Channel and St. George's Channel resulting in pronounced concentrations (Northridge *et al.* 2004). The ObSERVE aerial surveys of Irish waters showed common dolphins to be widely distributed in shelf waters off the south and west coasts of Ireland, with higher numbers observed in winter (Rogan *et al*. 2018). They are also the most frequently sighted and abundant cetacean recorded during Celtic Sea herring surveys off the south coast of Ireland in October (e.g. O'Donnell *et al.* 2017, 2018).

Figure A1a.8.7: The Celtic and Greater North Seas Management Unit and the distribution of sightings for short-beaked common dolphin, Risso's dolphin, Atlantic white-sided dolphin and white-beaked dolphin



During the summer, coinciding with the mating/calving period (May to September), the majority of sightings are more widely dispersed along and off the continental shelf slope and in deep waters to the south-west of the UK (Murphy *et al.* 2005; Murphy & Rogan 2006), off the west coast of Ireland and to the west and north-west of Scotland (Figure A1a.8.7). Density surface modelling of common dolphins in summer 2005 based on the SCANS-II survey showed well defined areas of higher density south of the Outer Hebrides, west of Ireland, in the Celtic Sea offshore of southeast Ireland, in the western Channel approximately between Devon and northern France, and to a lesser extent along the coast of north Cornwall (Figure A1a.8.8). They have been occasionally sighted further north and east on the shelf, in the northern North Sea and waters surrounding Orkney and Shetland, but only rarely in the southern North Sea and eastern English Channel (Reid *et al.* 2003).

Figure A1a.8.8: Predicted density surface for short-beaked common dolphins in 2016



Notes: Density values are predictions based on the observed distributions and their relationships with habitat variables (longitude and latitude, plus distance from coast, depth or aspect of seabed slope if selected). Source: SCANS-III (Hammond Pers. comm.)

The single CGNS MU was deemed appropriate for the management and conservation of this species (IAMMWG 2015). The abundance of common dolphins across the entire CGNS MU

was estimated at 102,656 (95% CI= 58,932-178,822) with the UK component estimated at 57,417 animals (95% CI =30,850-106,863) (IAMMWG 2021).

The population of common dolphins in UK waters has been estimated as 60,988 individuals (95%CI 31,735-117,203), based on results of SCANS-III pro-rated by area across UK waters (JNCC 2019).

A1a.8.2.6 Risso's dolphin

Risso's dolphins (*Grampus griseus*) are widely distributed in tropical and temperate seas of both northern and southern hemispheres. They are typically encountered in groups of up to 20 individuals, but may form larger aggregations, including mixed schools with bottlenose dolphins (Reid *et al.* 2003). They occur in small numbers along the Atlantic European seaboard from Shetland south to north-west France, the southern Bay of Biscay, around the Iberian Peninsula and into the Mediterranean Sea (Hammond *et al.* 2008). A map of sightings rates is given in Figure A1a.8.7. The majority of Risso's dolphin sightings in UK waters have been reported around the Hebrides, most frequently around the coast of the Outer Hebrides, especially Lewis (Paxton *et al*. 2014), where persistently high sightings (relative to wider Scottish territorial waters) have resulted in the North-east Lewis MPA proposal for this species. Marine mammal observations during seismic surveys have recorded Risso's dolphins mainly over the continental shelf edge to the west and north of Shetland, extending into deep waters (Stone 2015a). The species is uncommon but regularly sighted in nearshore waters around Shetland and Orkney, in the southern Irish Sea, particularly off the north-west coast of Wales, and off south-west Ireland. It is rare in the North Sea and all but the western end of the Channel. They are typically observed in small groups of 5-25 individuals, most frequently from June to September. In the north Atlantic, Risso's dolphins have occasionally been observed in association with other cetaceans, including long-finned pilot whales, white-beaked dolphins, white-sided dolphins and bottlenose dolphins (Reid *et al.* 2003), and several suspected Risso's-bottlenose dolphin hybrid individuals have been sighted off western Scotland (Hodgins *et al*. 2014).

The single CGNS MU was deemed appropriate for the management and conservation of this species (IAMMWG 2015). The abundance of Risso's dolphins across the entire CGNS MU was estimated at 12,262 (95% CI= 5,227-28,764) with the UK component estimated at 8,687 animals (95% CI =2,810-26,852) (IAMMWG 2021).

The population of Risso's dolphins in UK waters has been estimated as 7,864 individuals (95%CI 2,613-23,664) (JNCC 2019); this is based on results of SCANS-III pro-rated by area across UK waters.

A1a.8.2.7 Killer whale

The killer whale (*Orcinus orca*) has a worldwide distribution in tropical, temperate and polar seas in both hemispheres; their abundance is greatest at higher latitudes. Killer whales are widely distributed on the Atlantic seaboard of northern Europe, mainly around Iceland, western Norway and northern Scotland. They have been observed throughout the northern North Sea, including the east coast of Scotland, the Firth of Forth and as far south as the Farne Islands. Sightings are fairly frequent in coastal waters of Shetland and Orkney, and also around the Hebrides, and have been increasing in frequency in recent years. Very few sightings have been recorded in shelf seas to the south-west of the UK (Figure A1a.8.9). Many coastal observations are in the vicinity of seal colonies (Weir 2002).

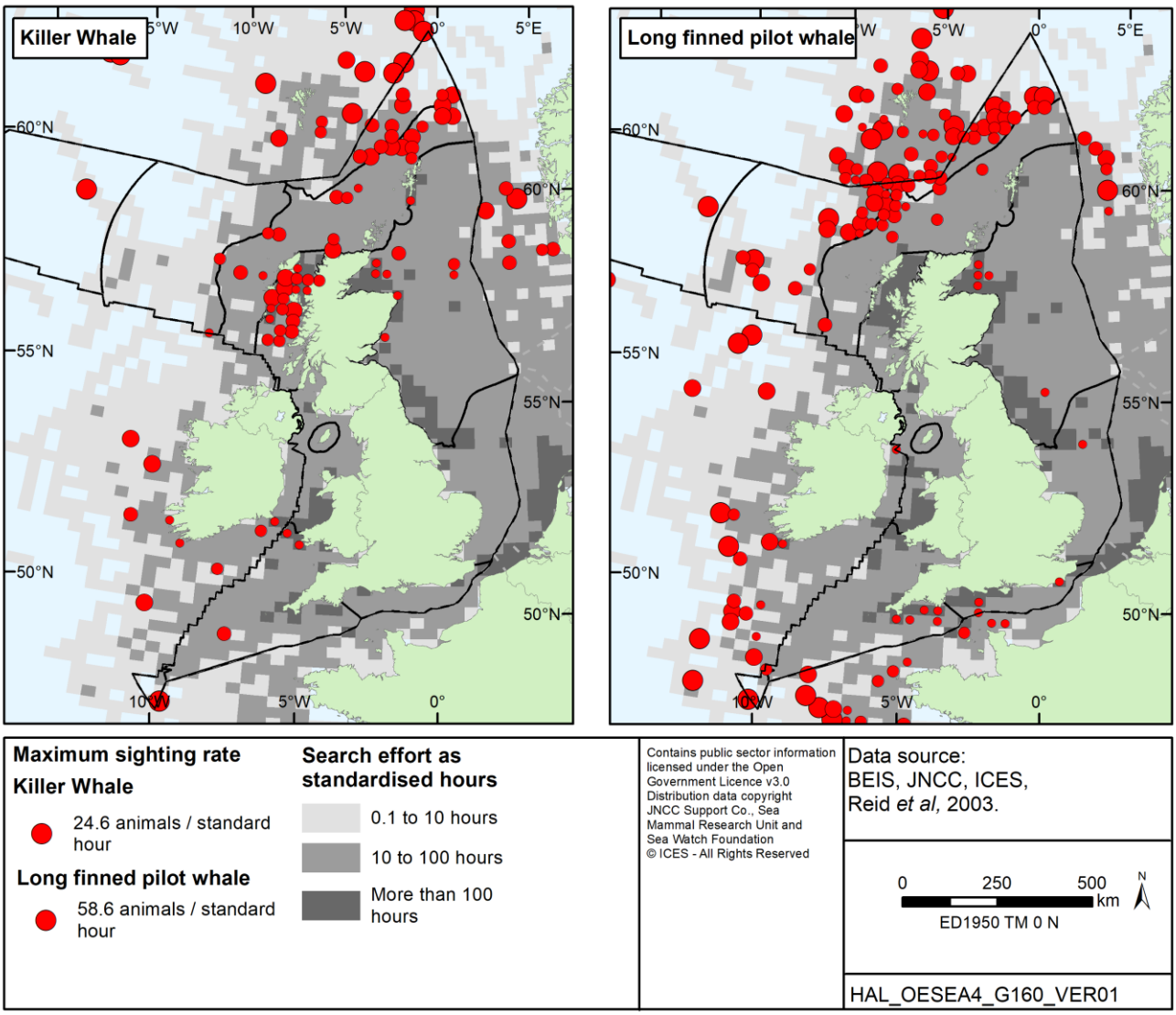
Offshore observations are often in the vicinity of fishing vessels, particularly larger boats targeting pelagic species, with greatest sightings occurring north and east of Shetland (Luque *et al.* 2006, Foote *et al.* 2007). They have been reported in most months of the year, with the greatest frequency between April and September. They are also sighted further offshore along the shelf slope and deeper waters north and west of Scotland. Photo-ID studies have shown individual killer whales identified off Scotland during the summer to travel to Iceland and spend the winter on herring overwintering grounds there; this seasonal movement pattern appears to be consistent for some years even though the numbers of individuals repeatedly moving between these locations may be small (Samarra & Foote 2015).

Pike *et al*. (2020) estimated the abundance of killer whales in the North East Atlantic to be in the low tens of thousands in the central and eastern North Atlantic, particularly to the east and northeast of Iceland and in the western Norwegian Sea. The low precision of the abundance estimates reflects the low number of sightings across all of the NASS surveys. Sightings in UK waters are most commonly of single animals or groups of less than 8 individuals; however, larger groups of approximately 100 have been observed (Pollock *et al.* 2000, Reid *et al.* 2003).

A1a.8.2.8 Long-finned pilot whale

The long-finned pilot whale (*Globicephala melas*) has a worldwide distribution in temperate and sub-polar seas of both hemispheres; it is common and widely distributed in deep north Atlantic waters, and also occasionally occurs in coastal areas. In UK and Irish waters, long-finned pilot whales occur mainly along the continental shelf slope, particularly around the 1,000m isobath (Hammond *et al.* 2008). They are frequently encountered along the shelf slope north and west of Scotland, and also in the western Celtic Sea where sightings are frequent along the shelf edge and southwards towards the French coast. Aerial surveys in the ObSERVE programme recorded long-finned pilot whales throughout Irish offshore waters, in similar numbers in winter and summer, and with most sightings over the continental slope and deeper waters of the Rockall Trough (Rogan *et al*. 2018). They are also occasionally reported in coastal waters, primarily around Orkney, Shetland and to the west of the Outer Hebrides. Sightings have occurred in all months of the year, with no clear peak in occurrence.

Figure A1a.8.9: Distribution of killer whale and long-finned pilot whale sightings



The population of pilot whales across the SCANS-III survey area has been estimated as 25,872 individuals with a 95% CI of 14,490-46,194 (Lacey & Hammond In prep). Estimated abundances for the European Atlantic combining NASS-15, SCANS-III and ObSERVE survey data are 83,889 individuals with a wide 95% CI of 51,092-137,738 (Lacey & Hammond in prep.). They are typically encountered in groups of up to 20 individuals, but may form larger aggregations, including mixed schools with bottlenose dolphins (Reid *et al.* 2003).

A1a.8.2.9 Sperm whale

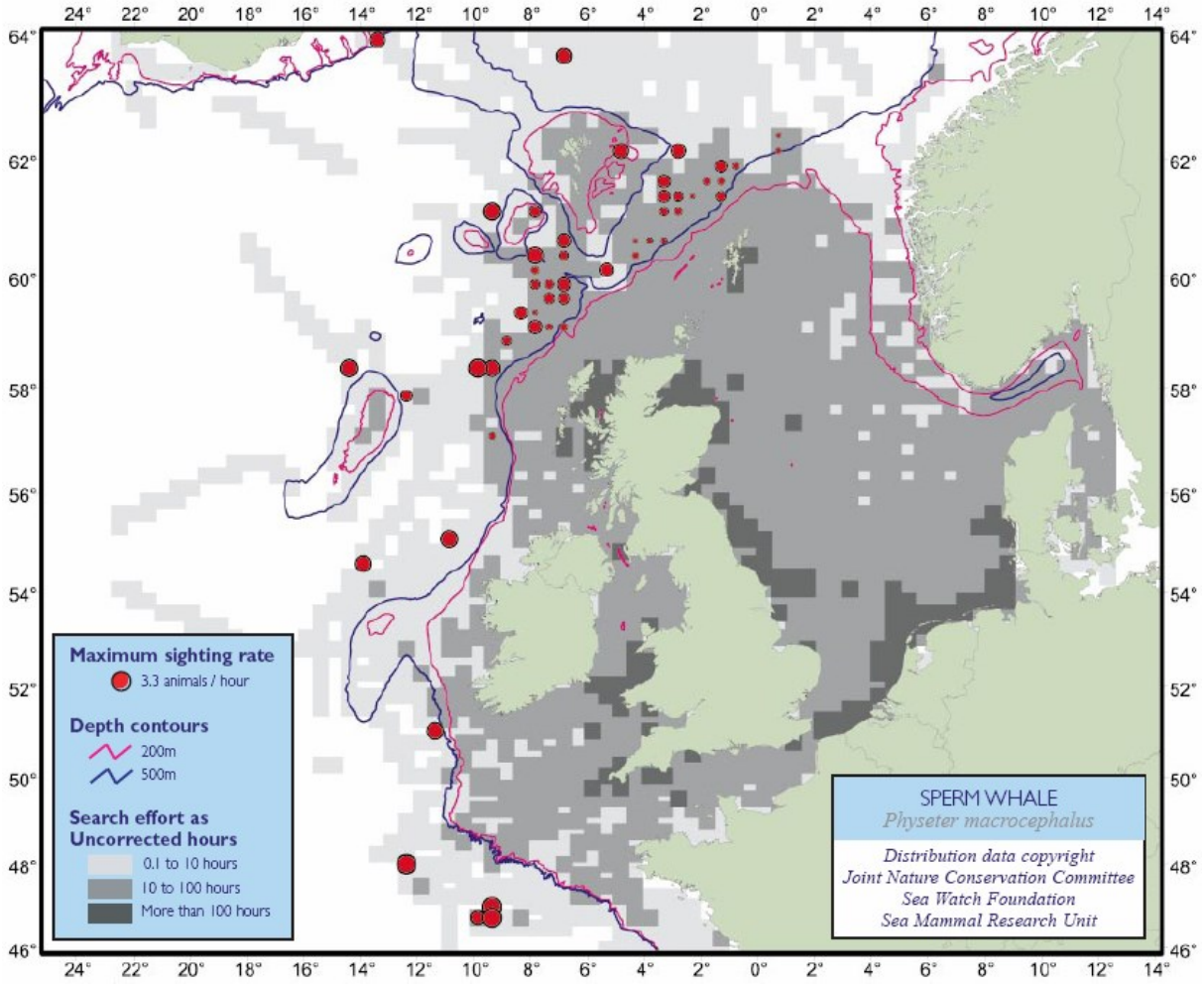
Sperm whales (*Physeter macrocephalus*) have a wide distribution that includes most seas and all oceans. They are widely distributed in deep waters to the north and west of Scotland, both on and beyond the shelf slope. Where records exist, all animals were males, with males migrating to high latitudes to feed. Group size may number tens of animals, although these are commonly spread over a wide area with only a proportion visible at the surface at one time (Reid *et al.* 2003). Limited survey effort has shown animals to be numerous in the Faroe-Shetland Channel in May, and also in the Rockall Trough in October (Hammond *et al.* 2006). They were the second most abundant species of cetacean north and west of Scotland observed by Pollock *et al.* (2000), and also the second most abundant species in deep,

offshore waters west of Regional Sea 8 (stratum 8) during the SCANS-III survey, at 12,662 animals (Hammond *et al*. 2021).

Acoustic monitoring north-west of the Outer Hebrides in the winter of 1997-1998 detected sperm whales over a wide area of the continental slope, primarily in waters >500m depth (Lewis *et al.* 1998). They have also been observed fairly regularly in the waters around Orkney and Shetland, with sightings and strandings reported in most months (Hammond *et al.* 2003). It can be assumed that these waters represent a migratory route for some portion of the north-east Atlantic population at certain times of the year. A few sightings have also been recorded over deep waters south-west of the UK. Towed passive acoustic monitoring surveys across the Irish Atlantic margin in the ObSERVE showed sperm whale detections to be clustered around the 1,000m depth contour and more frequent in the northern half of the area surveyed; there was a notable increase in the number of detections in the abyssal area of the Rockall Trough in summer compared to other seasons (Berrow *et al*. 2018).

The population of sperm whales across the SCANS-III survey area has been estimated as 13,683 individuals with a 95% CI of 7,066-26,498 (Lacey & Hammond In prep.). Estimated abundances for the European Atlantic combining NASS-15, SCANS-III and ObSERVE survey data are 35,517 individuals with a 95% CI of 17,763-71,016 (Lacey & Hammond In prep.) While considerably higher than the estimate presented previously (JNCC 2013), the earlier estimate is not considered to be robust and therefore not comparable with the current estimate. Based on results of towed PAM surveys in the ObSERVE programme, the density of sperm whales in Irish waters ≥300m deep (no animals were sighted in shallower waters) was estimated as 3.2 individuals per 1,000km (95% CI 3.0-3.5) resulting in an overall abundance estimate of 380 individuals (Berrow *et al*. 2018).

Figure A1a.8.10: Distribution of sperm whale sightings



A1a.8.2.10 Beaked whales

The distribution and occurrence of beaked whales in UK waters was reviewed by Aguilar de Soto *et al.* (2016) in a contribution to the SEA research programme. They have been recorded in deep waters to the north and west of Scotland, both on and beyond the shelf slope. This area may represent an important part of their habitat, but its true ecological significance is unknown due to the infrequency of encounters and small numbers of animals observed. Almost all sightings of beaked whales are in water ≥1,000m depth; however, rare observations have also been recorded from coastal waters of the Hebrides, Orkney, Shetland and the northern North Sea. Species recorded include the northern bottlenose whale (*Hyperoodon ampullatus*), Cuvier's beaked whale (*Ziphius cavirostris*), Sowerby's beaked whale (*Mesoplodon bidens*) and unidentified species of the genus *Mesoplodon*. Beaked whales are typically encountered as single individuals or groups of less than 10, although northern bottlenose whales have been observed in larger groups (Reid *et al.* 2003).

Among stranding records in the UK and Ireland, 251 records were identified at species level between 1800 and 2002 (MacLeod *et al.* 2003a) consisting of 109 northern bottlenose whales, 70 Sowerby's beaked whales, 63 Cuvier's beaked whales, seven True's beaked whales (*Mesoplodon mirus*), one Gervais' beaked whale (*Mesoplodon europeaus*) and one Blainville's beaked whale (*Mesoplodon densirostris*). Analyses of temporal variation in number of strandings was conducted for the three more common species; northern bottlenose whales were more likely to strand in August to October, Cuvier's beaked whales strandings were

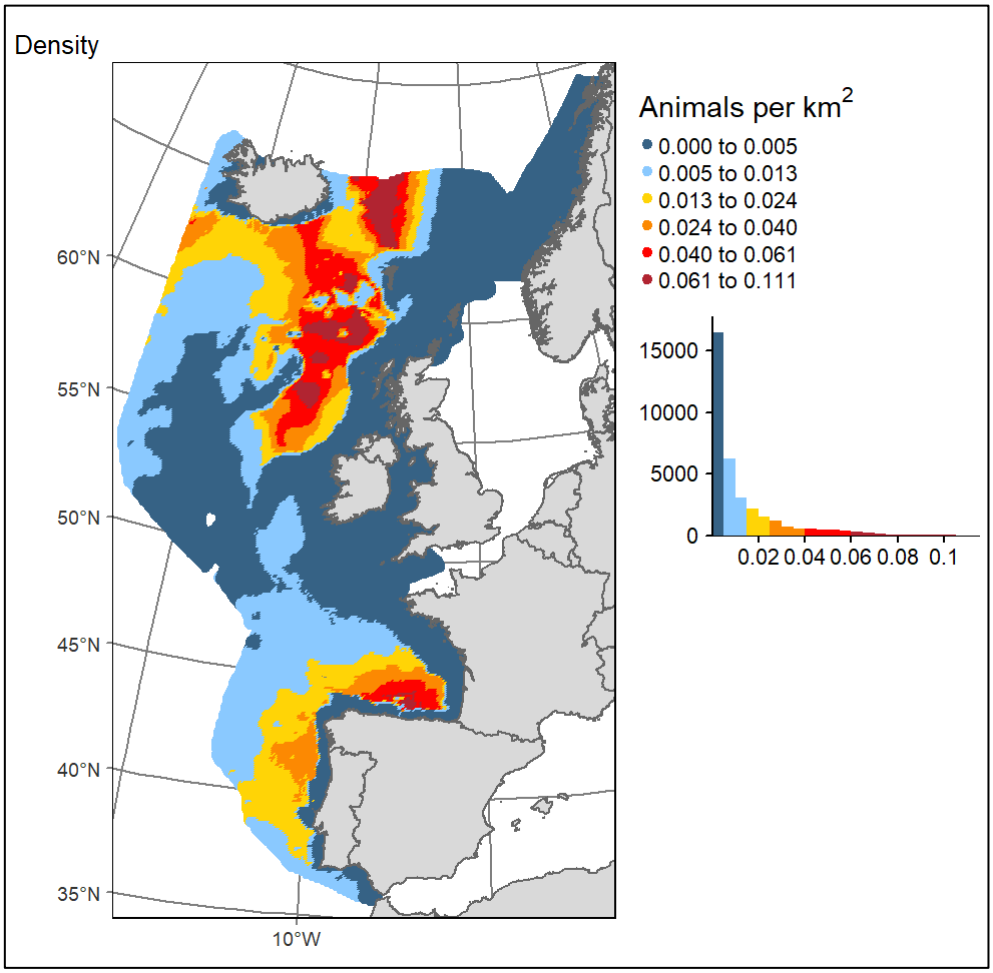
highest from November to July, while no significant seasonal pattern was found for Sowerby's beaked whales.

Due to low numbers of sightings, it is common to group sightings of all identified and unidentified species to produce a combined 'beaked whale' abundance estimate. The CODA survey estimated beaked whale abundance in the summer of 2007 as 6,992 (CV = 0.25), with the majority sighted north-west of the UK and Ireland and in the Bay of Biscay (Hammond *et al.* 2009). Lacey & Hammond (In prep.) compiled sightings data from NASS-15, SCANS-III and ObSERVE surveys and generated estimates of abundance of 22,807 (CV = 0.489) for all beaked whale species in the European Atlantic.

The Irish ObSERVE programme included a series of bottom-mounted acoustic loggers deployed along the Irish shelf edge from 2015-2016. These data suggested that beaked whales are more common in this area than previously known, with Sowerby's and Cuvier's present during all monitoring periods (Berrow *et al*. 2018, Kowarski *et al*. 2018). In particular, the breadth and regularity of Cuvier's beaked whale occurrence was somewhat unexpected given the limited sightings and acoustic detections during previous vessel-based visual and towed array surveys. Both species showed evidence of a latitudinal gradient in detection rates, with Sowerby's showing higher rates in the north and Cuvier's generally showing higher rates to the south (Kowarski *et al*. 2018). Lacey & Hammond (In prep.) investigated potential environmental factors influencing distribution of deep-diving cetaceans and found that beaked whales were predicted in higher densities in waters greater than 500-1000m in depth, in sea surface temperatures lower than 12°C and greater than 20°C , and that a deeper mixed layer earlier in the year also influenced variation in beaked whale density.

Particular attention was drawn to Cuvier's beaked whales recently due to an unusual mortality event (UME) in which abnormally high numbers of beaked whales (mostly Cuvier's) washed ashore in advanced stages of decomposition between July and October 2018 in countries bordering the north-east Atlantic from Ireland to Iceland (Brownlow *et al*. 2019a). In total, >70 animals washed ashore on the west and north coasts of Ireland and the west coast of Scotland in August and early September, with a smaller cluster of northern bottlenose whale (n=8) reported in northern Scotland in October. The chronology and state of decomposition of strandings suggested an acute, temporally-discrete source of mortality, while drift modelling identified a plausible origin for the carcases along the shelf edge to the west of Ireland. Considering that in such an event it is likely that many more carcasses do not wash ashore than those that do, this UME has the potential to be of population-level significance (Brownlow *et al*. 2019b).

Figure A1a.8.11: Distribution of beaked whales (all species combined) predicted from models of the data collected in SCANS-III, CODA and the Faroes block of T-NASS.



Source: Hammond (Pers. Comm.).

A1a.8.2.11 Other toothed cetaceans

Other toothed cetaceans infrequently reported in UK waters are the striped dolphin (*Stenella coeruleoalba*), pygmy sperm whale (*Kogia breviceps*), false killer whale (*Pseudorca crassidens*), Fraser's dolphin (*Lagenodelphis hosei*), melon-headed whale (*Peponocephala electra*), narwhal (*Monodon monoceros*) and beluga whale (*Delphinapterus leucha*),

Striped dolphin *Stenella coeruleoalba* is an offshore species found worldwide, mainly in tropical and sub-tropical seas, but also in warm temperate waters. In the north-east Atlantic it is found mainly in the Bay of Biscay and west of the Iberian Peninsula, normally restricted to deep offshore waters of 1,000m or more. UK waters are at the northern limit of this species' distribution; most sightings in British waters are from the south-west approaches with occasional records in deep waters west of Britain and further north (Reid *et al.* 2003; Stone 2015). They were first documented in UK stranding records between 1923 and 1939, but were not reported stranded again until 1975. Since the 1990's striped dolphins have stranded in most years with increasing frequency, between 2011-2017 it was the sixth most frequently stranded cetacean on the UK coast and strandings in that period were 46% higher than strandings recorded during the preceding seven-year period (Deaville *et al*. 2018). Approximately half of the strandings recorded during the 2011-2017 period were in Scotland, 37% in England and 11% in Wales and the remainder in the Isle of Man. Records from the SCANS-II survey were too few too calculate abundance estimates for striped dolphin.

However in European waters beyond the continental shelf, striped dolphin best estimate was derived from CODA surveys in the summer of 2007 as 67,414 (CV = 0.38), with the majority sighted towards the south in the Bay of Biscay and off northwest Spain (Hammond *et al.* 2009). SCANS-III survey sightings of striped dolphins were primarily in the southern area of the Bay of Biscay off the north and northwest coast of Spain, with estimated abundances of 441,500 individuals (CV 0.305) (Hammond *et al*. 2021). Striped dolphins often occur in large groups of hundreds or even thousands, although 6-60 individuals is the most common group size in European waters. In UK and Irish waters, group size is typically less than 10 individuals and they often occur in mixed schools with common dolphins (Reid *et al.* 2003).

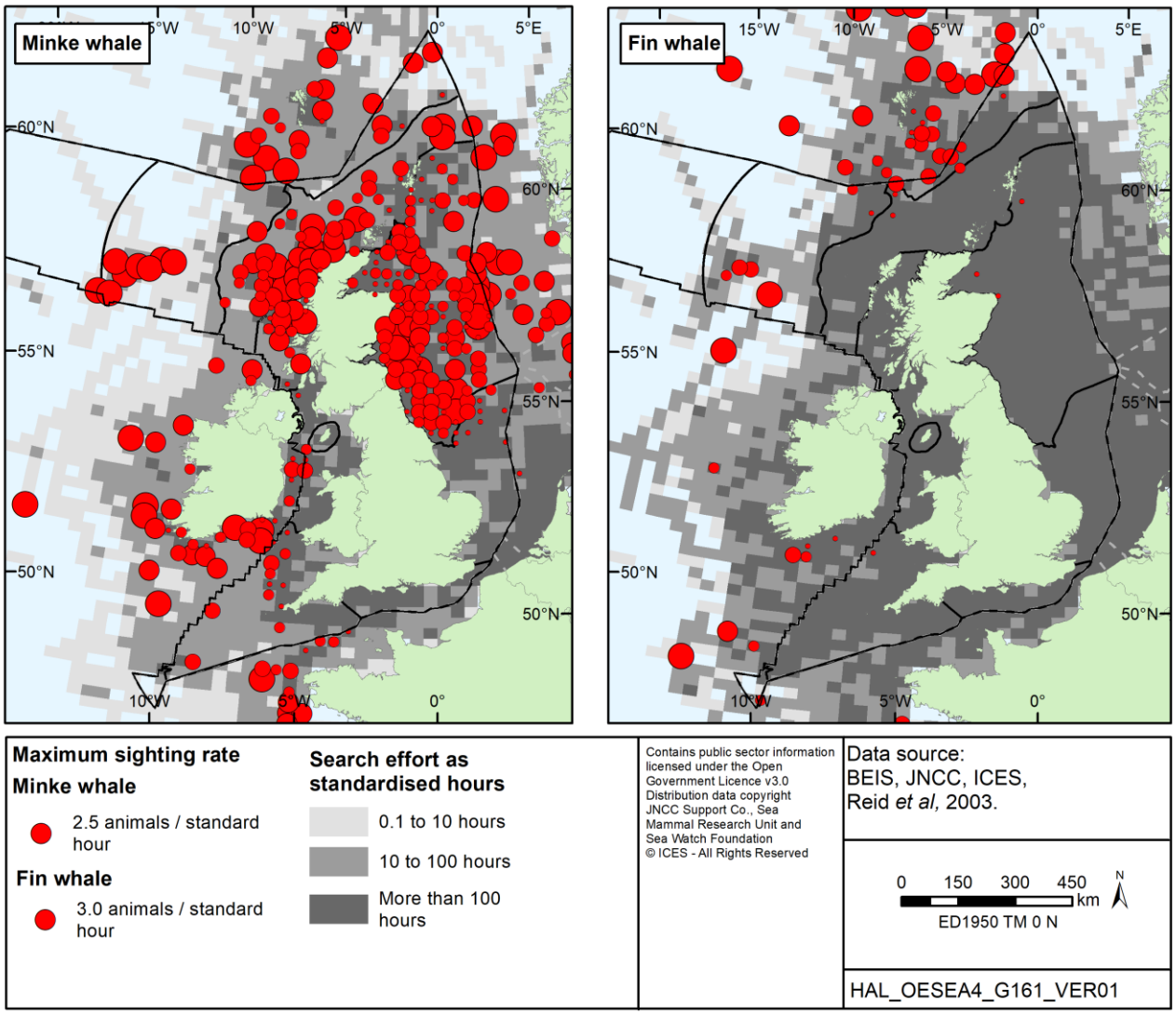
The pygmy sperm whale is distributed worldwide in tropical to temperate seas of both hemispheres, primarily in deep oceanic waters beyond the continental shelf edge. Records in European waters are rare, with sightings restricted to the Bay of Biscay, South West Approaches, western Ireland and occasional records from the North Sea off the east coast of England and Scotland (Reid *et al.* 2003). False killer whales show a similar global distribution; in European waters most reports are from the Bay of Biscay to the Canary Islands. UK records include a few strandings of large groups (approximately 25-150) from 1927-1935 but none since, and a few sightings since 1976 to the south of Cornwall and off western and north-east Scotland (Reid *et al.* 2003). Fraser's dolphins and melon headed whales have worldwide tropical and sub-tropical distributions; the only UK records for these species are of an animal stranded in the Outer Hebrides in 1996 (Bones *et al*. 1998) and of a skull found in Cornwall in 1949 (Reid *et al.* 2003) respectively. The two Arctic species, the beluga whale and the narwhal have been recorded only very rarely in UK waters, mainly in the North.

A1a.8.2.12 Minke whale

Minke whales (*Balaenoptera acutorostrata*) are widely distributed in all the major oceans of the world from tropical to polar seas; they are most abundant in relatively cool waters, and on the continental shelf in waters <200m depth. In the north-east Atlantic they range from Norway to Portugal and into the North Sea (Hammond *et al.* 2008). Within UK waters, minke whales are the most common among the baleen whales and most frequently sighted in the western central-northern North Sea, and west of Scotland around the Hebrides (Figure A1a.8.12).

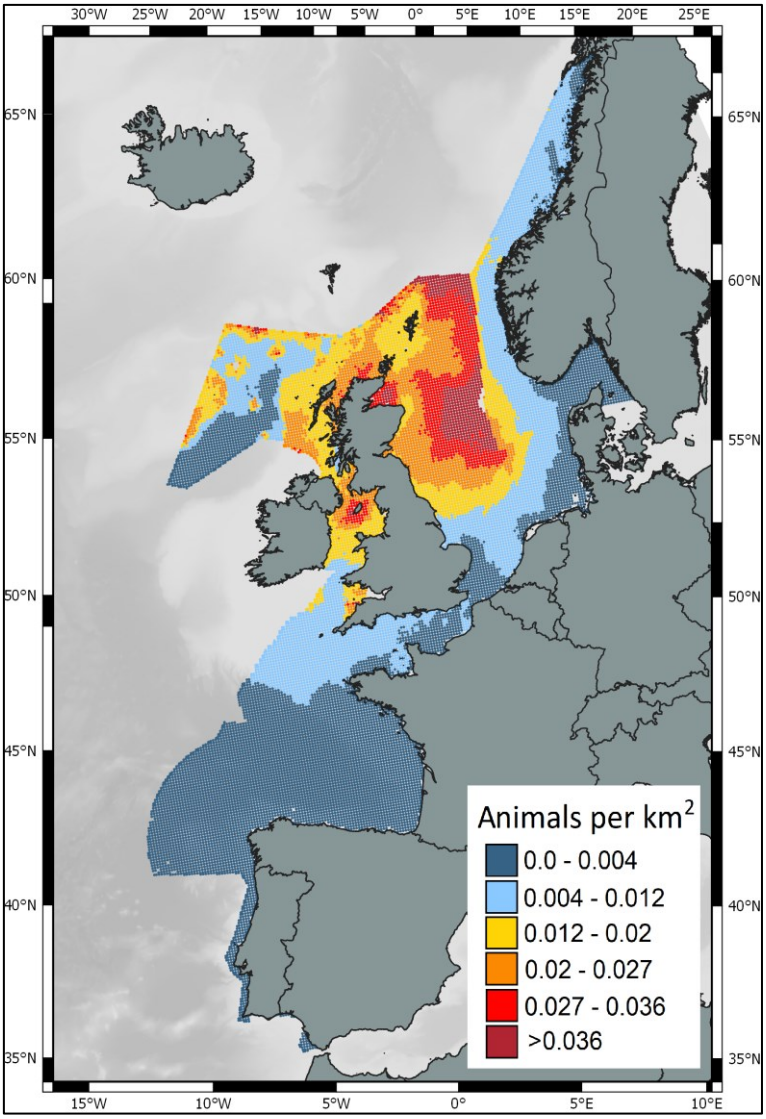
They are primarily a seasonal visitor to UK waters, with whales appearing to move south into the North Sea and western Scotland at the beginning of May and remaining present until October; sightings are rare outside of this period but some animals remain in coastal waters year-round (Evans 2008). During these summer months, they are widely distributed throughout the region, including coastal and offshore shelf waters, and deeper waters on and beyond the shelf slope. Pollock *et al.* (2000) reported several sightings of minke whales in the Faroe-Shetland Channel.

