WDCS, the Whale and Dolphin Conservation Society

Towards Marine Protected Areas for Cetaceans in Scotland, England and Wales

A scientific review identifying critical habitat with key recommendations

Josephine Clark, Sarah J. Dolman and Erich Hoyt

October 2010

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A Report from the WDCS Scotland and Critical Habitat / MPA Programmes

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EXECUTIVE SUMMARY

An important duty of the UK Marine and Coastal Access Act 2009 and the Marine (Scotland) Act 2010 is to create an ecologically coherent network of well managed Marine Protected Areas (MPAs) to deliver nature conservation priorities.

In order to create MPAs that feature or include the whales, dolphins and porpoises (cetaceans) in UK waters it will be necessary to identify areas used for important life processes such as feeding, breeding and raising young – referred to as cetacean critical habitat (Section 3). The purpose of this project was to identify areas of cetacean critical habitat in UK waters and to assess whether MPAs could be an effective conservation tool. Following a thorough review of cetacean distribution and habitat use (Section 4), and a consideration of threats (Section 5), an assessment was made as to whether critical habitat could be identified for each cetacean species. A scoring system was developed to make this assessment and the methodology used is outlined in Section 6.

Critical habitat was identified for harbour porpoises, bottlenose dolphins, white-beaked dolphins, Risso's dolphins, common minke whales and short-beaked common dolphins (Section 7). For harbour porpoises, white-beaked dolphins, minke whales and short-beaked common dolphins in particular, given the importance of UK waters for these species, it is highly likely that further areas of critical habitat exist.

Insufficient data were available to allow the identification of critical habitat for other species. For Atlantic white-sided dolphins, long-finned pilot whales, northern bottlenose whales, Sowerby's beaked whales, sperm whales and killer whales, UK waters provide significant and important areas of habitat and within these there are likely to be areas of critical habitat. Several 'areas of interest' were identified for these species showing some evidence of importance, and these should be investigated further.

It is important to note that information is often patchy and in some areas severely lacking. The results from this project will invariably be biased towards areas where we have information. Areas not identified as 'critical habitat' or 'areas of interest' are not necessarily unimportant, in most cases there is just less or no information available at present with which to make an assessment. This is especially relevant to offshore areas.

Following a consideration of threats present in these areas, we recommend that MPAs should be considered (or have existing protection extended) for four regions of the UK:

The Hebrides

- the Inner Hebrides, The Minches and the Sea of the Hebrides – harbour porpoise
- north east Isle of Lewis – Risso's dolphins
- the Inner Hebrides and the Sound of Barra – bottlenose dolphins

Other species present here that could also benefit from protective measures put in place are common dolphins, white-beaked dolphins, minke whales and killer whales.

North east Scotland

- south coast, Outer Moray Firth – harbour porpoise
- Inner Moray Firth and north east Scottish coast to St. Andrew's Bay – bottlenose dolphins[1]
- south coast, Outer Moray Firth – minke whales
- Aberdeenshire coast – white-beaked dolphins

[1] An EU Habitats Directive Special Area of Conservation (SAC) is already in place for part of this area.

South west England

- Celtic Deep – common dolphins

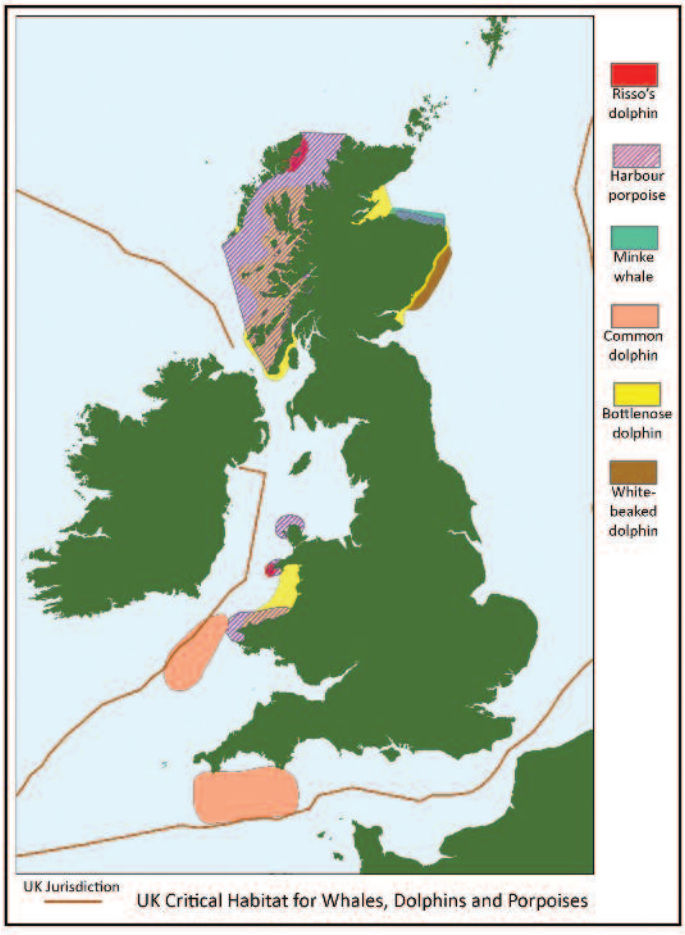
Other species that may benefit from an MPA in this area include minke whales.

Coastal Wales

- northern Pembrokeshire and southern Cardigan Bay; Lleyn Peninsula and Bardsey Island; and, north and west Anglesey – harbour porpoises
- Bardsey Island – Risso's dolphins
- Cardigan Bay – bottlenose dolphins [2]

Critical habitat was also identified for common dolphins in the western English Channel. An MPA is not being recommended at this time due to the extensive size of the area (identified and potential critical habitat) and the lack of finer-scale information that might allow the pinpointing of areas of particular importance or elevated threat level.

MPAs are used successfully in many parts of the world for cetacean conservation and could provide similar benefits in the UK. As highly mobile marine species, cetaceans present definite challenges in attempts to develop conservation measures, particularly as there are still many gaps in our knowledge. With this is mind, it will be important to develop MPAs in a precautionary manner. This means ensuring they are sufficiently large (at least in the early stages), flexible, and adaptive to new information in order to provide us with buffers against uncertainty and ensure critical habitats have been protected.



[2] An EU Habitats Directive Special Area of Conservation (SAC) is already in place for part of this area.

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CONTENTS

List of Figures and Tables

1. INTRODUCTION

We enter an exciting decade with frontier legislation in the form of new Marine Acts in the UK and Scotland. Marine planning and conservation may finally be catching up with that of the terrestrial world. However, the sea is a three-dimensional, largely unseen and little understood component of our planet. The sea differs greatly from the land and requires new ways of thinking and new approaches for conservation [3].

The creation of an ecologically coherent network of marine protected areas (MPAs) that includes UK whales, dolphins and porpoises — collectively known as *cetaceans* — will advance our understanding and protection of these animals, and go some way towards securing their future in our waters. There may also be direct benefits to us. There is a growing body of evidence linking better marine health with economic productivity, social well-being and climate change mitigation. The potential benefits of a UK network of MPAs could outweigh costs by a factor of between 7-40 and with estimated benefits of between £7 billion and £19 billion [4].

This report is the first attempt to map nationally important marine areas for cetaceans and the first step towards comprehensive marine protection for cetaceans in UK waters.

Cetaceans in UK waters

The seas around the UK host an incredible diversity of species, some of the richest in Europe. There are more than 20 different cetacean species found in UK waters, from the relatively small harbour porpoise to large species such as the sperm, humpback and endangered blue whales.

Due to the difficulty in studying cetaceans, many populations remain little known. However a combination of periodic large-scale oceanic surveys and localised long-term studies means that we can begin to answer some important questions about sizes, trends, habitat requirements and movements of UK cetacean populations.

Cetaceans have intrinsic value as species in themselves, and also for the role they play within ecosystems as top predators. As such, they are generally offered strict protection under law. Yet, multiple and increasing threats in UK waters make conservation research, and the development of associated management and legislative measures, a priority.

What is a Marine Protected Area?

A marine protected area (MPA) is defined under the umbrella definition for a protected area (PA) provided by the IUCN (International Union for the Conservation of Nature)[5] as:

> 'a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.'

'Marine protected area' is a common generic term, although in various jurisdictions, MPAs are called marine conservation zones (MCZs), marine reserves, marine parks, special areas of conservation (SACs), marine wildlife refuges, national marine sanctuaries, or more than 250 other names in use worldwide [6]. For the purposes of this report, the generic term MPA will be used when referring to all types of marine protected areas, including MCZs and SACs, in UK waters (both are discussed in more detail below).

The true essence of an MPA is protection of marine ecosystems, species and other features [3]. An MPA network can be defined as 'an organised collection of individual MPAs operating co-operatively and synergistically, at various spatial scales and with a range of protection levels, to fulfil ecological aims more effectively and comprehensively than individual sites could alone' [8].

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3 Hoyt, 2005a (2nd edition in prep. for 2011)
4 Natural England, 2009
5 Dudley, 2008; http://www.iucn.org/
6 Hoyt, 2009
7 Hoyt, 2005a (2nd edition in prep. for 2011)
8 WCPA/IUCN, 2007

MPAs for cetaceans

Cetaceans are warm-blooded social mammals that live their entire lives in the sea. They live long, mature late, reproduce slowly, invest heavily in the upbringing and development of each offspring and engage and flourish in complex social environments. These animals have evolved over millions of years to live in and be supported by their ecosystems[9].

Cetacean critical habitat, discussed in Section 3, refers to those parts of a cetacean species' range that are essential for day-to-day well-being and survival, as well as for maintaining a healthy population growth rate. Areas that are regularly used for feeding, breeding, raising calves and socialising, as well as sometimes, migrating, are all essential critical habitat[10]. Unlike land-based critical habitat, however, marine critical habitat boundaries may be less fixed, especially in terms of hunting and feeding areas that are dependent on upwellings and other ever-changing oceanographic conditions. Some species of cetaceans, for example, are known to feed in and around upwellings which vary depending on local and large-scale oceanographic conditions to some extent during a season and from year to year[11].

There are a number of reasons why cetaceans are appropriate for consideration in the designation of an ecologically coherent network of MPAs[12]:

- Cetaceans have intrinsic value as species in themselves, and the role they play within ecosystems[13];
- 45 out of 86 cetacean species are listed on the IUCN Red List[14] as 'data deficient', 'vulnerable', 'endangered' or 'critically endangered' (those found in the UK are listed in Annex 1) yet many currently receive little protection or focused conservation effort;
- Cetaceans are long-lived 'charismatic megafauna' and extraordinary ambassadors of the wider marine environment, providing a key to protecting ocean habitats and other species within them;
- Good cetacean-based MPA conservation is an integral part of ecosystem-based conservation;
- Cetaceans can provide an ecological monitor for the health of the marine environment;
- Cetaceans can spearhead successful public marine education and help forge a positive community identity; and,
- Cetacean popularity can be harnessed to extend management and increase funding for MPAs, thereby bringing larger areas of the ocean under ecosystem-based management.

In addition to their long migrations, cetaceans may depend on food webs whose critical habitats are widely separated. Thus, networks are essential to create an effective conservation plan for these wide-ranging species, as well as for the marine ecosystems that help to support them[15]. A carefully selected network of zoned MPAs (for example, using a biosphere reserve-type design) that includes both highly protected marine reserves (core zones), mixed zones (allowing tourism and light use) as well as transition zones to allow more extensive human uses, could be used alongside wider management approaches to ensure ecosystem-based protection of critical habitats along with integration of other MPA values for local communities (see Figure 1.1, p.9).

Such biosphere reserve-type areas are typically large and can be adapted for a variety of design and management approaches. For example, to accommodate highly mobile species, there has been discussion about the merits of flexible yet still highly protected core areas corresponding to cetacean and other species 'critical habitat', with boundaries that may be adjusted as needed from year to year or even within seasons. Such adjustments should be adaptive, periodically reviewed and sensitive to signals from the wider environment, thus taking into account ecosystem-based management (EBM)[16].

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9 Prideaux, 2003
10 Hoyt, 2005a (2nd edition in prep. for 2011)
11 *Ibid*
12 adapted from Hoyt, 2005a (2nd edition in prep. for 2011)
13 Hoyt, 2005a (2nd edition in prep. for 2011)
14 IUCN, 2010
15 Hoyt, 2009
16 Prideaux, 2003

Note: This schematic map shows the various zones of a hypothetical marine- and land-based biosphere reserve-type MPA. Core areas (IUCN Category I) are devoted to strict nature reserve protection; these are surrounded by buffer zones (Category II-V) where activities compatible with the conservation objectives occur, and the buffer zones are in turn surrounded by a more or less defined transition zone (Category VI) which integrates the local people with sustainable resource management into the fabric of the overall reserve. To be effective, biosphere reserves must include zoned highly protected areas that are declared and enforced through legislation with management plans, formulated by the community, including all stakeholders[17].

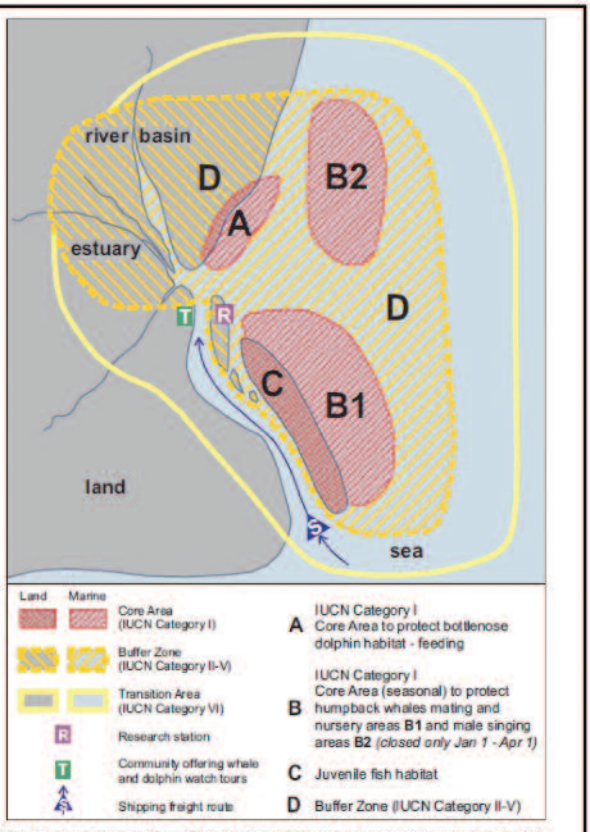

Figure 1.1 Example of a marine biosphere reserve-type MPA

International commitments to designate a coherent network of MPAs

This report is timely as the UK has national as well as international commitments to designate a coherent network of MPAs and the statutory agencies are working towards this.

All cetaceans are offered strict protection under Annex IV of the EU Habitats Directive[18]. Bottlenose dolphins and harbour porpoises *(Phocoena phocoena)* are also Annex II species requiring that Special Areas of Conservation (SACs) be designated under the Natura 2000 programme. Currently three SACs exist for some populations of bottlenose dolphins in UK waters. SACs, which include management and reporting responsibilities, have been designated in the Moray Firth in Scotland and two in Cardigan Bay in Wales. In one of the Cardigan Bay SACs, bottlenose dolphins are a 'qualifying feature' only.

No designations have been made for harbour porpoises. An *ad hoc* meeting of the EC Habitats Committee[19] to discuss issues surrounding the creation of harbour porpoise SACs concluded that 'it is possible to identify areas representing crucial factors for the life cycle of this species' and that they are identifiable on the basis of:

- the continuous or regular presence of the species (although subject to seasonal variations),
- good population density (in relation to neighbouring areas), and
- a high ratio of young to adults during certain periods of the year.

The EU Marine Strategy Framework Directive (MSFD)[20] requires that Member States prepare national strategies to manage the seas to achieve or maintain Good Environmental Status (GES) by 2020. The Directive requires that GES will be defined for marine waters by 2012, with a monitoring programme to measure progress towards achieving GES set up by 2014 and to report on progress of establishment of a system of MPAs, contributing to coherent and representative networks, by 2013.

[17] Map by Lesley Frampton. Text and figure reproduced with permission, from Hoyt, 2009
[18] EC, 1992
[19] 14th December 2002, DG Environment
[20] EC, 2008

The OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic[21] seeks to protect the marine environment and establish marine protected areas for threatened and declining species, particularly on the high seas.

In 2002, the World Summit on Sustainable Development (WSSD)[22] challenged European and other nations to establish an ecologically coherent and representative network of well-managed MPAs by 2012. In 2004, the Convention on Biological Diversity (CBD) agreed to the establishment and maintenance of MPAs to contribute to a global network, recognising that the Convention of Migratory Species (CMS) and various regional agreements would be needed to help fulfil this work[23]. In 2008, the IUCN World Conservation Congress called on nations to accelerate progress toward the 2012 MPA network and high seas goals.

Towards an ecologically coherent network of MPAs in the UK

An important duty of both the UK Marine and Coastal Access Act 2009 and the Marine (Scotland) Act 2010 will be to create an ecologically coherent network of well managed MPAs to deliver nature conservation priorities. The UK Act makes provisions for designating Marine Conservation Zones (MCZs) in English and Welsh territorial waters (0-12 nautical miles) as well as in UK offshore waters (12-200nm). The UK Act created new powers for Scottish Ministers to designate Marine Protected Areas (MPAs) in offshore waters adjacent to Scotland. The Scottish Act makes provision for MPAs in Scottish territorial waters. New legislation is expected in Northern Ireland to introduce equivalent provisions in its territorial waters.

The purpose of this project was to identify important areas for cetaceans within UK waters that might contribute towards the UK's goal of creating an ecologically coherent network of MPAs to deliver nature conservation priorities. This report documents the results of this project and its contents are as follows:

- Section 2 provides an assessment of the current UK and Scottish guidance[24] on the identification of MPAs and their applicability to cetaceans
- Section 3 defines the concept of 'critical habitat' for cetaceans and how the identification of critical habitat can inform the selection of MPAs for cetaceans in UK waters
- Section 4 provides a review of available information on cetacean distribution, abundance and habitat use in UK waters to inform the identification of critical habitat
- Section 5 identifies known and potential anthropogenic threats to cetaceans and assesses which of these might be addressed through the use of MPAs
- Section 6 analyses the information contained in Sections 4 and 5 to determine the location of cetacean critical habitat
- Section 7 considers the potential use of MPAs for the protection of critical habitat identified in Section 6
- Section 8 identifies gaps in our knowledge of cetaceans and critical habitat, and suggests some priorities for future research
- Section 9 provides a series of recommendations from this project
- Section 10 presents the conclusions.

[21] http://www.ospar.org/
[22] http://www.un.org/events/wssd/
[23] http://www.cbd.int/
[24] Both sets of guidance were in draft form at the time this report went to press. Natural England and JNCC, 2010; Marine Scotland, 2010

2. IDENTIFYING MARINE PROTECTED AREAS IN UK WATERS

To support the development of an ecologically coherent network of MPAs in UK waters, draft guidance documents on their selection have been produced by Marine Scotland[25] for Scottish seas, and Natural England and Joint Nature Conservation Committee (JNCC)[26] for English and Welsh waters. The following provides an assessment of these guidelines and considers how they apply to cetaceans.

England and Wales

The Ecological Network Guidance for England and Wales[27] lists 25 cetacean species as 'features of conservation importance' but excludes them all from further consideration in the guidance. Bottlenose dolphins and harbour porpoises are excluded because they are listed under the EC Habitats Directive and it is considered they will be sufficiently protected by the Natura 2000 site series. The remaining are either not known to occur in the project area[28]; are considered vagrant to UK waters[29]; or are highly mobile species for which MPAs were considered 'not currently appropriate'[30]. It is suggested that at least in some cases, this 'inappropriateness' may be due to a lack of information on the location of relevant areas, so as new information becomes available, they may be included in the future.

'Areas of ecological importance' are also to be incorporated within the MPA network and are not restricted to the current list of 'appropriate' features of conservation importance[31] so may potentially be considered for cetaceans. These are defined to include 'areas important to highly mobile species such as foraging, breeding, moulting, wintering or resting areas; and nursery, juvenile or spawning grounds'.

The guidance states that the identification of sites should be based on the best available scientific evidence and that the lack of full scientific certainty should not be a reason for delay.

Given that all cetacean species found in UK waters are considered features of conservation importance, the question of whether MPAs could be identified for cetaceans in the seas around England and Wales hinges on whether spatiotemporal areas used for important life processes can be identified.

Scotland

Scotland's MPA network must be capable of delivering Scotland's MPA commitments for the conservation of 'Marine Natural Features'. Marine Natural Features are the protected features for which a site is designated. 'Priority Marine Features' are a sub-set of Marine Natural Features and are primarily a tool to focus the search for MPAs (which may then include a wider range of features than the priority marine feature(s) alone). The presence of these features will underpin the selection of Nature Conservation MPAs. The selection of priority marine features will be based on advice from SNH and JNCC but the exact criteria for this process are currently under peer-review. Amongst other things, the guidelines for Scotland[32] consider that Nature Conservation MPAs are appropriate for contributing to the protection of:

- significant areas for geographically restricted habitats or species at global, north east Atlantic or UK scales
- significant aggregations or communities of important marine species in Scottish waters
- features representative of the range of features present in Scottish waters
- essential areas for key life cycle stages of important mobile species, including habitats known to be important for reproduction and nursery stages.

For wide-ranging species however, the guidelines state that MPAs are only appropriate where 'such species use defined areas predictably for key life cycle stages, such as breeding or nursery areas', and for cetaceans the focus would be on 'identifying areas that support feeding, breeding, nursery or resting behaviour'.

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[25] Marine Scotland, 2010. Draft March 2010. Accessed May 2010, www.scotland.gov.uk
[26] Natural England and JNCC, 2010. Accessed July 2010, www.jncc.gov.uk
[27] Natural England and JNCC, 2010
[28] Bowhead whale
[29] Blue whale, white whale (beluga), North Atlantic right whale, pygmy sperm whale, Gervais' beaked whale, and narwhal
[30] Common minke whale, sei whale, fin whale, short-beaked common dolphin, long-finned pilot whale, Risso's dolphin, northern bottlenose whale, Atlantic white-sided dolphin, white-beaked dolphin, humpback whale, Sowerby's beaked whale, True's beaked whale, killer whale, sperm whale, striped dolphin, Cuvier's beaked whale
[31] This list consists of three bony fish species at present
[32] Marine Scotland, 2010

For cetacean species that are considered a) priority marine features, and b) suitable for protection using MPAs, the Nature Conservation MPA selection guidelines will then be applied to areas where these species are found. The focus of Stage 1 of the guidelines is to identify search locations containing priority marine features within the broader search areas. For those cetacean species that have made it to this stage, an assessment would already have been made as to the existence of areas used for key life cycle stages, so these may already provide the search locations and could be passed on to Stage 2 of the process. However, as worded currently, the guidelines state that additionally, an area must meet at least one of the stated Stage 1 guidelines if it is to be considered a search location and go through to the next stage. These are:

- the presence of key features, or
- the presence of features considered to be under threat or subject to rapid decline, or
- the area has functional significance for the overall health and diversity of Scottish seas.

To be determined a 'key feature', a species has to be considered of conservation value at a national or international level which the guidelines state is likely to mean either Scotland is a stronghold for that species; it is 'characteristic' of Scotland's marine environment[33]; or, it can be considered of exceptional scientific importance. Features under threat include, but are not limited to, species on the OSPAR Threatened and Declining list which occur in and are considered to be threatened and/or declining in Scottish waters.

Locations that make it through to Stage 2 will be prioritised according to the perceived 'quality' of the priority marine features they contain. In the comparisons, locations with 'combinations of features, rather than single isolated features' and areas with naturally high biodiversity will be looked for. This method should be used with care, however, as there may be examples of cetacean or other species populations relying heavily on particular locations or having important parts of their distribution not necessarily used by other species.

Locations will also be prioritised at this stage if they contain 'features considered least damaged/more natural' and those that contain 'features considered to be at risk of significant damage'.

Stage 3 of the guidelines is concerned with adapting the size of the search location to ensure it is suitable for maintaining the integrity of the feature. Stage 4 assesses whether an MPA is the most effective mechanism to deliver the required management. Finally, Stage 5 prioritises between potential MPAs according to their contribution to the network.

The guidelines state that the identification of sites should be based on the best available scientific evidence and that the lack of full scientific certainty should not be a reason for delay.

A different set of criteria will be used by JNCC to determine which mobile marine species are priority marine features between 12- 200nm around the UK. This will be conducted in consultation with Marine Scotland Science by merging the OSPAR Threatened and Declining list and the UK BAP list; it is currently open to expert peer review.

Cetaceans and MPA guidelines

There would seem to be three key points that determine whether MPAs will be considered and implemented as a conservation tool for cetaceans in the UK. For both processes in Scotland and England/Wales, whether definable areas used for important life processes can be identified (the 'appropriateness' test); and for Scotland, whether species are determined to be 'key features' and/or under threat or declining.

The last two points are considered in Section 4.5. The question of whether it is possible to identify areas used for important life processes such as feeding, breeding and raising young, using current information about cetaceans in UK waters, forms the basis of much of this report.

[33] Defined as distinctive and/or representative

3. CRITICAL HABITAT

Interest in the development of coherent networks of MPAs and as a component of this, MPAs that feature or include cetaceans, is not limited to the UK. Elsewhere in the world the same questions are being asked about how to identify important cetacean habitat and subsequently how best to protect it. To define areas considered key to the survival of a population or species, the term increasingly in use in various countries, sometimes with detailed legal definition (as in the US), is critical habitat.

Critical habitat for cetaceans can be defined as:

> Those parts of a cetacean species' range, that are essential for day-to-day well-being and survival, as well as for maintaining a healthy population growth rate. Areas that are regularly used for feeding, breeding, raising calves and socialising, as well as, sometimes, migrating, are the key components of critical habitat[34].

In addition to places used regularly for feeding, breeding, raising calves and socialising, locations where associated and supporting activities such as hunting, courtship, singing, calving, nursing, resting, playing and communication take place are important to consider. For a complete consideration of cetacean critical habitat, it should also extend to the critical habitat of cetacean prey and areas where important ecosystem processes occur such as productive upwellings and fish spawning grounds.

A further important component of critical habitat is the consideration of movement corridors connecting these important areas. This aspect is vital to ensure that animal hotspots do not become islands of biodiversity and is crucial to long-term population viability[35].

Finally, in some cases, critical habitat can also be considered as a place where human activities pose a threat at the population level. Such habitat may have lower densities and not be used for feeding, breeding, calving or migrating, but if animals are being killed or harmed, with population level effects, then addressing the threats through habitat protection or other means is a matter of urgency[36]. Therefore, it is important also to consider where threats posed by human activities are taking place as part of considerations for the location of critical habitat.

For the most part, this project employs a review of available literature on cetacean distribution, abundance and habitat use, in order to identify areas used by cetaceans for important life processes — also known as critical habitat. The methodology for making these assessments is outlined in Section 6. Drawing on this information, and incorporating consideration of threats and human activities, this report then identifies suitable sites for UK MPAs that would protect cetacean habitat.

[34] adapted from Hoyt, 2005a (2nd edition in prep. for 2011)
[35] Reeves, 2009
[36] Reeves, 2009

3.1 DEVELOPING THE CRITICAL HABITAT APPROACH

The critical habitat approach has been adopted by various scientific bodies, governments and regional cetacean agreements, as a basis for identifying and protecting important habitat for cetaceans. As background information, a summary of this work follows below:

North America

Both Canada and the US have enshrined the term 'critical habitat' in their respective endangered species legislation and over the past few years have begun the process of identifying such areas for listed cetaceans. Although in both cases the term was used and defined for all species (terrestrial and marine), and not specifically cetaceans, these provide useful examples, showing how the term is being applied and implemented for cetaceans.

Canada's Species At Risk Act (SARA) (2002), defines critical habitat as:

> 'the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species' [37].

Critical habitat has been identified for northern and southern resident killer whales in the coastal waters of British Columbia [38] and incorporates areas known to be important foraging areas for this species in the summer when salmon, the principal prey of resident killer whales, migrate through the area. The critical habitat area for the northern population was designated not just due to its importance as a feeding ground, but also because of the traditional use of 'rubbing beaches' in the area – particular spots where the northern resident killer whales come to skim their bodies along the sand and pebbles on the sea floor.

As the core summer habitat of these killer whales stretches into US waters, areas have also been designated as critical habitat south of the border under the US Endangered Species Act (ESA) (1973). This piece of legislation gives a more detailed definition of critical habitat and how it should be interpreted. Critical habitat is defined as:

> 'the specific areas within the geographical area occupied by the species, at the time it is listed . . . on which are found those physical or biological features (I) essential to the conservation of the species and which may require special management considerations or protection; and (II) specific areas outside the geographical area occupied by the species at the time it is listed upon a determination by the Secretary to be essential for the conservation of the species.' [39]

Further guidance is offered in determining whether an area meets this definition as the authorities are required to:

> 'consider those physical or biological features that are essential to the conservation of a given species including space for individual and population growth and for normal behaviour; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, and rearing of offspring; and habitats that are protected from disturbance or are representative of the historical, geographical and ecological distribution of a species.' [40]

These essential biological and physical features are known as 'primary constituent elements', or PCEs, and must be listed with the critical habitat description for a species. For southern resident killer whales these PCEs were determined to be:

(1) Water quality to support growth and development;

(2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and

(3) Passage conditions to allow for migration, resting, and foraging [41].

To determine which specific areas in the region might contain these PCEs, a large sightings dataset (mostly opportunistic) spanning 14 years was analysed. From this, three specific areas were identified as containing the PCEs, based on presence and movements of the whales, behavioural observations and studies. In some cases where direct data on PCEs were unavailable, distribution patterns of the whales were used to infer presence of PCEs [42].

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[37] Species At Risk Act, 2002 Section 2(1)
[38] Fisheries and Oceans Canada, 2009
[39] Endangered Species Act (1973), Section 3
[40] 50 CFR 424.12(b)
[41] NOAA, 2006
[42] NMFS, 2006

Foraging, travel, socialising and play are all activities noted to occur in the core areas but the primary reasons for designation were feeding (two of the areas), and passage (one area).

The resident killer whale example is rather unusual in that its summer core habitat is relatively restricted, predictable, coastal, and well studied, and therefore identifying critical habitat is an easier process than for some other cetaceans[43].

Another example provided by the US is its designation of critical habitat for the highly endangered North Pacific right whale, decidedly more challenging given the sparse data and relatively few sightings. In this case, the only PCE known with certainty was the need for prey species (large zooplankton). It is thought that certain biological and physical features combine in some areas to produce prey patches of sufficient density for the whales, but these forcing mechanisms are not completely understood. Also, due to the patchy nature of zooplankton density, there may be no obvious correlation between abundance and distribution of prey, and distribution of right whales. So in this situation where there was an absence of data describing presence and density of PCEs, sightings of right whales themselves were used as a proxy for their existence and thus to identify the areas proposed for designation of critical habitat[44].

A further complicating factor is that survey effort has been inconsistent across the right whale's range, and indeed, the area designated is where most research has taken place. However, the authorities are required to designate critical habitat based on the 'best scientific data available', so even with these gaps in coverage, they are still able to put protective measures in place.

The North Pacific right whale provides a valuable example of designating cetacean critical habitat in a data-poor situation, applying a precautionary approach.

ACCOBAMS

As part of its programme of work on MPAs, ACCOBAMS[45] – Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area – adopted the definition of cetacean critical habitat as ‘a place or area regularly used by a cetacean group, population or species to perform tasks essential for survival and equilibrium maintenance’.[46] ACCOBAMS has developed a suggested list of criteria to identify sites containing critical habitat:

- Areas used by cetaceans for feeding, breeding, calving, nursing and social behaviour;
- Migration routes and corridors and related resting areas;
- Areas where there are seasonal concentrations of cetacean species;
- Areas of importance to cetacean prey;
- Natural processes that support continued productivity of cetacean foraging species (upwellings, fronts, etc.);
- Topographic structures favourable for enhancing foraging opportunities for cetacean species (canyons, seamounts).

These criteria are now being employed to identify critical habitat for cetaceans in the ACCOBAMS agreement area with the intention of establishing MPAs in the future. In 2006, ACCOBAMS Scientific Committee recommended 18 critical habitat areas as candidates for MPAs and, in 2007, the Parties to ACCOBAMS accepted the recommendations in principle. Since then, two of the areas have been declared MPAs and several others are in the process of being approved.

EU Habitats Directive

Although the term 'critical habitat' is not used in the Habitats Directive[47], there are similarities in approach worth highlighting. In order to maintain or restore listed habitats and the habitat of listed species at a favourable conservation status, sites are to be proposed that present the 'physical or biological factors essential to their life and reproduction'. Bottlenose dolphins and harbour porpoises are the two cetacean species listed on Annex II of the Habitats Directive. All cetaceans require ‘strict protection’ under Annex IV.

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[43] However, it should be noted that their whereabouts at other times of year remain less well-known, so their winter critical habitat remains undesignated
[44] NOAA, 2008
[45] www.accobams.org
[46] Hoyt, 2005a (2nd edition in prep. for 2011)
[47] EC, 1992

3.2 PROTECTING CRITICAL HABITAT

Once an area of critical habitat has been identified, there are a range of regulatory and management measures that can be taken to protect it. Creating an MPA is one option and it can be a highly effective conservation tool — providing cetacean populations with the space needed for critical life processes to take place; establishing a mechanism to assess, manage and, if necessary, limit the range of human activities occurring in an area; and providing science with a reference point against which to assess other managed sites. But an MPA will not always be the most appropriate solution, and in many cases it will not be sufficient on its own to protect an area from the range of threats present; a suite of other measures may also be required.

Decisions on whether an MPA is the most appropriate mechanism to protect a particular area involve consideration of:

- the specific circumstances at that location including the size of the area identified, how it is used by the species, and for how much of the year;
- what other mechanisms might be employed and whether they would be more effective, such as marine planning, fisheries measures and vessel restrictions;
- the type and level of anthropogenic threat(s) impacting the cetacean population, the species habitat, and/or prey species;
- the ecology of the relevant cetacean population;
- practical concerns such as management capacity in the area and the country, including funding constraints in terms of setting up a successful MPA, with provisions for a management plan, necessary research and monitoring.

Special characteristics of critical habitat for cetaceans and implications for MPA design

Boundaries in the marine environment are typically less fixed than those on land. In this three-dimensional and dynamic environment, species distributions and the location of critical habitat can be dependent not just on static bathymetric features such as seamounts and shelf breaks, but also on persistent and ephemeral hydrographic features including currents, frontal systems and upwellings[48]. These oceanographic features and processes often occur on large spatial and temporal scales.

Cetaceans, as highly mobile marine animals, can range over large areas – even ocean basins in some cases – but most will have at least periods of the year where they can be found in more localised and predictable areas to feed, breed or socialise for example.

These issues have important implications for MPA design. The nature of marine physical and biological processes, the ecology and life history of cetacean species, along with issues of spatial and temporal scale, must all be taken into consideration. As MPA practices have developed, certain strategies and concepts have emerged that attempt to incorporate these biological characteristics and take account of them within human management structures.

One is the concept of larger biosphere-style reserves, made up of highly-protected, zoned 'core' areas corresponding to critical habitat, surrounded by 'buffer' zones where non-conflicting activities are allowed to take place[49] (see Figure 1.1, p.9). These core, critical habitat areas may be based on oceanographic conditions such as upwellings that change within or between seasons, and this could be taken account of by employing flexible boundaries that can be adapted temporally and spatially. This approach also allows for new knowledge and refinements to be more easily incorporated in the future.

Cetacean MPAs will typically need to be larger than most terrestrial protected areas, particularly in the pelagic environment[50]. This is because the ranges of most cetaceans, and the oceanographic features and processes that drive these features, occur at such large scales.

The importance of connections between individual MPAs is also increasingly discussed, and the concept of developing MPA networks rather than individual areas, essentially isolated from one another, is being given greater consideration[51]. This approach is particularly appropriate for cetaceans, whose critical habitats may be separated by large distances, or whose populations may use different areas.

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[48] Hyrenbach *et al*, 2000

[49] For example, Hoyt, 2005a (2nd edition in prep. for 2011); Hoyt, 2009; Hyrenbach *et al*, 2000; Kelleher, 1999; Reeves, 2009

[50] Hoyt, 2005a (2nd edition in prep. for 2011); Hooker and Gerber, 2004; Hyrenbach *et al*, 2000; Kelleher, 1999

[51] Reeves, 2009; Hoyt, 2005a (2nd edition in prep. for 2011); Hoyt, 2009; Commission on Geosciences, Environment and Resources, 2001

4. DATA AND SPECIES ACCOUNTS

In order to assess whether critical habitat can be identified for cetaceans in UK waters, a thorough review of the available literature on distribution, abundance and habitat use was completed. The results of this review are presented in a series of species accounts below. Brief summary tables of the many studies used to inform this review are listed in Annex II. Following the species accounts, Section 4.5 considers which species may be considered a 'key feature' under the Scottish guidelines (see Section 2, p.11).

4.1 STUDY AREA

The study area included all UK waters out to the limits of the UK continental shelf, which at its widest stretches over 900km offshore to the west of Scotland (see Figure 4.1 below and Figure 4.2, p.18).

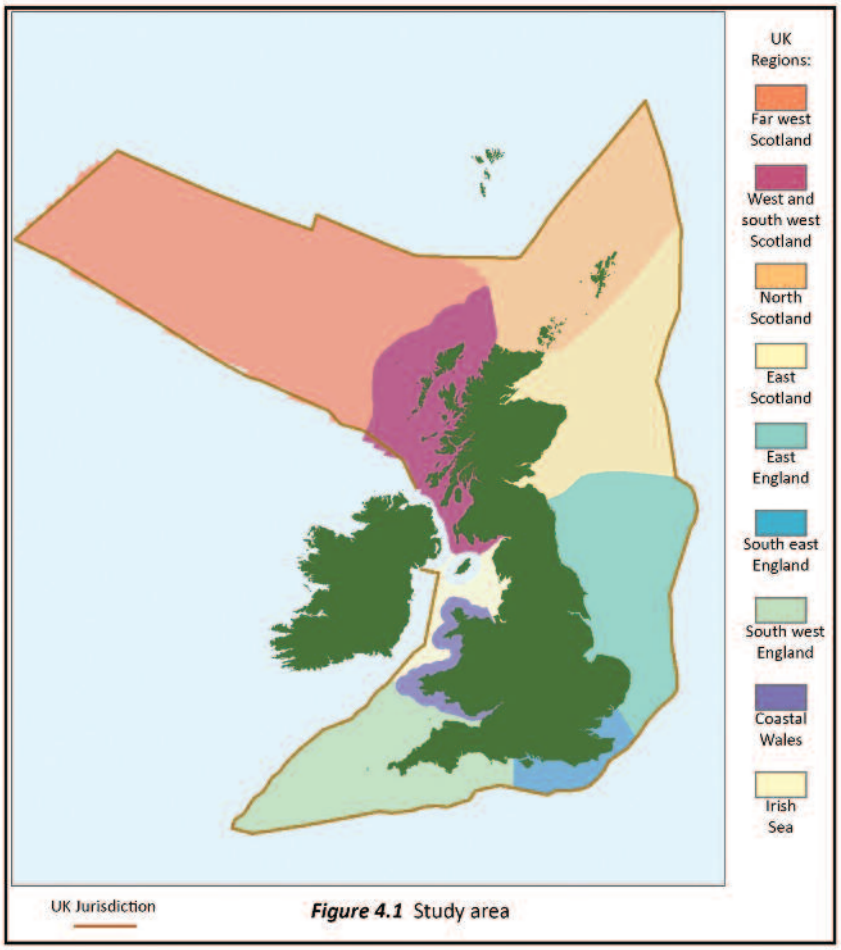

Figure 4.1 Study area

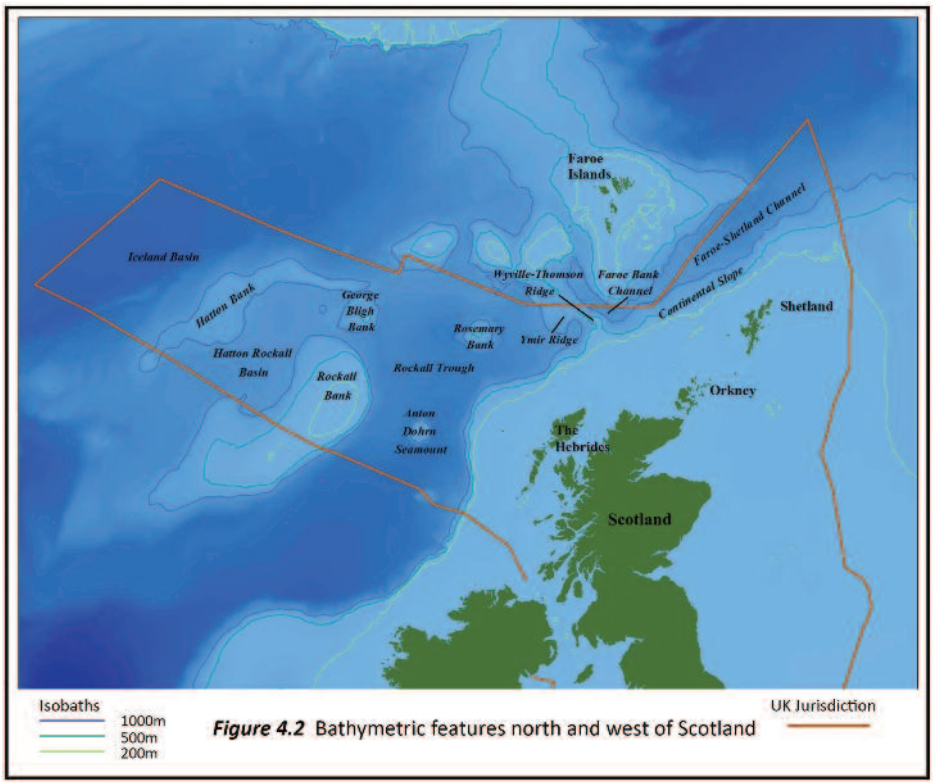

Figure 4.2 Bathymetric features north and west of Scotland

4.2 SPECIES

All cetacean species found in UK waters were initially considered for inclusion but following an assessment of the available literature[52], several were determined to be such infrequent visitors that it was unlikely critical habitat is located in these waters. The species excluded from further analysis are: pygmy sperm whale, false killer whale, Fraser's dolphin, narwhal, beluga, melon-headed whale, Blainville's beaked whale, Gervais' beaked whale and striped dolphin. The North Atlantic right whale at one time likely had critical habitat in UK waters but is now so rare and sightings so few that identification of its critical habitat is impossible. For other species, if there were any doubt as to whether a lack of sightings information was due to genuinely low level occurrence, or because of a life history trait that renders data collection difficult (e.g. deep divers that spend little time at the surface), the species was included to allow an assessment to be made.