Figure A1a.8.12: Distribution of minke whale and fin whale sightings



Minke whales are rare in the southernmost North Sea and eastern English Channel; North Sea sightings generally extend no further south than the Dogger Bank. In the western English Channel they are evenly distributed in low numbers along the continental shelf edge, and also present throughout much of the Celtic Sea and western Irish Sea during summer (Figure A1a.8.13). Although not as evident as for harbour porpoises, comparison of predicted surface densities based on minke whale sightings from SCANS-I, SCANS-II and SCANS-III surveys suggests a southerly shift in distribution in the North Sea, from north-western North Sea to central North Sea between 1994 and 2005, and within the Irish Sea in 2016 (Hammond *et al*. 2021).

Figure A1a.8.13: Predicted density surface for minke whale in 2016



Notes: Density values are predictions based on the observed distributions and their relationships with habitat variables (longitude and latitude, plus distance from coast, depth or aspect of seabed slope if selected). Source: SCANS-III (Hammond Pers. comm.)

Some genetic differentiation among individuals has been reported (Andersen *et al.* 2003) but since this does not appear to be caused by geographic structuring within the north-east Atlantic (Anderwald *et al.* 2011). A single CGNS MU was deemed appropriate for the management and conservation of this species (IAMMWG 2015), which is in accordance with the approach taken by the International Whaling Commission. The abundance of minke whales across the entire CGNS MU is 20,118 (95% CI= 14,061-28,786), with the UK component estimated at 10,288 animals (95% CI =6,210-17,042) (IAMMWG 2021). They are usually observed singly or in pairs although may form larger feeding aggregations of 10-15 individuals (Reid *et al.* 2003).

The current best estimate of population size in UK waters is 12,340 individuals (95%CI: 6,912-22,032), based on the SCANS-III surveys pro-rated by area across UK waters (JNCC 2019).

A1a.8.2.13 Fin whale

Fin whales (*Balaenoptera physalus*) have a worldwide distribution, present in all oceans where they range from tropical to polar regions. They are largely pelagic and are rarely seen in

nearshore waters. They are typically encountered singly or in pairs although do form larger pods of up to 20 individuals (Reid *et al.* 2003).

Fin whales occur to the north and west of Scotland along the shelf slope and deeper waters beyond, with most visual observations from the Faroe-Shetland Channel and Rockall Trough (Reid *et al.* 2003, Macleod *et al.* 2003b) as shown in Figure A1a.8.12. They are migratory, and exhibit seasonal movements between lower latitudes in winter and high latitudes in summer; for example Pollock *et al.* (2000) observed fin whales in UK waters between May and October, with a peak in sightings in August. However, Charif & Clark (2009) did not find clear evidence of large-scale seasonal migratory movements for this species in their analyses of acoustic monitoring of whale calls on the shelf edge and deeper waters north and west of the UK and Ireland. Over the ten year study, fin whale songs were the most frequently detected signals across all regions sampled and in every month of the year, but highest densities were recorded in December and January (Charif & Clark 2009). In Irish coastal waters, fin whales are regularly sighted in autumn and winter, particularly off the south coast (Wall *et al.* 2013), where they are the second most frequently sighted cetacean during annual herring acoustic surveys taking place in the region each October (e.g. O'Donnell *et al.* 2017, 2018). During the ObSERVE aerial surveys, fin whale sightings were greater in winter than summer, although in both seasons most sightings were near the shelf edge and in the Rockall Trough (Rogan *et al*. 2018). It has been suggested that fin whales use these coastal waters as a feeding "stop over" during an assumed migration from higher to lower latitudes.

The current best estimate of population size within UK waters is 28,836 animals, based on the SCANS-III surveys pro-rated by area across UK waters, although this estimate is subject to considerable uncertainty (95%CI: 7,590-106,556) (JNCC 2019).

A1a.8.2.14 Other baleen whales

Sei whales (*Balaenoptera borealis*) can be found worldwide in all oceans and adjoining seas; they primarily occur in offshore, deep waters. They migrate annually from cool and subpolar waters in summer to temperate and subtropical waters for winter. Sei whales exhibit a similar distribution to fin whales to the north and west of Scotland, with most observations from the Faroe-Shetland Channel and Rockall Trough (Reid *et al.* 2003, Macleod *et al.* 2003b). The majority of sei whale sightings reported in Pollock *et al.* (2000) were in August. They are usually encountered singly or in pairs. During the CODA survey in summer 2007, sei whales were exclusively sighted in the waters off north-west Spain, providing an abundance estimate of 366 whales (CV 0.33, 95%CI 176-762); no sei whales were observed during the SCANS-III survey and the species was rarely recorded offshore west of Ireland in the ObSERVE surveys (Berrow *et al*. 2018, Rogan *et al*. 2018).

Humpback whales (*Megaptera novaeangliae*) are present worldwide in tropical, temperate and polar seas of both hemispheres, typically favouring waters over and along the continental shelf edge and around oceanic islands (Reid *et al.* 2003). They migrate annually from high latitude, cold water, feeding grounds in summer to low-latitude, warm water, breeding grounds in winter. They are usually observed singly or in pairs and groups rarely exceed 4 or 5 individuals when not feeding or breeding (Reid *et al.* 2003). Humpback whale populations, including those in the North Atlantic, have been severely depleted by over-exploitation. From a comprehensive recent review of sightings data relevant to Scottish waters, Hague *et al*. (2020) concluded that humpback whales are likely present year-round in Scottish waters, but in extremely low numbers; shore-based sightings have increased over the past two decades. Most visual sightings in offshore waters over the UKCS are along the shelf edge and in deeper waters to the north and west of Scotland (Reid *et al*. 2003, Stone 2015). Using passive acoustic arrays,

Charif & Clark (2009) demonstrated their regular presence in deep waters west of the UK and Ireland between October and April. A north to south progression in the timing of humpback acoustic detections led these authors to suggest that they were most likely *en route* to breeding areas in the West Indies. No returning migration was detected, either because returning whales do no vocalise or because a different route is used. Shore-based sightings are infrequently reported throughout the year, although several resources have reported sightings to have become more frequent over the past two decades (Hague *et al*. 2020). Most such sightings, primarily derived from WDC Shorewatch and Seawatch Foundation data, come from the Northern Isles, the Western Isles and Grampian coast, northern Irish Sea, southern Irish Sea, Celtic Sea and the western Channel (Reid *et al.* 2003, Hague *et al*. 2020). In particular, a small number of humpback whales use waters off the south and south west coasts of Ireland as a feeding ground throughout the year, albeit with notably higher sighting rates from late summer through to early winter, similar to the pattern observed among fin whales (Ryan *et al*. 2016a). Leopold *et al*. (2018) showed a marked increase in sightings of humpback whales in the southern North Sea since the early 2000s, including adults and juveniles and with; sightings have been reported in all months of the year, although appear more frequent in winter months. The authors conclude that the species is now a yearly visitor to the region, albeit in small numbers (Leopold *et al*. 2018).

Blue whales (*Balaenoptera musculus*) have a worldwide distribution and are likely to exhibit seasonal migration (Reid *et al.* 2003). They usually occur in deep waters and have been recorded from visual observations and acoustic detections west of Britain and Ireland in the deep waters off the continental shelf (Pollock 2000, Charif & Clark 2009). Sightings are generally rare but blue whales were the second most common species detected by Charif and Clark (2009); peak detections densities were in November and December, declining through late winter early spring to minimal levels in April through June, before increasing again. Movements were in a southward direction through the study area during the fall and winter months.

A1a.8.3 UK context: Seal distribution and abundance

A1a.8.3.1 Grey seals

Grey seals (*Halichoerus grypus*) are found across the north Atlantic, from Nova Scotia and the Gulf of St. Lawrence in the west, to the UK and Baltic Sea in the east. Approximately 36% of the world population occurs in the UK (SCOS 2019). Population size is derived by extrapolation of pup production surveys and demographic parameters; the latest UK adult (1+ years age) population estimate is 152,800 (95% CI 135,300-173,800) for 2018, similar to the 2017 estimate (SCOS 2019).

Approximately 84% of the UK population breeds in Scotland, largely in the Hebrides and Orkney. Major colonies are also present on Shetland and along the east coast of Scotland including the Isle of May and Fast Castle. Larger colonies in England include the Farne Islands in the north-east, Donna Nook at the mouth of the Humber and Blakeney Point on the East Anglia coast. There are smaller colonies around south-west England and Wales, including Lundy and islands off Pembrokeshire and the Lleyn Peninsula. The distribution of grey seal colonies around the UK is shown in Figure A1a.8.14. Breeding takes place in the autumn with a clockwise cline in mean birth date around the UK: August-September in SW Britain, September-November in Scotland and November-December in eastern England.

Results of the most recent pup production surveys at the main colonies in the UK are shown in Table A1a.8.2. The best estimate of total pup production in the 2016 breeding season was 65,400 (95%CI 57,800-71,800). Pup production is currently estimated to be increasing at a

near-exponential rate at colonies in the North Sea; elsewhere, it is stable or increasing at a lower rate (SCOS 2019).

Table A1a.8.2: Grey seal pup production estimates at main colonies surveyed in the UK

Location	Regional Sea	2016 pup production	2014 pup production	Average annual change 2014 to 2016	Average annual change 2008 to 2014
Inner Hebrides	7	4,541	4,054	+5.8%	+3.8%
Outer Hebrides	7, 8	15,732	14,316	+4.8%	+2.7%
Orkney	8	23,849	23,758	+0.2%	+4.4%
Firth of Forth	1	6,426	5,860	+4.7%	+9.2%
Main biennially monitored Scottish Island groups	**1,8,7**	**50,548**	**47,988**	**+2.6%**	**+3.9%**
Other Scottish colonies [1] (incl. Shetland and mainland)	1,6,8	4,193	3,875	+4.0%	-
Total Scotland	**-**	**54,741**	**51,863**	**+2.7%**	**+4.3%**
Farne Islands	1	2,238	1,600	+18.3%	+3.5%
Donna Nook + East Anglia	2	5,919	5,027	+8.5%	+16.4%
Annually monitored English colonies	**1,2**	**8,157**	**6,627**	**+10.9**	**+12.0%**
SW England [2]	4	380 [2]	250 [3]	-	-
Total England	**-**	**8,537 [2]**	**6,877 [3]**	**-**	**-**
Total Wales	**6**	**2,000**	**1,650**	**+10.1%**	**-**
Northern Ireland	**6**	**100 [3]**	**100 [3]**	**-**	**-**
Total UK	**-**	**65,378**	**60,490**	**+3.7%**	**-**

Notes: [1] Estimates derived from data collected in different years. [2] Combination of survey counts of most colonies in 2016 to 2018 and an estimate for other colonies based on a multiplier derived from 2004 survey results. [3] Includes estimated production for colonies that are rarely monitored. Source: SCOS (2019).

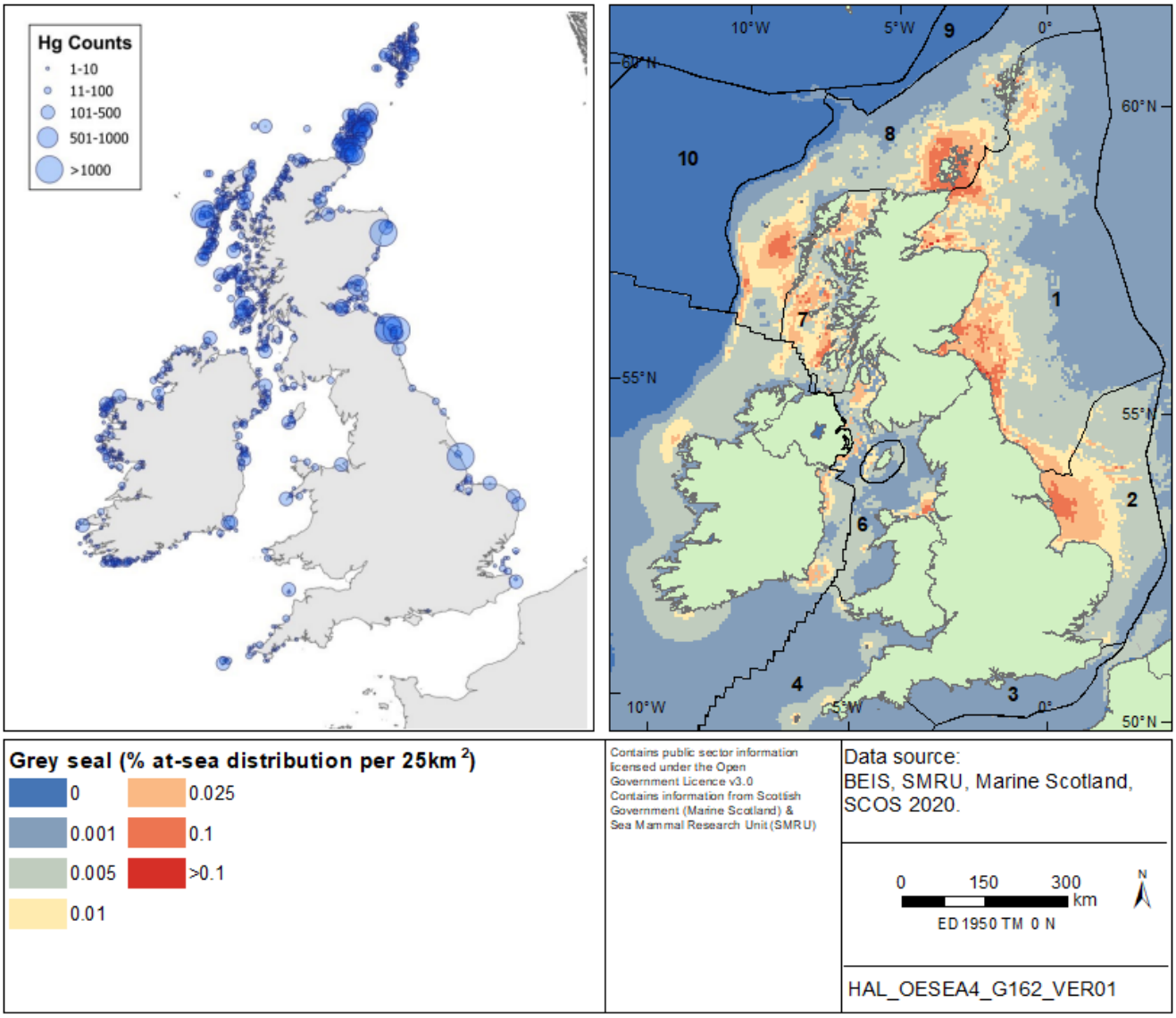
Small, but increasing, numbers of grey seals occur along the European continental coast of the southern North Sea and English Channel, the vast majority of which are recorded in the Dutch Wadden Sea, with counts during the 2017 spring moult totalling 5,445 and an average annual increase of 16% observed from 2008-2016 (Brasseur *et al*. 2017). Such rapid growth of the Dutch breeding population is fuelled by the annual immigration of grey seals from the UK (Brasseur *et al*. 2014). Rapid increases have also been observed on the French coast over the past decade, particularly in the eastern English Channel, although numbers are low

compared those occurring further north in the UK, with a combined maximum count from the five regularly monitored sites in 2015 of approximately 600 grey seals (Vincent *et al*. 2017).

A large proportion of the grey seal population will be on land and in waters close to colonies for several weeks from October to December during the pupping and breeding season, and again in February and March during the annual moult. Densities at sea are likely to be lower during this period than at other times of the year. They also haul-out and rest throughout the year between foraging trips to sea, although may re-distribute themselves outside of the breeding season; therefore regional differences in population estimates do not necessarily reflect the abundance of animals in each region at other times of the year (SCOS 2019). While pup production is the primary means of monitoring populations, grey seals are also counted in August during harbour seal surveys; these provide information on the summer distribution of grey seals, even though it is recognised that at this time of the year numbers can be highly variable between days (SCOS 2014, Duck & Morris 2015). Studies at two Scottish colonies have indicated that breeding females tend to faithfully return to their natal breeding colony for most of their lives (Pomeroy *et al.* 2000). Mature females give birth to a single pup which is nursed for about three weeks before it is weaned and moults into its sea-going adult coat.

As described in Section A1a.8.1, estimated at-sea distributions of grey seals around the UK and Ireland during the main foraging season have been derived from telemetry and haul-out data (e.g. Jones *et al*. 2015, Russell *et al*. 2017, Carter *et al*. 2020). The most recent distributions represent a new use-availability habitat preference modelling framework that utilises high-resolution GPS telemetry data from 114 grey harbour seals, habitat preference models and the most recently-available haul-out counts (Carter *et al*. 2020). The key outputs are predicted relative density estimates at a 5 x 5km grid scale, as presented in Figures A1a.8.14 (A) and A1a.8.14 (B). These recent distribution estimates indicate a relatively high density of grey seals on the UK west coast along the shelf edge to the west of the Western Isles. On the east coast, hotspots of density are patchily distributed offshore out to approximately 100km from the coast. In southeast England hotspots are evident along the western and southern fringes of the Dogger Bank, which appears to be an important feature in the region, potentially influencing seal foraging distribution (Carter *et al*. 2020, Figure A1a.8.14 (B)).

Figure A1a.8.14: Grey seal haul-out counts (A) and marine usage (B)



Grey seal foraging movements are on two geographical scales: long and distant trips from one haul-out site to another; and local repeated trips to discrete foraging areas (McConnell *et al.* 1999). Foraging areas can be up to 100km offshore and connected to haul-out sites by prominent high-usage corridors (Jones *et al.* 2015). Individual mature grey seals of both sexes are usually faithful to a particular breeding site and may return within 10-100m of previous sites (Pomeroy *et al.* 2000). High inter-annual fidelity to foraging season haul-outs has also been recorded (Vincent *et al.* 2005). Although many seals breed in the same region where they forage, this is not always the case; Russell *et al.* (2013) found that between 21% and 58% of the females studied foraged in a region different from where they bred around the UK, with degree of fidelity varying among regions. For example, analysis of recent tracking data indicates movements of female grey seals between foraging grounds in the Hebrides and breeding sites in North Scotland, suggesting that regional population dynamics may be affected by foraging conditions elsewhere (Carter *et al.* 2020).

The large distances travelled indicate that grey seals across the North Sea are not ecologically isolated. Some information on the distribution and movements of grey seals comes from using numbered tags attached to the flippers of pups. These indicate that young seals disperse widely in the first few months of life. Pups marked in the UK have, for example, been

recaptured or recovered along the North Sea coasts of Norway, France and The Netherlands, mostly during their first year (Wiig 1986).

Telemetry data from grey seals tagged at sites in the Netherlands between 2005 and 2014 shows that 21 of the 62 tagged animals spend time in the UK southern North Sea, including visits to Donna North, Blakeney Point and Horsey colonies (Brasseur *et al.* 2015). These data indicate considerable exchange of grey seals between colonies and haul-outs with the UK, although few of the seals tracked from the UK have visited Dutch waters. Movement data from 45 grey seals tagged on the French coast of the English Channel between 1999 and 2014 is presented in Vincent *et al*. (2017). Grey seals travelled widely, visiting haul-outs and colonies (data partially overlapped the breeding season) throughout the English Channel, south west England, west Wales, south west Scotland and Ireland, and also into the North Sea, including eastern England and Scotland and the Dutch coast.

A1a.8.3.2 Harbour seals

Harbour (or common) seals (*Phoca vitulina*) are one of the most widespread pinniped species and have a practically circumpolar distribution in the Northern Hemisphere. Animals around the UK belong to a European sub-species (*P. vitulina vitulina*) which mainly occur in UK, Icelandic, Norwegian, Swedish, Danish, German and Dutch waters; at the latest count in 2013 approximately 30% of the world population of this sub-species occurs in the UK; this proportion has declined from approx. 40% in 2002 (SCOS 2014).

Around Britain and Ireland, harbour seals haul out on tidally exposed areas of rock, sandbanks or mud. Pupping occurs on land from June to July, while the moult is centred around August and extends into September. Therefore, from June to September harbour seals are ashore more often than at other times of the year. The distribution of seals at haul-out sites around the UK is shown in Figure A1a.8.15. The largest concentrations are found in Scotland, primarily on the West coast, Inner and Outer Hebrides, Orkney and Shetland. Large numbers also occur on the English east coast at The Wash and adjacent coastline. Many other haul-out sites supporting lower numbers are present around the UK coast, the largest of which are found in the Moray Firth, east coast of Northern Ireland, the Firths of Tay and Forth, the greater Thames area and south-west Scotland.

Estimated numbers of harbour seals in the UK are derived from aerial survey counts of hauled out individuals during the moult; these provide minimum population estimates as they are believed to record between 60-70% of actual numbers. Not all areas are counted every year, but the aim is to cover the entire UK coast every 5 years. In response to a sharp decline in numbers observed after the year 2000 in Shetland, Orkney and the Firth of Tay, the survey effort has been increased to once a year in the critical areas; in The Wash yearly surveys have been conducted after the mass deaths from PDV in 1988. Results from the most recent surveys (between 2007-2014) at all sites have been combined to obtain a total of 28,925 harbour seals counted across the UK: 81% in Scotland, 16% in England, 3% in Northern Ireland and no established harbour seal haulout sites in Wales (SCOS 2014; Duck & Morris, 2015).

Minimum population estimates from aerial counts from haul-out sites along the UK coastline over the period 2007-2014 are shown in Table A1a.8.3. Overall counts in Scotland showed a reduction of about 11% since 2000-2006 and of as much as 30% since 1996-1997 estimates, while counts in England have increased since the 2002 epidemic. While total numbers in Scotland continue to show a decrease, there are marked geographical differences, especially at the latest counts in 2014 with the North & East coast of Scotland in decline and the West of

Scotland on the increase; so much so that West Scotland is now by far the most important Management Area for this species (Duck & Morris 2015). Overall, the UK population in 2014 has been estimated at 36,925 (approximate 95% CI 29,900 – 49,700) by scaling the aerial counts by the estimated proportion hauled out (SCOS 2014).

Harbour seals are widespread throughout coastal waters surrounding these colonies, and are abundant in waters surrounding larger colonies. Their distribution at sea is constrained by the need to return periodically to land; they tend to undertake relatively short excursions from their favoured haul-out sites, often less than 50 km, with little evidence of extensive seasonal migrations. Although harbour seals seem to show some fidelity to particular haul-out sites, they occasionally make long-distance movements to other haul-outs, transiting between regions and countries. Duration and distance of foraging trips are largely a function of region and season although sex, size and body condition may also play a role; seals on the east coast of the UK made some of the most wide-ranging trips (e.g. Moray Firth 100.6 km on average) while those from Orkney, Shetland and Outer Hebrides made much shorter trips (between 11-21 km on average) (Sharples *et al.* 2012). Estimated at-sea distributions of harbour seals around the UK and Ireland during the main foraging season have been derived from telemetry and haul-out data (e.g. Jones *et al*. 2015, Russell *et al*. 2017, Carter *et al*. 2020). The most recent distributions represent a new use-availability habitat preference modelling framework that utilises high-resolution GPS telemetry data from 239 harbour seals, habitat preference models and the most recently-available haul-out counts (Carter *et al*. 2020). The key outputs are predicted relative density estimates at a 5 x 5km grid scale, as presented in Figures A1a.8.15 (A) and A1a.8.15 (B) High at-sea usage is consistent with areas with high abundance counts at haul-out sites but clearly harbour seals are not exclusively restricted to coastal waters.

Aarts *et al*. (2016) present data on the movement and habitat use of over 200 harbour seals tagged on the Dutch Wadden Sea and west coasts Dutch coast between 2007 and 2015. While some tagged individuals made trips >80km from haul-outs, the highest densities were within a few kilometres of haul-outs and the vast majority of their time spent at-sea was within 40-50km of shore. Seals spent less time on land and ventured further from haul-out sites during winter months (Dec-Feb). Very few tagged animals entered UK offshore waters of the southern North Sea, and models predicted only low densities of animals close to the UK-Netherlands median line. Movement data from 28 harbour seals tagged on the French coast of the English Channel between 1999 and 2014 showed harbour seals to largely stay within the bays where they were tagged (data were from out with the breeding season) (Vincent *et al*. 2017).

Genetic analyses suggest that there are genetically distinct populations of harbour seals in European waters, with little movement of breeding animals between six distinct units: east coast of England, Ireland-Scotland, Wadden Sea, western Scandinavia, east Baltic and Iceland (Goodman 1998). However, satellite telemetry has shown some movement of animals between these units outside of the breeding season (e.g. SCOS 2014). Such connectivity can also be inferred from the spread of phocine distemper virus (PDV) among European populations in 1988 and 2002.

Figure A1a.8.15: Harbour seals August distribution from counts at haul-out sites (A) and marine usage (B)

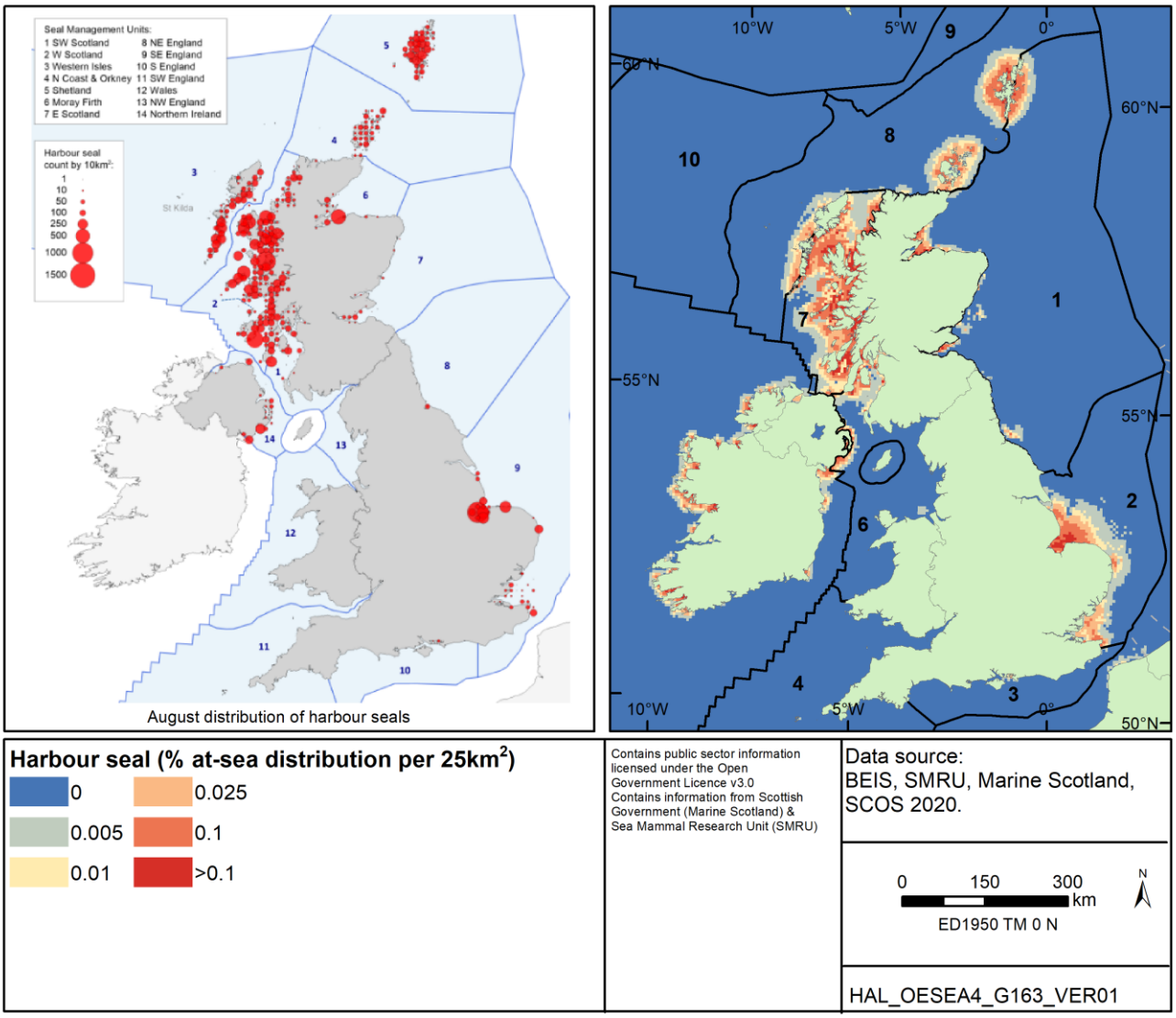


Table A1a.8.3: Most recent August counts of harbour seal at haul-out sites in the UK, compared with two previous periods

Seal management Unit / Country	Regional Sea	2015-2018	2007-2013	2000-2006
Southwest Scotland	6	1,709	923	623
West Scotland	7	15,600	11,072	11,666
Western Isles	7,8	3,533	2,739	1,981
North Coast & Orkney	8	1,349	1,938	4,388
Shetland	1, 8	3,369	3,039	3,038
Moray Firth	1	692	898	1,028
East Scotland	1	342	214	667
Total Scotland	-	26,864	20,823	23,391
North-east England	1	79	83	62
Southeast England	2	4,961	4,504	2,964
Other England SMUs and Wales [1]	3,4,6	55	35	22
Total England & Wales	-	5,095	4,622	3,051
Total Northern Ireland	6	1,012	948	1,176
Total UK	-	32,971	26,393	27,618

Notes: Numbers are counts of hauled-out seals from aerial surveys in August and provide a minimum population estimate, likely to represent approximately 60-70% of the total population. [1] No dedicated harbour seal surveys in this SMU and only sparse information available. Source: SCOS (2019).

The seal management units currently in use around the UK are shown in Figure A1a.8.14(A). They were originally formulated as a pragmatic approach in response to requirements of legislative drivers and do not aim to define discrete populations; they are applied to both species. Given the movement of animals between MUs (Russell *et al.* 2013), especially in the case of grey seals, impacts on animals may have effects at the population level outside the particular MU with which the 'population' is associated (SCOS 2014). For harbour seals, these are broadly similar to OSPAR EcoQO units and supported by recent ICES advice on assessment units for MSFD (ICES 2014); the main difference is that OSPAR has excluded part of the UK coastline where seal presence is minor (West England and Wales and North-east England). For grey seals, ICES has advised for only two assessment units, one for the North Sea and one to combine western Britain, Ireland and Western France.

A1a.8.4 UK context: Otter distribution and abundance

Otters (*Lutra lutra*) are semi-aquatic mammals which may inhabit rivers, lakes, coastal areas and marshy areas some distance from open water. Coastal populations utilise shallow, inshore marine areas for feeding but also require fresh water for bathing and terrestrial areas for resting and breeding holts. They are commonly seen foraging within a narrow zone close to

the shore (<100m) and only rarely cover larger distances, moving between islands (Kruuk 2006). Otters were formerly widespread throughout the UK but in the 1960s-1970s their population experienced a rapid and severe crash, largely as a consequence of widespread use of pesticides, draining of wetlands and river engineering; the impact was most severe in England where they were effectively lost from central and south-eastern counties and to a lesser extent in Wales. Since the 1980s, national surveys have recorded a continued recovery with significant gains across most affected areas; only the south-east and small parts of north-west Midlands remain to be colonised in England, while in Wales otters have been most recently recorded as present across the entire range (JNCC 2013).

Association with coastal habitats by otters occurs most commonly in Scotland where as much as one third of the population has been estimated to be linked to the marine environment, especially in western Scotland, Shetland and the Moray Firth. Other important coastal populations as illustrated by their presence in coastal Special Areas of Conservation include west Wales, and The Wash and north Norfolk coast (Figure A1a.8.16).

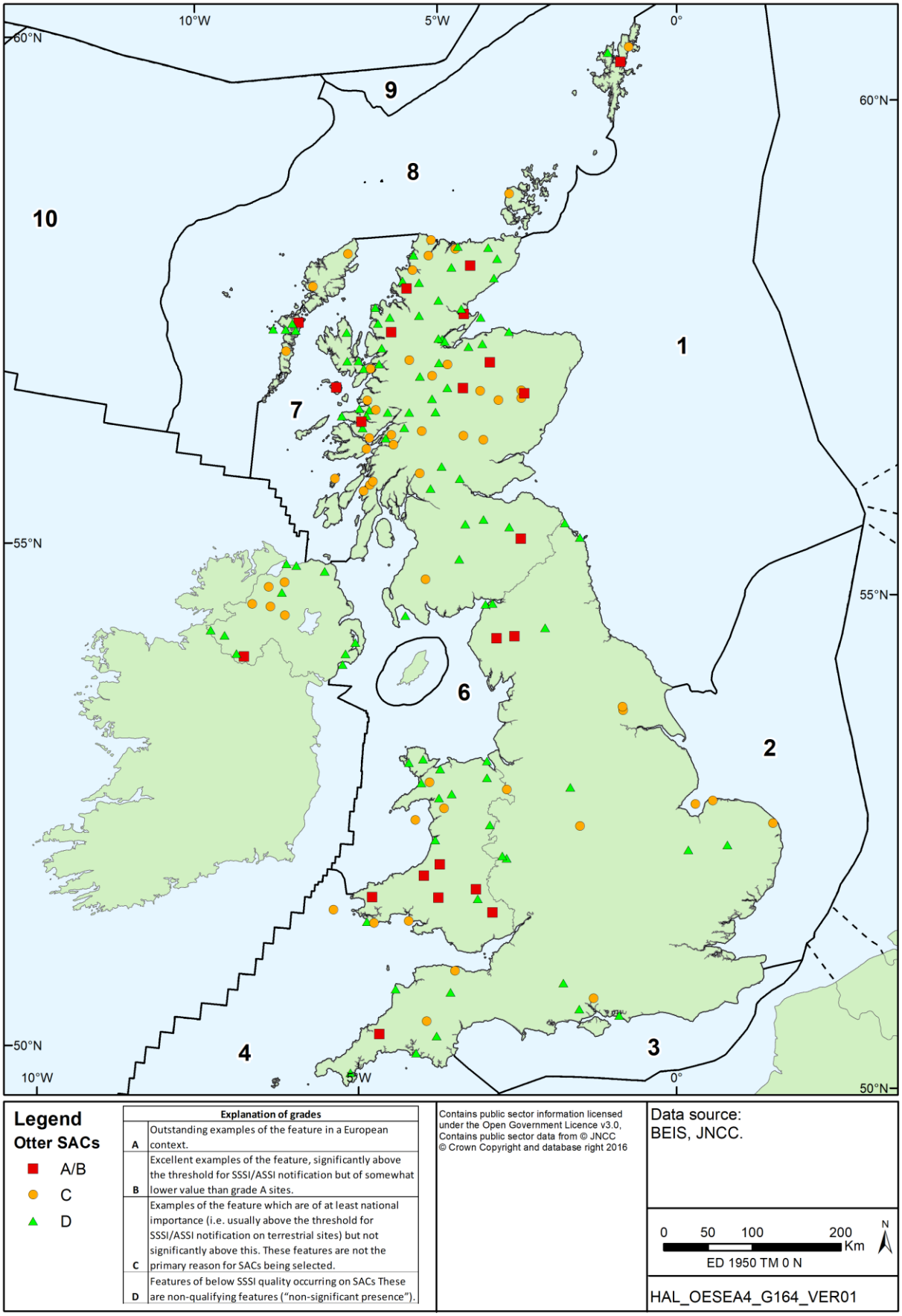
A1a.8.5 Feeding ecology

The abundance and availability of fish and other prey, particularly those species mentioned below, is clearly of prime importance in determining the success of marine mammal populations in UK waters and beyond. Changes in the availability of principal prey items can therefore be expected to have considerable effects on marine mammals. It is not possible to predict with any degree of certainty how a change in prey abundance would be likely to affect any of these marine mammal populations (Hammond *et al.* 2008).

A1a.8.5.1 Cetaceans

There is limited information on the feeding ecology of cetaceans in UK waters but through research our understanding is improving. Information is primarily drawn from analyses of stomach contents of stranded or bycaught individuals, to a lesser degree from stable isotope analyses of predator and prey tissues, and from direct observations.

Figure A1a.8.16: Distribution of Special Areas of Conservation where otters are present



A1a.8.5.2 Harbour porpoise

Harbour porpoise show rapid growth but attain a smaller size, mature at an earlier age, reproduce more frequently and experience shorter lives than other cetaceans (Read & Hohn 1995). Given their small size, energy balance and fat storage (blubber thickness) are thought to be particularly important in relation to insulation and heat loss (Lockyer 2007). It is a very active species with high metabolic cost of living; it is considered an opportunistic feeder and energy balance is maintained by feeding regularly (2.5-5 kg per day in adults) on a diet largely based on high energy density prey (Lockyer 2007, Spitz *et al.* 2012).

Harbour porpoises feed mainly on fish found on or near to the seabed. Analyses of the stomach contents of 188 harbour porpoises stranded in Scotland, from 1992 to 2003 revealed whiting and sandeels to be the main prey items, together comprising 80% of the diet (Santos *et al.* 2004). Other small gadoids and cephalopods were also important, along with clupeids such as herring and sprat; other preys identified included gobies, mackerel, brown shrimp and several isopods and amphipods. Regional, seasonal and inter-annual differences in diet composition were identified. For example, haddock/saithe/Pollock were more numerous in Shetland diet than in the East Coast while sandeels were least important in the West coast diet. Comparing these results with studies from the 1960s, there is some evidence that the diet has changed from one composed mainly of herring to one dominated by sandeels and whiting, mirroring the decline in North Sea herring abundance (Santos *et al.* 2004).

Elsewhere in British waters, investigations of harbour porpoise diet revealed the diet off southern England to be dominated by whiting, followed by poor cod and scad (Roberts 2005, cited in Hammond *et al.* 2008). Off Wales, whiting was also the dominant prey species consumed, followed by gobies.

The diet of marine mammals stranded on the Dutch, French and Belgian coasts from 1994-2000 was investigated by Das *et al.* (2003) through comparisons of carbon and nitrogen isotope ratios in their muscle compared to that of a wide range of potential prey species in the southern North Sea. The trophic level of harbour porpoises was estimated to be lower than that of white-beaked dolphin and also grey and harbour seals, although variations were observed with sex and age of porpoises. This suggests that harbour porpoise in the southern North Sea consume a greater proportion of zooplankton-feeding fish such as clupeids and sandeels than the other species investigated.

Some evidence for different diets between offshore waters and coastal areas has been suggested by comparing diet composition derived from stomach content and isotope analyses in porpoises stranded along the Dutch coast between 2006-2008 (Jansen *et al.* 2013); results from stable isotope analyses, which provide long-term diet composition, revealed a greater importance of pelagic schooling species (e.g. mackerel) than was observed in stomach contents.

A1a.8.5.3 Other toothed cetaceans

Bottlenose dolphins are considered generalist predators with a broad diet that includes many demersal and pelagic prey species. In Scotland, analyses of stomach contents have shown gadoids to be the main component, along with salmon, other fish species and cephalopods (Santos *et al.* 2001). Observations of feeding behaviour have been reported in a few locations within the inner Moray Firth (Kessock Channel, Chanonry narrows and mouth of the Cromarty Firth) and the waters surrounding Aberdeen harbour (Wilson *et al.* 1997, Hastie *et al.* 2004, Stockin *et al.* 2006). In French shelf waters, the predominant prey species reported in the stomachs of bottlenose dolphins were blue whiting, hake, scad, *Trisopterus* species, horse

mackerel and the squid *Loligo vulgaris* (Learmonth *et al.* 2004, cited in Hammond *et al.* 2008; De Pierrepont *et al.* 2005). In Irish waters, haddock, saithe and pollock are the dominant prey species ingested, followed by whiting, blue whiting, Atlantic mackerel and horse mackerel; cephalopods are also important (Hernandez-Milian *et al.* 2015).

The diet of common dolphins includes a variety of fish and squid, with main dominant species varying with season and region (see Hammond *et al.* 2008 and Murphy *et al.* 2013 and references therein). Some studies have described them as opportunistic, others as specialists with a preference for energy-rich species but the most recent large scale analysis was still unable to provide conclusive evidence either way (Santos *et al.* 2013). Fish preys identified in the stomachs of stranded specimens examined from UK and Irish waters revealed horse mackerel, mackerel, Norway pout and sardines to dominate, with other *Trisopterus* spp., whiting, herring, sprat and sandeel also present. Cephalopods prey included mainly *Loligo* spp., *Alloteuthis subulata*, *Ancistroteuthis lichtensteini*, *Todarodes sagittatus*, *T. eblane* and *Sepiola atlantica*, but various other species of squid, octopus and cuttlefish were also consumed. In a limited number of animals bycaught in Scottish waters, whiting was dominant. In the Celtic Sea and western Channel, the common dolphin predominately feeds on horse mackerel, sardines and mackerel. Common dolphins bycaught in Irish and French tuna driftnets on and beyond the continental shelf slope in summer were predominately feeding nocturnally on meso-pelagic fishes such as myctophids and squids. De Pierrepont *et al.* (2005) reported *Trisopterus* spp. and gobies as the main prey species consumed in French Channel waters.

White-beaked dolphins have been recorded taking whiting and other gadoids, sandeels, herring and octopus. Studies of the stomach contents of white-beaked dolphins stranded mainly on the Scottish east coast identified haddock and whiting as the predominant fish species consumed (Canning *et al.* 2008). The diet of Atlantic white-sided dolphin elsewhere in the north Atlantic has been reported to consist of pelagic species such as herring, mackerel, horse mackerel, silvery pout and squid (Reeves *et al.* 1999a, cited in Hammond *et al.* 2004). A study of the digestive tracts of 20 Atlantic white-sided dolphins stranded or bycaught in Irish waters showed a dominance of teleost fish, with gadoids the most important taxonomic group; species of importance included poor cod, pouting, blue whiting, mackerel and mesopelagic fish including myctophids and silvery pout (Hernandez-Milian *et al*. 2016). The diet of striped dolphins in the north-east Atlantic consists of a variety of mesopelagic and benthic fish, squid and crustaceans; studies of striped dolphins stranded around Scotland from 1992-2003 showed whiting and *Trisopterus* spp. to be the main prey species in the diet (Santos *et al.* 2008).

There has been limited documentation of killer whale diet in UK waters, but, elsewhere, they are known to have one of the most diverse diets among marine top-predators (Heyning & Dahlheim 1988). In the north-east Atlantic, herring has long been considered the key prey species (Similä *et al.* 1996) but a study in offshore waters between Norway and Iceland has demonstrated a strong association between killer whales and mackerel schools during the summer months (Nøttestad *et al.* 2014). In Scottish waters, they have been occasionally recorded feeding in the vicinity of pelagic vessels targeting herring and mackerel (Luque *et al.* 2006) and they have been reported predating on seals around major colonies, particularly in Orkney and Shetland (Weir 2002, Bolt *et al* 2009, Samarra & Foote 2015). Deecke *et al.* (2011) described coastal seal-hunting groups and offshore herring-eating groups off Shetland, characterised by different social and vocal behaviour suggesting dietary specialisation.

Risso's dolphins are generally assumed to feed on cephalopods (Hammond *et al.* 2008). This was confirmed by analyses of stomach contents of 11 dolphins stranded between 1992 and

2004 across Scotland (MacLeod *et al.* 2014); 7 cephalopods taxa and 3 fish taxa were identified but cephalopods made up 98% of the total prey (by weight and number). Just one single octopus species, *Eledona cirrhosa* made up 90% of the total; the next most important prey was the common squid *Loligo* sp.

Long-finned pilot whales primarily target cephalopods, with animals in the northwest Atlantic also reported to have consumed small amounts of fish such as saithe, mackerel and blue whiting (Gannon *et al.* 1997). In French Channel waters, cuttlefish (primarily *Sepia* species) were the dominant prey item (De Pierrepont *et al.* 2005); octopods (mainly Octopodidae) were numerically more important in stomach contents from pilot whales stranded in Portugal and Galicia while squids (mainly Ommatostrephidae) were dominant in Scotland (Santos *et al.* 2014) Stable isotope analyses have revealed a similar pattern, with octopus and squids the main prey items identified in Northwest Iberia and Scotland respectively (Monteiro *et al.* 2015).

It is generally assumed that sperm whales in waters adjacent to the UK feed on deep-water squid, as has been reported in animals stranded off the east coast of Scotland (Santos *et al.* 1999). In some parts of the world deep-water fishes have also been reported in sperm whale diet (Hammond *et al.* 2006). Beaked whales also show a strong preference for squid, especially deeper water species (*ca*. 200-1000m) (Hammond *et al.* 2006, MacLeod *et al.* 2003a). In bottlenose whales stranded in UK, Ireland and the Netherlands, prey remains consisted almost exclusively of cephalopod beaks; 90% were *Gonatus* spp, *Teuthowenia* spp and *Taonius pavo*, all oceanic squid species distributed in temperate to sub-polar regions (Fernandez *et al.* 2014).

A1a.8.5.4 Baleen whales

Minke whales feed on a variety of fish, including herring, cod, and haddock in Norwegian waters. Stephenson (1951, cited in Hammond *et al.* 2008) reported that most minke whales taken by commercial whaling in the UK waters of the North Sea during 1948 had been feeding on herring, with some mackerel and sandeels also reported. Analysis of stomach contents of ten minke whales stranded in Scotland from 1992-2002 showed sandeels to be the dominant prey item, with sprat, herring, mackerel and Norway pout consumed to a lesser extent (Pierce *et al.* 2004). Animals caught in the North Sea by Norwegian fisheries showed a similar diet composition, along with the addition of whiting (Olsen & Holst 2001). Minke whales off the west coast of Scotland and more specifically around the Isle of Mull have been shown to prefer areas of sandeel habitat in spring and early summer, and shift to pre-spawning herring habitat and to areas with high sprat abundance in late summer (Macleod *et al.* 2004, Anderwald *et al.* 2012). Off Iceland, diet composition of minke whales sampled during 2003-2007 was found to be predominantly composed of fish, with sandeels the single most important prey species and herring, capeling, haddock and cod also common; krill contribution was small (<10%). This recent diet was found to differ markedly from previously available stomach content data (1977-1984) when krill and capelin were dominant and may reflect the response of minke whales to a changed environment (Vikingsson *et al.* 2014).

The feeding habits of fin whales in UK waters are unknown, but elsewhere in the north-east Atlantic, especially off Iceland, they are reported to have a diet predominated by planktonic crustaceans (euphausiid shrimps such as *Meganyctiphanes norvegica*) although small schooling fish such as capelin and herring may also be taken (Lockyer 2007). Sei whales in the North Atlantic have also been reported as consuming planktonic crustaceans and small schooling fish, although are regarded as more specialist feeders (Pollock *et al.* 2000).

A1a.8.5.5 Seals

Grey seal foraging destinations at sea are typically localised areas characterized by a gravel/sand seabed sediment, which is the preferred burrowing habitat of their primary prey, sandeels. The distance from a haul-out site of a typical foraging trip indicates that the ecological impact of seal predation may be greater coastally than further offshore.

Grey seals are important marine predators in the UK marine environment. They are generalist feeders, foraging mainly on the sea bed at depths up to 100m, although likely capable to feed at all depths found across the continental shelf (SCOS 2014). Their diet primarily comprises sandeels, gadoids (cod, haddock, whiting, ling) and flatfish (plaice, sole, flounder, dab), in that order of importance, but varies seasonally and from region to region (Hammond & Grellier 2006). Around the Outer Hebrides, Orkney and Shetland, sandeels and gadoids typically dominate during winter, while flatfish and herring increase in importance during summer months. Food requirements depend on the size of the seal and fat content of the prey but an average consumption estimate is 7 kg of cod or 4 kg of sandeels per seal per day. An estimate of annual grey seal prey consumption in the North Sea is approximately 150,000 tonnes, of which almost 50% is sandeels (SCOS 2007). In addition, predation by grey seals on marine mammals has also been reported; Bouveroux *et al.* (2014) provided direct observations of grey seal predation and scavenging on harbour porpoises in the Strait of Dover, off the coast of France. Forensic DNA techniques implicated grey seals in attacks that caused harbour porpoises to strand in the Netherlands (van Bleijswijk *et al.* 2014). Adult males attacking grey seal pups and young harbour seals have also been reported (Thompson *et al.* 2015, van Neer *et al.* 2015). The Harbour Seal Decline programme reported low numbers (2-4 individuals) of possible grey seal attacks identified from harbour seal carcasses during each year of the four year research programme (2016 to 2019) in Scottish waters, possible predation of grey seals (mostly weaned pups) by grey seals was also reported and in slightly higher numbers than for harbour seals (Arso Civil *et al*. 2019).

Harbour seals are also important predators in the UK marine environment. The diet is composed of a wide variety of prey including sandeels, gadoids, herring and sprat, flatfish, octopus and squid. Diet varies seasonally and from region to region; current knowledge of the likely daily ration suggests approximately 3kg of fatty fish or up to 5kg of whitefish per day (SCOS 2007). Based on this, a very approximate estimate of minimum annual consumption of prey by harbour seals hauling out on Orkney, Shetland and the west coast of Scotland (including islands) would be 33,000-64,000 tonnes.

A1a.8.5.6 Otters

In general otters feed on a wide range of prey with a strong bias towards fish; however, they are somewhat opportunistic predators and will take many prey items provided they are of appropriate size. In UK coastal waters, they generally consume bottom-dwelling fish, some crustaceans, and have also been occasionally observed taking small water birds.

The diet of otters in coastal studies in Shetland by Kruuk *et al.* (1987) and Kruuk *et al.* (1990) consisted mostly of eelpout (*Zoarces viviparus*) and rockling (*Ciliata* spp.), which are nocturnal species most active at night. In northwest Scotland, Yoxon (2008) observed otters preying primarily on small benthic fish, with the five key prey species being viviparous blenny (*Lipophrys pholis*), five-bearded rockling (*Ciliata mustela*), butterfish (*Pholis gunnellus*), sea scorpion (*Taurulus bubalis*), and saithe (*Pollachius virens*). Britton *et al.* (2006) recorded sea bass (*Dicentrarchus labrax)* and thick lipped mullet *(Chelon labosus)* as prey items of otters in south west England.

Crustaceans are thought to be of secondary importance (Crass 1995), with coastal otters in Shetland feeding mainly on inter-tidal or benthic species (Kruuk *et al.* 1990). Watt (1993) recorded that the diet of coastal cubs and sub-adults comprised a significantly greater proportion of crustaceans, mainly shore crab (*Carcinus maenas*), and less fish than that of adults; there was a negative correlation between age and the proportion of crustaceans in the diet. Shore crabs and other hard bodied crustaceans are relatively unprofitable prey for otters as they provide little meat and require a lengthy handling time.

A1a.8.6 Features of Regional Sea 1

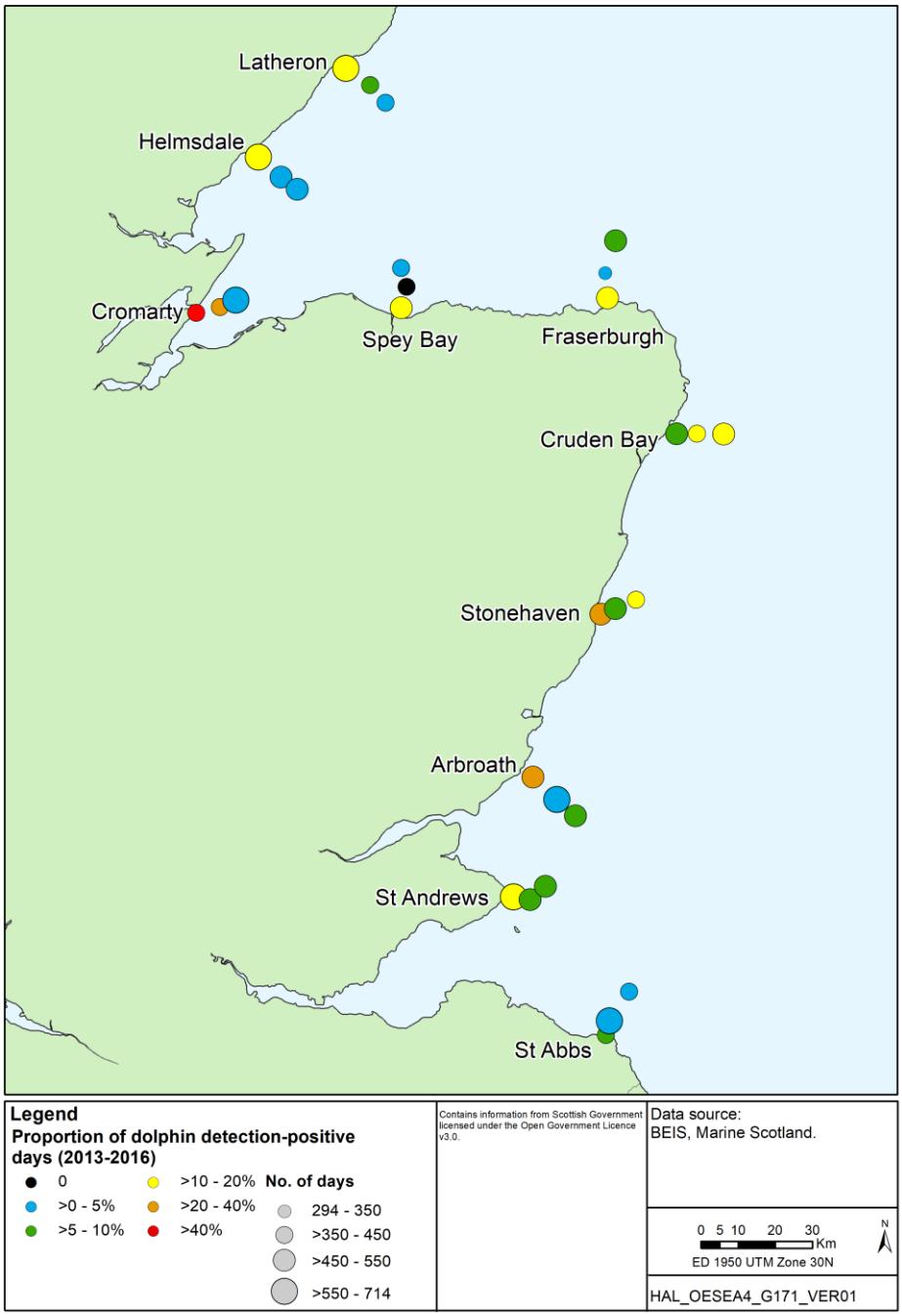
The central and northern North Sea has a moderate to high diversity and density of cetaceans, with a general trend of increasing diversity and abundance with increasing latitude. Harbour porpoise and white-beaked dolphin are the most widespread and frequently encountered species, occurring regularly throughout most of the year. Minke whales are regularly recorded as a frequent seasonal visitor. Coastal waters of the Moray Firth and east coast of Scotland support an important population of bottlenose dolphins, while killer whales are sighted with increasing frequency towards the north of the area. Atlantic white-sided dolphin, Risso's dolphin and long-finned pilot whale can be considered occasional visitors, particularly in the north of the area. Large numbers of grey and harbour seals breed in the area, with high densities observed in many coastal waters and some areas further offshore.

Harbour porpoise are frequently sighted throughout the central and northern North Sea, in both coastal and offshore waters. While sighted throughout the year, peak numbers are generally recorded in summer months from June to October. The 1994 SCANS survey showed this area to be one of the most important for harbour porpoise in the North Sea, with high densities predicted throughout the area (Hammond *et al.* 2002b). However, the 2005 SCANS-II surveys showed the main concentration of this species to have shifted southwards into the southern North Sea (Hammond *et al.* 2013), a pattern also observed during SCANS-III (Hammond *et al*. 2017, 2021). Stone (2015) reported a similar southerly shift from analysis of harbour porpoise recorded during seismic surveys between 1995 and 2010. Nonetheless, acoustic detections of porpoises were recorded throughout this region with high detection rates recorded in waters off north-east Scotland and the outer Moray Firth (SCANS-II 2008). More recent studies have confirmed a widespread distribution and regular presence of this species across the Moray Firth (Thompson *et al.* 2013), with the Smith Bank and Outer Moray Firth identified as persistent high density areas for porpoise in the summer (Heinänen & Skov 2015). A tendency toward spatio-temporal habitat partitioning between harbour porpoises and bottlenose dolphins has been observed in the Moray Firth (as elsewhere across the UK see Evans *et al.* 2015); the relatively high incidence of lethal attacks by bottlenose dolphins may be linked to this (Ross & Wilson, 1996). From land-based observations, southern and eastern areas of Shetland have the highest densities in the region (Evans *et al.* 2015). Regional Sea 1 overlaps five SCANS-III survey blocks (N, O, Q, R, S, T, U) for which harbour porpoise densities in summer 2016 varied between 0.152 animals/km^2 in the north-west North Sea adjacent to the Orkney Isles and 0.888 animals/km^2 in the southern part of Regional Sea 1 near Flamborough (Hammond *et al*. 2021). Harbour porpoise were the most abundant cetacean species across these survey blocks.

The East Coast Marine Mammal Acoustics Study (ECOMMAS) is a long-term, on-going study into the occurrence of dolphins and porpoises off the Scottish east coast and how that might be influenced by offshore industry, such as windfarm construction. This region covers the range of the coastal east Scotland bottlenose dolphin management unit associated with the Moray Firth SAC. Acoustic recorders (C-PODs50 and SM2Ms51) were deployed at 10 locations at ~50km intervals between the outer Moray Firth to St Abbs in Berwickshire. At each location, three C-PODS were deployed at sites ~3, 10 and 15km from shore, with an accompanying

SM2M at one site per location. The recorders collect data for up to seven months per year, starting in spring, recording broadband underwater noise (SM2Ms) and counting dolphin and porpoise echolocation clicks (C-PODS) see Palmer *et al*. (2017). Summary data from 2013-2016 illustrate that harbour porpoise were detected on ≥90% of days at all but two sites - the Cromarty and Spey Bay nearshore site, which are known for regular sightings of bottlenose dolphins (Brookes 2017). By contrast, dolphins (all species) were generally detected on a much lower proportion of days and with greater variability between sites (Figure A1a.8.17); for all but one site (Cromarty nearshore, 94% days) dolphins were detected on ≤37% of days (Brookes 2017).

A1a.8.17: ECOMMAS passive acoustic monitoring data showing the proportion of days when dolphins were detected and total days of data collected 2013-2016



Along with harbour porpoise, white-beaked dolphin are among the most commonly occurring cetacean in the central and northern North Sea, regularly encountered in coastal and offshore waters. While sighted throughout the year, sightings are slightly more frequent from July to October (in SCANS-III survey blocks O, R, S, T). SCANS-III surveys gave abundance estimates in the northern North Sea one to two orders of magnitude smaller than for harbour porpoise with highest abundances of 0.243 animals/km^2 recorded in the Block adjacent to the Firth of Forth (Hammon *et al*. 2017). Stone (2015a) found this species to be by far the most commonly encountered by marine mammal observers during seismic surveys. Atlantic white-sided dolphins appear to be seasonally present in the North Sea, where they are most frequently sighted in waters >10km from the coast in the northern and central North Sea from June to September (Reid *et al.* 2003). Common dolphins are regarded as notably rare in the northern North Sea (Reid *et al.* 2003) but regular surveys in the outer Moray Firth have shown sustained summer occurrence since 2006 (Robinson *et al*. *2010*).

Killer whales have been observed throughout the northern North Sea; sightings are fairly frequent in coastal waters of Shetland and Orkney, and they are also occasionally sighted off the east coast of Scotland, in the Firth of Forth and as far south as the Farne Islands. While they have been reported in most months of the year, sightings are most frequent between April and September.

During summer months, minke whales are well distributed (both coastally and offshore) throughout the central and northern North Sea, particularly in the west (Northridge *et al.* 1995). They are frequently sighted in small numbers off the coast of Scotland and north-east England, with sightings extending south to Flamborough Head. Frequent sightings were made in the western half of the central-northern North Sea during all SCANS surveys (Hammond *et al.* 2013, 2017). Inshore waters of the southern Moray Firth, primarily between Spey Bay and Fraserburgh (Robinson *et al.* 2009), are thought to provide a rich feeding ground, especially between June and October (Robinson and Tetley 2007, Paxton *et al*. 2014); minke whales in this area appear to have a strong preference for water depths between 20 and 50m, steep shelf slopes and sandy-gravel sediment type. In recognition of the seasonally high density of minke whales relative to elsewhere in Scottish territorial waters, the Southern Trench MPA has been proposed in this area, extending from shore to the 12nm limit from approximately Buckie to Peterhead.

A small, seemingly resident population of c. 200 bottlenose dolphins (*Tursiops truncatus*) exists off the east coast of Scotland, as represented by the Coastal East Scotland Management Unit (IAMMWG 2015). They typically range from coastal waters of the Moray Firth to the Firth of Forth; the dolphins are most frequently sighted within the inner Moray Firth. Bottlenose dolphin is listed in Annex II of the Habitats Directive[3], and the importance of this population, and the Moray Firth, is reflected in the designation of part of this area as a Special Area of Conservation (SAC).

In the 1980s, the core of the population's known range was focused in the inner Moray Firth, typically within three main areas; the Kessock Channel, Chanonry Narrows, and around the mouth of the Cromarty Firth (Wilson *et al.* 1997, 2004; Hastie *et al.* 2003). While dolphins are seen in these areas throughout the year, an apparent influx of animals is observed from May to September (Thompson *et al.* 2011). Since the early 1990s, data have shown the population's range to regularly include waters further south to the Firth of Forth (Wilson *et al.* 2004), and it is now well-established that the normal range of this population extends well beyond the

[3] *Council Directive 92/43/EEC on the conservation of natural habitats of wild flora and fauna*

boundaries of the SAC as animals regularly utilise waters off the southern Moray Firth, Grampian and Fife coasts (Cheney *et al*. 2013). Bottlenose dolphins are also occasional sighted in coastal waters off north-east England[4]; while unconfirmed by photo-identification data, it is likely that these represent individuals from the Coastal East Scotland MU.

Boat-based surveys conducted along the southern shore of the outer Moray Firth between Lossiemouth and Fraserburgh during summer and autumn months since 2001 show inshore waters of this area to be frequented by bottlenose dolphins, with most sightings between the mouth of the River Spey and Rosehearty (Robinson *et al*. 2007). Population estimates suggest that approximately 60 to 130 individuals use these waters each year over the period May-September/October (Culloch & Robinson 2008, Filan 2015), representing up to two thirds of the *ca*. 200 individuals of the total Scottish east coast population (Cheney *et al.* 2013, 2018). These inshore waters of the southern outer Moray Firth will be used by bottlenose dolphins transiting between the SAC and other areas of preferred habitat further south off the east coast; however, based on the regular sighting of animals in these nearshore waters, including a high proportion of females with calves, it is likely that they support ecological functions for the Scottish east coast population beyond a corridor to other areas (Culloch & Robinson 2008).

Dolphins are present year round off Aberdeenshire, with a peak in abundance during March to May (Stockin *et al.* 2006). Peak sightings in St Andrews Bay occur in June to August (Hammond *et al.* 2004). Two social units appear to exist within the population: those which are only observed in the inner Moray Firth, and those which are observed throughout the known range (Lusseau *et al.* 2006). For the latter group, individual variability in patterns of movement between the Moray Firth SAC and Tayside and Fife areas is high (Thompson *et al.* 2011, Quick *et al.* 2014). Quick *et al*. (2014) showed that in the Tayside and Fife areas, dolphins were most frequently encountered in waters less than 20m deep and within 2km of the coast; sightings were greatest in and around the Tay Estuary as well as along the coast between Montrose and Aberdeen. Further studies of animals occurring between St Andrews Bay and the Tay Estuary have revealed the estimated number of dolphins using this area in summer to have increased from 2009-2015 and represent, on average, 52.5% of the total estimated east coast population (Arso Civil *et al*. 2019). Occasional offshore observations in the North Sea may indicate that these animals are also distributed offshore at least for part of the year (Reid *et al.* 2003; SMRU 2007).

Robinson *et al*. (2012) reported that some individual dolphins sighted off the east coast of Scotland were sighted in subsequent years off the west coast of Scotland and in Irish waters, although the population identity of these apparently wide-ranging individuals was unknown. In 2019, sightings of several distinctive individuals from the coastal east Scotland population have been reported from non-UK waters[5]. One individual was observed of the east coast of Ireland in May 2019, and off south-west Ireland in July 2019 along with another individual from the Scottish east coast population. Furthermore, images from a sighting of bottlenose dolphins off the Netherlands coast in July 2019 confirmed the presence of at least four individuals from the Scottish east coast population. All of these individuals were observed in the Moray Firth in summer 2018.

The most recent site condition monitoring of the dolphin population (Cheney *et al.* 2018), estimated that 103 (95% CI: 93-115) different bottlenose dolphins used the Moray Firth SAC during the period May to September 2016. Using 16 years of data, results indicated inter-

[4] https://www.seawatchfoundation.org.uk/recentsightings/
[5] https://www.abdn.ac.uk/lighthouse/blog/international-sightings/

annual variability in the number of dolphins in the SAC, but no significant trend in abundance. With respect to estimates of overall abundance for the east coast of Scotland bottlenose dolphin population, estimates varied from 129 (95% HPDI[6] 104-155) in 2001 to 189 (95% HPDI 155-216) in 2015. Results suggest that between 2001 and 2016 there was a slight decrease in the proportion of the total population using the SAC, but this seems to be driven by an increase in overall population size rather than a reduction in the number of dolphins using the SAC. Despite this reduction, results suggest that the SAC is still used by the majority of this bottlenose dolphin population, but that it is marginally less important to the population as a whole in 2016 than it was in 2001. Cheney *et al*. (2018) concluded that whilst the east coast of Scotland bottlenose dolphin population remains small and potentially vulnerable, based on the monitoring data, they recommended that no change be made to the *favourable maintained* condition status associated with the SAC.

Major grey seal colonies in the northern and central North Sea include the Isle of May, Fast Castle and the Farne Islands. Amongst these sites, approximately 9,631 newborn pups were counted in 2018, accounting for a 14.4% increase at the Farne Islands since 2014 and a 4.2% increase at the Firth of Forth sites (SCOS 2020). Maps of marine usage by grey seals show hotspots of activity around Orkney and Shetland (see Region 8), in the Moray Firth by Helmsdale and along the West Bank, off the north-east coast of Scotland at Rattray Head and outside the Tay estuary and around the Farne Islands; marine usage in these areas is among the highest in UK waters (Matthiopoulos *et al.* 2004, Jones *et al.* 2015, SCOS 2020).

Harbour seals are widely distributed around most of the coasts of North Scotland, Shetland and Orkney (see Region 8 for further information in these areas) and along the Moray Firth and the east coast of Scotland. There are many important haul-out and breeding sites on these coastlines, several of which contain internationally important numbers; seals are abundant throughout coastal waters surrounding these sites. Models of marine usage by harbour seals show foraging areas off much of the east coast of Scotland, with hotspots of activity east of Shetland, north-east of Orkney, in the Moray Firth and north of St Andrews marine usage in these areas is among the highest in UK waters (Jones *et al.* 2015). Harbour seals in this region were largely unaffected by PDV in 1988 and 2002 but since 2000 numbers have declined sharply in some areas, particularly Shetland (47% decrease between 2000-2009), Orkney (85% decrease between since 2000) the Forth of Tay (95% decrease between 2000-2015) and the Moray Firth (45% 2000-2009) (SCOS 2020). In the Moray Firth there is considerable variability in the August total counts between years. For example, the latest count in summer 2019 was 12% higher for the whole Moray Firth than in 2018, the majority of which (60%) were observed between Culbin and Findhorn while counts at Ardersier, Dornoch Firth and Morrich More SAC and Brora were the lowest ever, confirming the importance of these sites and the continuing redistribution within the inner Moray Firth (SCOS 2020). Research into causes of the decline is ongoing: the main drivers of interest are changes in prey quality and/or availability, increasing grey seal population size which may be influencing harbour seal populations through direct predation or competition for prey resources and increased mortality from exposure to harmful algal toxin (Arso Civil 2019).

A1a.8.7 Features of Regional Sea 2

Compared to the central and northern North Sea, the southern North Sea generally has a relatively low density of marine mammals, with the likely exception of harbour porpoise. While over ten species of cetacean have been recorded in the southern North Sea, only harbour porpoise and white-beaked dolphin can be considered as regularly occurring throughout most

[6] Highest Posterior Density Interval: a measure of uncertainty used in Bayesian statistics.

of the year, and minke whale as a frequent seasonal visitor. Bottlenose dolphin and Atlantic white-sided dolphin can be considered uncommon visitors. Important numbers of grey and harbour seals are present off the east coast of England, particularly around The Wash where harbour seals forage over a wide area.

In summer 2005 during SCANS-II, harbour porpoise were observed in high densities throughout much of the UK southern North Sea, an area from which they were largely absent during the first SCANS survey in 1994 (Hammond *et al.* 2013). This southern shift in distribution may be partly explained by inter-annual variation in spatial distribution of abundance, but corroborating evidence of a systematic change has been found with increasing trends in sightings and strandings along the French, Belgian, Dutch and German waters over the last decade (Camphuysen 2004, Jauniaux *et al.* 2008, Haelters *et al.* 2011, Peschko *et al.* 2016). Regional Sea 2 overlaps five SCANS-III survey blocks (L, N, O) for which harbour porpoise densities in summer 2016 varied between 0.607 animals/km^2 and 0.888 animals/km^2 (Hammond *et al*. 2021). At the same time, survey effort has markedly increased in this region of the UKCS; with the exception of SCANS, the whole area south of a line between Flamborough Head and the northern flanks of the Dogger Bank had no effort before 2003 but between 2003-2011 it received a lot of attention on account of baseline surveys related to the offshore wind energy development schemes.

Heinänen & Skov (2015) developed statistical distribution models integrating 18 years of survey data in the Joint Cetacean Protocol with annual and seasonal environmental data (water depth, hydrodynamic variables, sediments, shipping intensity) to support the identification of persistent high-density areas for harbour porpoises. Within the southern North Sea, one large coherent offshore zone of high-density was identified, from the western slopes of the Dogger Bank southwards along the 30m depth contour to an area off Norfolk; once number of years with effort was taken into account (≥ 3 years), the area retained was smaller and split into three more rigorously identifiable areas; these persistent high-density areas were the inner Silver Pit, the north-western edge of Dogger Bank and offshore areas east of Norfolk and east of outer Thames estuary (year round, in summer and in winter respectively).

White-beaked dolphins are distributed in low densities in offshore areas in the north of Regional Sea 2 (Hammond *et al*. 2021). Very few sightings recorded along the east coast of England south of the Humber estuary, with a limited number of offshore sightings in the shallowest waters of the North Norfolk Sandbanks and within the Dogger Bank and adjacent areas (Gilles *et al* 2012). Minke whales are not regularly present throughout the southern North Sea, but are well distributed (both coastally and offshore) in the western central and northern North Sea and occasionally, sightings extend south to Flamborough Head and the north Humberside coast mainly from July to October. Relatively high densities of minke whale have been reported along the slopes of the Dogger Bank and adjacent areas during spring and summer surveys (de Boer 2010, Gilles *et al.* 2012, Hammond *et al.* 2013). Given the lack of records further south, including the English Channel, minke whales are thought to enter the North Sea from the north. A few sightings of Atlantic white-sided dolphins have been recorded in the southern North Sea, primarily in the north-west >10km from the coast, north-east of Flamborough Head and around Dogger Bank. Bottlenose dolphins are only occasionally sighted in this region (Reid *et al.* 2003, Evans *et al.* 2015).