For some species with similar life histories, or where there are difficulties in distinguishing between species in the field sighting reports (i.e. beaked whales and baleen whales), it was considered appropriate to assess these species as a group.

In-depth assessments were completed for the following species:

- Harbour porpoise *(Phocoena phocoena)*
- Bottlenose dolphin *(Tursiops truncatus)*
- Short-beaked common dolphin *(Delphinus delphis)*
- Common minke whale *(Balaenoptera acutorostrata)*
- White-beaked dolphin *(Lagenorhynchus albirostris)*
- Risso's dolphin *(Grampus griseus)*

[52] Key papers considered in this assessment were: Reid *et al*, 2003; MacLeod, 2000; Evans *et al*, 2003; and Evans and Hammond, 2004

- Killer whale *(Orcinus orca)*
- Atlantic white-sided dolphin *(Lagenorhynchus acutus)*
- Long-finned pilot whale *(Globicephala melas)*
- Sperm whale *(Physeter macrocephalus)*
- Beaked whales:
  Northern bottlenose whale *(Hyperoodon ampullatus)*
  Cuvier's beaked whale *(Ziphius cavirostris)*
  Sowerby's beaked whale *(Mesoplodon bidens)*
  True's beaked whale *(Mesoplodon mirus)*
- Large baleen whales:
  Humpback whale *(Megaptera novaeangliae)*
  Sei whale *(Balaenoptera borealis)*
  Fin whale *(Balaenoptera physalus)*
  Blue whale *(Balaenoptera musculus)*

4.3 DATA

A major aim of the project was to incorporate cetacean data from a wide range of sources to ensure the results represent a full account of what is currently known about cetacean occurrence in UK waters. The results of a range of study types were assembled from a wide variety of sources including both published and grey literature. Wherever possible, results were added to a Geographic Information System (GIS)[53] to aid in the visualisation and analysis process. The types of information used include:

1. Distribution and abundance data

Information of this kind can be used to identify areas cetaceans use regularly and predictably, and in higher densities. Absolute abundance and density estimates provide the estimated number of animals in the survey area at that time, and the estimated number of animals per square km respectively. For species with long-lasting and uniquely identifiable natural markings, photo-identification with a mark-recapture analysis can be used to estimate absolute abundance and it has proved effective for some populations of bottlenose dolphins in the UK. A faster way to estimate absolute abundance and density for multiple species is through line transect sampling. A few small scale surveys have used line transects to develop estimates for cetaceans[54] but the two primary sources of this type of data in the UK are the Small Cetacean Abundance in the North Sea (and adjacent waters) project (SCANS)[55] and the Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA)[56] project.

Due to the expensive and intensive nature of these types of surveys, many more studies produce an index of abundance or density rather than absolute estimates. These relative abundance or density estimates can be produced by land- and boat-based visual and acoustic studies, and report results in many different ways. These include: number of sightings or individuals per km or per hour, number of detections (vocalisations) per km or hour, and using varying sized symbols on a map. Wherever available, absolute abundance or density estimates are displayed on maps within each species account. As this type of study produces results in a common currency, it is possible to compare estimates between studies. This is not the case with relative abundance and density estimates so comparisons between different studies should be done cautiously. With this in mind, maps displaying relative density results from different studies were not created and the original papers should be referred to.

2. Spatial modelling

Spatial modelling of cetacean sightings data can be used to analyse relationships between cetacean distribution and environmental variables, as well as providing information on abundance at a finer resolution. Models using data from SCANS (I and II) and CODA have been created for many species and the results of these have been included for reference. It should be noted that the ability of a model to predict density distribution and the resulting maps are highly dependent on the variables included in the model, and if these are rough or subject to change, the results will also be rough or subject to change. Therefore although spatial modelling can provide interesting insights into the data, it is important not to over-interpret results particularly at a fine spatial scale[57].

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[53] ESRI ArcGIS 9.3
[54] See for example, Goodwin and Speedie, 2008
[55] Conducted in 1994 (Hammond *et al*, 1995 and Hammond *et al*, 2002) and 2005 (SCANS II, 2006)
[56] Conducted in 2007 (CODA, 2009)
[57] Philip Hammond, pers. comm.

3. Habitat use

Information on behaviour and habitat use was assembled to help identify locations used for important life processes. Observations of feeding activity, resting and socialising were noted, along with any information on migration. The presence of calves was recorded as this indicates the area may be used for calving and/or as a nursery area. Breeding is rarely directly observed in cetaceans in UK waters but the timings can sometimes be calculated based on when young calves begin to be seen[58]. Concentrations of animals observed during the months when that species is known to breed may indicate that an area is important for this purpose. Freshly stranded neonates also indicate that breeding and calving are taking place, so information on neonate strandings was also documented.

Wherever possible, information on cetacean prey distribution and abundance was included, although this should be regarded as a preliminary and incomplete review. A thorough review of this type of data was beyond the scope of the project but should be undertaken to gain a better understanding of prey-based requirements.

In the initial stages of the project, attempts were made to identify any unanalysed or partially analysed datasets that might be available for inclusion. Some datasets were identified that have not yet been fully analysed and incorporated into publicly available papers and reports. Unfortunately it was impossible to obtain these during the timeframe of this project. However, these were generally for areas where more information was available and not for the many areas where data are extremely sparse. Their inclusion was not considered vital to the success of the project. However, on a local scale, these additional datasets would be valuable to include in future analysis.

It is important to take into account that information is often patchy and in some areas severely lacking. In an ideal world, assessments such as these would be undertaken using datasets that when combined provide complete and even coverage throughout the survey area. This level of information will not be available for many years, if ever, and decisions must be taken in the meantime using the data that are available. The results from this project will invariably be biased towards areas where we have information. Areas not highlighted are not necessarily unimportant, there may just be little or no information available at present with which to make an assessment.

[58] Fedak, 2002

4.4 SPECIES ACCOUNTS

4.4.1 HARBOUR PORPOISE *(Phocoena phocoena)*

The harbour porpoise is the most commonly sighted and stranded cetacean in UK waters and is found widely distributed over the continental shelf of the eastern North Atlantic. Although considered abundant at this large scale, there has been considerable concern for its status in some regions due to apparent declines in numbers of sightings and strandings[59], and impacts which include high levels of incidental catches in fisheries[60]. The SCANS survey (in July, 1994) of the North Sea and adjacent waters, delivered an estimated abundance of 340,000 (95% CI = 260,000-449,000) for the harbour porpoise[61]. SCANS II in 2005 found a slight, but not statistically significant, decrease in abundance for the same area (315,027 animals; 95% CI 201,507-395,077)[62]. Figures 4.3 (below) and 4.5 (p.22) display harbour porpoise density estimates from SCANS and SCANS II. Figures 4.4 (below) and 4.6 (p.22) show harbour porpoise estimated density surfaces from the same surveys[63].

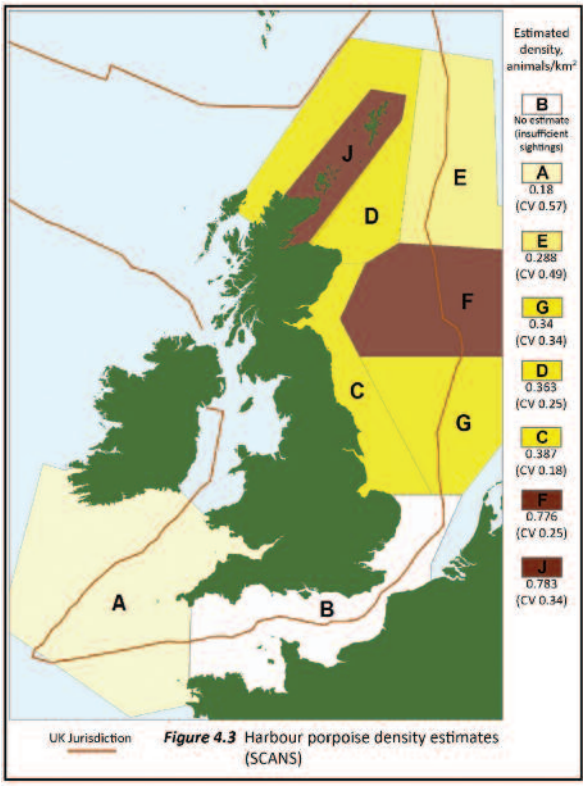

Figure 4.3 Harbour porpoise density estimates (SCANS)

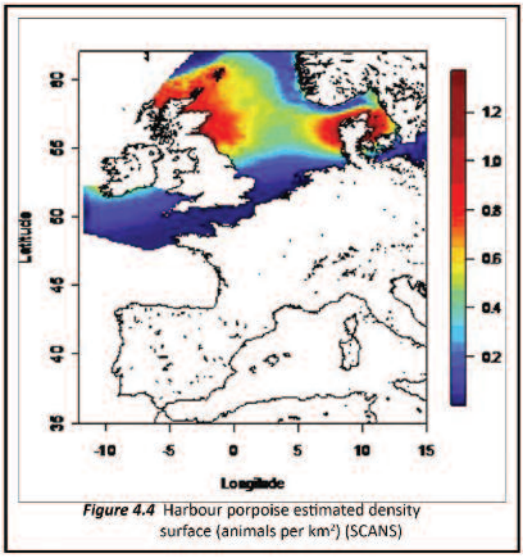

Figure 4.4 Harbour porpoise estimated density surface (animals per km²) (SCANS)

Harbour porpoises are considered to be widespread over the continental shelf and are commonly sighted throughout the year. Although they can be seen in deeper waters off the continental shelf, sightings are much less common in waters over 200m deep.

In many areas harbour porpoises are present throughout the year but there do seem to be seasonal changes in distribution and sightings rates, most likely linked to prey availability and the location of suitable breeding and calving habitat[64]. For example, a pattern of peak harbour porpoise numbers off the shelf in May and June, followed by a peak in numbers on the shelf two months later, is thought to relate to calving[65]. These aggregations, occurring in August-September, have been noted for several coastal locations around the UK and coincide with the peak final months of the mating season for harbour porpoises, with social and sexual behaviour frequently observed[66].

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[59] Evans *et al*, 2003; Tregenza, 1992
[60] Tregenza *et al*, 1997; Ross and Isaac, 2004
[61] Hammond *et al*, 2002
[62] SCANS II, 2006
[63] Reproduced with permission. Hammond *et al*, 1995; SCANS II, 2006. Please note that density surface maps show estimated density derived from a spatial model and should not be over-interpreted, particularly at a fine spatial scale.
[64] Evans *et al*, 2003; Weir *et al*, 2007; Northridge *et al*, 1995
[65] Evans *et al*, 2003
[66] Evans and Wang, 2002; Pierpoint, 1998

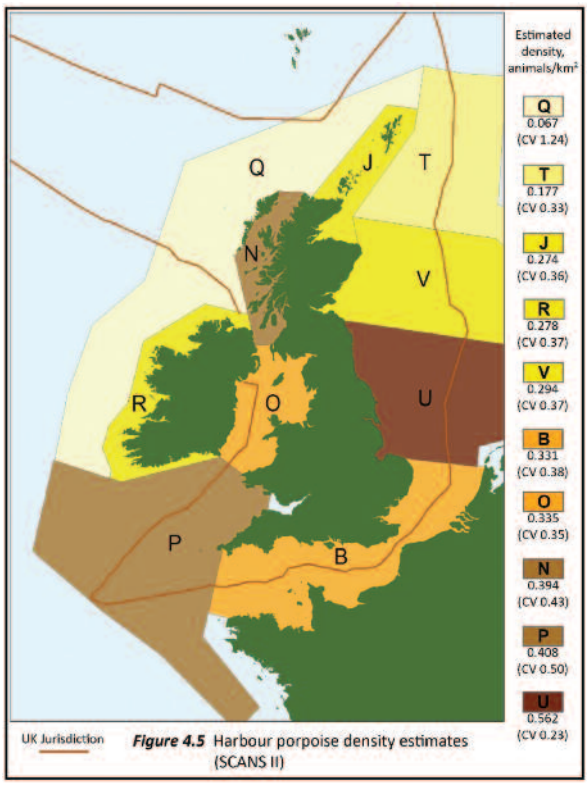

Figure 4.5 Harbour porpoise density estimates (SCANS II)

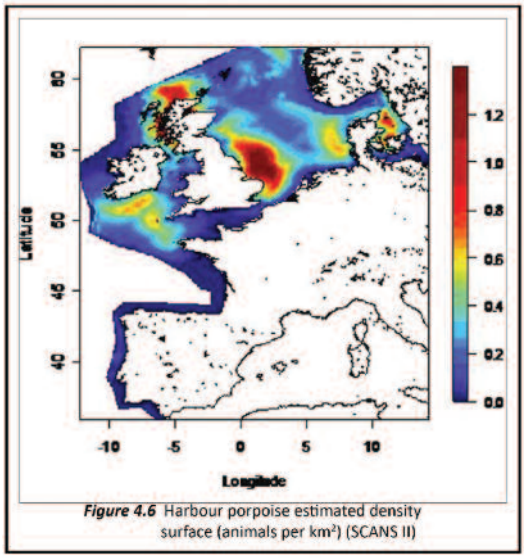

Figure 4.6 Harbour porpoise estimated density surface (animals per km²) (SCANS II)

Harbour porpoises have a gestation period of 10 to 11 months[67]. Calves are seen between February and September in UK waters, with a peak in June[68].

Due to the lack of markings that would allow recognition of individual animals (as is possible with many other cetacean species), it is not presently known whether harbour porpoises display site fidelity or have regular movement patterns between areas[69]. However, some researchers have reported resighting highly marked individuals over periods of time[70] which may indicate a degree of site fidelity. Genetic studies have demonstrated that female harbour porpoises disperse less than male harbour porpoises[71] and this may indicate that female harbour porpoises show site fidelity for the places they calve and nurse their young, returning to preferred areas for these activities[72].

Important foraging habitat for harbour porpoises includes areas of strong tidal currents, usually near islands or headlands, where the currents combine with the seafloor topography and seem to create conditions where prey become aggregated[73]. At several places around the UK these locations correspond with high porpoise densities.

The patchy nature of survey effort makes it sometimes difficult to determine whether changes in sightings rates are indications of seasonal movements or an artefact of the varying levels of search effort[74]. An additional issue is that the low profile and small size of the harbour porpoise make them considerably more challenging to see in poorer weather and higher seas[75]. Sightings rates therefore decrease markedly as sea state increases and for this reason, harbour porpoises are likely underestimated in offshore areas and winter months when sea states tend to be higher. Difficulties in sighting harbour porpoises, combined with the general situation of less research conducted away from the coast and in winter due to the rougher seas and expense of working in such conditions, is a significant hindrance to gaining a more complete understanding of this species.

Harbour porpoises are typically seen individually or in small groups of up to three animals. Occasionally large groups are sighted, usually associated with foraging. It is not presently known if there is a social or co-operative feeding element to these associations, as is the case with many other cetaceans[76].

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67 Jefferson *et al*, 2008
68 Evans, 1992 (in Goodwin, 2007)
69 Pierpoint *et al*, 1998
70 *Ibid*
71 Walton, 1997
72 Baines and Earl, 1999
73 Pierpoint *et al*, 2004; de Boer, 2006; Evans, 1997 (in Evans *et al*, 2003); Embling *et al*, 2010
74 Reid *et al*, 2003
75 Palka, 1996
76 Goodwin, 2007

Although there is some variation in prey depending on area, season and age of the porpoise, dietary studies have found that sandeels *(Ammodytes marinus)* are the most important prey species for north east Atlantic harbour porpoises during the spring and summer, and whiting *(Merlangius merlangus)* in the autumn and winter months[77]. These will be supplemented with other fish such as herring *(Clupea harengus)*, mackerel *(Scomber scombrus)* and gobies *(Pomatoschistus sp.)* throughout the year.

Anatomical and genetic studies on harbour porpoises to elucidate population structure have indicated that several populations and subpopulations exist in the North Atlantic. In UK waters, work suggests that genetically differentiated subpopulations exist in the Irish Sea/Wales and the North Sea, with some possible further divisions of the North Sea population[78].

Understanding population structure is important for conservation efforts. It is likely that the effects of regional threats such as bycatch will be underestimated if animals are thought to be part of a single, wider population but actually form discrete subpopulations[79].

See Annex II for summary tables with information from the individual papers used.

West and south west Scotland

Several studies have shown west Scotland, and especially the Hebrides, to be of particular importance to harbour porpoises[80]. The SCANS II survey which took place in July 2005, recorded one of the highest densities of harbour porpoises in the north east Atlantic for the Hebrides, at 0.394 animals/km^2 (see Figure 4.5, p.22). Other density estimates produced in the region covered two smaller areas, the Inner Hebrides and the Firth of Clyde (see Figure 4.7, below), again for the summer months. A very high density estimate of 1.071 animals/km^2 was reported for the Inner Hebrides, an area frequently reported to host concentrations of harbour porpoises[81]. The same study also recorded a high density of porpoises for the Firth of Clyde, 0.823 animals/km^2. There are much less data available for the Firth of Clyde compared to the Inner Hebrides, but this high density estimate suggests it may also be of importance for harbour porpoises. **High densities of harbour porpoises during the summer, the time of year when these animals breed and produce young, suggests these waters may be important for these functions. This should be investigated further**.

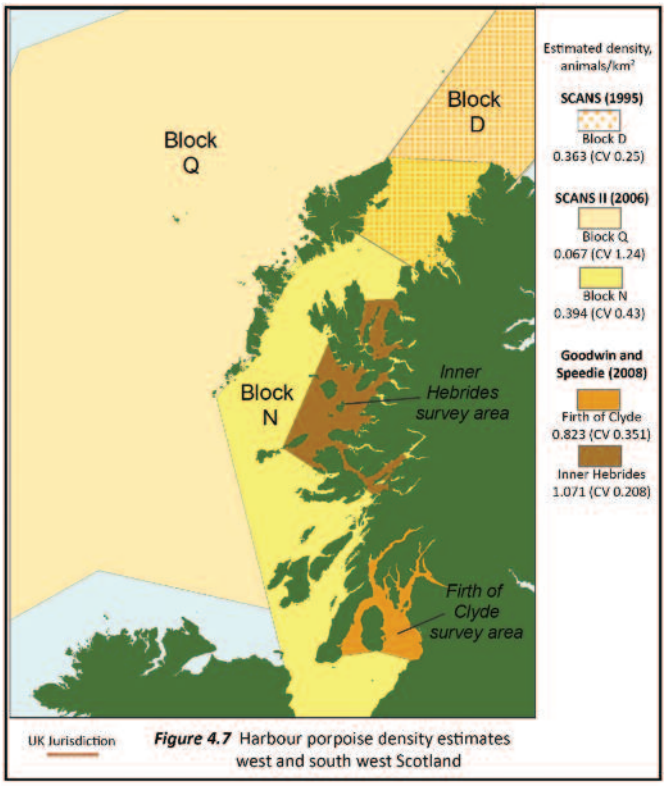

Figure 4.7 Harbour porpoise density estimates west and south west Scotland

[77] Santos and Pierce, 2003
[78] Anderson *et al*, 2001; Walton, 1997
[79] Anderson *et al*, 2001; Walton, 1997
[80] Including Evans and Wang, 2002; Northridge *et al*, 1995
[81] Pollock *et al*, 2000; Embling *et al*, 2010; Marubini *et al*, 2009; Evans and Wang, 2002

An in-depth study reviewing 22 years of effort-related harbour porpoise data from around the UK found the coastal waters of west Scotland, including the eastern sectors of The Minches and the Sea of the Hebrides (around the Isles of Skye, Mull and the Small Isles), to be one of four sites of key importance to harbour porpoises in UK waters[82]. This analysis found that porpoises are present in every month of the year, with concentrations in several months, including during the April-September period when calving takes place. They also found a higher than average proportion of calves to adults in the area which suggests its importance for calving and/or breeding harbour porpoises. The long time series of data showed that this situation has been consistent over many years.

Numerous studies in the region over recent years have reported high encounter rates for harbour porpoises. Encounter rates are generally highest in the spring and summer months, particularly in the Gairloch region[83], around the Isle of Skye[84], and the Firth of Lorne and Sound of Jura[85]. Outside of the summer months data are scarcer, but relatively high encounter rates have been recorded in the northern part of the Minch in autumn[86].

Data on harbour porpoise calf presence are problematic due to difficulties in sighting such small animals and they are likely underreported. However, studies have reported relatively high numbers of groups with calves in The Minches and the Sea of the Hebrides[87], and an aerial survey of the Inner Hebrides found a high calf to adult ratio with calves making up 10% of all animals sighted[88]. The presence of a higher proportion of mother and calf pairs is an indication that the area is used by harbour porpoises for calving[89]. This is supported by observations of researchers in the Gairloch region suggesting behaviour typical of porpoises calving[90].

Spatial modelling of harbour porpoise data has been used to look at distribution in the region on a finer scale. One model, created using four years of survey data from the month of August, predicted four areas of high relative abundance: 1) the region between Ardnamurchan, Coll and the Small Isles, which the authors highlight is also important sandeel habitat (harbour porpoise prey), 2) south east of Barra, an area they speculate may be preferentially used in seasonal movements to enter the Sea of the Hebrides from offshore areas to the west, where other surveys have made sightings[91], 3) north east of Skye to Gairloch, and 4) west of Pairc Peninsula (Isle of Lewis) to the Shiant Islands[92]. The area south of Barra has been found to have relatively high porpoise abundance by previous studies[93] and as discussed above, Gairloch has been identified as an important area for porpoise calving, and other studies have noted it to be a highly significant location for harbour porpoises[94].

A second habitat modelling study using summer data from further south in the Hebrides predicted highest densities close to the mainland – in the Sound of Jura, the Firth of Lorne, between Mull and the Treshnish Islands, in patches around the Small Isles and the Sound of Sleat[95]. Although harbour porpoises clearly use the whole area, the same core, high-use areas were predicted over three years. Some inshore areas – the Sound of Mull, upper Firth of Lorne and upper Sound of Jura – had sightings rates almost as high as the high density areas identified, but could not be included in the analysis because of a lack of environmental data. The authors suggest that these are also important to harbour porpoises and should be considered alongside the areas identified by the model.

Spatial habitat preference modelling such as this allows us to build on the knowledge gained from survey data and observations, and can help to further define areas of critical habitat for cetaceans[96].

West and north of the Outer Hebrides, data are much sparser. Harbour porpoises are generally only recorded in low numbers although some studies have reported high relative encounter rates west of the Uists and north east of Lewis[97]. Higher sea states and poorer weather offshore will inhibit the sighting of harbour porpoises and may mean they are underestimated in these areas.

Far West Scotland

The predominant view of harbour porpoises is of a species largely confined to nearshore waters less than 200m deep but despite this, several studies report their presence in deep offshore waters, albeit in relatively small numbers. The Wyville-Thomson Ridge and surrounding channels is an area noted for porpoise presence[98].

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82 Evans and Wang, 2002
83 MacLeod, 2001
84 Pollock *et al*, 2000; Goodwin and Speedie, 2008; Embling *et al*, 2010; Marubini *et al*, 2009
85 Pollock *et al*, 2000; Embling *et al*, 2010
86 MacLeod, 2001
87 Weir, 2008; Evans and Wang, 2002
88 SCANS II, unpublished data (in Embling *et al*, 2010)
89 Baines and Earl, 1998
90 Dolman and Hodgins, 2009
91 Macleod *et al*, 2003; Macleod *et al*, 2007
92 Marubini *et al*, 2009
93 MacLeod, 2001
94 Dolman and Hodgins, 2009; Shrimpton and Parsons, 2000
95 Embling *et al*, 2010
96 Hoyt, 2009
97 Pollock *et al*, 2000; Lewis *et al*, 1998
98 Pollock *et al*, 2000; Evans and Wang, 2002; MacLeod, 2001

North Scotland

The first SCANS survey (in July, 1994) recorded the highest densities in UK waters for the area around the Northern Isles – 0.783 animals/km^2, and an abundance of 24,335 animals. The adjacent survey area, covering the waters to the east, west and north of the Northern Isles recorded a moderate density of 0.363 animals/km^2 (see Figure 4.3, p.21). Spatial modelling of this data predicted a large area of high density spanning much of the waters of east, north east and north Scotland (see Figure 4.4, p.21).

A multi-year study during the 1990s covering porpoise distribution and habitat use in Shetland's coastal waters found them to be widespread but with concentrations on the east and south coasts of mainland Shetland[99]. The most important areas were Sumburgh Head/Quendale Bay, Mousa Sound to Helliness, south Noss Sound, and east Whalsay/Out Skerries. These areas tend to be characterised by strong tidal currents and as in other areas, harbour porpoises seem to take advantage of these conditions to forage[100].

Analysis of over 20 years of harbour porpoise data from around the UK found Shetland to be one of four sites rated most important for this species[101]. Porpoises were shown to be present here in every month, with concentrations during the April-September key calving period. They also found that a higher than average proportion of calves to adults was recorded here in August and September, suggesting its importance as a calving and/or nursery area[102].

However, distributional changes appear to have occurred in recent years and porpoise sightings have become much less common[103]. This observation was supported by the SCANS II survey that took place in 2005 and found densities to be less than half what they were during the mid-1990s, at 0.274 animals/ km^2 around the Northern Isles[104](see Figure 4.5, p.22). Spatial modelling of this dataset suggested that at a large scale, the area of high density observed off south east Scotland in 1994 had largely dispersed by 2005[105] (see Figures 4.4, p.21 and 4.6, p.22). To the north of the Scottish mainland, high densities had persisted and intensified[106]. **High densities of harbour porpoises during the summer, the time of year when these animals breed and produce young, suggests these waters may be important for these functions. This should be investigated further**.

The reasons for the apparent changes in distribution are unknown but may be related to prey distribution and abundance[107]. Shortages of sandeels, a staple food source for harbour porpoises as well as other cetaceans and seabirds, have been observed in the region over recent years and linked to starvation and breeding failures in seabirds[108]. The observed decrease in harbour porpoise sightings may be a result of reduced prey availability.

Relatively high sightings rates have also been recorded near the Fair Isle and in Orkney's coastal waters, during spring, summer and winter[109]. There is very little information about this area however.

East Scotland

This region is most famous for its bottlenose dolphin population but it is also home to significant numbers of harbour porpoises. The SCANS survey (in July, 1994) recorded the highest density of porpoises in UK waters off the Northern Isles and the Inner Moray Firth (see Figure 4.3, p.21) at 0.783 animals/km^2 and an abundance of 24,335 animals[110]. The adjacent survey block covering the waters of north Scotland and the Outer Moray Firth recorded a moderate density of 0.363 animals/km^2. Spatial modelling of this data predicted a large area of high density covering the waters of east, north east and north Scotland[111] (see Figure 4.4, p.21).

Ten years later when this survey was repeated (SCANS II), this high density area had changed, and only moderately low densities of harbour porpoises were recorded for north east and east Scottish waters[112] (see Figures 4.5 and 4.6, p.22). The reasons for this are unknown but may be related to prey distribution and abundance. (See East England section below for further discussion.)

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[99] Evans, 1997
[100] *Ibid*
[101] Evans and Wang, 2002
[102] *Ibid*
[103] Evans and Wang, 2008
[104] SCANS II, 2006
[105] *Ibid*
[106] *Ibid*
[107] Evans and Wang, 2008
[108] JNCC press release, 2005 http://www.jncc.gov.uk/page-3628
[109] Pollock *et al*, 2000; Evans and Wang, 2002
[110] Hammond *et al*, 1995
[111] SCANS II, 2006
[112] *Ibid*

For the Inner and Outer Moray Firth, harbour porpoises are the most commonly sighted cetacean, found throughout the area, in inshore and offshore waters[113]. For most or all of the year, harbour porpoises are widely distributed throughout the Inner Moray Firth[114], an area designated a Special Area of Conservation (SAC)[115] for bottlenose dolphins. There does appear to be some segregation between the two species in this area, perhaps unsurprising given that bottlenose dolphins are known to attack harbour porpoises[116]. Although porpoises can be sighted throughout the Inner Moray Firth, surveys and habitat modelling studies suggest higher relative densities away from the coastal areas used by bottlenose dolphins, towards the centre of the area from the outer SAC boundary towards the Inverness Firth, and also off Helmsdale on the northern coast[117]. High ratios of young to adult harbour porpoises were also found for this region off the north coast, suggesting its importance for breeding and calving[118].

Fewer data are available overall for the Outer Moray Firth, particularly the northern and central waters, but recent visual and acoustic surveys have found porpoises to be widespread in this area for much of the year[119]. Monitoring with PODs[120] found the highest level of detections for the Outer Moray Firth and recorded harbour porpoises at 97.5% of sites for an average of 6.7 hours a day[121]. Visual surveys carried out in conjunction with the acoustic monitoring supported these results, with harbour porpoises encountered on all surveys across the Outer Moray Firth, and with relatively high sightings rates[122]. **High densities of harbour porpoises during the summer, the time of year when these animals breed and produce young, suggest these waters may be important for these functions and this should be investigated further**.

A multi-year study of the southern coastal region of the Outer Moray Firth also reports high relative abundance of harbour porpoises for this area[123]. Numbers apparently increase progressively from May through to October. During the summer months, females and calves moved inshore, which the authors consider is due to sheltered inshore waters providing preferred calving habitat. Similar to other areas, neonatal calves were mostly observed between May and July. Increases in harbour porpoises over the summer are also likely due to sandeel availability in the area, providing good foraging opportunities[124].

Nearby, along the Aberdeenshire coast, harbour porpoises are also present throughout the year, with abundance peaking in August and September. Researchers concluded that the seasonal increase in harbour porpoises in the area was partly due to their preferential use of inshore waters for calving, and also to take advantage of foraging opportunities[125]. Most calves and juveniles were recorded between June and September, with June the peak month. This is the key period for harbour porpoise calving and indicates that the area is used for this purpose[126]. The timing of the increase in harbour porpoise sightings matches when mackerel are known to move inshore, and the particular area most favoured by porpoises is reportedly also where large numbers of mackerel are present[127].

In a study looking at several decades of harbour porpoise data from around the UK, the southern coast of the Moray Firth and the north east Aberdeen coast came through strongly as an important area for harbour porpoises[128]. Records over many years show they are present for most of the year and in significant concentrations during the summer calving months. Data on young are generally problematic because of difficulties with sighting calves, but several areas in this region were identified as having higher than average proportions of calves to adults – the Banff coast (June), the Inner Moray Firth and north Aberdeen coast (July), and the Aberdeen coast again in August[129].

For the remainder of this region – coastal south east Scotland, offshore east Scotland and the northern Moray Firth – there are insufficient data available to make an assessment of its importance for harbour porpoises.

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[113] Thompson *et al*, 2010
[114] Bailey and Thompson, 2009; Hastie *et al*, 2003; Evans and Wang, 2002
[115] Designated under the EC Habitats Directive
[116] Bailey and Thompson, 2009; Thompson *et al*, 2004
[117] Bailey and Thompson, 2009; Hastie *et al*, 2003
[118] Evans and Wang, 2002
[119] Eisfeld *et al*, 2009; Thompson *et al*, 2010
[120] Porpoise acoustic monitoring devices
[121] Thompson *et al*, 2010
[122] *Ibid*
[123] Robinson *et al*, 2007
[124] *Ibid*
[125] Weir *et al*, 2007
[126] *Ibid*
[127] *Ibid*
[128] Evans and Wang, 2002
[129] *Ibid*

East England

The seasonal pattern in the southern North Sea appears to be for an early spring peak in numbers in coastal waters to be followed by a northward migration towards more offshore waters. However, whilst some studies report that numbers of harbour porpoises in coastal waters around the southern North Sea then remains low for the summer[130], others have found a second peak to take place off east England in August and September, possibly highlighting a regional difference[131].

The major SCANS surveys undertaken in the summers of 1994 (SCANS) and 2005 (SCANS II) across the North Sea and European Atlantic continental shelf waters provided some interesting insights into possible large-scale changes in harbour porpoise distribution in the North Sea over recent years (see Figures 4.3-4.4, p.21 and 4.5-4.6, p.22). The 1994 survey[132] recorded moderate numbers of harbour porpoises off east England and in the central/southern North Sea region (0.387 animals/km^2 and 0.34 animals/km^2). Yet when SCANS II took place in 2005[133], numbers in the south North Sea had increased greatly and densities of 0.562 animals/km^2 were recorded, while in the northern North Sea a corresponding decrease was detected. This may indicate a redistribution of porpoises from north to south, which is thought to be most likely due to changes in the distribution or availability of prey[134]. Highest densities in 2005 stretched from The Wash and north Norfolk coast, north and west to the Dogger Bank region[135]. Many sandbanks exist in this area, important habitat for sandeel and other prey species utilised by harbour porpoises, other marine mammals, seabirds and fish[136].

Other studies have highlighted the importance of the Dogger Bank area to harbour porpoises, other cetaceans and many species of seabirds, and multi-species feeding associations have been documented here[137]. Surveys over the German sector of the Bank found high densities of porpoises (1 - 1.5 animals/km^2)[138]. The German side of the bank has been designated as an SAC and the Dutch and UK areas of the bank have also been proposed for an SAC, but not with harbour porpoises as a qualifying feature[139]. An acoustic study based on offshore installations on the Dogger Bank recorded porpoises regularly around the installations and considered these may be important foraging areas for this species[140]. The authors also noted that if porpoises cluster around these installations as their research suggests, these animals may be omitted by population surveys such as SCANS as survey vessels would have to remain outside the 500m exclusion zone.

Trying to understand these large-scale changes in distribution, and the driving forces behind them, will only be possible by repeating North Sea wide surveys such as SCANS on decadal or more frequent basis, and also by investigating porpoise-prey dynamics. The SCANS surveys — designed to provide large-scale population estimates — provide no information on the relative importance of habitats at a fine scale. It may be that smaller areas within the North Sea are important to harbour porpoises. **Smaller scale surveys are also necessary to determine if some areas remain important to harbour porpoises throughout these larger scale fluctuations**.

A review and analysis of over 20 years of harbour porpoise data from around the UK identified three areas off the east coast of England that are potentially consistently important to harbour porpoises – east of Northumberland, east of Yorkshire, and particularly, east of the Wash near the Norfolk coastline. Porpoises have been recorded in these locations for some or most months of the year, with concentrations in several months, and records over several years[141]. For east of the Wash these concentrations occur during the April to September key calving period for harbour porpoises[142]. **High densities of harbour porpoises during the summer, the time of year when these animals breed and produce young, suggest these waters may be important for these functions and this should be investigated further**.

South east England

Declines in harbour porpoise abundance have been observed in the southern North Sea region since the 1950s, for reasons not understood[143]. For the last few years, sightings and strandings data from Belgian and Dutch waters have indicated an increase in numbers for the southern North Sea, and the SCANS II survey results (see East England section) support this. However, the

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130 Haelters and Camphuysen, 2009
131 Evans and Wang, 2002
132 Hammond *et al*, 2002
133 SCANS II, 2006
134 *Ibid*
135 *Ibid*
136 JNCC, 2010
137 Camphuysen *et al*, 1995; Gubbay *et al*, 2002
138 Gilles *et al*, 2008
139 JNCC, 2010
140 Todd *et al*, 2009
141 Evans and Wang 2002
142 *Ibid*
143 Haelters and Camphuysen, 2009

eastern Channel does not seem to have had a similar increase in porpoise numbers. During SCANS (in July 1994) none were sighted off south east England. During SCANS II, a moderate density of 0.331 animals/km^2 was recorded for the block that included this area but spatial modelling of the results suggests higher densities of animals were in the western Channel, and only the very northern part of the eastern Channel stretching down from the region of high density off east England (see Figures 4.5 and 4.6, p.22).

South west England

The waters off south west England are a further area where the SCANS surveys showed significant changes in distribution of harbour porpoises in 10 years. SCANS (in July 1994) recorded no porpoises in the English Channel region and a relatively low density for the Celtic Sea and Bristol Channel[144] (see Figure 4.3, p.21). Ten years later during SCANS II, moderate densities were recorded in the English Channel (0.331 animals/km^2) and high densities in the Celtic Sea and Bristol Channel (0.408 animals/km^2) (see Figure 4.5, p.22). Spatial modelling of the SCANS II dataset predicted moderate densities for a large area of the Celtic Sea and the very western edge of the English Channel[145] (see Figure 4.6, p.22).

An increase in the summer occurrence of harbour porpoises in the English Channel has also been suggested by an 11-year study (1996-2006) using data collected from ferries travelling across the English Channel and the Bay of Biscay[146]. Findings indicate that this increase has occurred since 2002 and may only be the result of an increase in summer abundance, not a consistent year-round increase[147].

Analysis of over 20 years of harbour porpoise data for UK waters highlighted several hotspots for harbour porpoises in this region[148]. North Devon was determined to be important, with high concentrations of porpoises in several months of the year, particularly during the April to September period. An area in the Outer Bristol Channel, south to north west Cornwall, was rated as an important site, but with fewer months of high concentrations than north Devon. **High densities of harbour porpoises during the summer months, the time of year when these animals breed and produce young, suggest these waters may be important for these functions and this should be investigated further**.

Data were lacking for the western English Channel region but significant concentrations of porpoises were still noted for the first quarter of the year[149].

Little other data were found for the north Devon coast. One study investigated the fine-scale habitat use by harbour porpoises of two sites in this area and determined that one, Morte Point, was an important feeding ground for harbour porpoises[150]. Morte Point is a headland with an area of tidal rapids nearby and porpoises were observed to spend 60% of their time in the area foraging. This activity predominantly occurred within the tidal race[151] which is similar to results from other locations where porpoises are seen to take advantage of the aggregating effect of high tidal flow. At the second site, Lee Bay, porpoises were also observed feeding but spent more time travelling in this area and it seems to be used mainly as a corridor between more productive feeding sites[152].

Some survey work has taken place in the western English Channel and close to the Scilly Isles during the winter[153]. Although overall relative abundance was fairly low, porpoises were not evenly distributed, with large groups of apparently foraging porpoises seen at times[154]. A land-based survey conducted at the same time of year reported relatively high densities of porpoises off Land's End and frequently observed them to be foraging here[155]. These surveys would seem to support other analyses of data from the region that found there to be concentrations of porpoises in the western English Channel during the first few months of the year[156]. Analysis of multiple years of cetacean sighting data from the coastal waters of Cornwall, investigating spatial and temporal patterns, also found harbour porpoises were predominantly sighted off Land's End, with a peak in winter[157].

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[144] Hammond *et al*, 1995
[145] SCANS II, 2006
[146] Macleod *et al*, 2009
[147] *Ibid*
[148] Evans and Wang, 2002
[149] *Ibid*
[150] Goodwin, 2008
[151] *Ibid*
[152] *Ibid*
[153] De Boer and Simmonds, 2004; WDCS, 2005b; De Boer and Saulino, 2007
[154] De Boer and Simmonds, 2004
[155] De Boer and Saulino, 2007
[156] Evans and Wang, 2002
[157] Pikesley *et al*, IN PRESS

Irish Sea

Outside of coastal Welsh waters (see following section), the area of the Irish Sea consistently highlighted for high porpoise numbers is the St. George's Channel in the south[158]. The waters off Pembrokeshire appear to be the centre of high porpoise densities but further west into the St. George's Channel, several studies report high concentrations in some months, including during the summer [159]. **High densities of harbour porpoises during the summer, the time of year when these animals breed and produce young, suggest these waters may be important for these functions and this should be investigated further**.

The central Irish Sea has also been noted by some studies for possible concentrations of porpoises, although there are fewer data[160]. There is a potential association here between harbour porpoises and the western Irish Sea front which appears to create an area of increased productivity[161]. This front develops seasonally, south from the Isle of Man, as a body of deep, thermally stratified water meets a shallower body of mixed, nutrient rich water. There is some movement of this front but it remains relatively static throughout the season[162]. At this interface, an enhanced level of productivity develops, attracting top predators such as seabirds and harbour porpoises. A study here found that porpoises occurred more frequently in the frontal area, compared to other areas of the central Irish Sea included in the survey, and were predominantly found on the mixed side of the front[163]. The study suggests that the aggregation of harbour porpoises may be the result of this increased productivity.