A long established colony of breeding grey seals exists at Donna Nook, at the mouth of the Humber (Lincolnshire). Smaller colonies are present further south at Blakeney Point on the north Norfolk coast, and also at Horsey on the east Norfolk coast. Seal pup production at these colonies has continued to increase (*ca*. 9.2% annual increase) with 7,147 pups estimated from the latest counts in 2018 (SCOS 2020). Breeding grey seals are also recorded

at Flamborough Head and The Wash. Small numbers of grey seals occur along the European continental coast of the southern North Sea, the majority of which are recorded in the Dutch Wadden Sea; pup production in this area is also on the increase with 1,700 in 2020 (SCOS 2020). In addition to coastal areas adjacent to haul-out sites, at sea usage is high offshore in proximity of sandbanks (i.e. Dogger Bank) and along corridors connecting these offshore foraging areas to haul-out sites. To the south of The Wash, models of marine usage by grey seals show a generally low density of activity over offshore areas (Matthiopoulos *et al.* 2004, Jones *et al.* 2015).

Several harbour seal colonies and haul-out sites are present on the south east coast of England; minimum numbers here are estimated at approximately 3,081 animals (SCOS 2020). The largest colony by far is in The Wash with 2,415 animals; Donna Nook and Blakeney Point are also important (128 and 329 animals respectively in 2019). Colonies are also present at Scroby Sands off the east Norfolk coast and in the greater Thames area. The English east coast population has fluctuated considerably since the late 1980s in response to phocine distemper virus (PDV) epidemics in 1988 and 2002, causing 50% and 22% declines in population size respectively (Thompson *et al.* 2005). A period of population increase was recorded from 2003 to 2017, with some indication that population size was levelling off in recent years (SCOS 2020). The 2019 count was 27% lower than the 2012 to 2018 mean count, possibly indicating that the southeast England management unit was reaching carrying capacity and could be the first signs of a population decline. A preliminary examination of the 2020 survey images produced a similar estimate to the 2019 count, further surveys will help to confirm the populations status (SOCS 2020). Further information on population trends is provided in Section A1a.8.15.2 Tagging studies of harbour seals hauling out at The Wash have shown animals to forage over a wide area at distances much greater from haul-out sites than many other parts of the UK. Models of marine usage by harbour seals in the southern North Sea show a large area of fairly diffused activity extending from The Wash, with the greatest activity offshore of the Humber. Seals hauling-out in the greater Thames area appear to forage over a smaller area closer to the coast (Sharples *et al.* 2012).

A1a.8.8 Features of Regional Sea 3

The eastern English Channel has a relatively low density and diversity of marine mammals; it is a transition zone between the communities of the southern North Sea and the western Channel/Celtic Sea. Bottlenose dolphins are the most frequently sighted species in coastal waters, followed by harbour porpoise. Further offshore, occasional sightings of long-finned pilot whales or common dolphins have occurred but numbers are much less than in the Western Channel. The area is not particularly important for seals, with no major colonies present and very little activity recorded.

Seasonal movements of bottlenose dolphins in the English Channel have been reported with the majority of sightings reported off the Cornish coast during winter, followed by an eastwards movement during the spring as far as the east Sussex coast (Williams *et al.* 1996, cited in Hammond *et al.* 2008). During summer, highest sightings were reported from Lyme Bay eastwards, and in the autumn the majority of sightings were reported off the Dorset coast, east of the Isle of Wight. Several small resident groups of bottlenose dolphins are present off the northwest coast of Brittany and Normandy (e.g. Kiszka *et al.* 2004). It has been suggested that animals along the French Channel coast form very stable groups that are resident in small areas, whereas those along the southern English coast are wider-ranging (Reid *et al.* 2003).

Harbour porpoises were thought to have been lost from the eastern English Channel by the 1990s (Reid *et al.* 2003) and there were no sightings during the SCANS survey in July 1994;

however several sightings were made during the SCANS-II survey in July 2005 and over the last decade as effort has increased, so have encounters. McClellan *et al.* (2014) have analysed presence-only data and modelled a seasonal pattern: harbour porpoises are more likely to be encountered in the southern North Sea during winter and spring, move throughout the Channel in the summer and retract back to the North Sea and the western English Channel by the autumn. Data in the JCP for this area are relatively few and the recent analysis by Heinänen & Skov (2015) could not provide reliable estimates. Regional Sea 3 overlaps the SCANS-III survey block (C) in the English Channel for which harbour porpoise densities in summer 2016 were 0.213 animals/km^2 (Hammond *et al*. 2021).

The eastern English Channel is not a particularly important area for seals. No major colonies of either grey or harbour seals are present along the coast; only small colonies of both species are present on the east Kent coast. Small numbers of seals from these and other colonies on adjacent coasts can be expected to be present in the area and this is reflected in the maps of marine usage with low levels of activity off the Kent coast (Jones *et al.* 2015). Seal monitoring surveys in the eastern English channel have typically recorded low numbers of individuals (30 grey seals and 40 harbour seals) which mainly use haul-out sites in the Solent and around Dartmouth and Brixham (SCOS 2020). Some activity in this area can be attributed to a number of individual grey seals moving between northern Brittany and the Channel Islands and the English Channel to as far east as the greater Thames area (Matthiopoulos *et al.* 2004), as well as to harbour seals transiting across the Channel between haul-outs in the Thames estuary and France (Sharples *et al.* 2012).

A1a.8.9 Features of Regional Sea 4/5

The region experiences a relatively high density and moderate diversity of marine mammals. Four cetacean species occur frequently in the Regional Sea 4 area: short-beaked common dolphin, minke whale, harbour porpoise and bottlenose dolphin. Long-finned pilot whale and Risso's dolphin are also regularly encountered. Grey seals are present in the area, but in low densities relative to the rest of UK shelf waters. Harbour seals are rarely encountered.

Common dolphins are widespread and abundant in Regional Sea 4, with sightings reported throughout the year. Strong seasonal shifts in their distribution have been noted, with winter movements onto the Celtic Shelf and into the western English Channel (Northridge *et al.* 2004), resulting in a 10-fold increase in density in this area (Brereton *et al.* 2005, cited in Hammond *et al.* 2008). Indeed winter estimates of abundance in the Western Approaches of the English Channel obtained by de Boer *et al.* (2008) were the highest recorded from comparable surveys in the North Atlantic, showing that the Channel is an important winter habitat for this species. During the mating/calving period for this species from May to September the majority of sightings have been reported along and off the continental shelf slope to the south-west of the UK (Murphy *et al.* 2005; Murphy & Rogan 2006). However, large numbers of animals have been observed south-west of Wales (particularly over the 100m isobath) throughout much of the year (Reid *et al.* 2003). The vast majority of common dolphin strandings in the UK occur on the south-west coasts of England and Wales (Deaville *et al.* 2007). Common dolphin were recorded in the SCANS-III survey in Regional Seas 4 & 5 in higher densities than other cetaceans, with densities ranging from 0.374 to 0.784 animals/km^2 (Hammond *et al*. 2021).

Minke whales are present throughout much of the Celtic Sea and western Channel during summer. Concentrations of sightings have been reported around the Brittany coast and the northern edge of the Bay of Biscay (Reid *et al.* 2003). Minke whales were sighted in this region during all SCANS surveys; density surface modelling based on SCANS-II data predicted

high concentrations of minke whales in the western Channel between approximately Devon and northern France (Hammond *et al*. 2002 and Hammond *et al.* 2013, Hammond *et al*. 2021).

Harbour porpoise are widespread and numerous across much of the Celtic Sea, with the majority of individuals sighted off the south-west coast of Wales, outer Bristol Channel coast, west of Cornwall. In Addition to the SCANS surveys, several at sea surveys of different duration and geographical extent have confirmed harbour porpoise regular presence across this region; for example in coastal waters off south-west England between south Devon and the Isles of Scilly (Goodwin & Speedie 2008), at Runnelstone Reef in south-west Cornwall (off Lands' End) which is considered of regional importance both during summer and winter months (Jones *et al.* 2014 and references therein) and in the Channel along the route of the ferry 'The Pride of Bilbao' where MacLeod *et al.* (2009) found numbers in summer months to increase between 1996 and 2006. The analyses of sightings data carried out by Heinänen & Skov 2015, identified two areas of persistent high density in this region in the summer: part of the Bristol Channel (Carmarthen Bay) and an area in the Western Channel off Start Point. Coastal hotspots across this region have been identified from dedicated shore watches by Evans *et al.* (2015) in the following locations: Swansea Bay and the Gower Peninsula, along the south side of the outer Bristol Channel between Bideford (north Devon) and Minehead (Somerset) and on the South Devon Coast between Babbacombe Bay and Bigbury Bay. The importance of Swansea Bay has been further highlighted by Oakley *et al.* (2016). Regional Seas 4 & 5 overlap SCANS-III survey block (D) and parts of blocks (C, B) around Cornwall and the Bristol Channel for which harbour porpoise densities in summer 2016 varied between 0.118 animals/km^2 in Block D and 0.213 animals/km^2 in Block C (Hammond *et al*. 2021).

Reid *et al.* (2003) reported large aggregations of bottlenose dolphins in the vicinity of the shelf break to the south-west of the UK, particularly off south-west Ireland and southwards towards the French coast. Sightings are lower in offshore shelf waters, although still widespread. In coastal waters, sightings are highest off the Cornish coast during winter, followed by an eastwards movement during the spring into the eastern English Channel (Williams *et al.* 1996, cited in Hammond *et al.* 2008). A northerly shift in distribution of bottlenose dolphins off the Cornish coast across the Bristol Channel into Welsh waters has also been suggested (Wood 1998). Recent analysis of sighting data from dedicated shore watches identified areas around Falmouth Bay and the Lizard Peninsula in Cornwall and Bideford Bay in north Devon as important (Evans *et al.* 2015). SCANS-III data indicates densities of harbour porpoise ranging between 0.0585 and 0.0605 animals/km^2 in blocks B and D respectively, which are some of the highest within UK waters (Hammond *et al*. 2021). Several small resident groups of bottlenose dolphins are present off northern France, although these are not believed to spend significant time in UK waters (Reid *et al.* 2003, Kiszka *et al.* 2004).

In waters to the south-west of the UK, long-finned pilot whales occur mainly along the continental shelf slope, particularly around the 1,000m isobath. In the shelf waters to the south-west of the UK, they are predominately sighted in the western English Channel off the south-west coast of England, during the autumn and early spring (Evans 1980, cited in Hammond *et al.* 2008). The majority of pilot whale strandings reported in the UK are along the south-west coast (Sabin *et al.* 2002). Risso's dolphins are regularly seen in the southern Irish Sea and off south-west Ireland, but are rare across the majority of the Celtic Sea and western Channel. Sightings have been reported on the continental shelf slope.

Several other species of toothed cetacean have been recorded in the Celtic Sea and western Channel area in low numbers: killer whale, white-sided and white-beaked dolphin, striped dolphin. For beaked whales, only a handful of strandings have been recorded in the area, while fin, sei and humpback whales are occasionally seen (Hammond *et al.* 2008).

Several minor grey seal colonies are present along the south-west coast of England, including the Isles of Scilly and Lundy. Two larger colonies are present at Skomer and Ramsey off south-west Wales, just north of the Regional Sea 4 boundary. Latest estimate of pup production for south-west England is for 150 grey seal pups from 2016 surveys. In the Isles of Scilly, a recent survey estimated pup production to be 230 individuals in 2016 compared to 89 and 134 individuals in 2010 (Sayer *et al.* 2012, SCOS 2020). Models of marine usage by grey seals show a typically low level of activity across the majority of the Celtic Sea and western Channel. Areas of higher activity are observed in waters surrounding south-west Wales and to a lesser extent the Isles of Scilly (Jones *et al.* 2015). There are no harbour seal colonies in this region but a very small number of individuals (<20) has been increasingly reported for the West England & Wales management unit (SCOS 2020).

A1a.8.10 Features of Regional Sea 6

Effort-related sightings in this region have been collated by Baines and Evans into the Atlas of the Marine Mammal of Wales (Baines & Evans 2012). It combines results from sixteen groups / survey projects providing aerial, vessel and land-based sightings spanning the 20-year period 1990-2009. Eighteen species of cetaceans have been recorded in this region with highest species diversity offshore around the Celtic Deep and close to the Isle of Man. Five species are more commonly encountered: harbour porpoise, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin and minke whale. Grey and harbour seals are also regularly present in certain areas.

Harbour porpoises are widely distributed and sighted throughout much of the Irish Sea during most months of the year. Sightings are fairly frequent along the Welsh coast throughout the year, although peak from summer to autumn; sightings hotspots are off the coast of North Wales (Anglesey, Lleyn Peninsula), west Wales (Pembrokeshire and Cardigan Bay) with smaller areas north of the Isle of Man and on the Northern Irish coast near Strangford Lough. Regional Sea 6 overlaps with two SCANS-III survey blocks (E, F) in the Irish Sea for which harbour porpoise densities in summer 2016 ranged between 0.086 animals/km^2 off the north-west coast of England and 0.239 animals/km^2 in the Irish Sea (Hammond *et al*. 2021). Harbour porpoise abundance has been estimated for the Cardigan Bay SAC since 2001, numbers have fluctuated over the years with a clear peak of 340 individuals in 2011. Numbers decreased to 147 individuals in 2013, and increased to 232 in 2016, although confidence limits are high around these data (Lohrengel *et al*. 2018). Abundance estimates for harbour porpoise in the wide Cardigan Bay area saw a similar peak in numbers in 2011 (1074 individuals) with a sharp decline between 2012 and 2015 (565 and 291 individuals respectively) with numbers somewhat rebounding again in 2016 (828 individuals) (Lohrengel *et al*. 2018).

Bottlenose dolphins are the second most frequently recorded species in the Irish Sea, with a predominantly coastal distribution and particularly high concentrations off west Wales and off the coast of Co. Wexford in southeast Ireland. While effort-related sightings are few in the northern Irish Sea, the species is regularly sighted in summer off the Galloway coast of south-west Scotland and around the Isle of Man (Hammond *et al.* 2005, Baines & Evans 2012). The entire Irish Sea has been chosen as the appropriate Management Unit for this species in this region with an abundance of 397 animals (95% CI 362-141) (IAMMWG 2015).

Off the coast of Wales, bottlenose dolphins are most commonly seen in Cardigan Bay within 10 miles of the coast and particularly within two miles; sightings are greatest in the southern portion of the bay. However they occur also off the north coast of Wales, particularly north and east of Anglesey (Feingold & Evans 2014b). The importance of Cardigan Bay to this species has long been recognised and two Special Areas of Conservation (SACs) have been designated with this species as an interest feature. Bottlenose dolphin is a primary feature of

the Cardigan Bay SAC located in the south of the bay off the coast of Cardigan, New Quay and Aberaeron, and a qualifying feature of the Lleyn Peninsula and the Sarnau SAC in the northern end of the bay and around the Lleyn Peninsula.

Marked seasonal trends have been observed in Cardigan Bay, with high coastal sightings in summer and autumn and low records in winter and early spring; during the winter, a northwards shift in distribution and dispersal into the wider Irish Sea has been observed (Pesante *et al* 2008a, Veneruso & Evans 2012b). Photo ID has confirmed the waters around the Isle of Man to represent the northern range limit of the Cardigan Bay population (Feingold & Evans 2014b). Mean group size of sightings in Cardigan Bay has been recorded as 5.85 individuals (Lott 2004, cited in Pesante *et al.* 2008b) while largest group sizes (50-150 individuals) have been observed in the winter in North Wales and Manx waters. Juveniles have been recorded most frequently in Cardigan Bay, mainly during April to October; around 50% of groups encountered within Cardigan Bay SAC had one or more calves present during the systematic monitoring efforts between 2011 and 2013 (Feingold & Evans 2014a).

Monitoring efforts have largely concentrated upon the Cardigan Bay SACs with regular line-transect surveys providing abundance estimates yearly between 2001-2007 (Pesante *et al.* 2008a) and again between 2011-2013; in addition between 2011-2013 and 2015-2016, survey efforts increased in range to cover the wider Cardigan Bay (Feingold & Evans 2014a, Lohrengel *et al*. 2018). Abundance estimates within Cardigan Bay SAC were highest in 2006 with 214 individuals (95%CI 108-422) and lowest in 2012 with 70 (95% CI 37-131), most recent estimates are of 84 individuals in 2016 (95% CI 44-160). Abundance across the entire bay was estimated at 309 (95%CI 179-353), 390 (95%CI 203-534), 254 (95%CI 151-427), 277 (95% CI 138-555) and 289 (95% CI 184-453) in 2011, 2012, 2013, 2015 and 2016 respectively. Photo-identification efforts were maintained with relatively even coverage within the SAC yearly between 2001 and 2013 giving the opportunity to analyse trends in abundance estimates (using mark-recapture analysis) and no apparent trend was found (Feingold & Evans 2014a). Bottlenose dolphin population in Cardigan Bay SAC as well as across the whole bay include transients, occasional visitors as well as resident animals (Pesante 2008b) and rates of emigration and immigration fluctuate between years. Residency within the Cardigan Bay SAC was calculated as 58% between 2001 to 2007 (based on individual re-sightings) but in recent years it has declined to 44% (2001 to 2013) and 42% (2001 to 2016), raising concern with regard to the possible reasons (Feingold & Evans 2014a). At present, there is no evidence to infer any negative effect to the population and bottlenose dolphins are currently classified as 'favourable' in both the Cardigan Bay SAC and the Lleyn Peninsula and the Sarnau SAC (NRW 2018).

Risso's dolphins have a localised distribution in the Irish Sea, in a wide band running SW-NE that encompasses west Pembrokeshire, the western end of the Lleyn Peninsula and Anglesey, the south-east coast of Ireland in the west, and waters around the Isle of Man in the north (Baines & Evans 2012). They have mainly been observed in the region in summer and rarely between December and March (Hammond *et al.* 2005); young animals have been reported off the north coasts of Pembrokeshire and Anglesey and in Manx waters (Baines & Evans 2012). Through photo-identification, seasonal and long-term site-fidelity has been revealed for some individuals in the waters off Bardsey Island, in Cardigan Bay (de Boer *et al.* 2013, Eisfeld-Pierantonio & James 2018).

Common dolphins are most prevalent offshore, in the far south of the Irish Sea, over the Celtic Deep during the summer; this relatively high-density area extends eastwards towards the coast and islands of Pembrokeshire. Sightings have occurred further north and in Manx waters but much less frequently. A similar distribution has been observed also for minke whales. They

occur mainly in summer in the western side, over the Celtic deep, and very rarely north of the Isle of Man (Hammond *et al.* 2005) where small numbers appear to follow the spawning herring from the west side of the island to the east during the late summer and early autumn.

In the Irish Sea area, the size of the grey seal population breeding in Wales and Ireland has been estimated at 5,000-7,000 animals (Keily *et al.* 2000). Recent estimates of grey seal pup production rates for Wales are ~2,250, however, there is a high uncertainty around this as almost half of the estimate is based on sites in west Wales which have not been surveyed since the early 1990's (SCOS 2020). The adult population size of north-west England was recorded as 248 and 300 individuals, in 2019 and 2020 counts respectively, while pup production rates in this region are comparatively low (2-10 per year) (SCOS 2020). The most recent adult population count in Northern Ireland was 505 individuals (Duck and Morris 2019, cited in SCOS 2020), with the majority of grey seal pups being born in the Strangford Lough area. The larger haul-out sites are around Pembrokeshire, the Lleyn Peninsula, Liverpool Bay, the Firth of Clyde, southeast and east Ireland. Haul-outs are also present in Cardigan Bay, Anglesey, the Solway Firth, northern Isle of Man, east Northern Ireland and the Dumfries and Galloway coast (Hammond *et al.* 2005). A significant portion of the Irish Sea area is clearly important as foraging habitat for grey seals hauling out in Wales and Ireland (Hammond *et al.* 2005). Satellite tagging of 18 adult grey seals at Irish Sea colonies in 2004 and 17 pups in 2009-10 has provided some information of their movements at sea; average foraging trips were 16.9 km and 19.5 km long and maximum trip lengths were 173 and 436 km for adults and pups respectively (SCOS 2014). Tracking data, in combination with counts of animals at haul-out sites in summer, have formed the basis of models predicting marine usage by grey seals (Jones *et al.* 2015); the southern Irish Sea and northern St George's Channel are predicted to be used extensively by grey seals as foraging areas, with the southern part of Liverpool Bay also heavily used. In Welsh waters, Baines & Evans (2012) indicated highest sighting rates of grey seals in the north-east of Wales towards Hilbre Island in the mouth of the River Dee, reflecting the distribution of moulting and feeding haul-out sites; in addition, their presence was observed in both inshore and offshore waters of Cardigan Bay (Feingold & Evans 2013).

There are few harbour seals around the Irish Sea except along the coast of Northern Ireland and in Southwest Scotland (Firth of Clyde); no breeding site is known along the Welsh coast. The number of seals in the area is likely to be around 3,500-4,000 (Hammond *et al.* 2005). Models suggest at-sea activity by harbour seals in the Irish Sea to be mainly in the north: along the Northern Ireland coast, the North Channel and the Firth of Clyde (Jones *et al.* 2015). Few synoptic surveys of harbour seals have been conducted in Northern Ireland. However, more frequent monitoring has been undertaken for the sub-population from Carlingford Lough to Copeland Islands, which accounts for approximately 80-85% of the Northern Ireland population. Survey results indicate that the population in this area slowly declined from 2002-2011 at a rate of 2.7% per year (95% CI: 1.8-3.5), but the 2018 survey suggests that there has been no significant change since (SCOS 2020).

A1a.8.11 Features of Regional Sea 7

The Minches and western Scotland support a rich diversity and high density of marine mammals. Harbour porpoise and white-beaked dolphins are widespread and numerous. They are encountered throughout the year, although most frequently during summer months, minke whales are also abundant and Risso's dolphins and common dolphins are frequently sighted. Small numbers of bottlenose dolphins occur around coastal waters. Killer whales are occasionally observed throughout the area, most notably around seal haul-out sites during summer. Both grey and harbour seals are abundant throughout the area.

Harbour porpoise are widely distributed and frequently sighted throughout much of the Minches and western Scotland. While sighted throughout the year, peak numbers are generally recorded in summer months from June to September. Their abundance in this region is above average and this has been reflected in the identification of the coastal areas off north-west Scotland, including Minches and eastern parts of the Sea of Hebrides as a persistent high density area for this species (Heinänen & Skov 2015). Distribution within the region is partly a function of environmental characteristics (e.g. depth, tidal stream speed) and several studies have modelled habitat preferences at different spatial scales and identified hotspots. The regions between Ardnamurchan, Coll and the Small Isles, southeast of Barra, northeast of Skye to Gairloch and west of Pairc Peninsula (Isle of Lewis) to Shiant Islands were highlighted by Marubini *et al.* (2009); the Sound of Jura, the Firth of Lorne, the area between Mull and the Treshnish Islands, and Sound of Sleat were four clusters of predicted high use in the southern Inner Hebrides identified by Embeling *et al.* (2010), while land-based observations around Gairloch demonstrated regular occurrence in the adjacent coastal waters (Dolman *et al.* 2013). Regional Sea 7 overlaps with two SCANS-III survey blocks (G, H) for which harbour porpoise densities in summer 2016 ranged between 0.336 animals/km^2 off the Minches and 0.090 animals/km^2 to the south of the Hebrides (Hammond *et al*. 2021).

Individuals within this region are part of the West Scotland Management Unit (which encompasses ICES Division Via and Subdivision Vib$_2$ on the north coast of Northern Ireland and the west coast of Scotland); abundance for the UK portion of the WSMU has been estimated at 24,305 individuals (95% CI 17,121-34,505) (IAMMWG, 2021) and given the large overlap between this region and the UK waters of the MU this estimate is assumed to only partially overestimate regional abundance.

Following an increase in sightings rates over the past 15 years, common dolphins are now the most commonly sighted cetacean in the Sea of The Hebrides and The Minch (HWDT 2018). They are observed throughout the year in this region, although sightings peak in summer and are most frequent from April to October.

White-beaked dolphins are also frequently recorded across this region; they are widely dispersed with a preference for more offshore waters, especially in the northern part of the Minch and west of the Outer Hebrides (Reid *et al.* 2003, Paxton *et al.* 2014). Sightings are most frequent from June to October, with individual densities recorded during SCANS-III survey in 2016 of 0.316 animals/km^2 in the vicinity of the Minches (Hammond *et al*. 2021).

Bottlenose dolphins (*Tursiops truncatus*) are primarily sighted in small numbers around the Inner Hebrides; sightings are fairly common around Mull, Islay, Tiree and Skye. They have also been reported from the Outer Hebrides, particularly across the Sound of Barra, and occasionally off the west coast of the Outer Hebrides and in the northern entrance to the Minch (Grellier & Wilson 2003, Mandleberg 2006). Individual densities of bottlenose dolphins 0.003 to 0.121 animals/km^2 were recorded in the 2016 SCANS-III survey (Hammond *et al*. 2021). Bottlenose dolphins in this region appear to have a relatively larger range with a less predictable and more ephemeral distribution than on the East coast (Thompson *et al.* 2011). Presence is throughout the year and earlier photo-identification efforts had suggested a small, possibly resident population to occur in these waters (Grellier & Wilson 2003, Mandleberg 2006). This was confirmed by further dedicated photo-identification surveys in 2006 and 2007 (Thompson *et al.* 2011). Overall, only few bottlenose dolphins use the coastal waters of western Scotland; the best estimate obtained so far is for 2007 with 45 dolphins (95% PI: 33-66) (Thompson *et al.* 2011). They appear to belong to two discrete parapatric communities, one of which appears to be confined to the waters around the Sound of Barra whereas the

other ranges much more widely throughout the Inner Hebrides and mainland coasts (Thompson *et al.* 2011).

Risso's dolphins have been recorded throughout much of the region, although sightings are most frequent around the coast of the Outer Hebrides, particularly the north-east coast of Lewis. They are typically observed in small groups of 5-25 individuals, most frequently from June to September. A persistent area of relatively high density has been identified in the region to the North of Lewis/Harris (Paxton *et al.* 2014).

Atlantic white-sided dolphins are primarily an offshore, oceanic species. They are occasionally sighted in the coastal waters of western Scotland, with most sightings in the northern Minch and southern Sea of Hebrides. Sightings are most frequent in July and August.

Killer whales sightings are fairly frequent in the Minches and western Scotland, and have been increasing in frequency in recent years. Repeat observations are recorded around many of the islands of the Inner Hebrides; many observations are in the vicinity of seal colonies. They have been reported in most months of the year, with the greatest frequency between May and September.

Minke whales are seasonally present in the Minches and western Scotland, with whales appearing to move south into the area at the beginning of May and remaining until October, with a peak between July and September; sightings are rare for the rest of the year. In summer months they are widely distributed throughout the region. The observed distribution across the Minches has been modeled by Anderwald *et al.* (2012); important predictors of relative minke whale abundance included both fixed environmental parameters (depth, seafloor topography) and those that vary temporally (sea surface temperature and chlorophyll content), while fine-scale foraging behavior around the Small Isles best explained by the strength and direction of tidal currents. The model that best explained minke whale distribution across the whole of the Hebrides was for June, the only month when predicted sandeel presence was highly significant. Paxton *et al.* (2014) analysed data available in the Joint Cetacean Protocol for this region and identified contiguous, higher than average density areas in the Sea of the Hebrides and south and west of the Hebrides. This species has been regularly sighted throughout western Scotland by land-based observers (HWDT 2006, Dolman *et al*. 2013).

A few individuals of fin and humpback whales are occasionally sighted in the area during summer months. Small groups of pilot whales are also occasionally recorded during summer.

There are several major colonies of grey seals in this region, mainly along the Outer and Inner Hebrides. Latest pup production estimates exceed 20,273 pups during the 2016 breeding season, almost 40% of the total pup production in Scotland (SCOS 2020). Models of marine-usage show moderate-high activity throughout the Minches, especially between Tiree and Skye, as well as south and west of the Outer Hebrides (Jones *et al.* 2015).

This region is particularly important for harbour seals; the latest minimum population estimate of 9,132 (Western Isles and West of Scotland combined) corresponds to 71% of the total Scottish harbour seals population (or 60% of the total UK population) (SCOS 2020). Twenty years ago, this region accounted for about 40% of the Scottish population, but numbers have been on the increase here, while large reductions have been observed elsewhere in Scotland since 2001 (Duck & Morris 2015). Haul-outs are widely distributed and numerous in this area with seals abundant throughout adjacent coastal waters. Models of marine-usage show moderate-high levels of activity throughout the majority of Regional Sea 7 from Skye south to the North Channel; hotspots of activity occur around Mull, Jura, Isla and adjacent coasts, at the

entrance to the North Channel, the Sound of Barra and between Skye and North Uist (Jones *et al.* 2015).

A1a.8.12 Features of Regional Sea 8

The waters north and west of Scotland support a rich diversity of marine mammals. Containing a variety of habitats, the region supports species commonly associated with shallower coastal areas, offshore shelf waters, and those occupying the deeper waters of the shelf edge and slope. Ten cetacean species are known to occur regularly in this area: harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin, bottlenose dolphin, short-beaked common dolphin, killer whale, long-finned pilot whale, sperm whale and minke whale. Large numbers of grey and harbour seals breed in the area, with high densities observed in many coastal waters and some shelf areas further offshore.

Harbour porpoise are widespread and numerous throughout shelf waters in this region (<200m depth), especially off Shetland and Orkney. Offshore areas north of Shetland were identified as high-density areas by Heinänen & Skov (2015), but survey effort was limited to the period 1994-1999; since then survey effort has been low and SCANS survey results from both 2005 and 2016 suggest that porpoise numbers may have decreased in these northern areas since the 1994 survey. From land-based surveys, areas with moderate count rates and predicted likelihoods of occurrence include the coast of north Caithness and around Scapa Flow in Orkney (Evans *et al.* 2015). Regional Sea 8 overlaps five SCANS-III survey strata (H, J, K, S, T) for which harbour porpoise densities in summer 2016 varied between 0.09 animals/km^2 south and west of Barra (Outer Hebrides) and 0.40 animals/km^2 in the north-west North Sea, including Shetland (Hammond *et al*. 2021). Harbour porpoise were the most abundant cetacean species across these survey blocks.

White-beaked dolphins are also widely distributed in shelf waters of the region (Reid *et al*. 2003). In SCANS-III survey strata overlapping Regional Sea 8, white-beaked dolphin was the second most abundant species. Densities were highest south and west of Barra (Outer Hebrides) at 0.32 animals/km^2, and also in the stratum north of Lewis/The Minch/mainland coast at 0.22 animals/km^2; densities elsewhere ranged between 0.02 and 0.05 animals/km^2 (Hammond *et al*. 2021). Atlantic white-sided dolphins have also been widely sighted in shelf waters of the region, but are more frequently observed and in greater numbers over the shelf edge and slope. In the SCANS-III survey, white-sided dolphins were sighted north of Shetland in stratum T, but most sightings occurred in deep, offshore waters west of Regional Sea 8 (Hammond *et al*. 2021).

Sightings of Risso's dolphins are most frequent around Lewis/Harris in the Outer Hebrides, particularly during summer and autumn, such that ~900km^2 of coastal waters around north-east Lewis have been proposed as an MPA for this species. Photo-identification data suggest that some individuals are at least semi-resident in this area (Weir *et al*. 2019). Sightings of bottlenose dolphins in offshore shelf waters in this region are uncommon; sightings in coastal waters are occasional, and are likely of animals associated with either the Coastal East Scotland or Coastal West Scotland and Hebrides management units, which have core distributions along the Scottish east coast and Inner Hebrides, respectively.

Killer whale sightings are fairly frequent in coastal waters of Shetland and Orkney, and to a lesser extent around the Hebrides, where they are often observed in the vicinity of seal colonies (Weir 2002). In offshore shelf waters, they are often observed in association with fishing vessels (Luque *et al.* 2006). Common dolphin also occur in shelf and deeper waters in the region, mostly from summer-autumn, with the vast majority of sightings occurring south of

60ºN / the Wyville Thomson and Ymir Ridge area (Reid *et al*. 2003). Striped dolphins are typically a more southern species, with an affinity for warmer waters off the shelf, although a few sightings have been reported in shelf waters north and west of Scotland (Boisseau *et al*. 2011, Hammond *et al*. 2021). The beluga, an Arctic species, is a rare vagrant to waters north and west of Scotland (Reid *et al*. 2003).

Minke whales are widely distributed in coastal and offshore shelf waters on the region from May to October, with peak sightings in summer months (Reid *et al*. 2003, Hammond *et al*. 2009, 2017). The Minch supports some of the highest densities, with frequent sightings also reported from adjacent waters to the north and west of the Outer Hebrides, which is reflected is this species being a qualifying feature of the proposed Sea of the Hebrides NCMPA. In SCANS-III survey strata overlapping Regional Sea 8, estimated minke whale densities were highest in waters around Shetland (0.032 animals/km^2) and west of the Outer Hebrides (0.018 animals/km^2); densities elsewhere were approximately 0.01 animals/km^2 (Hammond *et al*. 2021). Humpback whales have been observed in coastal waters around western and northern Scotland, including the Northern Isles, with an increase in reported sightings from shore since the mid-2000s[7]. Other species of baleen whale (fin, sei, blue, and humpback) are largely restricted to deeper waters off the shelf.