Coastal Wales

Several areas in coastal Welsh waters have been highlighted for their high sightings rates and apparent importance to harbour porpoises. Northern Pembrokeshire, particularly Strumble Head and around Ramsey and Skomer islands, is an area shown to have high concentrations of porpoises in most months of the year, including the April to September calving period[164]. Several studies looking at data over a long time period have highlighted the waters west of Pembrokeshire as a harbour porpoise hotspot[165]. Peaks in abundance have been noted for late summer and early autumn, and again in April[166], but surveys at other times of year such as late autumn have also found the highest number of porpoises in the region to be off Pembrokeshire[167] indicating the area's relative importance at other times of year.

Foraging is the most frequently observed behaviour here — again, the area is characterised by strong tidal currents and races — and animals are observed holding their position in the current, often for extended periods, and regularly joined by feeding seabirds[168].

More detailed investigations into the foraging strategy and behaviour of harbour porpoises at Ramsey Sound found that foraging was almost entirely restricted to the ebb tidal phase[169]. At this site, aggregations of up to 20 porpoises were recorded at times and it was not uncommon to see groups repeatedly and closely surfacing together, appearing to pursue prey in a coordinated manner[170]. At other times, usually after extended periods of foraging, contact between groups of individuals seemed to take on a social context, with slow milling, intermingling, leaps and tail slapping observed[171].

These observations, combined with the presence of females with calves, throughout the year but particularly through the summer, indicate that breeding takes place in this area[172]. This assertion is supported by investigations into the strandings records in the region which have shown that in June and July (peak harbour porpoise birthing months), high proportions of freshly stranded harbour porpoises were neonates (> 50%)[173]. Review of effort- and non effort-related sightings data from the region has indicated that harbour porpoise mothers with calves prefer the Skomer-Ramsey region over Strumble Head — the area with the highest overall porpoise densities[174].

In a study looking at the comparative importance of sites around the UK, the area of Pembrokeshire and southern Cardigan Bay was rated as one of the four most important known sites for harbour porpoises in the UK[175]. Southern Cardigan Bay was also highlighted as an area with higher than average proportions of calves throughout the summer months indicating its importance as a calving and breeding area[176].

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[158] Northridge *et al*, 1995; Bravington *et al*, 2002; Evans and Wang, 2002
[159] Evans and Wang, 2002; Northridge *et al*, 1995
[160] Bravington *et al*, 2002
[161] Weir and O'Brien, 2000
[162] WWF
[163] Weir and O'Brien, 2000
[164] Baines and Evans, 2009; Evans and Wang, 2002
[165] Evans and Wang, 2002; Baines and Evans, 2009; Bravington *et al*, 2002; Northridge *et al*, 1995
[166] Pierpoint *et al*, 1998
[167] De Boer and Simmonds, 2003
[168] *Ibid*
[169] Pierpoint, 2008
[170] *Ibid*
[171] *Ibid*
[172] Pierpoint *et al*, 1998; Baines and Earl, 1999
[173] Penrose and Pierpoint, 1999
[174] Baines and Earl, 1999
[175] Evans and Wang, 2002
[176] Evans and Wang, 2002; Baines and Earl, 1999

Porpoises are present throughout the year in southern Cardigan Bay but with slight peaks during the winter months[177]. They are widespread throughout the inshore and offshore areas but have been found to have some preferred areas — densities on the whole are higher in the southern part of Cardigan Bay than further north[178], and presence is greatest around New Quay head, Aberporth, Ynys Lochtyn, and between Cemaes Head and Ceibwr Bay[179]. Abundance has been estimated at between 167 and 214 for harbour porpoises in the southern Cardigan Bay SAC[180].

Along the south coast of Wales, the Gower Peninsula has also been highlighted as an area of possible importance to harbour porpoises as it was found to have concentrations in some months of the year[181]. There are few data available for this region but one study looking at fine scale distribution found from acoustic and visual surveys that Mumbles Head and Burry Holms on the Gower Peninsula were high-use areas[182].

To the north coast of Wales, analysis of multiple-year data has found the Isle of Anglesey and the Lleyn Peninsula to have high relative densities of harbour porpoises, with concentrations for several months of the year[183]. A higher than average proportion of calves to adults was found to occur off Anglesey in July, suggesting the area's importance for calving.

Studies of the waters around Anglesey have found them to support high densities of harbour porpoises, particularly Point Lynas and South Stacks on the north and west of the island[184]. A three-year study (May-September) recorded the highest densities of porpoises at Point Lynas, an area of strong tidal currents and races, along with a high degree of aggregation of animals at this site[185]. Based on this, and that other studies have observed large aggregations of porpoises feeding in the area, researchers suggest it is likely an important foraging and feeding site for harbour porpoises. At South Stacks, porpoises were not found to be so highly aggregated and behavioural data for the area is not currently available, so conclusions about site use are harder to reach. However, high densities of porpoises are found here and the area contains the oceanographic features (tidal races and eddies for example) that seem to facilitate foraging for harbour porpoises so it may also be a site used for feeding[186].

The Lleyn Peninsula and Bardsey Island just off the coast have been the subject of study for a number of years in recognition of the high numbers of porpoises found in these waters[187]. Most survey work has taken place in spring and summer, with the highest levels of sightings in April and late July-September, and the lowest sighting levels in early July[188]. April seems to be a particularly favoured time of year for porpoises to aggregate and feed in the Sound that separates Bardsey Island from the mainland[189]. The waters around Bardsey Island are influenced strongly by the fast and complex tidal currents that occur and porpoise activity was found to be related to tidal state, with peaks observed during the low water period, and following the neap tide[190]. As at other locations, porpoises were observed holding their position into the current, apparently using the conditions to aid feeding. Lower numbers recorded during spring tides are possibly due to the tides becoming too strong and energetically demanding for porpoises to forage.

In addition to feeding, the area is also believed to be important as a porpoise breeding and nursing site[191]. A high proportion of sightings (10-24%) are females with young, particularly in August but also September and July[192]. They appear to favour the calmer, inshore waters, an observation that has been made at other sites (e.g. Ramsey Sound, south Wales).

Analysis of five years of stranding data from around England and Wales found that strandings of neonate porpoises occurred more often in Wales than anywhere else, suggesting that Cardigan Bay and west Wales is an important breeding and calving ground for harbour porpoises[193].

Little information for this area is available from outside the spring and summer months. One survey that took place in the autumn of 2002 and included the waters of northern Cardigan Bay noted a cluster of harbour porpoise sightings in the northern Cardigan Bay-Bardsey Island area, indicating that this area may still be important to harbour porpoises later in the year[194].

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[177] Pesante *et al*, 2008
[178] Although there has been much more survey effort in southern Cardigan Bay
[179] Pesante *et al*, 2008
[180] *Ibid*
[181] Meaning it was found to have porpoises present in at least three months of the year, with concentrations in at least two months although not necessarily during the April-September period (when calving takes place), and with records over several years
[182] Watkins and Colley, 2004
[183] Evans and Wang, 2002; Baines and Evans, 2009
[184] Shucksmith *et al*, 2008
[185] *Ibid*
[186] *Ibid*
[187] WDCS, 2002, 2003, 2004, 2005a, 2006; De Boer and Simmonds, 2003
[188] WDCS, 2005a
[189] *Ibid*
[190] *Ibid*
[191] *Ibid*
[192] *Ibid*
[193] Bennett *et al*, 2002
[194] De Boer and Simmonds, 2003

4.4.2 BOTTLENOSE DOLPHIN *(Tursiops truncatus)*

Bottlenose dolphins in the North Atlantic appear to consist of two forms, a coastal and an offshore form. The better known coastal form is locally common in the Irish Sea and off north east Scotland, and in smaller numbers in the Hebrides (west Scotland), and in the western half of the Channel, off south west England. It is present in coastal UK waters year-round but numbers peak in most places between July and October. Coastal bottlenose dolphins have a varied diet that includes several fish species, including cod *(Gadus morhua)*, salmon *(Salmo salar)* and whiting, and they will also prey on invertebrates[195].

No overall population estimate exists for bottlenose dolphins in UK coastal waters but due to their relatively predictable and coastal habitat preferences, and suitability for photo-ID studies, good population data are available for the best known populations. The east coast of Scotland bottlenose dolphin population is estimated to number 193 animals (95% Probability Interval = 162-245)[196] while the Cardigan Bay (Irish Sea) population is estimated to vary between 154 and 248[197] (see Figure 4.8, p.31). The less well studied population of dolphins inhabiting the west coast of Scotland (and consisting of two communities) apparently numbers about 45 animals (95% Probability Interval = 33-66)[198]. A poorly-known group of bottlenose dolphins appears to be resident to the waters of south west England and photo-ID studies conducted during the 1990s documented at least 50 animals[199]. Genetic testing of these coastal populations has indicated that a level of population structure exists and they do not form one single randomly mating population. However, there is not enough genetic divergence to suggest these populations are completely isolated from each other; there is at least a low level of gene flow occurring[200].

Little is known about the offshore form of bottlenose dolphins, including the relationship between the offshore and coastal forms. On the other side of the Atlantic, off the US east coast, where offshore and coastal forms of bottlenose dolphins are also observed, they appear to be ecologically and genetically discrete from each other[201]. There are indications that this situation is repeated across the North Atlantic[202] but further research is needed to confirm that this is the case in UK waters. Offshore bottlenose dolphins are thought to prey on mesopelagic fish and cephalopods. They are frequently found in mixed pods with pilot whales, and this is thought to be because of a shared preference for squid[203]. No population estimate exists for the offshore form of bottlenose dolphins in UK waters.

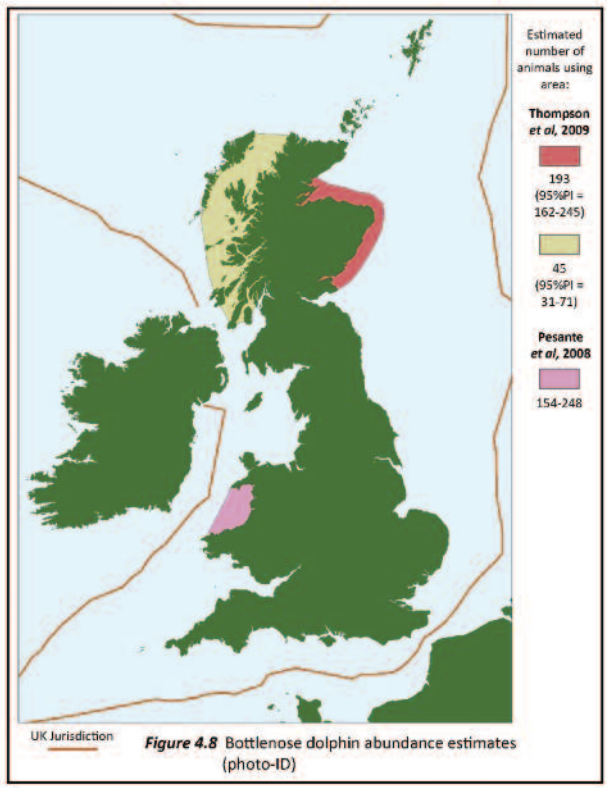

Figure 4.8 Bottlenose dolphin abundance estimates (photo-ID)

[195] Culik, 2004
[196] Thompson *et al*, IN PREP
[197] Pesante *et al*, 2008
[198] Thompson *et al*, IN PREP
[199] Wood, 1998
[200] Thompson *et al*, IN PREP
[201] Hoelzel *et al*, 1998
[202] Quérouil *et al*, 2007
[203] Skov *et al*, 1995

The SCANS II and CODA surveys have provided estimates for European Atlantic shelf and offshore waters. SCANS II (in July, 2005) estimated an abundance of 12,645 (95% CI = 7,504-21,307) animals for the survey area. The highest densities around the UK were estimated for the waters off south west England and Ireland, 0.0272 animals/km^2, with an abundance estimate of 5,370 animals (see Figure 4.9, below). Moderate densities were recorded for north east Scotland, the Hebrides, offshore west Scotland, and the Irish Sea.

The CODA survey (in July, 2007) generated an abundance estimate of 19,295 bottlenose dolphins (95% CI = 11,842-31,440) for the offshore waters covered by the survey. Highest densities were recorded for the waters off the shelf south west of Ireland and the UK at 0.034 animals/km^2, and an abundance of 11,536 animals (see Figure 4.10, below). Relatively high densities were also recorded for the waters offshore west of Scotland – 0.016 animals/km^2 – with an abundance of 5,709 animals.

These surveys have demonstrated that large numbers of offshore bottlenose dolphins live in UK waters, besides the better-known resident populations in coastal waters.

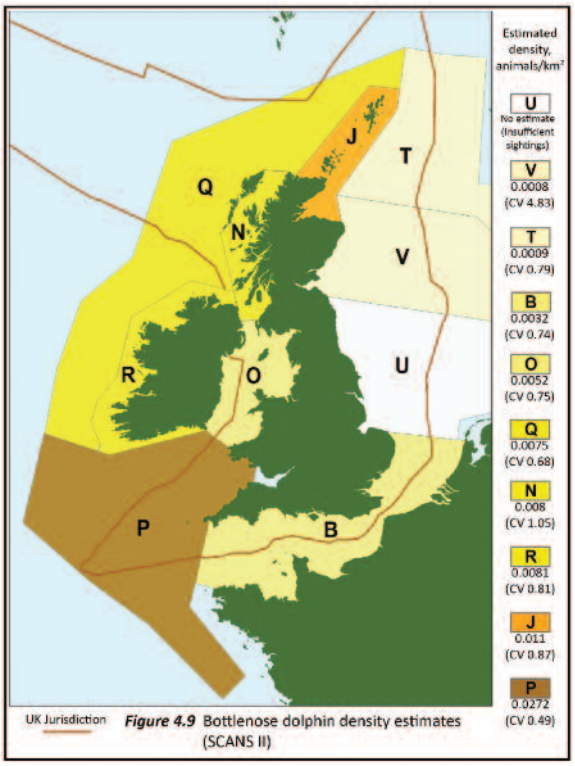

Figure 4.9 Bottlenose dolphin density estimates (SCANS II)

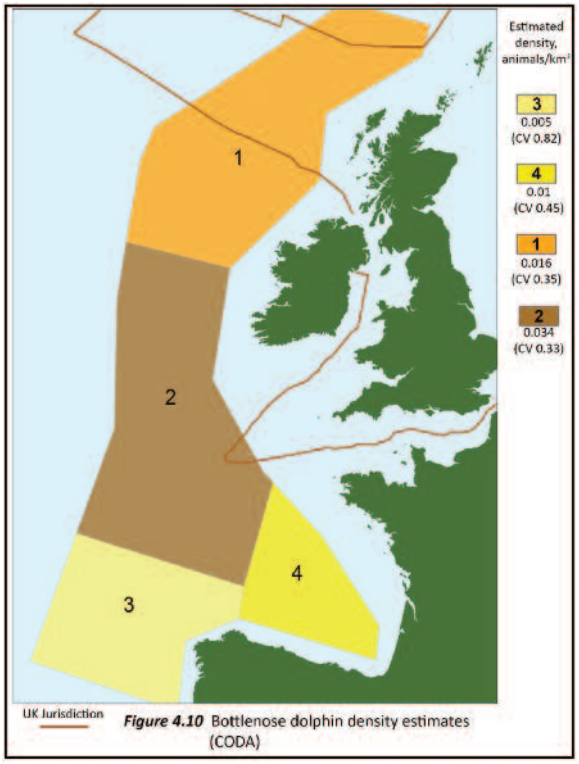

Figure 4.10 Bottlenose dolphin density estimates (CODA)

East Scotland

Probably the best known cetacean population in UK waters, the bottlenose dolphins of north east Scotland number about 193 animals and range throughout the coastal waters from the Moray Firth to St Andrews Bay and beyond, with occasional sightings in the Firth of Forth and north east England[204]. An SAC[205] was established in the waters of the Inner Moray Firth to protect this population of bottlenose dolphins. At the time, the Inner Moray Firth was intensely used by these animals for much of the year, and for critical activities such as breeding and feeding[206]. It is still important today but in recent years this population has expanded its range to include much of the east coast of Scotland, including north east England[207]. Studies in Aberdeenshire waters and along the south coast of the Outer Moray Firth report that these waters are being used for feeding, and by mothers with calves[208]. In Aberdeenshire, where studies have taken place all year, bottlenose dolphins were recorded throughout the year, with peak abundance in spring[209].

[204] Thompson *et al*, IN PREP; Hoyt, pers. comm
[205] Special Area of Conservation, established via the EU Habitats Directive
[206] Wilson, 2008 (in Evans, 2008)
[207] Thompson *et al*, IN PREP
[208] Culloch and Robinson, 2008; Robinson *et al*, 2007; Stockin *et al*, 2006
[209] Stockin *et al*, 2006

This expansion in range means this population is at risk of receiving less protection than previously, as at least part of the population spends considerably more time in waters outside the SAC, although under the Habitats Directive the protection should follow the animals regardless of whether they are inside or outside of the SAC boundary.

The whole stretch of coastal waters from the Inner Moray Firth to the Firth of Forth is clearly critical habitat for this population, yet there are areas within this that appear to be of particular importance with consistently higher peaks in abundance and observations of foraging. These 'hotspots' include Kessock Channel, the Chanonry Narrows, the Sutors, Lossiemouth, Spey Bay and Stonehaven in the summer[210]. The waters near Aberdeen harbour also seem to be an important area for foraging[211]. Much less is known about important areas to this population in the winter and abundance is lower in the places favoured during summer. However, they are still regularly recorded at Kessock Channel, the Chanonry Narrows and the Sutors in the winter, and at this time of year Tarbat Ness and Brora see an increase in detections[212].

West Scotland

A smaller and less well studied population of bottlenose dolphins inhabits the waters to the west of Scotland[213]. The 2007 population estimate is 45 animals which appears to be split into two communities, one widely ranging through the waters of the Inner Hebrides and the coastal mainland, and the other, numbering just 13-15 animals, using only the waters around the Sound of Barra[214]. It is reported that these two communities are discrete with little or no interchange, and have not been observed in mixed groups.

The Inner Hebrides community roams widely through this area and has been observed as far north as Gairloch, and south to the Kintyre peninsula. It appears to use the southern areas more regularly than the waters north of the Isle of Skye, although more research is needed to determine its distribution more accurately, and to identify any particularly favoured locations within the area. In contrast to the wide-ranging community of the Inner Hebrides, the Sound of Barra community appears to have a very limited range, focused on this small, but obviously productive, area of sea. Although small, these communities appear to be breeding successfully with young calves sighted in both. **In order to assess the viability of the small west coast bottlenose dolphin communities, studies into survivorship and stock structure are needed**.

The Irish Sea, Cardigan Bay and St. George's Channel

The bottlenose dolphin population in this region is focused around Cardigan Bay, particularly for the summer months. During this time of year, the dolphins are concentrated in the southern part of Cardigan Bay, and further north in Tremadog Bay, primarily within 5km of the coast[215]. These coastal areas are used for breeding, feeding, socialising, and by groups with young calves[216]. Other parts of this area have been less studied but bottlenose dolphins are also reported off the Llyn Peninsula and Anglesey in north Wales, and off northern Pembrokeshire and the St. George's Channel in the south[217].

Similarly to north Scotland, within this area of critical habitat, there appear to be areas of particular significance to these bottlenose dolphins. Aberaeron to Cardigan and around Fishguard have been highlighted as important areas, and particularly New Quay headland and harbour, Ynys Lochtyn, Mwnt, Aberporth and Pen Peles[218]. Further north, the dolphins appear to concentrate more in Tremadog Bay and in the vicinity of a number of sandbanks in the area[219].

Population estimates range from 154 to 248 animals for the whole of Cardigan Bay. Long-term studies in the area suggest that numbers of bottlenose dolphins and habitat use are stable[220]. Photo-ID studies have shown that while there is a level of site fidelity, there are also transient individuals and infrequent visitors, suggesting that the animals seen in the Bay are part of a wider population that encompasses part or possibly all of the Irish Sea[221].

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[210] Thompson *et al*, IN PREP
[211] Stockin *et al*, 2006
[212] Thompson *et al*, IN PREP
[213] Thompson *et al*, IN PREP
[214] Thompson *et al*, IN PREP; Grellier and Wilson, 2003
[215] Pesante *et al*, 2008; Baines and Evans, 2009
[216] Pesante *et al*, 2008; Anon, 2008
[217] Baines and Evans, 2009; Evans and Pesante, 2008 (in Evans, 2008);
[218] Pierpoint *et al*, 2009; Pesante *et al*, 2008
[219] Pesante *et al*, 2008
[220] Pierpoint *et al*, 2009; Bristow and Rees, 2001
[221] Pesante *et al*, 2008

Less is known about the distribution of this population in the winter months but its abundance in favoured summer locations is much lower during this time. This population appears to disperse more widely and head further offshore in the Bay and northward, sometimes in large groups[222]. One survey that took place in the Bay during autumn recorded most bottlenose dolphins in the northern part of the Bay, including young calves[223].