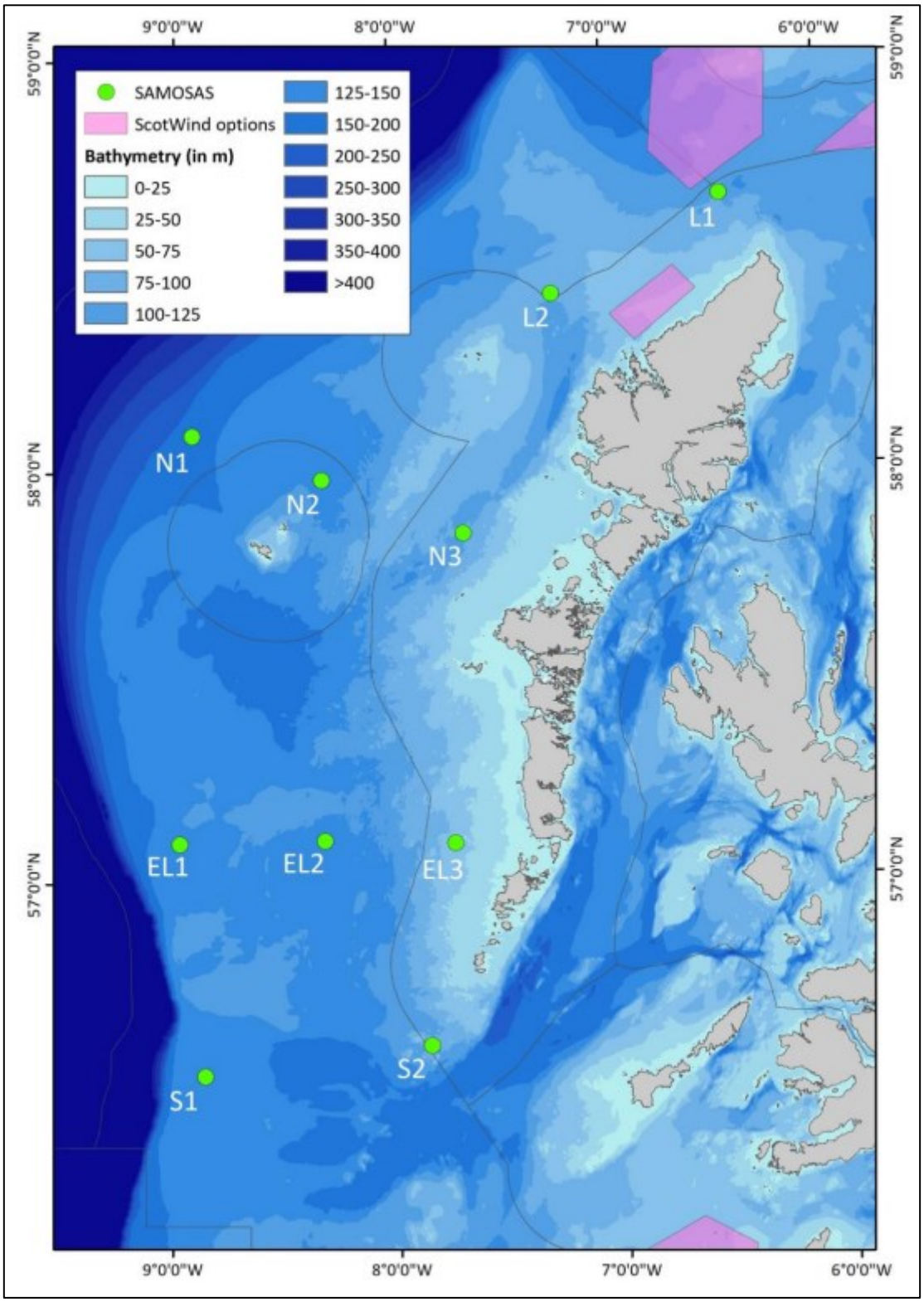
The Static Acoustic Monitoring of Scottish Atlantic Seas (SAMOSAS) project deployed passive acoustic monitoring devices at ten stations to the west of the Hebrides (Figure A1a.8.18) between September 2020 and August 2021, nine of which successfully recorded data. Initial analyses indicate the presence of eight species, harbour porpoise, baleen whales (humpback, minke, fin and sei whale at offshore moorings N1, EL1, S1), sperm whale (at offshore station N1), delphinids (no species differentiation) and grey seals. Several species showed seasonal variability in occurrence including humpback whales (song detected January -April), minke whales (song detected between spring and autumn, peaking in autumn), sei whales (detections in autumn) and delphinids which were recorded year-round with seasonal variability in occurrence. Further data analysis and reporting is currently on-going (March 2022).

Several major and minor colonies of grey seals are distributed across much of the coastline within Regional Sea 8 (including Shetland, Orkney and the Outer Hebrides). The highest concentration is to be found in Orkney where pup production (autumn-winter) was estimated at 23,849 in 2016; the estimated population size in Orkney in 2016 was 54,300 (SCOS 2017, 2018). The Outer Hebrides also support large colonies, particularly on the Monach Isles, with pup production estimated at 15,732 in 2016; the estimated population size in the Outer Hebrides in 2016 was 30,400 (SCOS 2017, 2018). Combined, these two island groups account for approximately 70% of total annual pup production in Scotland and 60% of the UK total.

Tagging studies show grey seals to utilise much of the coastal waters of the region, along with a considerable proportion of the adjacent offshore areas. Models of marine usage show activity throughout most shelf seas of Regional Sea 8, with greatest activity in coastal waters around Orkney, Shetland, west of the Outer Hebrides (particularly around the Monach Isles) and, to a lesser extent, North Rona, the Stern Isles and Stanton Banks; activity in these areas represents some of the highest in UK waters (Russell *et al.* 2017).

[7] https://uk.whales.org/2018/04/06/the-return-of-the-giants-humpback-whales-in-scottish-seas/

Figure A1a.8.18: Location of SAMOSAS Acoustic Monitoring Stations off the Outer Hebrides.



Harbour seals are also widely distributed around most of the coasts of Orkney and Shetland and along the north coast of Scotland and Outer Hebrides. There are many important haul-out and breeding sites on these coastlines, several of which contain internationally important numbers. Of the approximately 32,605 harbour seals most recently counted in the UK, 81% were on Scottish shores (SCOS 2018). Trends in the abundance of harbour seals vary considerably among different regions in the UK. A complete survey of Orkney was carried out during the moult in August 2016 and 2019: a total of 1,240 and 1,296 harbour seals were

counted respectively, representing a decrease of >30% over the previous count in 2013 and confirming that the rapid decline in the Orkney harbour seal population since 1997 is continuing (SCOS 2020). Overall counts for the North Coast and Orkney management unit have declined by 85% from approximately 8,800 individuals in the mid-1990's, which was the largest single management unit population in the UK. Numbers in Shetland have also decreased by 47% since their peak of 6,227 individuals in 1993, the latest count in 2019 recorded 3,180 individuals compared with 3,369 animals in 2015 (SOCS 2020). By contrast, the most recent count for the Western Isles, carried out in 2017, recorded 3,533 individuals which as the highest recorded count for the area and was 29% higher than the previous (2011) count of 2,739 (SCOS 2020).

Models based on tagged seals show harbour seals to be present throughout coastal waters of Shetland, Orkney, and the Outer Hebrides (Carter *et al*. 2020). The highest densities occur in near-shore waters adjacent to colonies; while some area of higher usage extend to 50km from the coast, harbour seal occurrence in offshore shelf waters is generally low (Carter *et al*. 2020). Hooded seals occur to a limited extent in the Faroe-Shetland Channel, particularly in the north (see Features of Regional Sea 9, below), but are expected to have an even lesser presence on adjacent shelf waters. Two Arctic species, the bearded seal and walrus, occasionally occur as vagrants in the region, with a small number of sightings recorded around Shetland and other parts of northern Scotland.

A1a.8.13 Features of Regional Sea 9

The Faroe-Shetland Channel supports a rich diversity and high density of marine mammals. Cetaceans known to regularly occur include: Atlantic white-sided dolphin, bottlenose dolphin, killer whale, long-finned pilot whale, and sperm whale. Beaked whales, common dolphins, Risso's dolphins, and fin, sei and minke whales are also recorded to a lesser extent, while other species of baleen whale such as blue and humpback are occasionally observed. Hooded seals occur to a limited extent, particularly in the north; grey and harbour seals are very uncommon. Regional Sea 9 is beyond the scope of both the SCANS surveys and seal management units, consequently other sources of data have been used to describe the populations within the region.

Atlantic white-sided dolphins are the most numerous cetacean in the area; they have been observed in all months of the year, with the highest abundance from June to November and a large increase in numbers observed in August. Estimated abundance of white-sided dolphins in waters of the Faroe-Shetland Channel north and west of the Northern Isles during summer 1998 was 74,626 (CV = 0.72) (Macleod 2004a, cited in Murphy *et al.* 2008). Bottlenose dolphin sightings appear to be concentrated around the Wyville Thomson and Ymir Ridges, in the south-west of the Faroe-Shetland Channel. Risso's dolphins (*Grampus griseus*) are occasionally recorded in deeper waters off the shelf slope, including the Faroe-Shetland Channel; Pollock *et al.* (2000) recorded all deeper water sightings between July and December.

Long-finned pilot whales are fairly common in the area, particularly around the 1,000m isobath, and were the second most abundant species of cetacean north and west of Scotland observed by Pollock *et al.* (2000). Acoustic monitoring northwest of the Outer Hebrides in the winter of 1997-1998 detected limited pilot whale presence over the continental slope in waters >600m depth (Lewis *et al.* 1998). Average group size appears to increase between June and September.

Sperm whales are widely distributed and frequently observed in the Faroe-Shetland Channel. Sightings are highest over the 1000m isobath, with animals either on or beyond the shelf slope. Acoustic monitoring northwest of the Outer Hebrides in the winter of 1997-1998 detected sperm whales over a wide area of the continental slope, primarily in waters >500m depth (Lewis *et al.* 1998). Sightings in this area have occurred in most months of the year, with a peak in June. Pollock *et al.* (2000) did not record any sperm whales in February and March; survey effort was limited during these months, although similarly low effort in November and December did record sperm whales. It can be assumed that these waters represent a migratory route for some portion of the north-east Atlantic population at certain times of the year.

Beaked whales, including northern bottlenose whale and *Mesoplodon* spp., have been recorded throughout much of the Faroe-Shetland Channel; this area may represent an important part of their habitat, but its significance is unknown due to the infrequency of encounters and small numbers of animals observed. *Mesoplodon* spp. have been sighted in most months of the year, with a distinct peak in August. Average group size was approximately 3 individuals. Northern bottlenose whales are thought to migrate north from lower latitudes in spring and return south from polar waters in autumn (Benjamin & Christensen 1979, cited in Pollock *et al.* 2000); peak numbers north and west of Scotland were observed in April and August. However, they have been recorded around the Faroe Islands throughout the year, so some individuals may not migrate. Average group size is approximately 2 individuals.

Pollock *et al.* (2000) observed fin whales in the Faroe-Shetland Channel only between May and October, with a peak in sightings in August. However, acoustic investigations have detected fin whale calls in all months of the year, with whale counts and vocal activity greatest from October to April (Charif & Clark 2000).

Grey seals appear to have only a very limited presence in deeper waters off the shelf edge but sightings have taken place in the Faroe-Shetland Channel (Pollock *et al.* 2000, Stone 2015). McConnell *et al.* (1999) observed a female grey seal tagged on the Farne Islands moving north to Orkney, Shetland, then the Faroe Islands before moving south through deep-waters west of Britain. Animals present in the Faroe-Shetland Channel are likely to be undertaking targeted long-distance movements between haul-out sites, with foraging activity highly unlikely.

Harbour seals tagged on Orkney and Shetland have been occasionally recorded in deeper water beyond the shelf edge northwest of Scotland, including the Faroe-Shetland Channel (Hammond *et al.* 2004); however, their presence in this area is very limited in comparison to adjacent coastal and offshore shelf waters. Pollock *et al.* (2000) only recorded one observation of a harbour seal in the Faroe-Shetland Channel.

Hooded seals tagged at Jan Mayen, east of Greenland, were recorded making post-breeding trips of an average of seven weeks duration over large areas of the Greenland and Norwegian Seas, around the Faroe Islands, and deeper waters to the north and west of Scotland (Folkow *et al.* 1996). A further 20 hooded seals were tagged on sea ice near Jan Mayen in 2007-2008, with one adult female observed foraging in the Faroe-Shetland Channel (Vacquie-Garcia *et al*. 2017). Pollock *et al.* (2000) recorded several observations of hooded seals in the Faroe-Shetland Channel. Two Arctic species, the bearded seal and walrus, occasionally occur as vagrants in the region, with a small number of sightings recorded around Shetland and other parts of northern Scotland.

A1a.8.14 Features of Regional Sea 10/11

Knowledge of marine mammal occurrence in the deep waters beyond the shelf slope to the west of Scotland is poor relative to other areas in UK waters. However, available information suggests that this is an important area for cetaceans, with a variety of species and high densities recorded.

These waters are beyond the scope of the SCANS surveys, and while other survey effort is moderate in the north-east corner of Regional Sea 10 the majority of the area has historically poor coverage to approximately 12°W, and very little west of that. The most recent and extensive information on cetaceans in this area is provided by the CODA (Strata 1), SCANS-III (Block 8) and NASS (Block FW) surveys (Pike *et al*. 2019), providing snapshots of the distribution in summers of 2007, 2015 and 2016 in offshore waters west of the UK, Ireland, France and northern Spain. Figure A1a.8.18 shows the distribution of CODA survey strata, effort and sightings of three of the most frequently encountered species.

In waters west of the UK and Ireland, long-finned pilot whales were the most frequently recorded species in the CODA survey (Macleod & Hammond 2008). Whilst widespread, a greater number of pilot whale encounters were recorded in the Rockall Trough over the southeastern slope of Rockall Bank. Sperm whales were widespread in this area, while many other species were also observed including common dolphin, bottlenose dolphin, Atlantic white-sided dolphin, striped dolphin, beaked whales, minke whale, fin whale and blue whale. Additionally, acoustic observations from survey vessels detected dolphin click trains throughout the area.

Abundance estimates derived from the CODA, SCANS-III and NASS 2015 survey data is presented in Table A1a.8.4.

Table A1a.8.4: Abundance estimates from CODA 2007, SCANS-III 2016 an NASS 2015 survey data for Regional Seas 10 & 11.

	CODA Strata 1 2007[1]	CV	SCANS-III Block 8 2016[2]	95% CL	NASS Block FW 2015[3]	95% CL
Bottlenose dolphin	5,709	0.35	1,195	363-3,933	-	-
Minke whale	5,547	1.03	1,657	555-4,949	5,072	2,071-12,423
Common dolphin	3,546	0.76	10,601	1,958-57,405	-	-
Beaked whale	3,512	0.33	1,530	426-5,492	-	-
Striped dolphin	519	1.05	-	-	-	-
Sperm whale	363	0.46	9,599	3,866-23,835	16,204	4,370-60,086
Fin whale	247	0.45	820	308-2,188	9,643	4,156-22,372
White-sided dolphin			13,322	2,797-63,448	86,053	19,436-380,991
Long-finned pilot whale			12,662	4,963-32,302	26,177	8,323-82,333

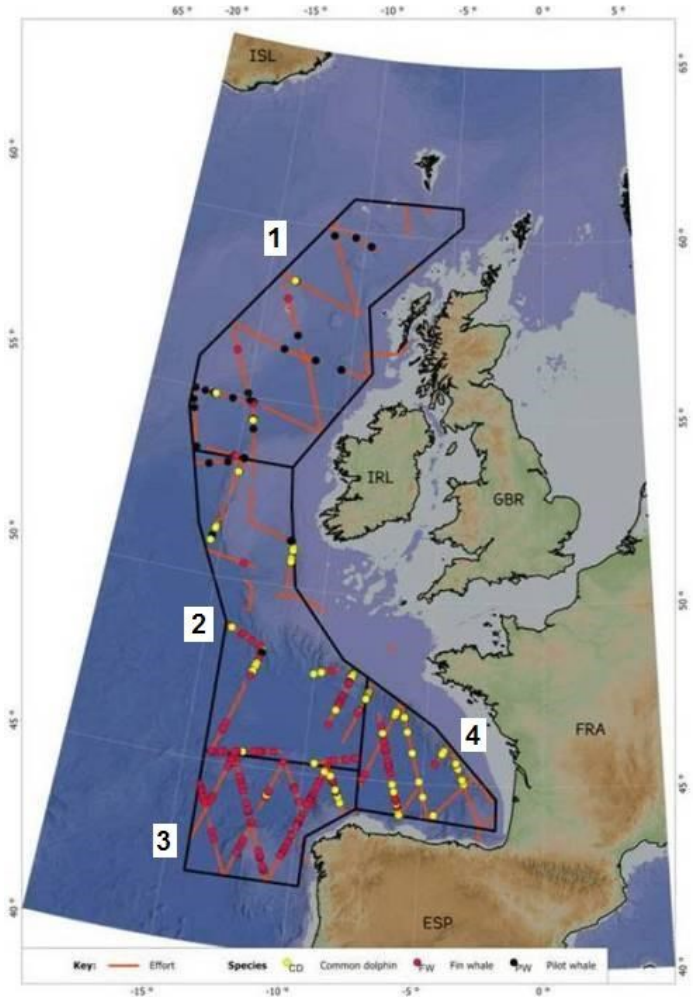
[1] Murphy *et al.* 2008
[2] Hammond *et al.* 2021.
[3] Pike *et al.* (2019) (supplementary files). Abundance estimates corrected for perception bias.

Previous visual surveys have recorded similar results. Pollock *et al.* (2000) reported long-finned pilot whales to be fairly common in the area, particularly around the 1,000m isobath, while common dolphins and sperm whales were also frequently encountered. A notable difference in occurrence concerns Atlantic white-sided dolphins, which have been reported as widespread and abundant along the continental slope north and west of Scotland (e.g. Pollock *et al.* (2000), Macleod *et al.* 2003b), but which were sighted a relatively low number of times in this area during the CODA survey; abundance was not estimated. However, survey conditions were poor during the CODA survey, particularly in the northern sector (Macleod *et al.* 2008), and therefore sightings are likely to have under-represented the true occurrence of white-sided dolphins during the survey. As mentioned previously, acoustic detections of dolphins were widespread and frequent throughout this area in summer 2007 (Macleod & Hammond 2008). Estimated abundance of white-sided dolphins in waters west of the Outer Hebrides (including an area on and beyond the shelf slope) during summer 1998 was 21,371 (CV = 0.54) (Macleod 2004a, cited in Murphy *et al.* 2008).

The two northernmost deep-water PAM stations in the ObSERVE Acoustic project (Berrow *et al*. 2018) were located approximately 70 and 120km south of the UK/Ireland median line, at water depths of 1,600m and 2,000m, respectively. These provided information on the occurrence of vocalising cetaceans from acoustic data between May and December 2015. While not lying within UK waters, these data are among the most recent and detailed information on cetaceans in deep water west of the UK and Ireland, and provide an indication of the likely composition and relative occurrence of cetaceans in slope waters west of Scotland. Cuvier's beaked whales were detected throughout the data collection period, with increasing frequency through November and into December; this species was detected on 30.4% and 20.6% of recording days at stations 1 and 2, respectively. Detections of Cuvier's beaked whale were much more frequent further south, with detections on ≥87% days at stations 4 through 8. Similarly, Sowerby's beaked whale was also detected throughout the data collection period, with increasing frequency from September to December 2015; this species was detected on 86% and 52% of the recording days at stations 1 and 2 respectively. Mooring station 1 had the highest rate of detection of Sowerby's beaked whale during all seasons with a total of 2,150 detections over 212 days of monitoring (Berrow *et al*. 2018).

Acoustic monitoring of fin, humpback and blue whale calls on the shelf edge and deeper waters north and west of the UK and Ireland showed fin whales to be the most frequently recorded species (Charif & Clark 2009). Fin whale sounds were detected throughout the study area, with peak densities typically occurring in December and January before gradually declining to minimal levels in May and June before increasing again. Patterns of seasonal variation in detection were similar across the study area. Only small seasonal variation in the minimum number of fin whales was detected; there was no evidence of large-scale seasonal migratory movements, although it is noted that acoustic tracking of vocalising individual fin whales is difficult. The highest detection densities occurred in the Rockall Bank area, where the maximum number of fin whales detected simultaneously was twelve. Fin whales were detected in high numbers across all of the mooring stations during the ObSERVE Acoustic project. The two northern-most stations of relevance to Regional Seas 10 and 11 recorded the greatest number of detections during September to December 2015 with 27,389 detections made on 100% of the days monitored, compared to 7,513 detections made on 71.7% of the days monitored during late spring and summer (Berrow *et al*. 2018).

Figure A1a.8.19: CODA survey sightings of the most frequently encountered species.



Notes: Survey strata (black polygon); ship transects (orange lines); sightings of long-finned pilot whale (black dots), common dolphin (yellow) and fin whale (red). Source: SMRU, St. Andrews, UK.

Blue whales were recorded to a lesser extent in waters north and west of the UK and Ireland. Peak detections occurred between November and December followed by a gradual decline to minimal levels from April to June, before gradually increasing again. This seasonal pattern in detection was similar throughout the study area with the exception of Faroese waters and the central and northern Faroe-Shetland Channel, where detection densities (which were among the lowest recorded) dropped to zero in November and December in most years, when peak levels occurred elsewhere. The maximum number of blue whales detected simultaneously in any one region was nine, recorded in the Rockall Trough area in November 1999. Observations of individually tracked blue whales suggest that most individuals detected during the autumn to winter period are migrating to the south or south-west; the northward migratory route is believed to lie further west in the Atlantic (Charif & Clark 2008).

Humpback whales were the least frequently detected species in waters north and west of the UK and Ireland. Vocalisations were recorded only from mid-October to late March. While recorded throughout the study area, detections were rare south of approximately 52°N. The maximum number of humpback whales detected simultaneously in a region was six, recorded between the Faroe Islands and Iceland in December 1996. Groups of singing humpbacks were tracked moving into the study area from the north and travelling on generally south-westerly courses. No corresponding northward migration was detected (Charif & Clark 2008). Humpback whales were not detected during any season at the two northernmost deep-water PAM stations in the ObSERVE Acoustic project (Berrow *et al*. 2018). The majority of

detections at the other more southerly stations occurred between March and April 2016, there were no humpback whale detections after late May at any of the moorings (Berrow *et al*. 2018).

Very few records exist of grey or harbour seal occurrence in deep waters west of the UK beyond the continental shelf. Predicted at-sea grey seal distribution maps, based on GPS tracking data from tagged seals, revealed that grey seals made frequent trips to the areas along the shelf edge to the west of the Western Isles but no seal in the tracking dataset crossed the shelf edge (600m isobath) (Carter *et al*. 2020).

A1a.8.15 Evolution of the baseline

Significant change has been documented in many aspects of the UK marine environment over the past few decades and beyond, likely due to an array of factors including climatic influences, nutrient inputs and anthropogenic factors such as fishing (e.g. Clark & Frid 2001). Some of the most notable and widespread trends observed include rising air and sea temperatures (Berry & Kent 2008, Holliday *et al.* 2008); increased phytoplankton abundance and an increase in the ratio of dinoflagellates to diatoms (e.g. Leterme *et al.* 2006); strong biogeographical shifts in many zooplankton assemblages, with a northward extension of warm-water species associated with a decrease in the number of colder-water species (Beaugrand *et al.* 2002); changes in spatial presence of many epibenthic species, particularly in the southern North Sea (Callaway *et al.* 2007); changes in the distribution and abundance of fish species, with southern species becoming more prominent (Heath *et al.* 2012), and increased abundance of scavenging seabirds (e.g. Camphuysen & Garthe 2000).

Such ecosystem-wide changes are likely to influence marine mammals in a variety of ways. In contribution to the Marine Climate Change Impacts Partnership's Report Card 2020[8], Evans & Waggitt (2020) provide an up-to-date review of the effects of climate change on marine mammals, with specific reference to the UK. This review builds upon earlier such work (Evans & Bjørge 2013), draws upon unpublished data from the Sea Watch Foundation, and includes an analysis of selected relevant data collected under the recently competed NERC/Defra-funded MERP project[9]. They note that, globally, the main effects of climate change on marine mammals observed to date include range shifts and loss of habitat (through ice cover loss), changes to food webs, increased exposure to algal toxins and susceptibility to disease. More specifically to the UK and wider north-west European waters, they highlight the following:

- Geographical range shifts appear to be occurring, with northward extensions of the range of warmer water species, such as striped dolphin, short-beaked common dolphin, and possible range contractions of cold-water species such as white-beaked dolphin.

- Continued rises in sea temperature could result in a shift in the species composition for cetaceans around the British Isles, with increased biodiversity particularly of subtropical and warm temperate pelagic species.

- Species that traditionally make long-distance seasonal migrations (e.g. most baleen whales) will likely arrive earlier or remain in high latitudes for longer, with increased breeding attempts.

[8] http://www.mccip.org.uk/impacts-report-cards/full-report-cards/2020/
[9] https://www.marine-ecosystems.org.uk/Research_outcomes/Top_predators

- Ecosystem regime shifts in UK waters may result in lower food availability for a number of marine mammal species, and lead to re-distribution of some regional populations.

- In low latitude, warm water regions, some species have experienced occasional mass die-offs linked to the presence of algal toxins. These may now also be affecting marine mammal species in mid-latitudes, including harbour seals.

- Responses of marine mammals to climate change, both at individual and population levels, remain poorly understood. Predicting future impacts is challenging, and it is currently unrealistic to assess these for specific time horizons beyond the likely continuations of range shifts which are already being observed.

In terms of vagrant species, over the last twenty years there have been extra-limital records of both warm-water and cold-water species, with little evidence of trends.

Range shifts in marine mammals have been reported in the north-east Atlantic, and these have been linked to increasing sea temperatures. Changes in species distribution, using future climate scenarios, have been predicted based on species habitats and thermal niche modelling: cold water-limited species risk northwards range contractions (e.g. white-beaked dolphin) while warm water-limited species will expand range into the UKCS (e.g. striped dolphin) (Lambert *et al.* 2014). However, the mechanisms causing those changes remain uncertain, and for some species, it is difficult to differentiate between short-term responses to regional resource variability and longer-term ones driven by climate change. While marine mammals are warm-blooded and generally target a wide range of prey, their distributions often fall between particular sea temperature boundaries which reflect the range preferences of their major prey organisms (Evans *et al.* 2008). Increasing temperatures and greater presence of southern fish species in the central and northern North Sea may lead to an increasing occurrence of southern marine mammal species. This could also cause species with affinities for cooler waters to undergo a northward shift in distribution (MacLeod *et al.* 2008). Additionally, prey distribution and abundance can show considerable variation in response to fisheries exploitation; this is likely to have knock-on effects on marine mammals which predate on the exploited fish populations.

A1a.8.15.1 Cetaceans

Trends in abundance

As data on cetaceans' abundance are typically few and often characterised by considerable uncertainty and both seasonal and spatial gaps, the identification of trends is very difficult. It is even more difficult to establish any causes of potential trends. There are currently no monitoring schemes for any offshore cetacean populations in UK waters that would be capable of detecting even large changes in population levels (Murphy *et al.* 2008). Systematic SCANS-type surveys provide the best opportunity to monitor cetacean abundance over time but even then, statistical power in assessing trends for most species is very poor if surveys are carried out only once every ten years. The ICES working group on Marine Mammal Ecology (ICES WGMME 2014) reported that the power of decadal SCANS surveys to determine a 30% decline over three generations (corresponding to IUCN definition of 'vulnerable') is 57% for harbour porpoise and <50% for all other species. The frequency of surveys needs to increase if changes are to be detected with a reasonable degree of confidence; every 5 years may be sufficient for harbour porpoise and every 3 years for minke whale, common dolphin and white-beaked dolphins.

For example, following SCANS-III, there are now three comparable estimates of abundance for harbour porpoise, white-beaked dolphin and minke whale in the North Sea, supplemented by additional estimates for minke whale from Norwegian surveys[10]. Consequently, trends in abundance over time were investigated, with trend lines fitted across the three estimates of abundance for harbour porpoise and white-beaked dolphin, and the eight estimates for minke whale. Estimated annual rates of change were small and with wide confidence intervals: +0.8% (95%CI: -6.8% to +9.0%) for harbour porpoise; -0.5% (95%CI: -18% to +22%) for white-beaked dolphin; and, -0.25% (95%CI: -4.8% to +4.6%) for minke whale. Giving consideration to the very low statistical power to detect anything other than large changes in abundance[11], these results show that there is no statistical support for a change in abundance over the period covered by the surveys for any species/region (Hammond *et al*. 2021).

For UK waters specifically, the most recent UK Conservation Status Assessment (as part of the 4th Report by the UK under Article 17 on the implementation of the Habitat Directive) noted that the UK harbour porpoise population estimate (derived from SCANS-III, which excluded Irish waters) of 197,579 (95%CI: 163,294-239,063) was 17% lower than that of the last assessment period. This lower estimate was attributed to lower densities of porpoise on the UK portion of the Celtic Shelf, and, taking into account the ObSERVE survey results (Rogan *et al*. 2018), there was no evidence of a statistically significant difference between the SCANS-II and SCANS-III surveys in wider European waters. Nonetheless, as described above, data are insufficient to confidently conclude a trend, hence the 'unknown' assessment for population size (JNCC 2019).

Changes in distribution

There is greater understanding of trends in abundance and distribution for the populations of bottlenose dolphins occurring in Cardigan Bay (and wider Welsh coast) (as described in Section A1a.10) and the Moray Firth (and wider Scottish east coast) (as described in Section A1a.6), which have been the subject of targeted research and monitoring for many years. However, these abundance estimates are still subject to considerable uncertainty and highly variable between some years; continued support for these time-series is required to detect trends with statistical confidence (ICES WGMME 2014).

Comparison between SCANS I and II surveys were instrumental in providing evidence for the distributional shift in the North Sea as discussed above, but the ecological reasons for this remain uncertain. There has been some speculation that the apparent shift in harbour porpoise abundance from the northern to southern North Sea may be due to a shortage of sandeels, a known prey item, with some suggestions of a recent increase in starvation observed amongst porpoises stranded in Scotland (MacLeod *et al.* 2007), although it is also argued that there is little evidence to support this (Thompson *et al.* 2007).

From acoustic monitoring of fin, humpback and blue whale calls in deeper waters north and west of the UK and Ireland, considerable inter-annual variations were observed in the patterns of detection densities over the period 1996-2005. Further data analyses over a longer time series will be necessary before statistically robust conclusions may be drawn (Charif & Clark 2008).

[10] Norwegian Independent Line Transect Surveys (see Hammond *et al*. 2021 for data sources).
[11] Power analysis showed that the annual rate of change that could be detected by the available data with 80% power was 1.8% for harbour porpoise, 5% for white-beaked dolphin and 0.5% for minke whale.

A 15-year time-series of sightings data by the Hebridean Whale and Dolphin Trust has shown a marked increase in the occurrence of common dolphins in the Sea of the Hebrides and The Minch over the period 2003-2017 (HWDT 2018). Early in the period, sightings of common dolphins were rare, at <0.2 animals per 100km survey effort, increasing to ≥0.8 animals per 100km from 2015 onward, with the species now the most commonly seen dolphin in the area, with the highest sighting frequency between April and October.

Using sightings data from north-west European waters compiled under the MERP project, Evans & Waggitt (2020) present results of an investigation of inter-annual variability in encounter rates and the relationships between encounter rates and key climatic variables over the period 1985-2017 for two cetacean species with a cold temperate to low Arctic range (Atlantic white-sided dolphin and white-beaked dolphin) and two species with a warm temperate range (short-beaked common dolphin and striped dolphin). Short-beaked common dolphin and striped dolphin both showed an increasing trend in encounter rates over time, and a strong positive correlation with increasing mean sea temperature in the upper 150m of the water column. By contrast, white-beaked dolphin showed a downward trend in encounter rate and a strong negative correlation with increasing mean sea temperature. For these three species, significant correlations were also observed between encounter ate and two climatic indices (NAO and AMO). Atlantic white-sided dolphin did not show any such correlations, although had shown significant inter-annual variability in encounter rate.

The conservation status for cetaceans in UK waters was recently assessed as part of the UK Government reporting for Article 17 of the Habitats Directive; this is fourth such report, covering the period 2013-2018 and all terrestrial and marine species listed under Annexes II, IV and V of the Directive that were present within the UK during the reporting period (JNCC 2019). For all regularly occurring cetacean species, the overall conservation status was assessed as 'unknown', due to two or more component parameters (covering: range, population, habitat and future prospects) being 'unknown'. For all species, the 'range' parameter was assessed as 'favourable', with no change since the last assessment. All other parameters were assessed as 'unknown' for all species, with the exception of future prospects for harbour porpoise, which were assessed as 'favourable' due to the designations of several SACs since the last assessment and their anticipated positive impact on habitat. A key driver of the widespread assessments of parameters as 'unknown' was insufficient data to assess trends in population size and habitat.

In coastal waters around western and northern Scotland, there has been an increase in reported sightings of humpback whales from shore since the mid-2000s[12].

A1a.8.15.2 Seals

Due to the greater ease with which seals can be studied, data on their distribution and abundance are more complete. Furthermore, structured monitoring has been on-going since the early 1960s, providing a long time-series of data from which to assess trends. While abundance estimates are often subject to considerable uncertainty, data are of sufficient quality and temporal coverage for larger magnitude changes and trends to be identified and interpreted (SCOS 2014).

The most recent estimate of grey seal population size provides some evidence that in the UK as a whole numbers are stable after several years of continued increase and there are early indications that the North Sea population may be reaching carrying capacity (SCOS 2020).

[12] https://uk.whales.org/2018/04/06/the-return-of-the-giants-humpback-whales-in-scottish-seas/

Average annual change in pup production for major colonies since 2008 are provided in Table A1a.8.2; with the exception of some central North Sea colonies (including Donna Nook, Blakeney Point and Horsey), where pup production is still increasing exponentially, numbers are stabilising. The overall conservation status for grey seal in the UK was most recently assessed as 'favourable' (JNCC 2019).

Results from aerial survey counts of harbour seals by UK survey regions are provided in Table A1a.8.3. The negative trend in harbour seal populations previously reported (Lonergan *et al.* 2007) has continued throughout several major colonies in Britain, especially in Orkney (2019 count is 85% lower than the highest count in 1997), Shetland (decreased by 30% between 2000 and 2009 and the 2019 count is 47% lower than the 1997 count of 6000 individuals) and Firth of Tay (down 93% between 2000 and 2013, but has been relatively stable in recent years). Other regions have largely been maintained at stable levels (West Coast and Outer Hebrides). Outbreaks of PDV in 1988 and 2002 were responsible for considerable declines in harbour seals on the east coast of England (Thompson *et al.* 2005), but caused only low mortality in Scottish colonies in 1988 and virtually none in 2002 (SCOS 2007). In Southeast England, the population recovered to pre-epidemic levels by 2012; with evidence of a relatively stable population size up to 2018 (SCOS 2020). The 2019 count was 27% lower than the 2012 to 2018 mean count, possibly indicating the first signs of a population decline (SCOS 2020). The overall conservation status for harbour seal in the UK was most recently assessed as 'unfavourable - inadequate' (JNCC 2019); this is an improvement on the previous (2013) assessment of 'unfavourable-bad', and reflects the genuine increase in population size over the last reporting period (JNCC 2019).

A1a.8.16 Environmental issues

A1a.8.16.1 Underwater noise

Marine mammals are sensitive to noise in the marine environment. Their extensive use of sound for communication, prey capture, predator avoidance and probably navigation, and the possession of large gas-filled organs make them vulnerable to both disturbance and physiological damage from underwater noise of sufficient magnitude. Identifying these effects, and the levels of sound which may induce them, continues to be subject of considerable research. Extensive reviews are available in relation to a variety of noise sources (e.g. Richardson *et al.* 1995, MMS 2004, Nowacek *et al.* 2007, Southall *et al.* 2007, 2019, OSPAR 2009, Finneran 2015, Gomez *et al*. 2016, Convention on Biological Diversity 2020). Additionally, reviews of marine mammals in UK waters in contribution to previous SEAs have addressed the issue of noise (e.g. Hammond *et al.* 2006, 2008).

Many human activities introduce sound into the marine environment, e.g. shipping, ice breaking, geophysical survey, underwater construction, and the use of sonars and explosives. Some of these sounds are of very high amplitude at source and often of low frequency, and therefore may be detectable by marine mammals at substantial ranges from the source. Recent technological developments have introduced many new sources of noise in offshore waters. Those typically of greatest concern to marine mammals, and marine fauna in general, are those producing the most intense sound pressure levels: seismic exploration, underwater explosions, sonar (particularly naval), pile-driving and some acoustic harassment devices (AHDs). However, less intense noise sources such as shipping are also of concern due to their persistent nature and long-range of audibility. Shipping is the dominant noise source at low frequencies in most locations, and its contribution to increased ambient noise levels has been considerable in recent decades.

Many of the activities assessed in the current SEA introduce noise potentially capable of causing injury and/or disturbance to marine mammals. See Section 5.3 of the Environmental Report for information on the characteristics of underwater noise and the potential effects on marine mammals.

A1a.8.16.2 Contaminants

Marine mammals are exposed to a variety of anthropogenic contaminants, primarily through the consumption of prey. As top predators, they are at particular risk from contaminants which are biomagnified through the food chain (i.e. are found at increasing concentrations at higher trophic levels). Most research has focussed on two main groups of contaminants: the persistent organic pollutants (POPs) and the heavy metals. POPs are extremely toxic substances for environment and human health; they are man-made compounds produced by industry for a wide variety of applications (i.e. pesticides, insecticides, flame retardants) or as by-product from industrial or combustion processes (i.e. PAHs). Several of these compounds (i.e. PCBs, DDT) have been banned but since they are highly stable, and resistant to metabolic degradation, they continue to persist in the environment long after their use is interrupted. Consequently their biomagnification in marine food webs continues to result in high concentrations in the fatty tissues of top predators in European seas (Jepson *et al*. 2016). For many compound groups (i.e. perfluorinated compounds, organochlorine pesticides and butyltins) temporal trends are downwards. In contrast, PCBs (controlled since 1980s) earlier downward trends appear to have stalled from 1998 onwards (Law 2014); concentrations in UK-stranded harbour porpoises are still reported to be on average above the threshold level for adverse health effects (Murphy *et al.* 2015). The use of organophosphorus flame retardant (PFRs) compounds is likely to be on the increase, but current levels do not suggest a high level of concern and routine monitoring is not warranted (Papachlimitzou *et al.* 2015). POPs may affect the reproductive, immune and hormonal systems(Jepson *et al*. 2016, Gajdosechova *et al*. 2016). This includes a widely publicised finding of PCB concentrations in the blubber of a killer whale at levels >100 times higher than the accepted toxicity threshold for marine mammals[13]. The adult female, which died as a result of entanglement in a creel rope, was found to have never reproduced, despite being much older than the average age for maturity in the species. High concentrations of PCBs in harbour porpoises have been linked to increase susceptibility to disease (Jepson *et al.* 2005, Hall *et al.* 2006, Pierce *et al.* 2008), to parasite burdens (Bull *et al.* 2006) and to reproductive failure (Murphy *et al.* 2015). A negative trend in POP concentration was reported also for common dolphins bycaught in fisheries off the SW coast of the UK from 1992 to 2006; nonetheless 72% of the dolphins analysed (n=43) had blubber PCB concentrations above the toxicity threshold level (Law *et al.* 2013). Geographical differences in contaminant load have been demonstrated by Pierce *et al.* (2008) in the blubber of female common dolphins and harbour porpoises stranded on the Atlantic coast of Europe from 2001-2003. Harbour porpoises stranded on the Scottish coast showed lower concentrations of PCBs than those from the southern North Sea coast, although were still above the threshold for effects on reproduction in a third of animals; the lowest levels of POPs were generally recorded in animals stranded on the Irish and Galician coasts. For common dolphins, those stranded along the French and Galician coasts had significantly higher concentrations of PCBs than those in Ireland. Fish are good metabolisers of PAHs, therefore fish-eating marine mammals commonly exhibit lower levels of PAHs than those feeding primarily on cephalopods, small crustaceans and plankton. Both cetaceans and seals contain

13 https://www.sruc.ac.uk/news/article/1860/scottish_killer_whale_contained_one_of_the_highest_concentrations_of_pcb_pollutants_ever_recorded_in_marine_mammals

enzyme systems which can detoxify PAHs, although this process itself may release new toxic substances within the animal. While short-term acute exposure to PAHs has been shown to cause damaging effects to marine mammals, little is known of the effects of long-term chronic exposure.

Cadmium, lead, zinc and mercury are the heavy metals of greatest concern in marine mammals (Hammond *et al.* 2006). They are frequently present in the highest concentrations in the liver, kidney and bone, with levels varying considerably with the geographic location of the species. Marine mammals are able to produce certain proteins (metallothioneins) which can sequester certain metal ions into less toxic complexes; this enables many species to cope with relatively high dietary exposures to certain metals. Whilst there are few studies that show major impacts of heavy metals, it is possible that they may have combined effects as they often co-occur with the persistent organic contaminants. Higher hepatic metal concentration was reported from harbour porpoises which had died from infectious disease compared to healthy porpoises (died from physical trauma) in strandings along the Southern North Sea and Bay of Biscay (Mahfouz *et al.* 2014). Heavy metal concentrations were determined for common dolphins as part of the 2008 mass stranding investigation: for all adults, levels were found to be lower when compared to samples taken from strandings in 1990-1992 (Jepson & Deaville 2009).

Direct mortality of marine mammals from exposure to oil spills has rarely been reported, and has usually only been observed in major oil spills such as the *Exxon Valdez* in Alaska in 1989 (Hammond *et al.* 2006). Unlike seabirds, they generally rely on blubber for insulation, so are less vulnerable to fouling from oil. Grey seal pups are the most vulnerable to oil fouling, as these rely on their thicker fur for insulation during the first few weeks of their life before developing blubber and moulting into a sea-going coat; they are also restricted to their breeding colony until they are weaned. A direct threat to marine mammals from oil slicks is the exposure to the volatile and aerosolized petroleum-associated compounds that evaporate from the surface of a slick at sea within the first few days. Both seals and cetaceans typically inhale just above the surface of the water, so any animal surfacing in a fresh slick is likely to inhale vapours. Symptoms from acute exposure to volatile hydrocarbons include irritation to the eyes and lungs, lethargy, poor coordination and difficulty with breathing; individuals may then drown as a result of these symptoms (Hammond *et al.* 2006). Sub-lethal and/or chronic effects of this type of exposure have been described in a coastal population of bottlenose dolphins in the Gulf of Mexico, following the Deepwater Horizon explosion in 2010; a higher than normal proportion of dolphins was found to be in poor condition, with teeth loss, pulmonary and haematological abnormalities, lung disease, low reproductive success and increased mortality rates (Schwacke *et al.* 2013; Lane *et al*. 2015, Venn-Watson *et al*. 2015, Kellar *et al*. 2017 cited in Schwacke *et al*. 2017).

The rapid and catastrophic decline of otters across much of the UK and Europe from the 1950s-1970s has been linked with, among other factors, an increase in the levels of certain contaminants, especially organochlorine pesticides (e.g. Jefferies 1989). Sufficient levels of such contaminants in vertebrates cause lethal and sub-lethal detrimental effects; contaminants entered water systems and accumulated in the tissues and organs of otters through the consumption of contaminated prey. The most significant declines in otters were observed in the southeast of England and the Midlands. Coastal otter populations were generally exposed to lower levels of contaminants, and did not experience such catastrophic declines. Recovery has taken place once pesticide practices changed.

A1a.8.16.3 Disease

It is well known that marine mammals harbour large numbers of macroparasites, such as nematodes and cestodes as well as various ectoparasites (Hammond *et al.* 2006). However, these parasites do not usually cause severe harm unless the animals are suffering from an underlying primary disease or are stressed for other reasons. Outbreaks of viral and bacterial disease epidemics have occurred among seals and cetaceans worldwide; these appear to have increased in frequency in recent years, particularly in the U.S. (e.g. Harvell *et al.* 1999). In addition to high profile, large-scale epidemic diseases, marine mammals are also known to suffer from a range of viral and bacterial infectious diseases. A range of organisms has been cultured from healthy and sick marine mammals; many are secondary infections in malnourished and starving animals, particularly juveniles.

In UK and European waters, harbour seals suffered from major epidemics of PDV, a morbillivirus, in 1988 and again in 2002. The greatest mortality was observed on the English east coast, with 50% and 22% population declines respectively (Thompson *et al.* 2005); mortality in most Scottish colonies was low in 1988 and virtually zero in 2002 (SCOS 2007). The main cause of death from PDV is often secondary bacterial infection due to a weakening of the immune system; in the 1988 outbreak, *Bordetella* organisms were isolated from a large proportion of the sick animals but not found in healthy individuals (Munro *et al.* 1992, cited in Hammond *et al.* 2006). While PDV infection has been observed in grey seals, no substantiated fatal cases have been observed; it is believed that grey seals may act as carriers of the virus (Pomeroy *et al.* 2005; Hall *et al.* 2006).

Morbilliviruses (MV) are also observed in cetaceans, including harbour porpoises and dolphins where they are commonly referred to as PMV and DMV respectively. DMV caused mass mortality in Mediterranean striped dolphins in 1990 and US bottlenose dolphins in 1987. A survey of stranded animals of different cetacean species in Europe indicated that infections with DMV and PMV-like morbilliviruses are not uncommon (Visser *et al.* 1993). Post-mortem investigations of 89 porpoises found dead along the coasts of England and Wales revealed 37 individuals to have died of infectious diseases caused by parasitic, bacterial, fungal and viral pathogens (most frequently pneumonia caused by lungworm and bacterial infections) (Bennet *et al.* 2001). The remaining 49 animals were described as healthy before having suffered some form of physical trauma, most commonly entrapment in fishing gear.

Bottlenose dolphins occurring in the Moray Firth show a high prevalence of skin lesions (Wilson *et al.* 1997). This has been suggested to be caused by environmental conditions impacting skin integrity or increasing physiological stress, potentially making animals more vulnerable to natural infections or anthropogenic factors (Wilson *et al.* 1999).

Anthropogenic pathogens are largely found in marine mammals from effluents of untreated sewage or from facilities which contain domestic animals. For example, up to 11.8% of grey and harbour seals taken into rehabilitation centres on the east coast of England tested positive for *Salmonella* (Baker *et al.* 1995 cited in Hammond *et al.* 2006).

A1a.8.16.4 Bycatch

The accidental capture of marine mammals in fishing gear (bycatch) remains an issue of concern throughout European waters and beyond. In UK waters, the two main species affected by fishing are the harbour porpoise and the short-beaked common dolphin; Region 4 is the main area of concern.

Observations of incidental cetacean by-catch by commercial fishing vessels in relation to EU Regulation 812/2004[14] and the Habitat Directive are undertaken by the UK by-catch monitoring scheme and reported annually (Northridge *et al.* 2015).

Since 1995 when the UK Bycatch monitoring Scheme was established, the SMRU has undertaken work on determining bycatch rates of marine mammals in several fisheries in UK waters in support of the UK Government in meeting obligations under Council Regulation 812/2004 and under the Habitats Directive. Monitoring takes place regularly across a variety of fisheries and coverage has been extended from the North Sea, to West of Scotland and the Southwest, where most monitoring effort is currently concentrated. In addition to monitoring and reporting, work is undertaken to improve mitigation measures (Northridge *et al.* 2011).

In the North Sea, the primary gear types that have been associated with marine mammal bycatch are set nets such as gill and tangle nets (Hammond *et al.* 2002a). Harbour porpoises are predominantly bottom feeding, and therefore particularly vulnerable to set bottom nets. The major fishing fleets involved in bottom set gillnetting and tangle netting in the North Sea are from Denmark, the UK and Norway, with lesser effort from Belgium and Germany. The latest advice by ICES has evaluated the total annual bycatch of harbour porpoises in set net fisheries in the North Sea (including Divisions VIId and IIIa) to range between 1235 and 1990 animals (lower and higher 95% CI); using the abundance from SCANS-II, these estimates equate to a mortality of 0.54% to 0.88%. This is below the 1.7% limit established by ASCOBANS but caution is required as many caveats apply to the range of by-catch estimates due to effort data reliability and the potential for biases in the observation data (ICES website). By-catch has been decreasing. The smaller UK fleet is estimated to take around 500 porpoises per year (Northridge *et al.* 2011). UK gill and tangle net fisheries operate predominantly in coastal waters, in the central southern North Sea and to the west of Shetland.

Bycatch of Atlantic white-sided and white-beaked dolphins has been reported in the North Sea but much more rarely (ICES WGBYC 2015). Some by-catch mortality of bottlenose dolphins associated with illegal salmon nets has been observed in Scotland (Thompson *et al.* 2004).

Bycatch levels in the Celtic Sea and Western Channel area are relatively high in comparison to other areas around the UK, due to the presence of large amounts of gillnetting and high densities of harbour porpoise and common dolphin (Hammond *et al.* 2008). ICES latest estimate for bycaught porpoises from setnets across the Celtic and Irish Sea is for 1137-1472 (lower and higher 95% CI); this corresponds to a mortality of 1.07% to 1.39% with respect to the best estimate of abundance in 2005. Mortality in UK set net fisheries in this region are likely to be in the mid to high hundreds of animals per year (Northridge *et al.* 2011). Common dolphins seemed particularly vulnerable to bycatch in pelagic pair trawls targeting bass in the winter months, when common dolphin densities are at a peak. Total mortalities in UK bass pair teams peaked at over 400 animals in the 2003-2004 winter, but have since declined following strict management measures; as of 2014 this fishery is effectively ended on UK vessels (Northridge *et al.* 2015). In the Western Channel, striped dolphins have also been recorded as bycatch (ICES WGBYC 2015).

Since 2005, in accordance with European Council Regulation (EC) 812/2004, it has been mandatory for vessels over 12m involved in specified fixed gear fisheries (bottom-set gillnet or entangling net) in the North Sea to use acoustic devices ("pingers") attached to fishing gears. These are designed to deter cetaceans with a view to reducing bycatch and guidance for their

[14] Laying down measures concerning incidental catches of cetaceans in fisheries.

use has been produced by the Marine Monitoring Organisation (https://www.gov.uk/guidance/reduce-dolphin-and-porpoise-by-catch-comply-with-regulations). The regulation also requires the monitoring of by-catch of vessels ≥15m by on board observers in specified fisheries. Since its introduction, a number of weaknesses have been identified; it is not necessarily targeted at the right fisheries or in the right areas and it relies heavily on use of acoustic deterrent devices to mitigate bycatch. Further review of this regulation is expected by end 2015 (ICES WGBYC 2015).

Hall *et al.* (2001) used the SMRU seal tagging database to estimate the minimum level of seal mortality from tags returned from seals found in fishing gear. They estimated that a minimum of around 2% of all seals tagged were subsequently killed in fishing gear, and it is thought that most of this mortality is in gill and tangle nets. The latest UK report estimated a total of 469 seals from net fisheries across the UK, thought to be predominantly grey seals (ICES 2015). While not strictly bycatch, fishery-related mortality of seals occurs due to the shooting of seals which interfere with fishing and aquaculture operations. Since the Marine (Scotland) Act 2010 (Section 6) came into force, the killing of seals has been strictly regulated under license and much effort has been made to develop effective non-lethal measures. In 2014, Marine Scotland granted 53 licenses seals for a maximum of 765 grey seals (across all seal management areas) and 240 common seals (no license granted in East Coast); the actual number of seals reported shot were much lower (164 grey and 41 harbour seals) (Marine Scotland, 2015).

A1a.8.16.5 Collision

Another potential source of mortality to marine mammals, primarily cetaceans, may be through collisions with vessels. In other parts of the world, whales are occasionally reported to be struck and killed, especially by fast-moving ferries. Smaller cetaceans can also be impacted by propeller strikes from smaller vessels. In areas where cetacean numbers are depleted and vessels are numerous, ship-strike mortality can be a serious cause for concern. In the UK certain areas experience very high densities of commercial and recreational shipping traffic, some of which may be frequented by large numbers of marine mammals; despite this, relatively few deaths are recorded as results of collisions (Hammond *et al.* 2008). Between 2000 and 2009, only 11 out of 1100 post-mortems on harbour porpoises and common dolphins identified collision as the cause of death (UKMMAS, 2010). Increase in recreational use of coastal areas, including dolphin watching activities, pose the potential to increase the risk of collision and disturbance; codes of conduct have been produced.

Since 2008 several dead seals with corkscrew injuries (>76 animals) (Bexton *et al.* 2012) were found on beaches; at first, in the absence of any evidence of predation, concern was raised of the potential for ship propellers, in particular those using ducted propulsion systems, to cause such injuries (Onoufriou & Thompson, 2014). Most recently however, evidence for predation by adult grey seals as the cause of such spiral-cut injuries has been obtained both on young harbour seals in Germany and on grey seal pups on the Isle of May (van Neer *et al.* 2015, Thompson *et al.* 2015). It is now considered highly unlikely that the use of duct propeller vessels should pose any increased risk over and above normal shipping activities (SNCBs interim advice 2015).

The installation of wave and tidal energy devices creates a potential collision risk for marine mammals (Wilson *et al.* 2007). Several studies have investigated the use of tidal-stream environments by marine megafauna (see review by Benjamins *et al.* 2015). In many cases, high tidal stream speed has been linked to increased habitat usage; for example harbour porpoises in the Minches and Wales (Marubini *et al.* 2009, Pierpoint 2008) and bottlenose

dolphins in the inner Moray Firth (Mendes *et al.* 2002). This result however is far from ubiquitous and higher abundance in low tidal currents has also been observed (Embling *et al.* 2010). Consequently, site specific studies are important when assessing risk at a specific location. For example, the tidal narrows of the Sound of Islay and the Kyle Rhea were surveyed specifically to determine how often harbour porpoises occurred in these areas of immediate interest for tidal-stream development (Wilson *et al. 2*014); while porpoises were seen and detected in both areas, they were an order of magnitude less abundant than in surrounding waters. In addition to area usage, several research projects are being undertaken on the behaviour of marine mammals to gather a better understanding of how they perceive and avoid tidal and wave energy devices. High resolution GPS/GSM tags are the tool of choice for monitoring seal movements but other methodologies are also being developed including hydrophone arrays for Passive Acoustic Monitoring and active sonar (McConnell *et al.* 2013). Sparling *et al.* (2013) observed that while no marine mammal collision at any tidal device had yet been reported, an effective methodology able to detect collision still needs to be demonstrated in the field.

On land, collisions between otters and motor vehicles can be a cause of considerable mortality (e.g. Kruuk & Conroy 1991, Philcox *et al.* 1999). In a study of patterns of otter road mortality in Britain, Philcox *et al.* (1999) identified coastal roads and those running alongside rivers in steep valleys a particular problem; especially coastal roads in the vicinity of freshwater streams. However, investigations of otter mortality in Shetland suggested food shortage to be the most common cause of death; high proportions of recorded deaths attributable to road mortality was believed to be an artefact of sampling methods (Kruuk & Conroy 1991).

A1a.8.16.6 Other issues

Plastic litter has been identified as an increasing anthropogenic pressure in the marine environment (OSPAR, 2009). It is argued that the main problem is with discarded fishing gear which can result in entanglement and death of cetaceans and seals (UKMMAS 2010, OSPAR 2009). A recent study by MacLennan *et al*. (2020) estimated that around five humpback whales and 30 minke whales may become entangled in creel fishing gear each year. The authors suggest that entanglements occurring in Scottish waters could potentially impact small populations of humpback whales in the NE Atlantic, and that the estimated fatal entanglement rate of minke whales (2.2% of the estimated abundance from the SCANS-III survey) could present a risk of localised population depletion. Previous analysis conducted by Ryan *et al*. (2016b), and based on half the number of entanglements identified by MacLennan *et al*. (2020), indicated that Scottish inshore waters could not support a population of humpback whales and that these waters currently act as a high mortality sink for the species in the NE Atlantic. Ingested plastics have been identified in the stomachs of several species of marine mammals but there is little or no evidence of a pathological effect (UKMMAS 2010).

A1a.8.17 Conservation frameworks

A wide range of international treaties and conventions, European directives and national legislation apply to the protection and conservation of marine species and habitats in the UK as outlined in Appendix 1j and Appendix 2. Many of these are directly relevant to the protection of marine mammals.

A1a.8.17.1 International

It is noted that legislation transposed from EU Directives, amongst other sources of EU-derived law, will form part of the body of UK “retained EU law” created under the *EU (Withdrawal) Act 2018*, which will come into effect from 1st January 2021. Consequently, provisions of

instruments such as the Habitats Directive will continue beyond the UK's exit from the EU and the end of the transition/implementation period in January 2021.

All species of cetacean and the European otter (*L. lutra*) are listed on Annex IV (Animal and Plant Species of Community Interest in Need of Strict Protection) of the EU Habitats Directive[15]. Under Annex IV, the keeping, sale or exchange of such species is banned as well as deliberate capture, killing or disturbance[16]. Grey and harbour seals are listed on Annex V (Animal and plant species of community interest whose taking in the wild and exploitation may be subject to management measures). The harbour porpoise, bottlenose dolphin, grey seal, harbour seal and otter are also listed in Annex II of the Habitats Directive. Member countries of the EU are required to consider the establishment of Special Areas of Conservation (SACs) for Annex II species. The purpose of the Habitat Directive is to achieve and maintain the favourable conservation status of the habitat and species it lists; the assessment of conservation status does not only relate to that component of a species population that is within SACs but to the totality of the species throughout its range. This is particularly important with wide ranging and migratory species as marine mammals and cetaceans.

The Marine Strategy Framework Directive covers all marine biodiversity; among the indicative list of characteristics to be used in the assessment of Good Environmental Status (GES) given in Table 1 of Annex III of the Directive, reference is made to 'population dynamics, natural and actual range and status of species of marine mammals'. This has been further interpreted and a set of listed species has been produced for the north-east Atlantic region (OSPAR 2012). The UK has proposed a set of indicators under Descriptor 1 and 4 based on the five most common species of cetacean (harbour porpoise, bottlenose dolphins, common dolphins, white-beaked dolphins, minke whales) as well as on grey and harbour seals (DEFRA 2012). Associated monitoring programmes are largely based on existing programmes such as the UK Seals monitoring programme, UK bycatch monitoring scheme, UK stranding scheme (CSIP) and inshore bottlenose dolphin population monitoring scheme (Defra 2014).

The OSPAR Convention covers all marine biodiversity of the north-east Atlantic and cetaceans and seals are two of eight marine biodiversity components identified for assessment purposes. In addition, the harbour porpoise and blue whale are listed on the OSPAR list of threatened and/or declining species and habitats in the north-east Atlantic; these species are in need of protection in the north-east Atlantic and are the focus of regular assessments and further priority setting for conservation under Annex V of the OSPAR Convention.

The UK has been a signatory to the Convention on the Conservation of Migratory Species (The Bonn Convention) since 1985. States are required to enter into agreement to protect migratory species throughout their entire range. ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas) was set up under the auspices of The Bonn Convention and came into force in March 1994. Under ASCOBANS, provision is made for protection of specific areas, monitoring, research, information exchange, pollution control and heightening public awareness. Measures cover the monitoring of fisheries interactions and

[15] *Council Directive 92/43/EEC on the conservation of natural habitats of wild flora and fauna*

[16] The definition of disturbance in Scotland is slightly different from elsewhere in the UK. To help avoid or minimise the risk by activities in the marine environment to kill, injure or disturb European Protected Species, guidance has been prepared by JNCC, Natural England and Countryside Council for Wales (2010), relevant to for the marine area in England and Wales and the UK offshore marine area and by Marine Scotland (2014) for Scottish inshore waters.

disturbance, resolutions for the reduction of bycatch in fishing operations, and recommendations for the establishment of specific protected areas for cetaceans.

Minke, fin, humpback, blue and northern bottlenose whales, along with otters (*L. lutra*) are all listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). These animals are classified as threatened with extinction; CITES prohibits international trade in specimens of these species for commercial purposes. Additionally, all cetaceans are listed under Appendix II of CITES; these animals are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. However, all cetaceans and otter (*L. lutra*) are listed on Annex A of the EU Wildlife Trade Regulations[17] and are therefore treated by the EU as if they were on CITES Appendix I, thus prohibiting commercial trade (Murphy *et al.* 2008).

The International Union for Conservation of Nature (IUCN)'s Red List of Threatened Species provides assessments of the conservation status of animals evaluated at a global scale using the IUCN Red List Categories and Criteria, with the aim of determining their relative risk of extinction. Assessments are updated periodically to reflect new information. Where sufficient information exists, the majority of marine mammal species occurring in UK waters fall into the lowest category of 'least concern'. Of higher extinction risk are the 'threatened' categories: 'vulnerable', 'endangered' and 'critically endangered'. Sperm and fin whales are assessed as 'vulnerable', while sei and blue whale are 'endangered'. Otter are assigned a precautionary status of 'near-threatened' primarily due to a declining population globally, albeit with considerable variation in trends across their range and a lesser rate of decline currently compared to previous decades. Table A1a.8.5 tabulates the assessed status for species which are known to regularly occur in UK waters.

[17] *Council Regulation (EC) 338/97 on the protection of species of wild fauna and flora by regulating trade therein*

Table A1a.8.5: IUCN Red List of Threatened Species Assessments for marine mammal species regularly occurring in UK waters

Species	Assessed status	Year assessed
Harbour porpoise *Phocoena phocoena*	Least concern	2020
Bottlenose dolphin *Tursiops truncatus*	Least concern	2018
White-beaked dolphin *Lagenorhynchus albirostris*	Least concern	2018
Atlantic white-sided dolphin *Lagenorhyncus acutus*	Least concern	2019
Short-beaked common dolphin *Delphinus delphis*	Least concern	2008
Risso's dolphin *Grampus griseus*	Least concern	2018
Killer whale *Orcinus orca*	Data deficient	2017
Long-finned pilot whale *Globicephala melas*	Least concern	2018
Sperm whale *Physeter macrocephalus*	Vulnerable	2008
Northern bottlenose whale *Hyperoodon ampullatus*	Data deficient	2008
Cuvier's beaked whale *Ziphius cavirostris*	Least concern	2008
Sowerby's beaked whale *Mesoplodon bidens*	Data deficient	2008
Minke whale *Balaenoptera acutorostrata*	Least concern	2018
Fin whale *Balaenoptera physalus*	Vulnerable	2018
Sei whale *Balaenoptera borealis*	Endangered	2018
Blue whale *Balaenoptera musculus*	Endangered	2018
Humpback whale *Megaptera novaeangliae*	Least concern	2018
Harbour seal *Phoca vitulina*	Least concern	2016
Grey seal *Halichoerus grypus*	Least concern	2016
Otter *Lutra lutra*	Near threatened	2014

Source: IUCN Red List website (accessed October 2020).

A1a.8.17.2 United Kingdom

In the UK, all species of cetacean and otter (*L. lutra*) are protected under Schedule 5 of the *Wildlife and Countryside Act 1981*[5] (WCA 1981) and the *Wildlife (Northern Ireland) Order 1985*. Under WCA 1981, it is an offence (subject to exceptions) to intentionally kill, injure, or take, possess, or trade in any wild animal listed under Schedule 5, and prohibits interference with places used for shelter or protection, or intentionally disturbing animals occupying such places. Amendments to the WCA 1981 in Scotland by the *Nature Conservation (Scotland) Act 2004* made it an offence to intentionally or recklessly disturb a cetacean. Additionally, whaling is illegal under the *Fisheries Act 1981*.

[5] The Wildlife and Countryside Act (as amended) implements the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention) which entered into force in 1982.

The *Conservation (Natural Habitats, &c.) Regulations 1994* (as amended) implements the EU Habitats Directive in the UK. Amendments to the Conservation Regulations in England and Wales, followed by the introduction of the *Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007* (implementing the Habitats Directive beyond 12nm), have revised the definition of deliberate disturbance of European Protected Species (those listed on Annex IV of the Habitats Directive). The *Conservation of Habitats and Species Regulations 2010* consolidate all the various amendments made to the *Conservation (Natural Habitats, &c.) Regulations 1994* in England and Wales. In Scottish waters to 12nm, the EU Habitats Directive is transposed through a combination of the *Conservation of Habitats and Species Regulations 2010* and the *Conservation (Natural Habitats, &c.) Regulations 1994*, which was amended specifically for Scotland (2004, 2007, 2008 (twice), 2011 and 2012) to include the 12nm limit. The *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended) implement the EU Habitats Directive for all oil and gas activities within the UK Continental Shelf. Under these regulations, any company wishing to carry out a seismic survey must apply for consent, which, if granted, must be carried out in accordance with the Joint Nature Conservation Committee (JNCC) guidelines for minimising acoustic disturbance to marine mammals from seismic surveys (JNCC 2010).

The *Grey Seal (Protection) Act 1914*, provided the first legal protection for any mammal in the UK because of a perception that seal populations were very low and there was a need to protect them. In the UK seals are protected under the *Conservation of Seals Act 1970* (England, and Wales), the *Marine (Scotland) Act 2010* and the *Wildlife (Northern Ireland) Order 1985*. The *Conservation of Seals Act* prohibits taking seals during a close season (01/09 to 31/12 for grey seals and 01/06 to 31/08 for harbour seals) except under licence issued by the Marine Management Organisation (MMO). The Act also allows for specific Conservation Orders to extend the close season to protect vulnerable populations. After consultation with NERC, three such orders were established providing year round protection to grey and harbour seals on the east coast of England and in the Moray Firth and to harbour seals in the Outer Hebrides, Shetland, Orkney and the east coast of Scotland between Stonehaven and Dunbar (effectively protecting all the main concentrations of harbour seals along the east coasts of Scotland and England). The *Marine (Scotland) Act 2010* (Section 6) prohibits the taking of seals except under licence. Licences can be granted for the protection of fisheries, for scientific and welfare reasons and for the protection of aquaculture activities. In addition, in Scotland it is now an offence to disturb seals at designated haulout sites. NERC (through SMRU) provides advice on all licence applications and haulout designations. The *Wildlife (Northern Ireland) Order 1985* provides protection for both grey and harbour seals and prohibits the killing of seals except under licence. In Northern Ireland it is an offence to intentionally or recklessly disturb seals at any haulout site.

UK Biodiversity Action Plan (UK BAP) was first published in response to the Convention on Biological Diversity (Rio de Janeiro, 1992); it included a number of specific plans for listed priority species and habitats including several cetaceans and otter. After devolution, each country developed strategies for biodiversity and the environment while maintaining a shared vision; these are ongoing. Following the publication of the CBD's Strategic Plan for Biodiversity 2011-2010 and its 20 'Aichi Biodiversity Targets', the UK BAP was succeeded by the UK Post-2010 Biodiversity Framework, published in 2012 to cover the period 2011-2020. The framework was supported by an Implementation Plan published in 2013 and revised in 2018 to cover 2018-2020[18].

[18] Further info: https://jncc.gov.uk/our-work/uk-post-2010-biodiversity-framework/

JNCC and NatureScot have developed a list of Priority Marine Features (PMFs) in Scotland to help focus future research, planning and conservation. The list, adopted in 2014, includes grey and harbour seals and most species of cetaceans occurring in UK waters (Tyler-Walters *et al.* 2016).

A1a.8.17.3 Marine Protected Areas

In the UK, SACs have long been established for the inshore populations of bottlenose dolphins in Wales (Cardigan Bay SAC and Lleyn Peninsula and the Sarnau SAC) and in Scotland (Moray Firth SAC).

Based on the identification of persistent areas of relatively high porpoise density (Evans *et al*. 2015, Heinänen & Skov 2015), five SACs for harbour porpoise were selected in Welsh, Northern Irish, English inshore and offshore waters: The Southern North Sea SAC, Bristol Channel Approaches SAC, West Wales Marine SAC, North Anglesey Marine SAC and North Channel SAC[19]. These five sites were submitted in 2017 and fully designated in 2019. Similarly, the Inner Hebrides and the Minches SAC in Scottish territorial waters was submitted in 2016 and fully designated in 2018. Harbour porpoise are also a qualifying feature of the Skerries and Causeway Candidate SAC in inshore waters of Northern Ireland (fully designated in 2017), although are not the primary reason for site selection. Several SACs in waters of neighbouring nations include harbour porpoise as a qualifying feature; these sites, along with those in UK waters, are illustrated in Figure A1a.8.2.

There are currently no exclusively marine SACs for grey or harbour seals in the UK, although a number of terrestrial SACs (with intertidal and/or marine components) have been established for these species around the coast to protect key breeding colonies. Additionally, there are 194 designated haul-out sites in Scotland where both grey and harbour seals are protected under Order; these comprise locations on land where seals come ashore to rest, moult or breed (Figure A1a.8.15). Numerous SACs have been established for otters throughout the UK, several of which contain marine components.

Through national legislation, areas for species other than those already listed in Annex II of the Habitats Directive may also receive protection; in Scotland, following the 2010 Marine (Scotland) Act, white-beaked dolphins, Risso's dolphins and minke whales have been included on the list of MPA search features (Marine Scotland, 2011) and regions of persistent high-use have been sought (Paxton *et al.* 2014). One site has been proposed exclusively for minke whales (the Southern Trench MPA proposal, in the southern Moray Firth) and minke whale, along with basking shark, are also a feature of the Sea of Hebrides MPA proposal. One site has been proposed for Risso's dolphins (North East Lewis MPA proposal).

[19] Further info: https://sac.jncc.gov.uk/species/S1351/

References

Aguilar de Soto N, Gillespie D, Hammond P, Johnson M, Reyes C & Tyack P (2016). Beaked whales: a review of distribution and abundance in UK waters and new information on life history, diving behaviour and ecology, noise impacts, approaches to monitoring and options for mitigation. Report for the DECC Offshore Energy SEA programme by the Sea Mammal Research Unit, University of St Andrews.

Andersen LW, Born EW, Dietz R, Haug T, Oien N & Bendixen C (2003). Genetic population structure of minke whales *Balaenoptera acutorostrata* from Greenland, the North East Atlantic and the North Sea probably reflect different ecological regions. *Marine Ecology Progress Series* **247:** 263-280.

Andersen LW, Holm LE, Siegismund HR, Clausen B, Kinze CC & Loeschcke V (1997) A combined DNA-microsatellite and isozyme analysis of the population structure of the harbour porpoise in Danish waters and West Greenland. *Heredity* **78**: 270–276

Andersen LW, Ruzzante DE, Walton M, Berggren P, Bjørge A & Lockyer C (2001). Conservation genetics of the harbour porpoise, *Phocoena phocoena*, in eastern and central North Atlantic. *Conservation Genetics* **2**: 309-324.

Anderwald P, Danielsdottir AK, Haug T, Larsen F, Lesage V, Reid RJ, Vikingsson GA & Hoelzel AR (2011). Possible cryptic stock structure for minke whales in the North Atlantic: implications for conservation and management. *Biological Conservation* **144:** 2479-2489.

Anderwald P, Evans PGH, Dyer R, Dale A, Wright PJ & Hoelzel AR (2012). Spatial scale and environmental determinants in minke whale habitat use and foraging. *Marine Ecology Progress Series* **450**: 259-274.

Arnett EB, Brown WK, Erickson WP, Fiedler JK, Hamilton BI, Henry TH, Aaftab J, Johnson GD, Kerns J, Koford RR, Nicholson CP, O'Connell TJ, Piorkowski MD & Tankersley Jnr RD (2008). Patterns of bat fatalities at wind energy facilities in North America. *The Journal of Wildlife Management* **72**: 61-78.

Arso Civil M, Quick NJ, Cheney B, Pirotta E, Thompson PM & Hammond PS (2019). Changing distribution of the east coast of Scotland bottlenose dolphin population and the challenges of area-based management. *Aquatic Conservation: Marine and Freshwater Ecosystems* **29**: 178-196.

Baerwald EF, D'Amours GH, Klug BJ & Barclay RMR (2008). Barotrauma is a significant cause of bat fatalities at wind turbines. *Current Biology* **18(16)**: Article R695, 2pp.

Baines ME & Evans PGH (2012). Atlas of the marine mammals of Wales. CCW Marine Monitoring Report No. 68. 2nd edition, 139pp.

Barclay RMR, Baerwald EF & Gruver JC (2007). Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. *Canadian Journal of Zoology* **85**: 381-387.

Beaugrand G, Ibañez F, Lindley JA & Reid PC (2002). Diversity of calanoid copepods in the North Atlantic and adjacent seas: species associations and biogeography. *Marine Ecology Progress Series* **232**: 179-195.

Benjamins S, Dale A, Hastie G, Waggitt JJ, Lea M-A, Scott B & Wilson B (2015). Confusion reigns? A review of marine megafauna interactions with tidal-stream environments. *Oceanography and Marine Biology* **53**: 1-54

Bennet PM, Jepson PD, Law RJ, Jones BR, Kuiken T, Baker JR, Rogan E & Kirkwood JK (2001). Exposure to heavy metals and infectious disease mortality in harbour porpoises from England and Wales. *Environmental Pollution* **112**: 33-40.