Two SACs are in place in Cardigan Bay in recognition of the importance of the area for bottlenose dolphins. The site in the southern part of the Bay was established primarily for bottlenose dolphins, and at the second site in the north of Cardigan Bay, they are classified as a qualifying feature (thus not a primary reason for the site being selected). Since the establishment of these sites, more has been learnt about this population of bottlenose dolphins. First, it has become clear that this population ranges much more widely in the Irish Sea than was initially thought[224]. As a result, there may be other areas of critical habitat for this population in the region. Research so far suggests that waters further to the north and offshore, such as north and east of the Isle of Anglesey are important, particularly during the winter months. Second, areas in the northern part of the Bay (such as Tremadog Bay) appear to be of sufficient importance to warrant bottlenose dolphins being listed as a primary feature for the SAC rather than only a qualifying feature.

South west England

A population of bottlenose dolphins has been documented to be wide-ranging and resident to the coast of south west England since the early 1990s[225]. Photo-ID studies conducted at this time documented at least 50 animals[226]. They appear to make seasonal movements along the coast between Cornwall and Sussex[227]. However, since the late 1990s, sightings of these animals have been declining, possibly by as much as 93%.[228] Given the increase in public awareness of cetaceans in UK waters, particularly bottlenose dolphins, it seems likely that this decrease in sightings is real. It is unknown whether the decline in sightings represents the loss or movement of animals away from the area but the decline is substantial and there have been no reports of them elsewhere along the coastline that would suggest a shift in range.

Little is known about bottlenose dolphins outside of coastal waters in the UK, even though large-scale surveys such as SCANS II and CODA demonstrate that considerable numbers inhabit these areas (see Figures 4.9 and 4.10, p.32). Both these surveys found the highest densities of bottlenose dolphins to be in waters to the south west of Ireland and England — in the Celtic Sea and beyond the continental shelf edge. Almost half the abundance of bottlenose dolphins for the whole SCANS II survey area was recorded in the Celtic Sea sector, suggesting the region is important to offshore bottlenose dolphins. However, the first SCANS survey 10 years earlier did not make sufficient sightings in the Celtic Sea to estimate abundance. **More research is clearly needed to determine if parts of the Celtic Sea are critical habitat for offshore bottlenose dolphins**.

Offshore

CODA recorded moderately high densities offshore west of Scotland. Other studies have noted the offshore banks, particularly Rockall Bank, and over the Wyville-Thomson and Ymir Ridges, as locations with higher sightings rates of bottlenose dolphins[229], and future research efforts could usefully be focused here as a starting point. Few other data are available that might help determine specific areas within this region that are important to bottlenose dolphins.

[222] Baines and Evans, 2009; Pesante *et al*, 2008
[223] De Boer and Simmonds, 2003
[224] Evans and Pesante, 2008 (in Evans, 2008)
[225] Wood, 1998
[226] Wood, 1998
[227] Williams *et al*, 1996 (in Reid *et al*, 2003)
[228] Doyle *et al*, 2007; Pikesley *et al*, IN PRESS
[229] Skov *et al*, 1995; Reid *et al*, 2003

4.4.3 SHORT-BEAKED COMMON DOLPHIN *(Delphinus delphis)*

Short-beaked common dolphins are found both on and off the shelf of the UK, and are thought to be the most numerous offshore cetacean species in the temperate north east Atlantic[230]. They appear to be relatively infrequent north of about 60°N[231] and are thought of as typically a warmer water species than the Atlantic white-sided or white-beaked dolphins[232].

In continental shelf waters, common dolphins are found most notably in the Celtic Sea and the western English Channel but are also commonly seen in the Hebrides[233]. Survey effort has been limited in offshore waters to the west of the UK but they are also found here regularly[234]. This species is considered an occasional or rare visitor to the North Sea and eastern English Channel. However, recent evidence suggests they occur with greater regularity now, potentially as a result of rising sea temperatures. Analysis of sightings from the Moray Firth (east Scotland) suggests they are now present here throughout the summer months[235].

A wide range of species has been reported as prey of common dolphins but they primarily appear to feed on fish including myctophids, mackerel, horse mackerel *(Trachurus trachurus)* and whiting[236]. Cephalopods are also an important prey type, particularly in offshore waters[237].

Little is currently known about the population or social structure of common dolphins. Genetic testing suggests that animals in the north east Atlantic make up a single population, but has so far not been able to rule out the possibility of subdivisions[238].

No overall population estimates exist for common dolphins in the north east Atlantic or UK waters but several estimates have been produced for different areas of the UK and surrounding seas. SCANS (in July, 1994) only detected common dolphins in the sector off south west England and produced an estimated abundance of 74,450 (95% CI 22,900-248,900) and a density of 0.374 animals/km^2 (CV 0.67)[239]. Due to a lack of data, this estimate was not corrected for animals missed on the trackline or responsive movement by the animals, both of which are known to be significant sources of error. The SCANS II survey (in July, 2005) produced new estimates, which were corrected for these errors so it can be considered more accurate. This survey generated an estimated common dolphin abundance of 63,366 (95% CI 26,973 - 148,865) in the survey area. Figures 4.11 and 4.12 (below) display common dolphin density estimates from SCANS and SCANS II.

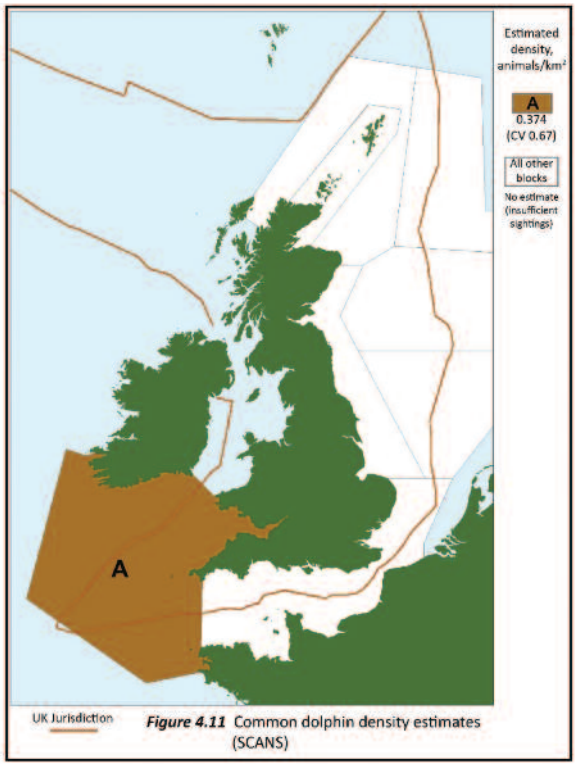

Figure 4.11 Common dolphin density estimates (SCANS)

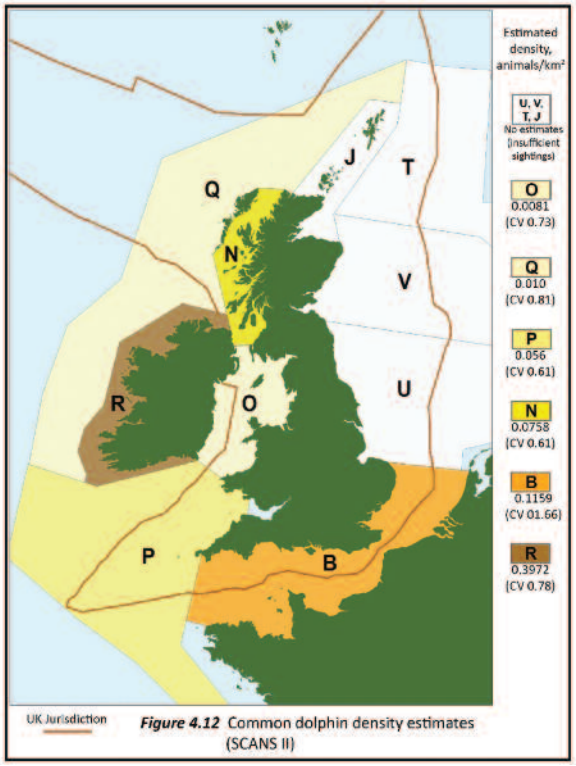

Figure 4.12 Common dolphin density estimates (SCANS II)

[230] Reid *et al*, 2003
[231] MacLeod, 2001; Pollock *et al*, 2000
[232] Weir *et al*, 2009
[233] Reid *et al*, 2003
[234] *Ibid*
[235] Robinson *et al*, 2010
[236] Brophy *et al*, 2009; BIOCET unpub. data (in Hammond *et al*, 2006); Reid *et al*, 2003
[237] Brophy *et al*, 2009
[238] Mirimin *et al*, 2009
[239] Hammond *et al*, 1995

Figure 4.13 (below) is the estimated density surface for common dolphins produced from SCANS II[240].

Results from the CODA survey which took place beyond the shelves of the UK, Ireland, France and Spain are displayed in Figures 4.14 (below) and 4.15 (p.37)[241].

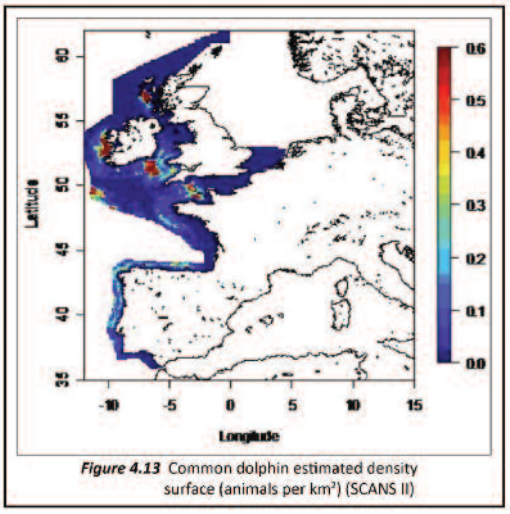

Figure 4.13 Common dolphin estimated density surface (animals per km²) (SCANS II)

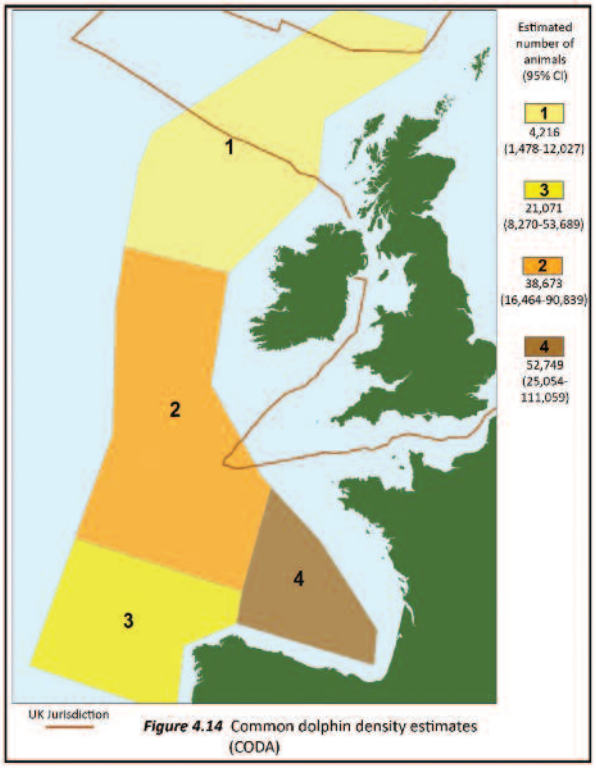

Figure 4.14 Common dolphin density estimates (CODA)

Far west and west Scotland

The more northerly CODA block and the SCANS II sector over the continental shelf to the west of the Hebrides both reported low densities of common dolphins (0.01 animals/km² for both) (see Figures 4.12, p.35 and 4.14, above). No data are currently available about common dolphin abundance for the north west sector of UK waters. Surveys of the area of sea immediately south of this sector have recorded very high densities of common dolphins during the summer, 1.36 animals/km² and an abundance of 273,159 animals (95% CI 153, 392 - 435,104) in the survey area[242]. It may be that this region of high density extends north into UK jurisdiction and survey work will be needed to confirm this (see Figure 4.16, p.37).

Common dolphins are seen in the inshore waters of the Hebrides mainly during the summer. The SCANS II survey found moderately high densities here (0.0758 animals/km²), and an abundance of 2,322 animals in this small area[243]. In other studies here, this species is reported as common in the summer, particularly in the Sea of the Hebrides[244]. Observations of them feeding in the waters of The Minch have been made, as have the presence of calves, raising the possibility that they use the area to breed and nurse young[245]. There is some evidence that their numbers are increasing in this area and this is thought to be due to rising sea temperatures[246]. If this trend continues, the area may become increasingly important for common dolphins.

Although the results from SCANS and CODA indicate that the area further offshore of the Hebrides may have lower densities of common dolphins in the summer, some studies report notable concentrations over the shelf edge and beyond for the autumn months[247]. Data are sparse at this time of year but there are indications that the north east Rockall Trough and adjacent continental slope area, along with the Rosemary Bank, may be particularly used by common dolphins. Shelf-edges and offshore banks are often areas of increased productivity so their importance may be as foraging habitat.

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[240] Reproduced with permission. SCANS II, 2006. Please note that density surface maps show estimated density derived from a spatial model and should not be over-interpreted, particularly at a fine spatial scale.
[241] Reproduced with permission. CODA, 2009. Please note that density surface maps show estimated density derived from a spatial model and should not be over-interpreted, particularly at a fine spatial scale.
[242] Cañadas *et al*, 2009
[243] SCANS II, 2006
[244] Reid *et al*, 2003; HWDT data (in Hammond *et al*, 2006)
[245] Weir *et al*, 2009
[246] *Ibid*
[247] Pollock *et al*, 2000; MacLeod, 2001; Reid *et al*, 2003

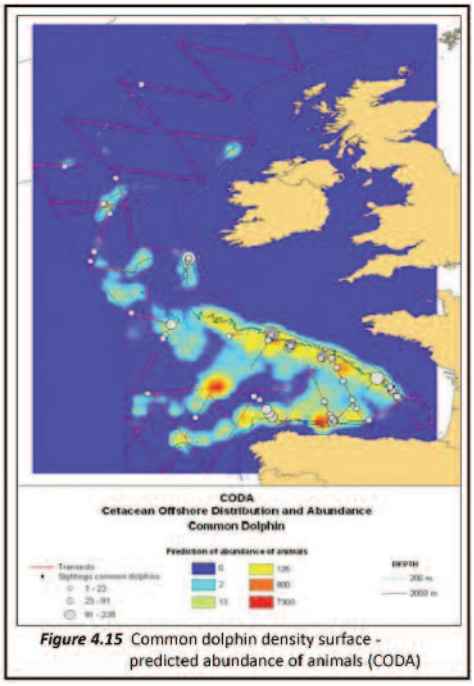

Figure 4.15 Common dolphin density surface - predicted abundance of animals (CODA)

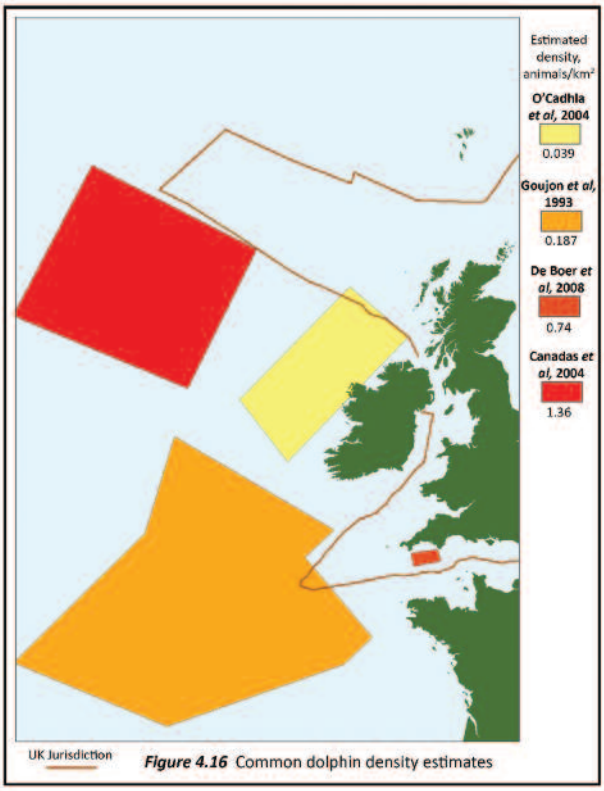

Figure 4.16 Common dolphin density estimates

South west England

Based on observations of seasonal patterns in sightings data, common dolphins are thought to show a general movement into offshore waters during the summer months. Their occurrence and range in offshore waters is still poorly understood but the recent CODA survey (in July, 2007) which took place beyond the shelves of the UK, Ireland, France and Spain, has contributed to our knowledge. Conducted at the same time of year as the SCANS surveys to allow comparison, CODA recorded a density of 0.159 animals/km^2 (CV 0.54) in the block off the shelf to the south west of the UK (see Figure 4.14, p.36). This is more than twice that recorded for the adjacent, on-shelf SCANS sector (0.056 animals/km^2) (see Figure 4.12, p.35), seeming to support the idea of an offshore movement during the summer. Spatial modelling of the CODA data predicted a high density area along the continental slope (see Figure 4.15, above). Common dolphins have been noted in the past to be associated with areas of high topographic relief[248].

The apparent movement into offshore waters during the summer is likely prey-driven and it has been hypothesised that movement out of Celtic Sea waters may be connected to the summer spawning of fish[249]. Many species of fish (such as sprat and Atlantic horse mackerel) spawn in the Celtic Sea and during this time, their lipid content decreases significantly, reducing their value as prey species to common dolphins[250]. This occurs at the same time that common dolphins give birth and nurse their young (May to September), a time when females particularly require high calorific prey. By migrating to offshore areas they may be able to prey on lipid-rich myctophid prey (which they have been documented to feed on in offshore waters), and meet these calorific demands more effectively[251]. The high proportion of females and young calves bycaught in the Irish offshore tuna driftnet fishery at this time of year lends further weight to this suggestion[252].

It is clear though, that even if a large proportion of the population move into offshore waters, not all do. Encounter rates during the summer are still quite high off south west England[253] and SCANS II (in July, 2005) recorded the second highest density of common dolphins in the survey for the English Channel (0.1159 animals/km^2)[254] (see Figure 4.12, p.35). Spatial modelling of this data predicted an area of high density in the western part of the Channel, from the Channel Islands near north west France, north to almost the south west Devon coast (see Figure 4.13, p.36). This supports the findings of previous studies in this area during the summer[255].

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[248] Hui, 1979; Evans *et al*, 2003
[249] Brophy *et al*, 2009,
[250] *Ibid*
[251] *Ibid*
[252] Murphy and Rogan, 2006 (in Brophy *et al*, 2009)
[253] Reid *et al*, 2003; Evans *et al*, 2003
[254] SCANS II, 2006
[255] Kiszka *et al*, 2007; Rosen *et al*, 2000

SCANS II (in July, 2005) estimated an abundance of 11,141 common dolphins and a density of 0.056 animals/km^2 (CV 0.61) in the south west UK region[256]. This was a moderate level of density compared to other regions but spatial modelling to reveal finer-scale distribution predicted a high density area off south east Ireland and stretching over the southern end of the Celtic Deep[257]. The Celtic Deep – St. George's Channel region is an area particularly noted for high abundance of common dolphins, from May to November[258]. Effort is low during winter and spring months but it appears that this cluster of high abundance disperses into the wider Celtic Sea during the later autumn and winter. It has been suggested that the high summer abundance is a result of the Celtic Sea Front that persists in this area over the summer. Fronts are biologically productive areas that result in increased prey through enhanced local primary productivity and/or convergence processes that act to aggregate prey[259]. From November to April, the waters in the Celtic Sea are mixed, but from May to November thermal stratification dominates and a surface front develops[260] that can be observed using satellite imagery[261]. As well as high encounter rates in the Celtic Deep – St. George's Channel area, studies have reported a high proportion of sightings of young animals. One study reported that between July and September, 51% of sightings consisted of groups of adults with calves, often young calves, suggesting they were born recently, in or near the study area[262].

Although genetic differences within the population have not been detected, that part of the population remains in on-shelf waters over the summer while another moves offshore, suggesting that ecological differences exist. This has already been indicated by dietary studies which investigated cadmium exposure in common dolphins and found different levels between animals in offshore and nearshore waters[263]. These studies suggested the existence of two ecological stocks within the north east Atlantic, a coastal and a neritic stock, that have accumulated different levels of this element through the exploitation of different prey species[264]. **Further research will be necessary to confirm the existence of at least two stocks of common dolphins, and to determine if further divisions exist**.

Abundance of common dolphins increases in the south west England region during the winter months[265], and their distribution mainly seems to be in offshore Celtic Sea waters and the western English Channel. Data are too sparse to know if there is a movement of animals into this area from off-shelf waters, or whether numbers remain high in offshore areas too. There are also insufficient data to identify locations within the Celtic Sea with particular concentrations of animals. More information is available for the western English Channel, however, including a density estimate of 0.74 individuals/km^2 for a small area south of Cornwall[266]. This is the only density estimate available for common dolphins in the winter in UK waters and shows there are high numbers of animals in the region at this time of year. The survey area was small so it is unknown at present how much of the rest of the area has similarly high abundance of common dolphins. Little survey work has been carried out here in the winter but other studies have also shown a high relative abundance of common dolphins in much of the western Channel area[267], some reporting a 10-fold increase over summer numbers[268]. Large aggregations of prey species are in the region at this time of year, such as sprat, horse mackerel and herring, and are likely the reason for the high abundance of common dolphins[269].

[256] SCANS II, 2006
[257] *Ibid*
[258] Reid *et al*, 2003; Baines and Evans, 2009; Earl *et al*, 2004; Earl *et al*, 2005
[259] Bost *et al*, 2009 ; Hyrenbach *et al*, 2000
[260] Brown *et al*, 2003
[261] see for example, Goold *et al*, 1998 (abstract only seen)
[262] Earl *et al*, 2004 and 2005
[263] Lahaye *et al*, 2005
[264] Lahaye *et al*, 2005
[265] Northridge and Kingston, 2009
[266] De Boer *et al*, 2008
[267] Reid *et al*, 2003; MacLeod *et al*, 2009; De Boer and Simmonds, 2003
[268] Brereton *et al*, 2005
[269] Northridge and Kingston, 2009

4.4.4 COMMON MINKE WHALE *(Balaenoptera acutorostrata)*

Minke whale sightings are frequent and widespread from May to October in UK waters. The general pattern appears to be an increased use of coastal areas as the season progresses, peaking July to September when large feeding aggregations can be observed in coastal waters[270]. Outside these months sightings are fewer and little is known about their winter distribution. Some individuals at least remain close to the UK and Ireland[271] but for the majority, it is unclear if they undergo a latitudinal migration or simply move further offshore for the winter months. In some locations around the UK at least, photo-ID studies have found individuals to be resident seasonally[272], or possibly year round[273].

Sandeels, herring and sprat *(Sprattus sprattus)* have been noted as principal prey items of minke whales in British waters[274] but other fish species, such as mackerel, cod and capelin *(Mallotus villosus)*, are also eaten[275]. Minke whale distribution and abundance during the summer feeding season, partly spent in UK waters, ultimately depends on prey distribution and abundance[276]. Minke whales are often noted feeding in association with seabirds, including kittiwakes, gulls and shearwaters[277].

The first SCANS survey of 1994 produced an estimate of 8,445 (95% CI = 4,987-13,546; CV = 0.24) for minke whales in the North Sea. SCANS II (in July, 2005) resulted in an estimate of 10,541 (CV = 0.32) for the same area but this difference was not significant[278]. The CODA offshore cetacean survey produced an estimated abundance of 6,765 (95% CI = 1,239-36,925; CV = 0.99) for minke whales, with sightings restricted to the northern blocks of the survey area, in UK and Irish offshore waters. Figures 4.17 (below), 4.19 (p.40) and 4.21 (p.41) display density estimates produced by SCANS, SCANS II and CODA respectively. Figures 4.18 (below) and 4.20 (p.40) show the estimated density surfaces produced using SCANS and SCANS II data[279].

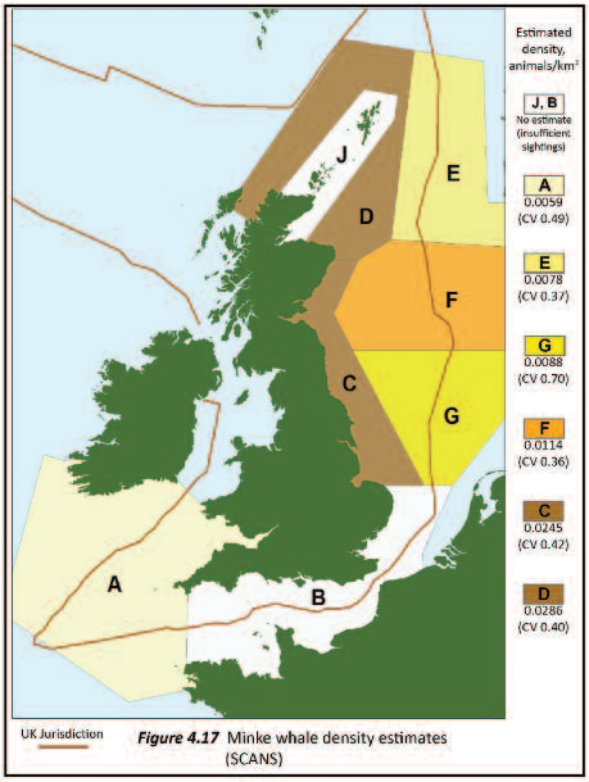

Figure 4.17 Minke whale density estimates (SCANS)

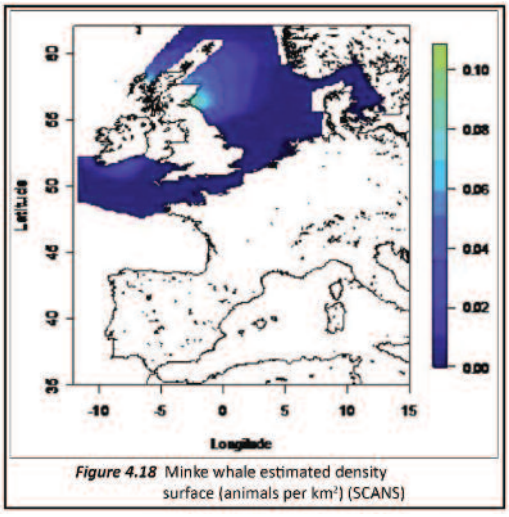

Figure 4.18 Minke whale estimated density surface (animals per km²) (SCANS)

[270] Evans *et al*, 2003; Northridge *et al*, 1995; Reid *et al*, 2003; Macleod *et al*, 2007
[271] Anderwald and Evans, 2007; Gill *et al*, 2000
[272] Gill *et al*, 2000
[273] MacLeod *et al*, 2004
[274] Pierce *et al*, 2004; Macleod *et al*, 2004; Anderwald and Evans, 2007
[275] Reid *et al*, 2003; Anderwald and Evans, 2007
[276] MacLeod *et al*, 2004;
[277] Robinson and Tetley, 2007; Skov *et al*, 1995; Reid *et al*, 2003
[278] SCANS II, 2006
[279] Reproduced with permission. SCANS II, 2006. Please note that density surface maps show estimated density derived from a spatial model and should not be over-interpreted, particularly at a fine spatial scale.

East Scotland

SCANS II (in July, 2005) found the second highest density of minkes in the survey area off east Scotland and the central North Sea (see Figure 4.19, below). The adjacent sector, covering north east Scotland, was also one of the highest densities in the survey area. Density surface modelling of this data, which allows some investigation of distribution at a finer scale, predicted high densities of minke whales to be around north east Scotland, including the Moray Firth (see Figure 4.20, below).

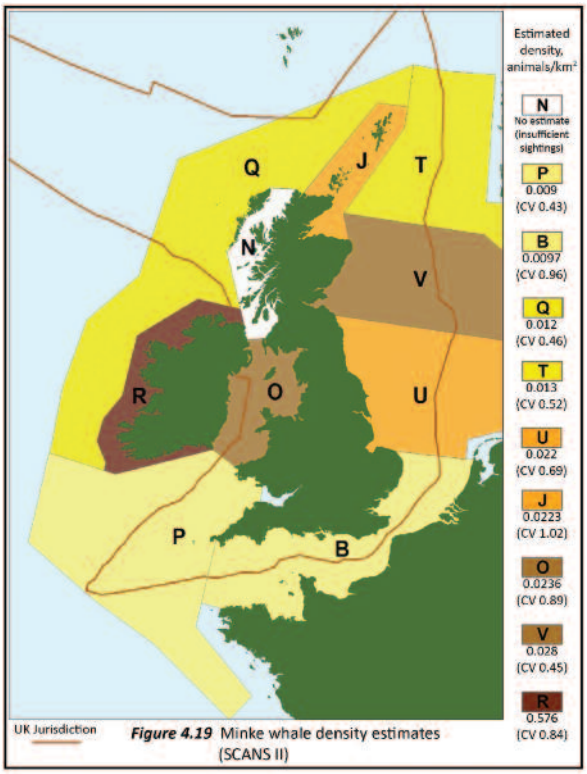

Figure 4.19 Minke whale density estimates (SCANS II)

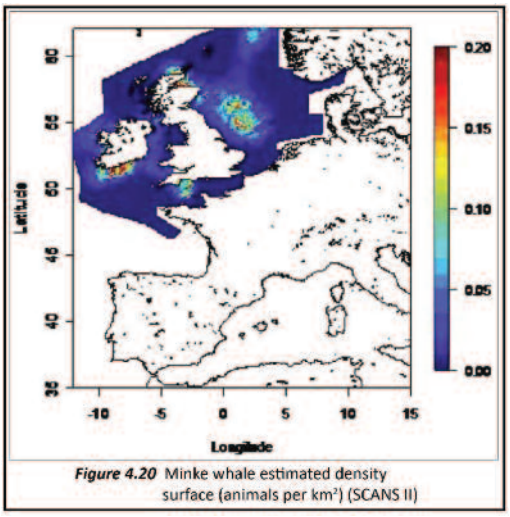

Figure 4.20 Minke whale estimated density surface (animals per km²) (SCANS II)

The first SCANS survey which occurred ten years previously (also in July), recorded similarly high densities around north east and east Scotland, the highest for the survey (see Figure 4.17, p.39). Density surface modelling this time predicted that south east Scotland had the highest densities (see Figure 4.18, p.39). The differences between the years may be due to variations in the distribution and availability of prey species[280]. However, the results from both surveys indicate that east Scotland is important habitat for minke whales, at least in July.

An earlier UK-wide study identified the waters off east Scotland (from the north east coast of England, north to Orkney) as an area with one of the main concentrations of minke whales[281].

A multi-year study (2001 to present) that takes place along the southern coast of the Outer Moray Firth also reports considerable numbers of minke whales in this area, although again, with some variation in numbers between years[282]. Given that research effort is restricted to a relatively small area compared to the scale minke whales will be operating at, this fluctuation in numbers is not surprising and has been commonly reported in other studies of baleen whales on their feeding grounds[283]. It has been suggested that minke whales sighted here, and those sighted in the Inner Hebrides on the west coast, may be part of one population that utilise both areas, favouring one over the other in response to changes in prey abundance[284]. This is based on the observation that increases in sightings for the Outer Moray Firth in recent years have been matched by decreases in the Inner Hebrides[285]. Also, initial comparisons of photos of minke whales from this area with photo-ID records from the Inner Hebrides on the west coast, have revealed some possible matches[286]. **The suggestion that the east and west coast minke whale populations may be linked should be investigated, along with the factors behind the potential shift in distribution observed**.

[280] Hammond, 2007
[281] Northridge *et al*, 1995
[282] Robinson, Tetley and Mitchelson, 2009
[283] Robinson, Tetley and Mitchelson, 2009 (and references within)
[284] Stevick, 2007
[285] Robinson *et al*, 2007; Stevick, 2007
[286] Robinson, Tetley and Mitchelson, 2009

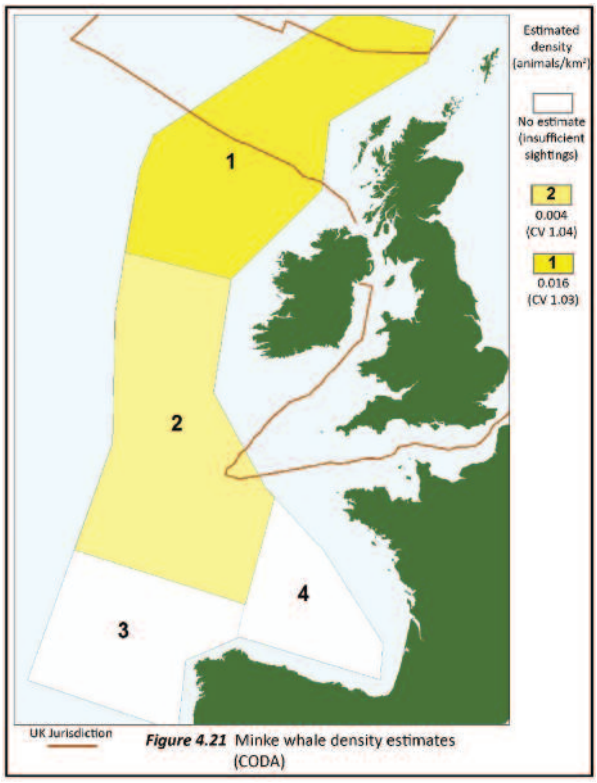

Figure 4.21 Minke whale density estimates (CODA)

Sightings for this area of the Outer Moray Firth are commonly recorded between June and October, with peaks during July and August, and a general inshore movement as the season progresses[287]. Overall, a preference has been noted for the central and eastern areas of the study site. This area is thought to provide rich coastal feeding habitat for minke whales during the summer period at least[288]. Foraging minke whales are regularly recorded in this part of the Outer Moray Firth, often engaging in bird-associated feeding, where prey species are compacted at the surface by feeding seabirds above and predatory fish below[289].

Movements into and within the area are most likely connected to the accessibility and distribution of different prey species, and these in turn will be determined by physiographic and oceanographic variables. In the absence of quantitative fisheries data for prey species[290], these variables can be studied as a proxy and indirectly linked to minke whale distribution. In the southern Outer Moray Firth, correlations have been found between minke whale distribution and static, physical characteristics and also more fluid oceanographic variables. Minke whale distribution in this area was found to be strongly correlated to sediment type, with a clear preference for sandy-gravel sediments[291]. This sediment type is optimal sandeel habitat[292] which likely explains this correlation. Minke whale distribution has also been correlated with warm water plume events that occur in the Moray Firth and at times dominate a cold water current (the Dooley current) that enters the area from the north[293]. These warm water events appear to result in increased phytoplankton densities which are thought to attract greater numbers of sandeels, and in turn result in greater numbers of minkes in the area[294].

There are fewer data available for the rest of the Outer Moray Firth but recent surveys and a review of sightings for the area report that minke whales are commonly encountered throughout the area[295]. They appear to be the second most commonly sighted species in offshore waters after harbour porpoises, although this may be a relatively recent situation as it does not appear to have been the case a few years ago[296].

Sightings are fewer for the Inner Moray Firth but do occur throughout much of the year, albeit in low numbers[297].

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[287] Robinson *et al*, 2007; Reid *et al*, 2003 (monthly data); Robinson, Tetley and Mitchelson, 2009
[288] Robinson and Tetley, 2007; Robinson *et al*, 2007
[289] Robinson and Tetley, 2007
[290] Robinson, Tetley and Mitchelson, 2009
[291] Robinson, Tetley and Mitchelson, 2009
[292] *Ibid*
[293] Tetley *et al*, 2008
[294] *Ibid*
[295] Eisfeld *et al*, 2009; Thompson *et al*, 2010
[296] Thompson *et al*, 2010
[297] Bailey and Thompson, 2009

Data from further south, off east and south east Scotland are scarcer. As discussed above, SCANS predicted high abundance for these waters. Other studies have noted it as an area where multi-species feeding associations occur, involving minke whales, harbour porpoises, white-beaked dolphins, seals and several seabird species[298]. A study off Aberdeenshire conducted between March 1999 and October 2001 only reported small numbers of minke whales, and sightings were restricted to August[299]. However, spatial modelling of minke whale sightings data has indicated that most of the coastal waters of east Scotland are important minke habitat[300] so these areas may warrant further attention.

West Scotland

Similar studies to those from east Scotland, relating minke whale occurrence to physiography and prey distribution have been undertaken for the Inner Hebrides[301]. Using data collected from whale watch vessels from 1992 to 1999 (March to November), fine-scale changes in minke distribution and abundance between March and November for the waters between Mull, Coll and the Small Isles were linked to shifts in prey preferences, along with changes in prey distribution and abundance[302]. In the spring, minke distribution compares well with the expected distribution of sandeels, and the timing coincides with the local sandeel fishery (April to mid-July). By the summer minke whales became more widespread in the study area, thought to be because they additionally start to exploit herring which uses the waters of the Inner Hebrides as a nursery ground[303]. This study sighted minke whales in all three seasons but the highest encounter rates were in late summer/autumn. By this time of year, it was also noted that the proportion of young animals to adults had increased. Overall, tentative estimates were made of 40.5% of sightings being juveniles and 5.1% calves[304].

Other surveys of The Minches and Sea of the Hebrides have also highlighted this part of the Inner Hebrides, between Coll and the Small Isles, as an area with concentrations of minke whale sightings, along with the northern Minch (off the east coast of Lewis), and west of the Isle of Skye[305]. Land-based surveys from the east coast of the Isle of Lewis found that minke whales, along with harbour porpoises and white-beaked dolphins, were regularly sighted and tended to favour the area north of Tiumpan Head, particularly around Tolsta Head[306].

Photo-ID studies in the Inner Hebrides have found some individuals to be resident seasonally[307] or possibly year-round[308], but, as elsewhere, numbers peak from July to September[309].

More recently (2003 to 2007), dedicated surveys have taken place in the Inner Hebrides, covering much of the west coast but with most effort within the Mull-Coll-Small Isles area. This study has found a large decrease in numbers of minkes over the survey period, with exceptionally low sightings rates in 2005 and 2006[310]. Similar declines in sightings were noted for some seabird populations in these years[311], along with a large-scale failure to fledge chicks due to a lack of food[312]. Sandeels, which are usually abundant in the waters around western Scotland and are a staple food source for seabirds as well as minke whales, were largely absent in 2005 and resulted in the starvation of seabirds[313]. It seems likely it may also have contributed to the decrease in minke whale sightings. In the North Sea, 2004 was a very poor year for seabirds — again thought to be linked to sandeel declines. Cetacean surveys in the Outer Moray Firth recorded no sightings of minkes in 2004, the only year of the study to produce such a result[314].

As discussed previously, an increase in minke whales has been noted post-2004 in the Outer Moray Firth, coinciding with the decrease for the Hebrides. This has led, in part, to suggestions that the two groups are connected and may have relocated in response to changes in prey distribution[315]. SCANS II, which took place in July 2005, would seem to support these findings as only low levels of minke whale sightings were recorded for west Scotland. SCANS did not cover this area so we do not have earlier data to compare to.

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[298] Camphuysen *et al*, 1995
[299] Weir *et al*, 200
[300] Tetley, IN PREP
[301] MacLeod *et al*, 2004
[302] MacLeod *et al*, 2004
[303] *Ibid*
[304] *Ibid*
[305] Boran *et al*, 1999; Pollock *et al*, 2000
[306] Gill *et al*, 1997
[307] Gill *et al*, 2000
[308] MacLeod *et al*, 2004
[309] MacLeod *et al*, 2007; MacLeod *et al*, 2004
[310] Anderwald and Evans, 2007; Stevick, 2007
[311] Anderwald and Evans, 2007
[312] JNCC press release (2005) http://www.jncc.gov.uk/page-3628
[313] JNCC press release (2005) http://www.jncc.gov.uk/page-3628
[314] Robinson *et al*, 2009
[315] Stevick, 2007

The JNCC Atlas of cetacean distribution, which includes a longer time series of data (from the early 1970s to today), shows relatively high sightings rates clustered around the Hebrides, and the monthly breakdown shows peaks from June to August. This is supported by other pre-2005 studies that have highlighted the Hebrides as one of the main areas of concentrations for minke whales around the UK[316]. It may be that the observed decrease in the Inner Hebrides since 2004 is a recent phenomenon, or that there is a regular cycle of increases and decreases occurring, dependent on prey availability. Another possibility suggested by reports from the last few years, is that there is a more localised shift in distribution with minke whales utilising more northern and western areas of the Hebrides[317].

More time and study are needed to understand the processes at play here. As fluctuations in minke whale numbers are most likely connected to prey availability, the lack of data on sandeel and herring distribution and abundance for the west coast of Scotland[318] and the complexities of predator-prey relationships hinders making firm conclusions. **Overall, information on minke whale distribution and habitat use is poor considering there are high densities of animals in the UK's coastal waters for six months of the year. More research is needed to inform conservation efforts**.

Far west Scotland

Further offshore, west of the Hebrides, SCANS II found a density of about half that of the east coast (see Figure 4.19, p.40). There appear to be higher sightings rates for this area earlier in the year (May and June)[319], which may show animals moving into the coastal areas for the summer. The CODA survey in July 2007, which took place even further west, made a similar density estimate to SCANS II. This is not surprising given that minke whales are generally a species that occurs on the continental shelf in waters of less than 200m[320]. A possible area of importance to minke whales in offshore waters is the Rockall Bank in late summer where some studies have found high sightings rates clustered over this Bank[321]. However, effort is low in this area so comparison with other parts of the area is difficult.

North Scotland

In line with the rest of the UK, most sightings in this area occur between June and September. A similar movement to that noted further south in the Outer Moray Firth has also been suggested for around the Orkney and Shetland Isles, from more offshore waters early in the season, to nearshore by August[322].