Berrow SD, O'Brien J, Meade R, Delarue J, Kowarski K, Martin B, Moloney J, Wall D, Gillespie D, Leaper R, Gordon J, Lee A & Porter L (2018). Acoustic Surveys of Cetaceans in the Irish Atlantic Margin in 2015-2016: Occurrence, distribution and abundance. Department of Communications, Climate Action & Environment and the National Parks and Wildlife Service (NPWS), Department of Culture, Heritage and the Gaeltacht, Dublin, Ireland, 348pp.

Berry D & Kent E (2008). Marine air temperature. *Marine Climate Change Impacts Partnership Annual Report Card 2007-2008 Scientific Review* from National Oceanography Centre, Southampton, 5pp.

Bexton S, Thompson D, Brownlow A, Barley J, Milne R & Bidewell C (2012). Unusual mortality of pinnipeds in the United Kingdom associated with helical (corkscrew) injuries of anthropogenic origin. *Aquatic mammals* **38**: 229-240.

Boer M de (2010). Spring distribution and density of minke whale *Balaenoptera acutorostrata* along an offshore bank in the central North Sea. *Marine Ecology Progress Series* **408**: 265–274.

Bolt HE, Harvey PV, Mandleberg L & Foote AD (2009). Occurrence of killer whales in Scottish inshore waters: temporal and spatial patterns relative to the distribution of declining harbour seal populations. *Aquatic Conservation* **19**: 671-675.

Bones M, Neill B, Reid B (1998). Fraser's Dolphin *Lagenodelphis hosei* stranded in South Uist: first record in UK waters. Journal of Zoology, London 246, 460–461.

Bouveroux T, Kiszka J, Heithous MR, Jauniaux T & Pezeril S (2014). Direct evidence for grey seal (*Halichoerus grypus*) predation and scavenging on harbour porpoises (*Phocoena phocoena)*. *Marine Mammal Science* **30**: 1542-1548.

Britton R, Pegg J, Shepherd J & Toms S (2006). Revealing the prey items of the otter *Lutra lutra* in South West England using stomach contents analysis. *Folia Zoologica* **55**: 167–174.

Brookes, K. 2017. The East Coast Marine Mammal Acoustic Study data. doi: 10.7489/1969-1

Brownlow A, Davison NJ & ten Doeschate MTI (2019a). Scottish Marine Animal Stranding Scheme (SMASS) Annual Report 2018. Report to Marine Scotland, 94pp. Doi: 10.31219/osf.io/qkcwg

Brownlow A, Davidson N, ten Doeschate M, Berrow S, Dagleish M, Deaville R, van Geel N, Hantke G, Jepson P, Onoufriou A, Risch D, Rocchi M & Dale A (2019b). Deep trouble: Investigation into an unprecedented number of beaked whale strandings, eastern Atlantic, July-October 2018. World Marine Mammal Conference, Barcelona, 9-12 December 2019.

Brownlow A, ten Doeschate MTI & Davison NJ (2020). Scottish Marine Animal Stranding Scheme (SMASS) Annual Report 2019. Report to Marine Scotland, 96pp. https://doi.org/10.31219/osf.io/8c7vm

Bull JC, Jepson PD, Ssuna RK, Deaville R, Allchin CR, Law RJ & Fenton A (2006). The relationship between polychlorinated biphenyls in blubber and levels of nematode infestations in harbour porpoises, *Phocoena phocoena*. *Parasitology* **132**: 565-573.

Callaway R, Engelhard GH, Dann J, Cotter J & Rumohr H (2007). A century of North Sea epibenthos and trawling: comparison between 1902–1912, 1982–1985 and 2000. *Marine Ecology Progress Series* **346**: 27-43.

Camphuysen CJ & Garthe S (2000). Seabirds and commercial fisheries: population trends of piscivorous seabirds explained? *In: MJ Kaiser & SJ de Groot Eds. Effects of fishing on non-target species and habitats. Blackwell Scientific, Oxford, pp. 163-184.*

Camphuysen KCJ (2004). The return of the harbour porpoise (*Phocoena phocoena*) in Dutch coastal waters. *Lutra* **47**: 113–122.

Camphuysen KCJ, Smeenk C, Addink MJ, Van Grouw H, Jansen OE (2008) Cetaceans stranded in the Netherlands from 1998 to 2007. Lutra 51: 87–122.

Cañadas A, Donovan GP, Desportes G & Borchers DL (2009). A short review of the distribution of short beaked common dolphins (*Delphinus delphis*) in the central and eastern North Atlantic with an abundance estimate for part of this area. North Atlantic Sightings Surveys. *NAMMCO Scientific Publications* **7**: 201-220.

Canning SJ, Santos MB, Reid RJ, Evans PGH, Sabin RC, Bailey N & Pierce GJ (2008). Seasonal distribution of white-beaked dolphins (Lagenorhynchus albirostris) in UK waters with new information on diet and habitat use. Journal of the Marine Biological Association of the United Kingdom 88: 1159-1166.

Carter MID, Boehme L, Duck CD, Grecian WJ, Hastie GD, McConnell BJ, Miller DJ, Morris CD, Thompson D, Thompson P & Russell DJF (2020). Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles. Report to BEIS, OESEA-16-76/OESEA-16-78. Sea Mammal Research Unit, University of St Andrews.

Charif RA & Clark CW (2000). Acoustic monitoring of large whales off north and west Britain and Ireland: a two-year study, October 1996 - September 1998. JNCC Report No. 313, Joint Nature Conservation Committee, Peterborough, UK, 35pp.

Charif RA & Clark CW (2009). Acoustic monitoring of large whales in deep waters north and west of the British Isles: 1996 - 2005. Preliminary Report to the UK Department of Energy and Climate Change, 40pp.

Cheney B, Corkrey R, Quick NJ, Janik VM, Islas-Villanueva V, Hammond PS & Thompson PM (2012). Site Condition Monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation: 2008 - 2010. Scottish Natural Heritage Commissioned Report No.512, 41pp.

Cheney B, Thompson PM, Ingram SN, Hammond PS, Stevick PT, Durban JW, Culloch RM, Elwen SH, Mandleberg L, Janik VM, Quick NJ, Islas-Villanueva V, Robinson KP, Costa M, Eisfield SM, Walters A, Phillips C, Weir CR, Evans PGH & Anderwald P (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, Graham IM, Barton TR, Hammond PS & Thompson PM (2014). Site Condition Monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation: 2011-2013. Scottish Natural Heritage Commissioned Report No. 797.

Cheney B, Graham IM, Barton TR, Hammond PS & Thompson PM (2018). Site Condition Monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation: 2014-2016. Scottish Natural Heritage Commissioned Report No. 1021.

Clark RA & Frid CLJ (2001). Long-term changes in the North Sea ecosystem. *Environmental Review* ***9***: 131-187.

Convention on Biological Diversity (2020). Anthropogenic Underwater Noise: Impacts on Marine and Coastal Biodiversity and Habitats, and Mitigation and Management Measures. Convention on Biological Diversity Technical Series. Ref: SCBD/SSSF/AS/ML/JA/JG/89022. Draft report circulated for peer review on 06/09/2020. https://www.cbd.int/doc/notifications/2020/cbd-ts-underwater-noise-peer-review-en.pdf

Crass D (1995). Foraging behaviour and feeding ecology of the otter (*Lutra lutra*): A selective review. *Hystrix* **7**: 179-194.

Crawford A (2010). Fifth Otter Survey of England 2009-2010. Environment Agency, Bristol, 125pp. http://www.thepredationactiongroup.co.uk/images/EA_otter_survey_oct10.pdf

Culloch RM & Robinson KP (2008). Bottlenose dolphins using coastal regions adjacent to a Special Area of Conservation in north-east Scotland. *Journal of the Marine Biological Association of the UK* **88:** 1237-1243.

Das K, Lepoint G, Leroy Y & Bouquegneau JM (2003). Marine mammals from the southern North Sea: feeding ecology data from $\delta^{13}C$ and $\delta^{15}N$ measurements. *Marine Ecology Progress Series* **263**: 287-298.

de Boer MN (2010). Spring distribution and density of minke whale *Balaenoptera acutorostrata* along an offshore bank in the central North Sea. *Marine Ecology Progress Series* **408**: 265-274.

de Boer MN, Leaper R, Keith S & Simmonds MP (2008). Winter abundance estimates for common dolphin (*Delphinus delphis*) in the western approaches of the English Channel and the effect of responsive movement. *Journal of Marine Mammals and their Ecology* **1**: 15-21.

de Boer MN, Clark J, Leopold MF, Simmonds MP & Reijnders PJH (2013). Photo-identification methods reveal seasonal and long-term site-fidelity of Risso's dolphins (*Grampus griseus*) in shallow waters (Cardigan Bay, Wales). *Open Journal of Marine Science* **3**: 65-74.

De Pierrepont JF, Dubois B, Desmonts S, Santos MB & Robin JP (2005). Stomach contents of English Channel cetaceans stranded on the coast of Normandy. *Journal of the Marine Biological Association of the United Kingdom* **85**: 1539-1546.

Deaville R & Jepson PD (2007). UK Cetacean strandings investigation programme. Annual Report to Defra for the period 1st January – 31st December 2006 (Contract No. CR0346). 37pp. plus appendix.

Deaville R, Jjepson PD, Perkins M, Brownlow A, Davison N, ten Doeschate M, Smith B, Allan L, Clery M, Swindells K, Wilson S, Sabin RC, Penrose R, Barnett JEF, Astley K, Clear N, Crosby A & Williams R (2018). UK Cetacean Strandings Investigation Programme final contract report to Defra (MB0111 2011-2017) http://randd.defra.gov.uk/Document.aspx?Document=14514_FINALCSIPContractReport2011-2017.pdf

DECC (2016). Offshore Energy Strategic Environmental Assessment 3, Environmental Report. Department of Energy and Climate Change, UK, 613pp. plus appendices.

Deecke VB, Nykänen M, Foote AD & Janik VM (2011). Vocal behaviour and feeding ecology of killer whales *Orcinus orca* around Shetland, UK. *Aquatic Biology* **13**: 79−88.

Defra (2005). Charting Progress: An Integrated Assessment of the State of UK Seas. Department for Environment, Food and Rural Affairs, London, 130pp.

Defra (2012). Marine Strategy Part One: UK Initial Assessment and Good Environmental Status. Consultation document published by the Department for Environment Food and Rural Affairs on behalf of HM Government. December 2012. 163 pp.

Defra (2014). Marine Strategy Part Two: UK marine Monitoring Programmes. Published by the Department for Environment Food and Rural Affairs on behalf of HM Government. July 2014. 86pp. https://www.gov.uk/government/publications/marine-strategy-part-two-uk-marine-monitoring-programmes

Dolman SJ, Hodgins NK, MacLeod CD, Pierce GJ & Weir CR (2013). Harbour porpoises (*Phocoena phocoena*) and minke whales (*Balaenoptera acutorostrata*) observed during land-based surveys in The Minch, north-west Scotland. *Journal of the Marine Biological Association of the United Kingdom* **94**: 1185-1194.

Duck CD & Morris CD (2014). Surveys of harbour and grey seals on the east, north and north-west coast of Scotland and in Orkney, including the Moray Firth and the Firth of Tay, in August 2013. Scottish Natural Heritage Commissioned Report No. 759, 40pp.

Duck CD & Morris CD (2015). Surveys of harbour and grey seals on the west coast of Scotland (Ullapool to Scarba), in the Moray Firth and in the Firth of Tay, in August 2014. Scottish Natural Heritage Commissioned Report No. 869.

Eisfeld-Pierantonio S & James V (2018). Risso's dolphins of Ynys Enlli / Bardsey Island: Photo-ID catalogue. NRW Evidence Report No: 261, Natural Resources Wales, Bangor, 17pp.

Embling CB, Gillibrand PA, Gordon J, Shrimpton J, Stevick PT & Hammond PS (2010). Using habitat models to identify suitable sites for marine protected areas for harbour porpoises (*Phocoena phocoena*). *Biological conservation* **143**: 267-279.

Evans PGH & Bjørge A (2013). Impacts of climate change on marine mammals, *MCCIP Science Review 2013*, pp. 134-148.

Evans PGH & Waggitt JJ (2020). Impacts of climate change on marine mammals, relevant to the coastal and marine environment around the UK. *MCCIP Science Review 2020*: 421-455.

Evans PGH, Pierce GJ, Veneruso G, Weir CR, Gibas D, Anderwald P & Santos BM (2015). Analysis of long-term effort-related land-based observations to identify whether coastal areas of harbour porpoise and bottlenose dolphin have persistent high occurrence & abundance. JNCC Report No. 543, Joint Nature Conservation Committee, Peterborough, UK, 152pp.

Feingold D & Evans PGH (2013). Bottlenose dolphin and harbour porpoise monitoring in Cardigan Bay and Pen Llŷn a'r Sarnau Special Areas of Conservation. Sea Watch Foundation, Interim report, 76pp plus appendices.

Feingold D & Evans PGH (2014a). Bottlenose Dolphin and Harbour Porpoise Monitoring in Cardigan Bay and Pen Llŷn a'r Sarnau Special Areas of Conservation 2011 - 2013. NRW Evidence Report Series Report No. 4, Natural Resources Wales, Bangor. 120pp.

Feingold D & Evans PGH (2014b). Connectivity of Bottlenose Dolphins in Welsh Waters: North Wales Photo-monitoring report. Report by the SeaWatch Foundation, 16pp.

Fernandez R, Pierce GJ, Macleod CD, Brownlow A, Reid RJ, Rogan E, Addink M, Deaville R, Jepson PD & Santos MB (2014). Strandings of northern bottlenose whales, *Hyperoodon ampullatus*, in the north-east Atlantic: seasonality and diet. *Journal of the Marine Biological Association of the United Kingdom* **94**: 1109-1116.

Filan M (2015) Mark recapture abundance estimates and distribution of bottlenose dolphins (*Tursiops truncatus*) using the southern coastline of the outer southern Moray Firth. MSc Wildlife Biology & Conservation, Research Dissertation. Edinburgh Napier University.

Finneran JJ (2015). Noise-induced hearing loss in marine mammals: a review of temporary threshold shift studies from 1996 to 2015.

Folkow LP, Mårtensson P & Blix AS (1996). Annual distribution of hooded seals (*Cystophora cristata*) in the Greenland and Norwegian Seas. *Polar Biology* **16**: 179-189.

Fontaine MC, Baird SJE, Piry S, Ray N and others (2007) Rise of oceanographic barriers in continuous populations of a cetacean: the genetic structure of harbour porpoises in Old World waters. *BMC Biology* **5**: 30

Foote AD, Vikingsson G, Øien N, Bloch D, Davis CG, Dunn TE, Harvey P, Mandleberg L, Whooley P & Thompson PM (2007). Distribution and abundance of killer whales in the North East Atlantic. Scientific Committee Paper SC/59/SM5, International Whaling Commission, 10pp. http://www.iwcoffice.org/_documents/sci_com/SC59docs/SC-59-SM5.pdf

Gajdosechova Z, Brownlow A, Cottin NT, Fernandes M, Read FL, Urgast DS, Raab A, Feldmann J & Krupp EM (2016). Possible link between Hg and Cd accumulation in the bain of long-finned pilot whales (*Globicephala melas*). *Science of the Total Environment* 545-546: 407-413.

Gannon DP, Read AJ, Craddock JE, Fristrup KM & Nicolas JR (1997). Feeding ecology of long-finned pilot whales *Globicephala melas* in the western north Atlantic. *Marine Ecology Progress Series* **148**: 1-10.

Gilles A, Peschko V, Scheidat M & Siebert U (2012). Survey for small cetaceans over the Dogger Bank and adjacent areas in summer 2011. Document submitted by Germany to 19th ASCOBANS Advisory Committee Meeting in Galway, Ireland, 20-22 March 2012. AC19/Doc.5-08(P). 16pp.

Gilles A, Viquerat S, Becker EA, Forney KA, Geelhoed SCV, Haelters J, Nabe-Nielsen J, Scheidat M, Siebert U, Sveegaard S, van Beest FM, van Bemmelen R & G Aarts (2016). Seasonal habitat-based density models for a marine top predator, the harbor porpoise, in a dynamic environment. *Ecosphere* **7**: e01367.

Gomez C, Lawson JW, Wright AJ, Buren AD, Tollit D & Lesage V (2016). A systematic review on the behavioural responses of wild marine mammals to noise: the disparity between science and policy. *Canadian Journal of Zoology* **94**: 801-819.

Goodman SJ (1998). Patterns of extensive genetic differentiation and variation among European harbour seals (*Phoca vitulina vitulina*) revealed using microsatellite DNA polymorphisms. *Molecular Biology and Evolution* **15**: 104-118.

Goodwin L & Speedie C (2008). Relative abundance, density and distribution of the harbour porpoise (*Phocoena phocoena*) along the west coast of the UK. *Journal of the Marine Biological Association of the United Kingdom* **88**: 1221-1228.

Grellier K & Wilson B (2003). Bottlenose dolphins using the Sound of Barra, Scotland. *Aquatic Mammals* 29.3: 378–382.

Haelters J, Kerckhof F, Jacques TG & Degraer S (2011). The harbour porpoise *Phocoena phocoena* in the Belgian part of the North Sea: trends in abundance and distribution. *Belgian Journal of Zoology* **141**: 75-84.

Hague EL, Sinclair RR & Sparling CE (2020). Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters. *Scottish Marine and Freshwater Series* **11(12)**. Marine Scotland Science, Aberdeen, 305pp.

Hall AJ, Hugunin K, Deaville R, Law RJ, Allchin CR & Jepson PD (2006). The risk of infection from polychlorinated biphenyl exposure in the harbour porpoise (*Phocoena phocoena*): a case control approach. *Environmental Health Perspectives* **114**: 704-722.

Hall AJ, McConnell BJ & Breen C (2001). By-catch of Seals in Fishing Gear - A preliminary analysis of tagging data, 1950-2000. ICES WGMMPH, Copenhagen, 10 pp.

Hammond PS & Grellier K (2006). Grey seal diet composition and prey consumption in the North Sea. Final Report to Department for Environment Food and Rural Affairs Project MF0319.

Hammond PS, Gordon JCD, Grellier K, Hall AJ, Northridge SP, Thompson D & Harwood J (2001). Background information on marine mammals relevant to SEA 2. Report to the DTI from the Sea Mammal Research Unit, University of St. Andrews, UK, 70pp.

Hammond PS, Gordon JCD, Grellier K, Hall AJ, Northridge SP, Thompson D & Harwood J (2002a). Background information on marine mammals relevant to Strategic Environmental Assessments 2 and 3. Report to the DTI from the Sea Mammal Research Unit, University of St. Andrews, UK, 60pp. plus appendices.

Hammond PS, Berggren P, Benke H, Borchers DL, Collet A, Heide-Jørgensen MP, Heimlich S, Hirby AR, Leopold MF & Øien N (2002b). Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. *Journal of Applied Ecology* **39**: 361-376.

Hammond PS, Macleod K, Northridge SP, Thompson D & Matthiopoulos J (2003). Background information on marine mammals relevant to Strategic Environmental Assessment 4. Report to the DTI from the Sea Mammal Research Unit, University of St. Andrews, UK, 49pp. plus appendices.

Hammond PS, Northridge SP, Thompson D, Gordon JCD, Hall AJ, Aarts G & Matthiopoulos J (2005). Background information on marine mammals for Strategic Environmental Assessment 6. Report to the Department of Trade and Industry. Sea Mammal Research Unit, St. Andrews, Scotland, UK, 73pp.

Hammond PS, Northridge SP, Thompson D, Gordon JCD, Hall AJ, Duck CD, Aarts G, Cunningham L, Embling CB & Matthiopoulos J (2006). Background information on marine mammals for Strategic Environmental Assessment 7. Report to the DTI from Sea Mammal Research Unit, University of St. Andrews, UK, 63pp. plus appendices.

Hammond PS, Northridge SP, Thompson D, Gordon JCD, Hall AJ, Murphy SN & Embling CB (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, 52pp.

Hammond PS, Northridge SP, Thompson D, Gordon JCD, Hall AJ, Sharples RJ, Grellier K, & Matthiopoulos J (2004). Background information on marine mammals relevant to Strategic Environmental Assessment 5. Report to the DTI from the Sea Mammal Research Unit, University of St. Andrews, UK, 52pp. plus appendices.

Hammond P, Macleod K, Gillespie D, Swift R, Winship A, Burt M, Cañadas A, Vázquez J, Ridoux V, Certain G, Van Canneyt O, Lens S, Santos B, Rogan, Uriarte A, Hernandez C & Castro R (2009). Cetacean Offshore Distribution and Abundance (CODA) survey report 43pp.

Hammond P, Macleod K, Berggren P, Borchers D, Burt L, Cañadas A, Desportes G, Donovan G, Gilles A, Gilliespie D, Gordon J, Hiby L, Kuklik I, Leaper R, Lehnert K, Leopold M, Lovell P, Øien N, Paxton C, Ridoux V, Rogan E, Samarra F, Scheidat M, Sequeira M, Siebert U, Skoz H, Swift R, Tasker M, Teilmann J, Canneyt O & Vázquez J (2013). Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. *Biological Conservation* **164**: 107-122.

Hammond PS, Lacey C, Gilles A, Viquerat S, Börjesson P, Macleod K, Ridoux V, Santos MB, Scheidat M, Teilmann J, Vingada J & Øien N (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys,

Hammond PH, Lacey C, Breen P, Cañadas A, Geelhoed S, Gilles A, Herr H, Jessopp M, Macleod K, Ó Cadhla O, Ridoux V, Rogan E, Santos MB, Scheidat M, Teilmann J, Vingada J & Øien N (2019). Decadal-scale changes in cetacean species-habitat relationships and distribution in summer in European Atlantic waters. *World Marine Mammal Conference*, Barcelona, 9-12 December 2019.

Harvell CD, Kim K, Burkholder JM, Colwell RR, Epstein PR, Grimes DJ, Hofmann EE, Lipp EK, Osterhaus ADME, Overstreet RM, Porter JW, Smith GW & Vasta GR (1999). Emerging marine diseases - Climate links and anthropogenic factors. *Science* **285**: 1505-1510.

Hastie GD, Barton TR, Grellier K, Hammond PS, Swift RJ, Thompson PM & Wilson B (2003). Distribution of small cetaceans within a candidate Special Area of Conservation; implications for management. *Journal of Cetacean Resource Management* **5**: 261-266.

Hastie GD, Wilson B, Wilson LJ, Parsons KM & Thompson PM (2004). Functional mechanisms underlying cetacean distribution patterns: hotspots for bottlenose dolphins are linked to foraging. *Marine Biology* **144**: 397-403.

Heath MR, Neat FC, Pinnegar JK, Reid DG, Sims DW & Wright PJ (2012). Review of climate change impacts on marine fish and shellfish around the UK and Ireland. *Aquatic Conservation: Marine and Freshwater Ecosystems* **22**: 337-367 DOI: 10.1002/aqc.2244.

Heinänen S & Skov H (2015). The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area. JNCC Report No. 544, Joint Nature Conservation Committee, Peterborough, UK, 108pp.

Hernandez-Milian G, Berrow S, Santos MB, Reid D & Rogan E (2015). Insights into the trophic ecology of bottlenose dolphins (*Tursiops truncatus*) in Irish waters. *Aquatic mammals* **41**: 226-239.

Hernandez-Milian G, Begoña Santos M, Reid D & Rogan E (2016). Insights into the diet of Atlantic white-sided dolphins (*Lagenorhynchus acutus*) in the Northeast Atlantic. *Marine Mammal Science* **32**: 735-742.

Heyning JE & Dahlheim ME (1988). Orcinus orca. *Mammalian Species* **304**:1-9.

Holliday NP, Kennedy J, Kent EC, Marsh R, Hughes SL, Sherwin T & Berry DI (2008). Sea temperature. Marine Climate Change Impacts Partnership Annual Report Card 2007-2008 Scientific Review, 9pp.

Hodgins NK, Dolman SJ & Weir CR (2014). Potential hybridism between free-ranging Risso's dolphins (*Grampus griseus*) and bottlenose dolphins (*Tursiops truncatus*) off north-east Lewis (Hebrides, UK). *Marine Biodiversity Records* **7**: e97.

Hutterer R, Ivanova T, Meyer-Cords C & Rodrigrues L (2005). Bat migrations in Europe: a review of banding data and literature. Naturschutz und Biologische Vielfalt. Vol. 28. Federal Agency for Nature Conservation, Bonn, Germany.

HWDT (2006). HWDT sightings report 2005. Hebridean Whale and Dolphin Trust, Tobermory, Mull, Scotland, UK, 7pp. http://www.whaledolphintrust.org/research/documents/HWDTSightingsSummary2005.pdf

HWDT (2018). Hebridean Marine Mammal Atlas. Part 1: Silurian, 15 years of marine mammal monitoring in the Hebrides. A Hebridean Whale and Dolphin Trust Report (HWDT), Scotland, UK, 60pp.

IAMMWG (2015). Management Units for cetaceans in UK waters (January 2015). JNCC Report No. 547, Joint Nature Conservation Committee, Peterborough, UK, 42pp.

IAMMWG (2021). Updated abundance estimates for cetacean Management Units in UK waters. JNCC Report No. 680, JNCC Peterborough, ISSN 0963-8091. https://data.jncc.gov.uk/data/3a401204-aa46-43c8-85b8-5ae42cdd7ff3/JNCC-Report-680-FINAL-WEB.pdf

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 (2015). Bycatch of small cetaceans and other marine animals – Review of national reports under Council Regulation (EC) No.812/2004 and other published documents. ICES Special Request Advice. Published 15 April 2015. ICES website [accessed August 2015]. http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/Bycatch_of_PETS_Advice_2015.pdf

ICES WGBYC (2015). Report of the Working Group on Bycatch of Protected Species (WGBYC), 2-6 February 2015, International Council for the Exploration of the Sea Headquarters, Copenhagen, Denmark. ICES CM 2015\ACOM:26, 82pp.

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

Ingram SN & Rogan E (2002). Identifying critical areas and habitat preferences of bottlenose dolphins *Tursiops truncatus*. *Marine Ecology Progress Series* **244**: 247-255.

IJsseldijk LL, ten Doeschate MTI, Brownlow A, Davison NJ, Deaville R, Galatius A, Gilles A, Haelters J, Jepson PD, Keijl GO, Kinze CC, Olsen MT, Siebert U, Thøstesen CB, van den Broek J, Gröne A & Heesterbeek H (2020). Spatiotemporal mortality and demographic trends in a small cetacean: Strandings to inform conservation management. *Biological Conservation* **249**: 108733.

IUCN Red List website. The IUCN Red List of Threatened Species. https://www.iucnredlist.org/ (Accessed October 2020).

Jansen OE, Leopold MF, Meesters EHWG & Smeenk C (2010). Are white-beaked dolphins *Lagenorhynchus albirostris* food specialists? Their diet in the southern North Sea. *Journal of the Marine Biological Association of the United Kingdom* **90**: 1501-1508.

Jansen OE, Michel L, Lepoint G, Das K, Couperus AS & Reijnders PJH (2013). Diet of harbour porpoises along the Dutch coast: a combined stable isotope and stomach contents approach. *Marine Mammal Science* **29**: E295-E311.

Jauniaux T, Berguerie H, Camphuysen K, Daoust P-Y, Drouguet O, Ghisbain T, Garcia-Hartmann M, Grondin A, Haelters J, Jaques T, Kiszka J, Leopold M, Pezeril S, Schnitzler JG & Coignoul F (2008). Causes of death of harbour porpoises (*Phocoena phocoena*) stranded on the continental coastline of the southern North Sea (Belgium, France and Dutch coasts) between 1990 and 2007. ICES CM 2008/D:09.

Jefferies DJ (1989). The changing otter population of Britain 1700-1989. *Biological Journal of the Linnean Society* **38**: 61-69.

Jefferson TA, Webber MA, Pitman RL (2015). Marine Mammals of the World (Second Edition)@ A comprehensive guide to their identification. Academic Press.

Jepson PD & Deaville R (2009). Investigation of the common dolphin mass stranding event in Cornwall, 9th June 2008. Funded as a variation under contract CR0364. Available at: http://randd.defra.gov.uk/Document.aspx?Document=WC0601_8031_TRP.pdf

Jepson PD, Bennett PM, Deaville R, Allchin CR, Baker JR & Law RJ (2005). Relationships between PCBs and health status in harbour porpoises (*Phocoena phocoena*) stranded in the United Kingdom. *Environmental Toxicology & Chemistry* **24**: 238–248.

Jepson, PD, Deaville R, Barber JL, Aguilar À, Borrell A, Murphy S, Barry J, Brownlow A, Barnett J, Berrow S, Cunningham AA, Davison NJ, ten Doeschate M, Esteban R, Ferreira M, Foote AD, Genov T, Giménez J, Loveridge J, Llavona Á, Martin V, Maxwell DL, Papachlimitzou A, Penrose R, Perkins MW, Smith B, de Stephanis R, Tregenza N, Verborgh P, Fernandez A & Law RJ (2016). PCB pollution continues to impact populations of orcas and other dolphins in European waters. *Scientific Reports* **6**: 18573.

JNCC (2007). Species conservation status reports. Second Report by the United Kingdom under Article 17 of the EU Habitats Directive. Joint Nature Conservation Committee, Peterborough. http://jncc.defra.gov.uk/page-4060 (accessed August 2015).

JNCC (2010). JNCC guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys. Joint Nature Conservation Committee, Aberdeen, 16pp.

JNCC (2013). Species conservation status reports. Third Report by the United Kingdom under Article 17 of the EU Habitats Directive. Joint Nature Conservation Committee, Peterborough. http://jncc.defra.gov.uk/page-6564 (accessed August 2015).

JNCC (2019). Species conservation status assessment reports. Third Report by the United Kingdom under Article 17 of the EU Habitats Directive. Joint Nature Conservation Committee, Peterborough. https://jncc.gov.uk/our-work/article-17-habitats-directive-report-2019-species/#regularly-occurring-species-vertebrate-species-mammals-marine (accessed March 2022).

JNCC (2021). Our work. Joint Cetacean Data Programme. https://jncc.gov.uk/our-work/joint-cetacean-data-programme/ (accessed January 2022).

Jones EL & Russell DJF (2016). Updated grey seal (*Halichoerus grypus*) usage maps in the North Sea. Report for the Department of Energy and Climate Change(OESEA-15-65).

Jones AR, Hosegood P, Wynna RB, De Boer MN, Butler-Cowdry S & Embling CB (2014). Fine-scale hydrodynamics influence the spatio-temporal distribution of harbour porpoises at a coastal hotspot. *Progress in Oceanography* **128**: 30-48.

Jones EL, McConnell BJ, Smout S, Hammond PS, Duck CD, Morris CD, Thompson D, Russell DJF, Vincent C, Cronin M, Sharples RJ & Matthiopoulos J (2015). Patterns of space use in sympatric marine colonial predators reveal scales of spatial partitioning. *Marine Ecology Progress Series* **534**: 235-249.

Jung J-L, Stephan E, Louis M, Alfonsi E, Liret C, *et al.* (2009) Harbour porpoises (*Phocoena phocoena*) in north-western France: aerial survey, opportunistic sightings and strandings monitoring. Journal of the Marine Biological Association of the United Kingdom 89: 1045–1050.

Keily O, Lidgard D, McKibben M, Connolly N & Baines M (2000). Grey seals: status and monitoring in the Irish and Celtic Seas. INTERREG Report No. 3. Maritime Ireland/Wales, 85pp.

Kiszka JJ, Hassani S & Pezeril S (2004). Distribution and status of small cetaceans along the French Channel coasts: using opportunistic records for a preliminary assessment. *Lutra* **47**: 33-46.

Kowarski K, Delarue J, Martin B, O'Brien J, Meade R, Ó. Cadhla O & Berrow S (2018). Signals from the deep: Spatial and temporal acoustic occurrence of beaked whales off western Ireland. *PLoS ONE* **13**: e0199431.

Kruuk H (2006). *Otters: Ecology, behaviour and conservation*. Oxford University Press, Oxford, UK, 280pp.

Kruuk H, Conroy, J & Moorhouse A (1987). Seasonal reproduction, mortality and food of otters (*Lutra lutra* L.) in Shetland. *Symposium of the Zoological Society of London* **58**: 263-278.

Kruuk H, Wansink D & Moorhouse A (1990). Feeding patches and diving success of otters, (*Lutra lutra* L.) in Shetland. *Oikos* **57**: 68-72.

Kruuk H & Conroy JWH (1991). Mortality of Otters (*Lutra lutra*) in Shetland. *The Journal of Applied Ecology* **28**: 83-94.

Lacey C & Hammond P (In prep.) Distribution and abundance of beaked whales and other deep-diving cetaceans around the British Isles. Report by SMRU for BEIS.

Lambert E, Pierce GJ, Hall K, Brereton T, Dunn TE, Wall D, Jepson PD, Deaville R & Macleod CD (2014). Cetacean range and climate in the eastern North Atlantic: future predictions and implications for conservation'. *Global Change Biology* **20**: 1782-1793.

Law RJ (2014). An overview of time trends in organic contaminant concentrations in marine mammals: going up or down? *Marine Pollution Bulletin* **82**: 7-10.

Law RJ, Bersuder P, Barry J, Barber J, Deaville R, Barnett J & Jepson PD (2013). Organochlorine pesticides and chlorobiphenyls in the blubber of bycaught female common dolphins from England and Wales from 1992 to 2006. *Marine Pollution Bulletin* **69:** 238-242.

Learmonth, JA (2006). Life history and fatty acid analysis of harbour porpoises (*Phocoena phocoena*) from Scottish waters. PhD Thesis. University of Aberdeen, Scotland, UK.

Learmonth JA, Murphy S, Luque PL, Reid RJ, Patterson IAP, Brownlow A, Ross HM, Barley JP, Santos BM & Pierce GJ (2014). Life history of harbour porpoises (*Phocoena phocoena*) in Scottish (UK) waters. *Marine Mammal Science* **30**: 1427-1455.

Leeney RH, Amies R, Broderick AC, Witt MJ, Loveridge J, *et al.* (2008) Spatio-temporal analysis of cetacean strandings and bycatch in a UK fisheries hotspot. Biodiversity and Conservation 17: 2323–2338.

Leopold MF, Rotshuizen E & Evans PGH (2018). From nought to 100 in no time: how humpback whales (*Megaptera novaeangliae*) came into the southern North Sea. *Lutra* **61**(1): 165-188.

Lewis TP, Swift R, Gonzalbes P, Butler J & Gordon JG (1998). Passive acoustic monitoring of cetacean distribution north-west of the Hebrides, 1997-1998. Hebridean Whale and Dolphin Trust, Mull, 75pp.

Lockyer C (2007). All creatures great and smaller: a study in cetacean life history energetic. *Journal of the Marine Biological Association of the United Kingdom* **87**: 1035-1045.

Lohrengel K, Evans PGH, Lindenbaum CP, Morris CW & Stringell TB (2018) Bottlenose Dolphin Monitoring in Cardigan Bay, 2014 – 2016. NRW Evidence Report No. 191. 162pp. Prepared by Sea Watch Foundation and Natural Resources Wales

Lonergan M, Duck CD, Thompson D, Mackey BL, Cunningham L & Boyd IL (2007). Using sparse survey data to investigate the declining abundance of British harbour seals. *Journal of Zoology* **271**: 261-269.

Luque PL, Davis CG, Reid DG, Wang J & Pierce GJ (2006). Opportunistic sightings of killer whales from Scottish pelagic trawlers fishing for mackerel and herring off north Scotland (UK) between 2000 and 2006. *Aquatic Living Resources* **19**: 403-410.

Lusseau D, Wilson B, Hammond PS, Grellier K, Durban JW, Parsons KM, Barton TR & Thompson PM (2006). Quantifying the influence of sociality on population structure in bottlenose dolphins. *Journal of Animal Ecology* **75**: 14-24.

MacLennan E, Leaper R, Brownlow A, Calderan S, Jarvis D, Hartny-Mills L & Ryan C (2020). Estimates Of Humpback and Minke Whale Entanglements in Scotland. International Whaling Commission Scientific Committee (SC68B)

MacLeod CD, Bannon SM, Pierce GJ, Schweder C, Learmonth JA, Herman JS & Reid RJ (2005). Climate change and the cetacean community of north-west Scotland. *Biological Conservation* **124**: 477-483.

MacLeod CD, Santos MB, Reid RJ, Scott BE & Pierce GJ (2007). Linking sandeel consumption and the likelihood of starvation in harbour porpoises in the Scottish North Sea: could climate change mean more starving porpoises? *Biology Letters* **3**: 185-188.

MacLeod CD, Weir CR, Santos MB & Dunn TE (2008). Temperature-based summer habitat partitioning between white-beaked and common dolphins around the United Kingdom and Republic of Ireland. *Journal of the Marine Biological Association of the United Kingdom* **88**: 1193-1198.

MacLeod CD, Santos MB, Burns F, Brownlow A & Pierce GJ (2014). Can habitat modelling for the octopus *Eledone cirrhosa* help identify key areas for Risso's dolphin in Scottish waters? *Hydrobiologia* **725**: 125-136.

MacLeod CL, Santos MB & Pierce GJ (2003a). Review of data on diets of beaked whales: evidence of niche separation and geographic segregation. Journal of the Marine Biological Association of the United Kingdom 83: 651-665.

Macleod K & Hammond PS (2008). Progress Report on the CODA project prepared for 15th Ascobans Advisory Committee Meeting, Bonn, Germany, 31 March-3 April 2008. Document AC15/Doc.39(S), 5pp.

Macleod K, Simmonds MP & Murray E (2003b). Summer distribution and relative abundance of cetacean populations off northwest Scotland. Journal of the Marine Biological Association of the United Kingdom 83: 1187-1192.

Macleod K, Fairbairns R, Gill A, Fairbairns B, Gordon J, Blai-Myers C & Parsons ECM (2004). Seasonal distribution of minke whales Balaenoptera acutorostrata in relation to physiography and prey off the Isle of Mull, Scotland. Marine Ecology Progress Series 277: 263-274.

Mahfouz C, Henry F, Courcot L, Pezeril S, Bouveroux T, Dabin W, Jauniaux T, Khalaf G & Amara R (2014). Harbour porpoises (*Phocoena phocoena*) stranded along the southern North Sea: an assessment through metallic contamination. *Environmental Research* **133**: 266-273.

Mandleberg L (2006). Bottlenose dolphins of the Hebrides, a summary report from five years of research (2001-2005). Report to Biodiversity Action Grants Scheme. Hebridean Whale and Dolphin Trust, Tobermory, 19pp.

Marine Scotland (2011). Guidelines on the selection of MPAs and development of the MPA network – Appendix 3: List of MPA search features in Scotland's seas. Marine Scotland [website accessed December 2015]. http://www.gov.scot/Resource/Doc/295194/0114024.pdf

Marine Scotland (2015). Report of the inaugural quinquennial review of the operation of seal licensing system under the Marine (Scotland) Act 2010, 23pp. http://www.gov.scot/Resource/0048/00484588.pdf

Marubini F, Gimona A, Evans PGH, Wright PJ & Pierce GJ (2009). Habitat preferences and interannual variability in occurrence of the harbour porpoise, *Phocoena phocoena*, in the north-west of Scotland (UK). *Marine Ecology Progress Series* **381**: 297-310.

Matthiopoulos J, McConnell B, Duck C & Fedack M (2004). Using satellite telemetry and aerial counts to estimate space use by grey seals around the British Isles. *Journal of Applied Ecology* **41**: 476-491.

McClellan CM, Brereton T, Dell'Amico F, Johns DG, Cucknell A-C, Patrick SC, Penrose R, Ridoux V, Solandt J-L, Stephan E, Votier SC, Williams R, Godley BJ (2014). Understanding the distribution of marine megafauna in the English Channel region: identifying key habitats for conservation within the busiest seaway on earth. *PLoS ONE* **9**: e89720

McConnell BJ, Fedak MA, Lovell P & Hammond PS (1999). Movements and foraging of grey seals in the North Sea. Journal of Applied Ecology 36: 573-590.

McConnell B, Gillespie D, Gordon J, Hastie GD, Johnson M & Macaulay J (2013). Methods for tracking fine scale movements of marine mammals around marine tidal devices. Edinburgh: Scottish Government.

Mendes S, Turrell W, Lütkebohle T, Thompson P (2002) Influence of the tidal cycle and a tidal intrusion front on the spatio-temporal distribution of coastal bottlenose dolphins. *Marine Ecology Progress Series* **239**: 221-229.

Monteiro S, Ferreira M, Vingada JV, Lopez A, Brownlow A & Mendez-Fernandez P (2015). Application of stable isotopes to assess the feeding ecology of long-finned pilot whale (*Globicephala melas*) in the North-east Atlantic Ocean. *Journal of Experimental Marine Biology and Ecology* **466**: 55-63.

Murphy S (2004). The biology and ecology of the common dolphin *Delphinus delphis* in the North-east Atlantic. PhD thesis, University College Cork, Ireland.

Murphy S, Collet A & Rogan E (2005). Mating strategy in the male common dolphin *Delphinus delphis*: what gonadal analysis tells us. *Journal of Mammalogy* **86**: 1247-1258.

Murphy S & Rogan E (2006). External morphology of the short-beaked common dolphin, *Delphinus delphis*: growth, allometric relationships and sexual dimorphism. *Acta Zoologica* **87**: 315-329.

Murphy S, Gordon JCD, McConnell B, Matthiopoulos J, Isojunno S & Hammond PS (2008). Background information on marine mammals for Offshore Strategic Environmental Assessment. Report to the Department of Energy and Climate Change. SMRU Limited, St. Andrews, Scotland, UK, 130pp.

Murphy S, Pinn EU & Jepson PD (2013). The short-beaked common dolphin (*Delphinus delphis*) in the North-East Atlantic: distribution, ecology, management and conservation status. *Oceanography and Marine Biology: An Annual Review* **51**: 193-280.

Murphy S, Barber JL, Learmonth JA, Read FL, Deaville R, Perkins MW, Brownlow A, Davison N, Penrose R, Pierce GJ, Law RJ & Jepson PD (2015). Reproductive failure in UK harbour porpoises *Phocoena phocoena*: legacy of pollutant exposure? *PLoS ONE* **10(7)**: e0131085.

Northridge SP, Tasker ML, Webb A & Williams JM (1995). Distribution and relative abundance of harbour porpoises (*Phocoena phocoena* L.), white-beaked dolphins (*Lagenorhynchus albirostris* Gray), and minke whales (*Balaenoptera acutorostrata* Lacèpede) around the British Isles. *ICES Journal of Marine Science* **52**: 55-66.

Northridge S, Mackay A, Sanderson D, Woodcock R & Kingston A (2004). A review of dolphin and porpoise bycatch issues in the Southwest of England. Report to the Department for Environment Food and Rural Affairs. Sea Mammal Research Unit, St. Andrews, Scotland, UK.

Northridge S, Kingston A, Mackay A & Lonergan M (2011). Bycatch of Vulnerable Species: Understanding the Process and Mitigating the Impacts. Final Report to Defra Marine and Fisheries Science Unit. Project No. MF1003. University of St Andrews. Defra, London, 99pp.

Northridge S, Kingston A & Thomas L (2015). Annual report on the implementation of Council Regulation (EC) No 812/2004 during 2014. European Commission, 41pp.

Nøttestad L, Sivle LD, Krafft BA, Langård L, Anthonypillai V, Bernasconi M, Langøy H & Fernö A (2014). Prey selection of offshore killer whales *Orcinus orca* in the Northeast Atlantic in late summer: spatial associations with mackerel. *Marine Ecology Progress Series* **499**: 275-283.

Nowacek DP, Thorne LH, Johnston DW & Tyack PL (2007). Responses of cetaceans to anthropogenic noise. *Mammal Review* **37**: 81-115.

NRW (2018). Cardigan Bay / Bae Ceredigion Special Area of Conservation: Indicative site level feature condition assessments 2018. NRW Evidence Report Series, Report No: 226, 39pp, NRW, Bangor.

O'Donnell C, O'Malley M, Lynch D, Lyons K, Keogh N & O'Driscoll D (2017). Celtic Sea Herring Acoustic Survey (CSHAS) cruise report 2017. FSS Survey Series 2017/04, 38pp

O'Donnell C, Mullins E, Lynch D, Lyons K, Keogh N & O'Callaghan S (2018). Celtic Sea Herring Acoustic Survey cruise report 2018. FSS Survey Series 2018/04, 44pp.

Oakley JA, Jenkins RE, Thomas T, Williams AT & Phillips MR (2016). Assessing harbour porpoise populations in south-west Wales, data issues and implications for conservation and management. *Ocean and Coastal Management* **119**: 45-57.

Olsen E & Holst JC (2001). A note on common minke whale (*Balaenoptera acutorostrata*) diets in the Norwegian Sea and the North Sea. *Journal of Cetacean Research and Management* **3**: 179-183.

Onoufriou J & Thompson D (2014). Testing the hypothetical link between shipping and unexplained seal deaths: final report. SMRU Report to Scottish Government under Marine Mammal Scientific Support Research Programme MMSS/001/11, 33pp.

OSPAR (2009). Overview of the impacts of anthropogenic underwater sound in the marine environment. OSPAR Commission Biodiversity Series 2009. Publication Number 441/2009, 134pp.

OSPAR (2012). OSPAR's MSFD Advice Manual on Biodiversity: Approaches to determining good environmental status, setting of environmental targets and selecting indicators for Marine Strategy Framework Directive descriptors 1, 2, 4 and 6. Version 3.2 (5 March 2012). Prepared by the OSPAR Intersessional Correspondence Group on the Coordination of Biodiversity Assessment and Monitoring (ICG COBAM) under the responsibility of the OSPAR Biodiversity Committee (BDC), OSPAR Commission, London.

Oudejans MG, Visser F, Englund A, Rogan E & Ingram SN (2015). Evidence for distinct coastal and offshore communities of bottlenose dolphins in the North East Atlantic. *PLoS ONE* **10(4)**: e0122668.

Palmer KJ, Brookes K & Rendell L (2017). Categorizing click trains to increase taxonomic precision in echolocation click loggers. *The Journal of the Acoustical Society of America* **142:** 863-877.

Papachlimitzou A, Barber JL, Losada S, Bersuder P, Deaville R, Brownlow A, Penrose R, Jepson PD, Robin & Law RJ (2015). Organophosphorus flame retardants (PFRs) and plasticisers in harbour porpoises (*Phocoena phocoena*) stranded or bycaught in the UK during 2012. *Marine Pollution Bulletin* **98**: 328-334.

Paxton CGM & Thomas L (2010). Phase one data analysis of Joint Cetacean Protocol Data. Report to Joint Nature Conservation Committee, 75pp.

Paxton CGM, Mackenzie M, Burt ML, Rexstad E & Thomas L (2010). Phase two data analysis of Joint Cetacean Protocol Data Resource. Report to Joint Nature Conservation Committee, 126pp.

Paxton CGM, Scott-Hayward LAS & Rexstad E (2014). Review of available statistical approaches to help identify Marine Protected Areas for cetaceans and basking shark. Scottish Natural Heritage Commissioned Report No. 573, 47pp.

Paxton CGM, Scott-Hayward. L, Mackenzie M, Rexstad E & Thomas L (2016) Revised Phase III Data Analysis of Joint Cetacean Protocol Data Resource JNCC Report No.517

Pesante G, Evans PGH, Baines ME & McMath M (2008a). Abundance and life history parameters of bottlenose dolphin in Cardigan Bay: monitoring 2005-2007. CCW Marine Monitoring Report No. 61. Countryside Council for Wales, UK, 81pp.

Pesante G, Evans PGH, Anderwald P, Powell D & McMath M (2008b). Connectivity of bottlenose dolphins in Wales: north Wales photo-monitoring interim report 2008. CCW Marine Monitoring Report No. 62. Countryside Council for Wales, UK, 42pp.

Peschko V, Ronnenberg K, Siebert U & Gilles A (2016) Trends of harbour porpoise (*Phocoena phocoena*) density in the southern North Sea. *Ecological Indicators* **60**: 174-183

Philcox CK, Grogan AL & Macdonald DW (1999). Patterns of otter, *Lutra lutra,* road mortality in Britain. *Journal of Applied Ecology* **36:** 748-762.

Pierce GJ, Santos MB, Reid RJ, Patterson IAP & Ross HM (2004). Diet of minke whales *Balaenoptera acutorostrata* in Scottish (UK) waters with notes on strandings of this species in Scotland 1992-2002. *Journal of the Marine Biological Association of the United Kingdom* **84**: 1241-1244.

Pierce GJ, Santos MB, Murphy S, Learmonth JA, Zuur AF, Rogan E, Bustamente P, Caurant F, Lahaye V, Ridoux V, Zegers BN, Mets A, Addink M, Smeenk C, Jauniaux T, Law RJ, Dabin W, López A, Alonso Farré JM, González AF, Guerra A, García-Hartmann M, Reid RJ, Moffat CF, Lockyer C & Boon JP (2008). Bioaccumulation of persistent organic pollutants in female common dolphins (*Delphinus delphis*) and harbour porpoises (*Phocoena phocoena*) from western European seas: geographical trends, causal factors and effects on reproduction and mortality. *Environmental Pollution* **153**: 401-415.

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.

Pike DG, Gunnlaugsson Þ, Øien N, Desportes G, Víkingsson GA, Paxton CGN & Bloch D (2005). Distribution, abundance and trends in abundance of fin and humpback whales in the North Atlantic. ICES CM 2005/R:12, 24pp.

Pike DG, Gunnlaugsson T, Mikkelsen B, Halldórsson SD & Víkingsson GA (2019). Estimates of the Abundance of Cetaceans in the Central North Atlantic Based on the NASS Icelandic and Faroese Shipboard Surveys Conducted in 2015. NAMMCO Scientific Publications 11. https://doi.org/10.7557/3.4941

Pike DG, Gunnlaugsson T, Mikkelsen B, Víkingsson G & Desportes G (2020). Distribution and Abundance of Killer Whales in the Central North Atlantic, 1987-2015. NAMMCO Scientific Publications, 11. https://doi.org/10.7557/3.5579

Pollock CM, Mavor R, Weir CR, Reid A, White RW, Tasker ML, Webb A & Reid JB (2000). The distribution of seabirds and marine mammals in the Atlantic Frontier, north and west of Scotland. Joint Nature Conservation Committee, Aberdeen, 92pp

Pomeroy PP, Twiss SD & Redman P (2000). Philopatry, site fidelity and local kin associations within grey seal breeding colonies. *Ethology* **106**: 899-919.

Pomeroy PP, Hammond JA, Hall AJ, Lonergan M, Duck CD, Smith VJ & Thompson H (2005). Morbillivirus neutralizing antibodies in Scottish grey seals: assessing the effects of the 1988 and 2002 PDV epizootics. *Marine Ecology Progress Series* **287**: 241-250.

Preston SJ & Reid N (2010). Northern Ireland Otter Survey. Report prepared by the Natural Heritage Research Partnership, Quercus, Queen's University Belfast for the Northern Ireland Environment Agency. Northern Ireland Environment Agency Research and Development Series No. 11/06.

Quick N, Arso M, Cheney B, Islas V, Janik V, Thompson PM & Hammond PS (2014). The east coast of Scotland bottlenose dolphin population: improving understanding of ecology outside the Moray Firth SAC. Document produced as part of UK Department of Energy and Climate Change's offshore energy Strategic Environmental Assessment Programme. 7th May 2014. URN 14D/086, 87pp.

Read JA & Hohn AA (1995). Life in the fast lane: the life history of harbour porpoises from the Gulf of Maine. *Marine Mammal Science* **11**: 423-440.

Reid J, Evans PGH & Northridge S (2003). An atlas of cetacean distribution in northwest European waters. Joint Nature Conservation Committee, Peterborough, UK, 77pp.

Richardson WJ, Greene CR Jr, Malme CI & Thomson DH (1995). Marine Mammals and Noise. Academic Press, San Diego, US, 576pp.

Robinson KP & Tetley MJ (2007). Behavioural observations of foraging minke whales (*Balaenoptera acutorostrata*) in the outer Moray Firth, northeast Scotland. *Journal of the Marine Biological Association of the UK* **87**: 85-86.

Robinson KP, Tetley MJ & Mitchelson-Jacob EG (2009). The distribution and habitat preference of coastally occurring minke whales (*Balaenoptera acutorostrata*) in the outer southern Moray Firth, northeast Scotland. *Journal of Coastal Conservation* **13**: 39-48.

Robinson KP, Eisfeld SM, Costa M & Simmonds MP (2010). Short-beaked common dolphin (*Delphinus delphis*) occurrence in the Moray Firth, north-east Scotland. *Marine Biodiversity Records* **3**: 1-4.

Robinson KP, O'Brien JM, Berrow SD, Cheney B, Costa M, Eisfeld SM, Haberlin D, Mandleberg L, O'Donovan M, Oudejans G, Ryan C, Stevick PT, Thompson PM & Whooley P (2012). Discrete or not so discrete: long distance movements by coastal bottlenose dolphins in the UK and Irish waters. *Journal of Cetacean Research and Management* **12**: 365–371.

Rogan E, Cañadas A, Macleod K, Santos MB, Mikkelsen B, Uriarte A, Canneyt OV, Vázquez JA & Hammond PS (2017). Distribution, abundance and habitat use of deep diving cetaceans in the North East Atlantic. *Deep Sea Research Part II: Topical Studies in Oceanography* **141:** 8-19.

Rogan E, Breen P, Mackey M, Cañadas A, Scheidat M, Geelhoed S & Jessopp M (2018). Aerial surveys of cetaceans and seabirds in Irish waters: Occurrence, distribution and abundance in 2015-2017. Department of Communications, Climate Action & Environment and National Parks and Wildlife Service (NPWS), Department of Culture, Heritage and the Gaeltacht, Dublin, Ireland. 297pp.

Rosel PE, Dizon AE & Heyning JE (1994). Genetic analysis of sympatric morphotypes of common dolphins (genus *Delphinus*). *Marine Biology* **119**: 159-167.

Ross HM & Wilson B (1996). Violent interactions between bottlenose dolphins and harbour porpoises. *Proceedings of the Royal Society London* **263**: 283-286.

Russ JM, Hutson AM, Montgomery WI, Racey PA & Speakman JR (2001). The status of Nathusius' pipistrelle (*Pipistrellus nathusii* Keyserling & Blasius, 1839) in the British Isles. *Journal of the Zoological Society of London* **254**: 91-100.

Russ JM, Jones G, Racey PA & Hutson AM (2008). Nathusius' pipistrelle. *In: Mammals of the British Isles. 4th edition (Eds. Harris S & Yalden D)*. The Mammal Society, Southampton.

Russell DJF, McConnell B, Thompson D, Duck C, Morris C, Harwood J & Matthiopoulos J (2013). Uncovering the links between foraging and breeding regions in a highly mobile mammal. *Journal of Applied Ecology* **50(2)**: 499-509.

Russell DJF, Jones EL & Morris CD (2017). Updated seal usage maps: the estimated at-sea distribution of grey and harbour seals. Scottish Marine and Freshwater Science Vol 8 No 25, 25pp.

Ryan C, Whooley P, Berrow SD, Barnes C, Massett N, Strietman WJ, Broms F, Stevick PT, Fernald Jr TW & Schmidt C (2016a). A longitudinal study of humpback whales in Irish waters. *Journal of the Marine Biological Association of the United Kingdom* **96:** 877-883.

Ryan C, Leaper R, Evans PGH, Dyke K, Robinson KP, Haskins GN, Calderan S, van Geel N, Harries O, Froud K, Brownlow A & Jack A (2016b). Entanglement: an emerging threat to humpback whales in Scottish waters. Paper presented to the International Whaling Commission, Scientific Committee. SC/66b/HIM/01.

Sabin R, Jepson PD, Reid PDJ, Chimindies R & Deaville R (2002). Trends in cetacean strandings around the UK coastline and marine mammals post-mortem investigations for the year 2002. Report No. ECM 516F00/03. Report to the Department for Environment Food and Rural Affairs. Natural History Museum, London, UK.

Samarra FIP & Foote AD (2015). Seasonal movements of killer whales between Iceland and Scotland. *Aquatic Biology* **24**: 75-79.

Santos MB, Pierce GJ, Boyle PR, Reid RJ, Ross HM, Patterson IAP, Kinze CC, Tougaard S, Lick R, Piatkowski U & Hernández-García V (1999). Stomach contents of sperm whales *Physeter macrocephalus* stranded in the North Sea 1990-1996. *Marine Ecology Progress Series* **183**: 281-294.

Santos MB, Pierce GJ, Reid RJ, Patterson IAP, Ross HM & Mente E (2001). Stomach contents of bottlenose dolphins (*Tursiops truncatus*) in Scottish waters. *Journal of the Marine Biological Association of the United Kingdom* **81**: 873-878.

Santos MB, Pierce GJ & Learmonth JA (2004). Variability in the diet of harbour porpoises (*Phocoena phocoena*) in Scottish waters 1992-2003. *Marine Mammal Science* **20**: 1-27.

Santos MB, Pierce GJ, Learmonth JA, Reid RJ, Sacau M, Patterson IAP & Ross HM (2008). Strandings of striped dolphin *Stenella coeruleoalba* in Scottish waters (1992-2003) with notes on the diet of this species. *Journal of the Marine Biological Association of the United Kingdom* **88**: 1175-1183.

Santos BM, German I, Correia D, Read FL, Martinez Cedeira J, Caldas M, Lopez A, Velasco F & Pierce GJ (2013). Long-term variation in common dolphin diet in relation to prey abundance. *Marine Ecology Progress Series* **481**: 249-268.

Santos BM, Monteiro SS, Vingada JV, Ferreira M, Lopez A, Martinez Cedeira JA, Reid RJ, Brownlow A & Pierce GJ (2014). Patterns and trends in the diet of long-finned pilot whales (*Globicephala melas*) in the northeast Atlantic. *Marine Mammal Science* **30**: 1-19.

Sayer S, Hockley C & Witt MJ (2012). Monitoring grey seals (*Halichoerus grypus*) in the Isles of Scilly during the 2010 pupping season. Natural England Commissioned Reports, Number 103. 68pp.

SCANS-II (2008). Small Cetaceans in the European Atlantic and North Sea. Final Report to the European Commission on Project LIFE04NAT/GB/000245. http://biology.st-andrews.ac.uk/scans2/

Schwacke LH, Smith CR, Townsend FI, Wells RS, Hart LB, Balmer BC, Collier TK, DeGuise S, Fry MM, Guillette LJ, Lamb SV, Lane SM, McFee WE, Place NJ, Tumlin MC, Ylitali GM, Zolman ES & Rowles TK (2013). Health of common bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, Louisiana, following the Deepwater Horizon Oil Spill. *Environmental Science and Technology* **48**: 93-103

Schwacke LH, Thomas L, Wells RS, McFee WE, Hohn AA, Mullin KD, Zolman ES, Quigley BM, Rowles TK & Schwacke JH (2017). Quantifying injury to common bottlenose dolphins from the Deepwater Horizon oil spill using an age-, sex- and class-structured population model. *Endangered Species Research* **33:** 265-279.

SCOS (2007). Scientific advice on matters related to the management of seal populations: 2007. Special Committee on Seals, 93pp.

SCOS (2008). Scientific advice on matters related to the management of seal populations: 2008. Special Committee on Seals, 99pp.

SCOS (2014). Scientific advice on matters related to the management of seal populations: 2014. Special Committee on Seals, 161pp.

SCOS (2017). Scientific Advice on Matters Related to the Management of Seal Populations: 2017. Special Committee on Seals, 144pp.

SCOS (2018). Scientific Advice on Matters Related to the Management of Seal Populations: 2018. Special Committee on Seals, 154pp.

SCOS (2019). Scientific Advice on Matters Related to the Management of Seal Populations: 2019. Special Committee on Seals, 154pp.

SCOS (2020). Scientific advice on matters related to the management of seal populations: 2019. Special Committee on Seals, 161pp.

Sharples RJ, Matthiopoulos J & Hammond PS (2008). Distribution and movements of harbour seals around the coast of Britain: Outer Hebrides, Shetland, Orkney, the Moray Firth, St Andrews Bay, The Wash and the Thames. Report to the DTI from the Sea Mammal Research Unit, University of St Andrews, UK, 63pp. plus appendix.

Sharples RJ, Moss SE, Patterson TA & Hammond PS (2012). Spatial variation in foraging behaviour of a marine top predator *(Phoca vitulina*) determined by a large-scale satellite tagging program. *PLoS ONE* **7**: e37216.

Similä T, Holst JC & Christensen I (1996). Occurrence and diet of killer whales in northern Norway: seasonal patterns relative to the distribution and abundance of Norwegian spring-spawning herring. *Canadian Journal of Fisheries and Aquatic Sciences* **53**: 769-779.

SMRU (2007). Potential impact of Oil and Gas Exploration and Development on SACs for bottlenose dolphins and other marine mammals in the Moray Firth and Cardigan Bay/Pembrokeshire. Report to the Department of Trade and Industry. Sea Mammal Research Unit (SMRU), University of St. Andrews, UK, 13pp.

Sophie C. Leterme SC, Seuront L & Edwards M (2006). Differential contribution of diatoms and dinoflagellates to phytoplankton biomass in the NE Atlantic Ocean and the North Sea. *Marine Ecology Progress Series* **312**: 57-65.

Southall BL, Bowles AE, Ellison WT, Finneran JJ, Gentry RL, Greene Jr. CR, Kastak D, Ketten DR, Miller JH, Nachtigall PE, Richardson WJ, Thomas JA & Tyack PL (2007). Marine mammal noise exposure criteria: Initial scientific recommendations. *Aquatic Mammals* **33**: 411-522.

Sparling CE, Coram AJ, McConnell B, Thompson D, Hawkins KR & Northridge SP (2013). Marine Mammal Impacts. Paper three. Wave and Tidal Consenting Position Paper Series. Nature Environment Research Council.

Spitz J, Trites AW, Becquet V, Brind'Amour A, Cherel Y, Galois R & Ridoux V (2012). Cost of living dictates what whales, dolphins and porpoises eat: the importance of prey quality on predator foraging strategies. *PLoS ONE* **7**: e50096.

Stockin KA, Weir CR & Pierce GJ (2006). Examining the importance of Aberdeenshire (UK) coastal waters for North Sea bottlenose dolphins (*Tursiops truncatus*). *Journal of the Marine Biological Association of the United Kingdom* **86**: 201-207.

Stone CJ (2015). Marine mammal observations during seismic surveys from 1994-2010. JNCC Report No. 463a, Joint Nature Conservation Committee, Peterborough, UK, 69pp.

Strachan R (2007). National survey of otter *Lutra lutra* distribution in Scotland 2003-2004. Scottish Natural Heritage Commissioned Report No. 211 (ROAME No. F03AC309).

Strachan R (2015). Otter Survey of Wales, 2009-10. Natural Resources Wales, 105pp.

Thomas L (2009). Potential use of joint cetacean protocol data for determining changes in species' range and abundance: exploratory analysis of southern Irish Sea data. Report to the Joint Nature Conservation Committee; National parks and Wildlife Service and Countryside Council for Wales, 35pp.

Thompson PM, Lusseau D, Corkrey R & Hammond PS (2004). Moray Firth bottlenose dolphin monitoring strategy options. Scottish Natural Heritage Commissioned Report No. 079 (ROAME No. F02AA409), 59pp. plus appendix.

Thompson D, Lonergan M & Duck C (2005). Population dynamics of harbour seals *Phoca vitulina* in England: monitoring growth and catastrophic declines. *Journal of Applied Ecology* **42**: 638-648.

Thompson P, Ingram S, Lonergan M, Northridge S, Hall A & Wilson B (2007). Climate change causing starvation in harbour porpoises? *Biology Letters* **3**: 533-534.

Thompson PM, Cheney B, Ingram S, Stevick P, Wilson B & Hammond PS (Eds.) (2011). Distribution, abundance and population structure of bottlenose dolphins in Scottish waters. Scottish Government and Scottish Natural Heritage funded report. Scottish Natural Heritage Commissioned Report No. 354.

Thompson PM, Brookes KL, Graham IM, Barton TR, Needham K, Bradbury G & Merchant ND (2013). Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises. *Proceedings of the Royal Society B* **280**: 20132001.

Thompson D, Onoufriou J, Brownlow A & 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. SMRU Report to Scottish Government under Marine Mammal Scientific Support Research Programme MMSS/001/11. 15pp.

Tolley KA, Vikingsson G, Rosel P (2001). Mitochondrial DNA sequence variation and phylogeographic patterns in harbour porpoises (*Phocoena phocoena*) from the North Atlantic. *Conservation Genetics* **2**:349–361

Tyler-Walters H, James B, Carruthers M (eds.) Wilding C, Durkin O, Lacey C, Philpott E, Adams L, Chaniotis PD, Wilkes PTV, Seeley R, Neilly M, Dargie J & Crawford-Avis OT (2016). Descriptions of Scottish Priority Marine Features (PMFs). Scottish Natural Heritage Commissioned Report No. 406.

UKMMAS (2010). Charting Progress 2: Healthy and Biological Diverse Seas Feeder report. Eds. Frost M & Hawkridge J. Published by Department for Environment Food and Rural Affairs on behalf of the UK Marine Monitoring and Assessment Strategy. 672pp. http://chartingprogress.defra.gov.uk/healthy-and-biologically-diverse-seas-feeder-report

van Bleijswijk JDL, Begeman L, Witte HJ, Ijsseldijk LL, Brasseur SMJM, Gröne A & Loepold MF (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 LS & Siebert U (2015). Grey seal (*Halichoerus grypus*) predation on harbour seals (*Phoca vitulina*) on the island of Helgoland, Germany. *Journal of Sea Research* **97**: 1-4.

Vacquie-Garcia J, Lydersen C, Biuw M, Haug T, Fedak MA, Kovacs KM (2017). Hooded seal *Cystophora cristata* foraging areas in the Northeast Atlantic Ocean - Investigated using three complementary methods. *PLoS ONE* **12**: e0187889.

Veneruso G & Evans PGH (2012b). Connectivity of Bottlenose Dolphins in Welsh Waters: North Wales Photo-Monitoring Interim Report. Report to Countryside Council for Wales. Sea Watch Foundation, 17pp.

Víkingsson GA, Elvarsson BP, Ólafsdóttir D, Sigujónsson J, Chosson V & Galan (2014). Recent changes in the diet composition of common minke whales (*Balaenoptera acutorostrata*) in Icelandic waters. A consequence of climate change? *Marine Biology Research* **10**: 138-152.

Vincent C, Fedak MA, McConnell BJ, Meynier L, Saint-Jean C & Ridoux V (2005). Status and conservation of the grey seal, *Halichoerus grypus*, in France. *Biological Conservation* **126**: 62-73.

Vincent C, Huon M, Caurant F, Dabin W, Deniau A, Dixneuf S, Dupuis L, Elder J-F, Fremau M-H, Hassani S, Hemon A, Karpozopoulos J, Lefeuvre C, McConnell BJ, Moss SEW, Provost P, Spitz J, Turpin Y & Ridoux V (2017). Grey and harbour seals in France: Distribution at sea, connectivity and trends in abundance at haulout sites. *Deep-Sea Research Part II* **141**: 294-305.

Visser IKG, Van Bressem M-F, de Swart RL, van de Bildt MWG, Vos HW, van der Heijden RWJ, Saliki JT, Orvell C, Kitching P, Kuiken T, Barrett T & Osterhaus ADME (1993). Characterization of morbilliviruses isolated from dolphins and porpoises in Europe. *Journal of General Virology* **74**: 631-641.

Waggitt J, Evans P, Andrade J, Banks A, Boisseau O, Bolton M, Bradbury G, Brereton T, Camphuysen C, Durinck J, Felce T, Fijn R, Garcia-Baron I, Garthe S, Geelhoed S, Gilles A, Goodall M, Haelters J, Hamilton S, Hartny-Mills L, Hodgins N, James K, Jessopp M, Kavanagh A, Leopold M, Lohrengel K, Louzao M, Markones N, Martinez-Cediera J, O'Cadhla O, Perry S, Pierce G, Ridoux V, Robinson K, Santos M, Saavedra C, Skov H, Stienen E, Sveegaard S, Thompson P, Vanermen N, Wall D, Webb A, Wilson J, Wanless S & Hiddink J (2020). Distribution maps of cetacean and seabird populations in the North-East Atlantic. *Journal of Applied Ecology* **57**: 253-269.

Wall D, Murray C, O-Brien J, Kavanagh L, Wilson C, Ryan C, Glanville B, Williams D, Enlander I, O'Connor I, McGrath D, Whooley P & Berrow S (2013). Atlas of the distribution and relative abundance of marine mammals in Irish offshore waters: 2005-2011. Irish Eahle and Dolphin Group and Galway-Mayo Institute of Technology, 58pp.

Watt J (1993). Ontogeny of hunting behaviour of otters (*Lutra lutra* L.) in a marine environment. *Symposium of the Zoological Society of London* **65**: 87-104.

Weir CR (2002). Killer whales (*Orcinus orca*) in UK waters. *British Wildlife* **14**: 106-108.

Weir CR, Hodgins NK, Dolman SJ & Walters AEM (2019). Risso's dolphins (*Grampus griseus*) in a proposed Marine Protected Area off east Lewis (Scotland, UK), 2010–2017. *Journal of the Marine Biological Association of the United Kingdom* **99**: 703-714, doi:10.1017/S0025315418000516.

Wiig O (1986). The status of the grey seal *Halichoerus grypus* in Norway. *Biological Conservation* **38**: 339-349.

Wilson B, Thompson PM & Hammond PS (1997). Habitat use by bottlenose dolphins: seasonal distribution and stratified movement patterns in the Moray Firth, Scotland. *Journal of Applied Ecology* **34**: 1365-1374.

Wilson B, Arnold H, Bearzi G, Fortuna CM, Gaspar R, Ingram S, Liret C, Pribanic S, Read AJ, Ridoux V, Schneider K, Urian KW, Wells RS, Wood C, Thompson PM & Hammond PS (1999). Epidermal diseases in bottlenose dolphins: impacts of natural and anthropogenic factors. *Proceedings of The Royal Society of London Series B* **266**: 1077-1083.

Wilson B, Reid RJ, Grellier K, Thompson PM & Hammond PS (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.

Wilson B, Batty RS, Daunt F & 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. 12 March 2007, 110pp.

Wilson B, Benjamins S, Elliott J, Gordon J, Macauley J, Calderan S & van Geel N (2014). Estimates of collision risk of harbour porpoises and marine renewable energy devices at sites of high tidal-stream energy. Report for the Scottish Government, 79pp.

Wood, CJ (1998). Movement of bottlenose dolphins around the south-west coast of Britain. *Journal of Zoology London* **246**: 155-163.

Yoxon P (2008). Otter Surveys of the North West Scottish Islands. Scholarly Research Exchange. Volume 2008: 735403. doi:10.3814/2008/735403.