SCANS (in July, 1994) made insufficient sightings of minke whales in the survey block off the Northern Isles to calculate density estimates. The adjacent survey block covering shelf waters off north Scotland, however, had the highest minke whale density in the survey at 0.0286 animals/km^2 (CV 0.4) and SCANS II (which took place in 2005) found quite a high density (see Figures 4.17, pg.39 and 4.19, p.40). Spatial modelling of the SCANS II data predicted densities to be higher close to the north coast of the mainland for this block[323] (see Figure 4.20, p.40).

A land- and boat-based study of the waters around Shetland and south to Fair Isle reported that sightings of minke whales were concentrated close to the east and south coasts of Shetland, off Sumburgh Head or in the vicinity of Whalsay and Out Skerries[324]. Many sightings were also made between Shetland and Fair Isle. Spatial modelling work to identify priority habitat for minke whales also highlighted the area to the south and east of Shetland[325].

Large-scale survey work for this region suggests the area supports large numbers of minke whales, at least at certain times, but there is insufficient finer-scale work to determine where specific habitats of importance might be. There are indications from surveying and modelling work that the waters to the south and east of Shetland may be of some importance but further research will be necessary to confirm this.

East England

SCANS II recorded high densities of minke whales in the sectors off the east coast of the UK (Figure 4.19, p.40), and spatial modelling of the data predicted a large area of high density in the central North Sea, over much of the Dogger Bank and to the north west of it[326] (Figure 4.20, p.40).

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316 Northridge *et al*, 1995; Evans *et al*, 2003; Pollock *et al*, 2000
317 HWDT, 2008; Weir *et al*, 2007
318 Stevick, 2007
319 Reid *et al*, 2003 (monthly data)
320 Reid *et al*, 2003
321 MacLeod, 2001, Summer (June to September); Reid *et al*, 2003 (monthly data, September)
322 MacLeod *et al*, 2007
323 SCANS II, 2006
324 Evans, Nice and Weir, 1996
325 Tetley, IN PREP
326 SCANS II, 2006

A recent survey of an area north east of the Dogger Bank in May recorded high relative densities of minke whales along the bank slope during spring, where they were often observed foraging and associating with foraging seabirds[327]. The Dogger Bank is a large sand bank where at times, a front develops which is characterised by relatively high primary productivity, particularly during May and the summer months[328]. The Bank is sandeel habitat and the area supports a significant sandeel fishery during the spring. It is suggested that at certain times of the year, increased primary productivity results in an increased availability of sandeels to foraging minke whales[329].

Aerial surveys for harbour porpoises over the section of the Dogger Bank in German waters recorded minke whales and white-beaked dolphins in the area although encounter rates and densities were not calculated for these non-target species[330].

Irish Sea

Sightings are generally lower for the Irish Sea than north and east of the UK. One review identified the western side, south of the Isle of Man, as being the location of most sightings[331] and by comparison, sightings in Liverpool Bay and Cardigan Bay seem to be a rare event[332]. SCANS II recorded one of the highest densities anywhere for the UK and Ireland in the Irish Sea (Figure 4.19, p.40) although modelling of the data did not highlight any particular areas within this sector (Figure 4.20, p.40).

St. George's Channel, the Celtic Sea and the English Channel

Both SCANS and SCANS II recorded low densities overall for these areas (see Figures 4.17, p.39 and 4.19, p.40). However, modelling of the SCANS II data predicted an area of higher density off south west England, in the western part of the Channel (see Figure 4.20, p.40). Sightings from ferries travelling from the south coast of England to Bilbao tend to record minke whales in the western section of the Channel, and mainly from July to September[333]. Generally though, minke whales are thought to be uncommon in the eastern English Channel and southern North Sea[334].

The Celtic Deep to the south of the St. George's Channel has been highlighted as an area of relatively high densities of minke whales during the summer months, along with several other cetacean species[335]. This is an area where surface and bottom fronts develop over the summer[336]. Increases in prey abundance are the most likely explanation of the observed high sightings rates of minke whales.

[327] De Boer, 2010
[328] De Boer, 2010, and references within;
[329] De Boer, 2010
[330] Gilles *et al*, 2008 (in Evans *et al*, 2008)
[331] Evans *et al*, 2003
[332] Evans and Anderwald, 2005; Reid *et al*, 2003
[333] MacLeod *et al*, 2007
[334] Reid *et al*, 2003; Van der Meij and Camphuysen, 2006
[335] Baines and Evans, 2009; Rosen *et al*, 2000
[336] Brown *et al*, 2003

4.4.5 WHITE-BEAKED DOLPHIN *(Lagenorhynchus albirostris)*

White-beaked dolphins are found over a large part of the northern European continental shelf, favouring colder northern shelf waters, less than 200m deep[337]. In north west Europe, their distribution is centred around Scotland and north east England, where they can be seen throughout the year but with peaks between June and October[338]. UK waters may hold a significant proportion of the total population of white-beaked dolphins in the north east Atlantic[339]. High concentrations of white-beaked dolphins are particularly noted for the west coast of Scotland, in the northern Minch and northern Outer Hebrides, and the western sector of the Sea of the Hebrides, and to the east of the UK in the northern and central North Sea[340].

Analysis of the distribution of sightings has led to the suggestion that white-beaked dolphins observed around Scotland and north east England make up a local population, isolated to some extent from animals in shelf regions further north or west in the North Atlantic[341]. Movement between these areas may be restricted by their preference for shelf waters, and by the deep oceanic waters that separate these areas[342].

SCANS generated a population estimate for the survey area of 7,856 (CV 0.30; 95% CI = 4,032-13,301) white-beaked dolphins (see Figure 4.22, below). An estimate of 11,760 (CV 0.26; 95% CI = 5,867-18,528) was produced for Atlantic white-sided and white-beaked dolphins combined (see Figure 4.24, p.51), but the large majority of these are expected to be white-beaked dolphins given that they greatly outnumber Atlantic white-sided dolphins in shelf waters where the survey took place[343]. The highest densities of white-beaked dolphins were found in the western sectors of the northern North Sea, and the central North Sea. SCANS II took place ten years later and over an extended survey area which included the waters of western Scotland, omitted from the first SCANS survey. This time, highest densities of white-beaked dolphins were found for the Hebrides, followed by the northern North Sea[344] (Figure 4.23, below). The population estimate for the extended area was calculated to be 22,664 (CV 0.42) for white-beaked dolphins, and 37,981 (CV 0.36) for both *Lagenorhynchus* species combined (see Figure 4.25, p.51). Comparing estimates for the area common to both surveys, they were not found to be statistically different between years.

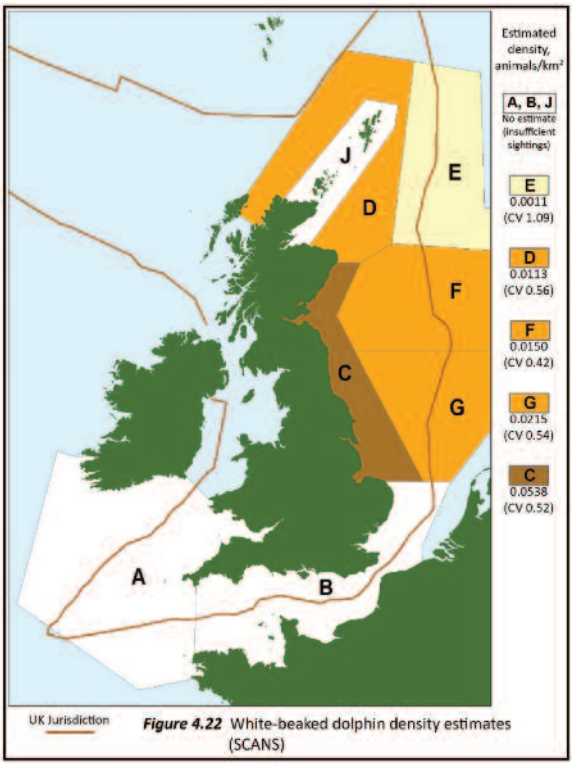

Figure 4.22 White-beaked dolphin density estimates (SCANS)

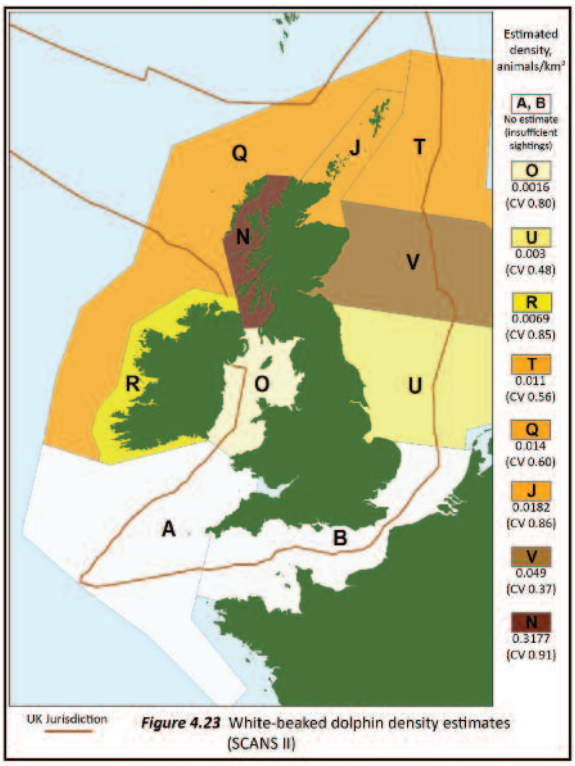

Figure 4.23 White-beaked dolphin density estimates (SCANS II)

[337] Reid *et al*, 2003
[338] Reid *et al*, 2003; Northridge *et al*, 1995
[339] JNCC, 2007
[340] Hammond *et al*, 1995; SCANS II, 2006; Reid *et al*, 2003; Northridge *et al*, 1995 and 1997; Evans *et al*, 2003; MacLeod, 2001; Pollock *et al*, 2000; Stone, 1997, 1998, 2003, 2006; Weir *et al*, 2007 and 2009; Camphuysen *et al*, 1995; Canning *et al*, 2008; Gill *et al*, 1997; Boran *et al*, 1999
[341] Northridge *et al*, 1995; Northridge *et al*, 1997
[342] MacLeod *et al*, 2005
[343] Hammond *et al*, 1995
[344] SCANS II, 2006

West Scotland

Numerous studies over a long time period have noted high relative abundance of white-beaked dolphins for the northern Hebrides, particularly the northern Minch[345]. There are fewer data available for the winter months but it appears that white-beaked dolphins use this area throughout the year. The waters north of here, extending east to Orkney, along with the western Sea of the Hebrides, also have reportedly high relative abundance of white-beaked dolphins although there are fewer data available[346]. Studies in The Minch have reported calves to be present in 60% of groups in the summer months[347], indicating the area provides calving and nursing habitat for white-beaked dolphins.

Based on the reports of some sightings surveys, and on strandings records, it has been suggested that there has been a decrease in abundance of white-beaked dolphins for the west coast of Scotland[348]. A decrease has not been conclusively proven yet, and some recent surveys have continued to record high encounter rates and abundance for white-beaked dolphins in this area[349]. This suspected decrease has coincided with an apparent increase in recent years of common dolphin sightings in the region. Common dolphins are typically a warmer water species, and these observations have led to the suggestion that these may be changes linked to rising sea temperatures[350].

Studies looking at the pattern of white-beaked dolphin strandings for the whole of the UK suggest changes may be occurring over a wider area than the west of Scotland, with an apparent northward shift in the location of strandings[351]. Decreases in the number of reported strandings have been noted for all regions except the north east of Scotland[352].

Longer-term monitoring of distribution and abundance will be needed to confirm the status of white-beaked dolphins and to determine the nature of any possible shifts in distribution.

East Scotland

A seasonal inshore movement of white-beaked dolphins has been suggested for the summer months[353]. There appears to be evidence of this for the east coast[354], and particularly off Aberdeenshire[355] where studies have shown strong seasonality with peaks in the summer months. Recorded white-beaked dolphin strandings also peak during the summer months[356] suggesting an inshore movement of animals at this time of year. More in-depth analysis of strandings data suggests that females move into inshore waters first, to be followed later by males[357]. This earlier peak in female strandings coincides with a peak in calf strandings and this has led to the suggestion that females make this movement to inshore waters to give birth[358]. The later increase in strandings of male white-beaked dolphins may signify their arrival into the area in order to breed with females that have calved[359].

Sightings records of calves in UK waters support this timing, with studies reporting their presence only in the summer months[360]. As with most cetacean species, data on calf presence are generally scarce and hindered by difficulties in sighting them. However, a study in Aberdeenshire coastal waters reported calves to be present in 32% of groups in the summer months[361]. This further indicates that this area provides calving and nursing habitat for white-beaked dolphins.

The observed summer peaks in sighting frequencies and possible inshore movement could also be related to changes in prey distribution and abundance. White-beaked dolphins take a wide variety of fish but cod, haddock, whiting and hake have been found to be the predominant species in the stomachs of stranded animals[362]. The North Sea provides habitat including spawning grounds for many of these fish species[363] and their distribution and abundance will in turn affect that of white-beaked dolphins. Anecdotal evidence has been put forward suggesting white-beaked dolphins follow mackerel or herring into inshore waters[364] but so far, no particular movements or concentrations of favoured prey species have been correlated with the observed distribution and increased sighting frequencies of white-beaked dolphins[365].

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[345] Reid *et al*, 2003; Northridge *et al*, 1995; Evans *et al*, 2003; MacLeod, 2001; Pollock *et al*, 2000; Weir *et al*, 2009; Shrimpton and Parsons, 2000; Gill *et al*, 1997; Boran *et al*, 1999
[346] Reid *et al*, 2003; Northridge *et al*, 1995; Evans *et al*, 2003; MacLeod, 2001; Pollock *et al*, 2000; Shrimpton and Parsons, 2000; Boran *et al*, 1999
[347] Weir, 2008
[348] MacLeod *et al*, 2005; Evans, 1992
[349] Weir, 2008; SCANS II, 2006
[350] MacLeod *et al*, 2005; Weir *et al*, 2009
[351] Canning *et al*, 2008; Jepson, 2006 (in JNCC, 2007)
[352] Canning *et al*, 2008
[353] Evans, 1992
[354] Reid *et al*, 2003
[355] Canning *et al*, 2008; Weir *et al*, 2007; Evans *et al*, 2008
[356] Canning *et al*, 2008
[357] *Ibid*
[358] *Ibid*
[359] *Ibid*
[360] MacLeod, 2001; Weir *et al*, 2007; Pollock *et al*, 2000; Canning *et al*, 2008
[361] Weir *et al*, 2007
[362] Reid *et al*, 2003; Canning *et al*, 2008
[363] CEFAS, 2001
[364] Weir *et al*, 2007; Canning *et al*, 2008; Evans, 1980
[365] Canning *et al*, 2008

4.4.6 RISSO'S DOLPHIN *(Grampus griseus)*

Risso's dolphins have a wide distribution through temperate and tropical regions of the world[366]; the UK's waters are at the northern limit of the species' range. The status of Risso's dolphins in the UK is currently unknown, and there are no population estimates available. Large scale surveys such as SCANS and SCANS II made insufficient sightings to be able to estimate abundance for any areas of UK waters[367].

Preliminary results from genetic studies on this species have indicated that UK Risso's dolphins are genetically different from the better-studied Mediterranean animals which have less genetic diversity[368].

In UK waters they tend to be seen in small- to medium-sized groups, most commonly 6-12 individuals but between 2-50 could be regarded as typical[369]. In the North Atlantic they are at times observed swimming with other cetaceans including long-finned pilot whales, bottlenose dolphins, and white-beaked and Atlantic white-sided dolphins[370].

Life history information is generally scarce. A peak in calving has been noted for the winter months[371] in some locations but researchers suggest that in Scottish waters, births are likely to occur between July and December[372].

Typical prey for Risso's dolphins are neritic and oceanic squid[373]; they may also feed on crustaceans[374] and octopus[375].

In most places in the world, Risso's dolphins show a strong preference for the deep waters of the continental slope[376]. It is believed they take advantage of the highly-productive frontal systems that oceanographic mechanisms create near the shelf break[377]. In the UK, however, they are found in coastal areas, over the continental shelf and in some cases, close to the shore of some islands[378]. They are most common off the Outer Hebrides of west Scotland, and in parts of the Irish Sea[379]. Few sightings of Risso's dolphins are made on the east coast of the UK or in the Channel, except for its westernmost parts[380].

This species is present in UK waters all year round but with some seasonal patterns of occurrence. They are seen in greater numbers in shelf waters from May to October, and during the remainder of the year sightings are greater in offshore areas[381].

West Scotland

The Outer Hebrides in north west Scotland, and particularly the Isle of Lewis, have been shown to have significant concentrations of Risso's dolphins. Sightings indicate possible year-round residency but are most frequent over the summer and autumn months, with clear peaks in numbers in August and September[382]. The suggestion that at least a part of this population is resident here is supported by studies off the north east of Lewis that have repeatedly resighted individuals[383]. A photo-ID study conducted over two years identified 142 individuals, with at least 52 animals resighted between years[384]. In this area, Risso's dolphins seem generally to spend May and July further offshore in deeper waters and in larger groups, moving into nearshore habitat to forage in smaller groups for August and September. This movement is possibly linked to prey availability as the lesser octopus *(Eledone cirrhosa)*, thought to be a prey species for these Risso's dolphins[385], is abundant in Scottish coastal waters during August and September[386].

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366 Baird, 2002
367 Hammond *et al*, 1995; SCANS II, 2006
368 Gaspari *et al*, 2007
369 Reid *et al*, 2003
370 *Ibid*
371 Baird, 2002
372 Atkinson and Gill, 1996 (in Wharam and Simmonds, 2008)
373 Baird, 2002; Culik, 2004
374 Culik, 2004
375 Atkinson et6 al, 1998
376 Baumgartner, 1997; Mangion and Gannier, 2002; Casacci and Gannier, 2000
377 Baumgartner, 1997
378 Gaspari *et al*, 2007; Reid *et al*, 2003
379 Reid *et al*, 2003
380 Evans *et al*, 2003; Kiszka *et al*, 2007
381 Reid *et al*, 2003; Evans *et al*, 2003
382 Wharam and Simmonds, 2008; Pollock *et al*, 2000; Atkinson *et al*, 1998
383 Atkinson *et al*, 1998
384 *Ibid*
385 A stranded animal had lesser octopus beaks in its stomach - Atkinson *et al*, 1998
386 Atkinson *et al*, 1998; Hastie *et al*, 2006

Juveniles have been sighted in this region between March and November[387]. Off the north east coast of Lewis, whole groups comprised exclusively of sub-adults or juveniles were noted on several occasions, and a group consisting of eight females, each with a calf, has also been observed[388]. Sightings such as these strongly suggest this area has importance for breeding, nursing and/or raising young.

North east Lewis is the focus of Risso's dolphins activity in this area but high sightings rates are reported for the rest of the western part of the Hebrides during the summer and there may be further areas of importance in these less studied waters.

There are generally few data available about Risso's dolphins in more offshore waters but sightings occur mostly during autumn and winter and are concentrated along the continental slope[389]. Sightings are too few to suggest particular areas of importance.

Coastal Wales and the Irish Sea

Certain locations in the Irish Sea – the Isle of Man, Anglesey, Bardsey Island and the Lleyn Peninsula, and Pembrokeshire – record Risso's dolphin sightings relatively regularly[390]. Bardsey Island records the highest sightings rates, followed by northern Pembrokeshire[391].

The waters off Bardsey Island in North Wales have been subject to a small-scale, multi-year study of its cetacean fauna and this has confirmed the area's importance for Risso's dolphins[392]. Despite being predominantly a land-based survey, 133 individual Risso's dolphins have been catalogued, with a few resightings between years[393]. The survey has been conducted in April, July, August and September and Risso's have been observed in every month. Bardsey Islanders report seeing Risso's at other times also but it is unknown whether Risso's are present all year round in coastal waters, present all year but further offshore or only seasonally present.

As in the Isle of Lewis study, Bardsey Island researchers have observed groups containing only sub-adults and 'nursery groups' consisting of multiple females, each with a calf. High numbers of young animals are seen here; 10% of photographed Risso's dolphins have been calves and juveniles and 29% were identified as sub-adults[394]. Some apparently very young calves have been observed, including one with foetal folds[395]. These observations indicate that the area is important to Risso's dolphins for breeding, nursing and/or raising calves.

Behaviour indicative of feeding (such as deep dives or remaining submerged for a long period) has been observed often around Bardsey[396] and prey availability is likely a driver for them being in the area. It has been suggested that the complex topography and deep ocean trenches around Bardsey may create areas of upwelling with increased productivity that Risso's dolphins exploit[397]. The lesser octopus, known prey for Risso's dolphins from stomach studies of stranded animals found in Wales and Scotland[398], is found in the trenches offshore and reportedly comes inshore to lay its eggs on the horse mussel reefs in this area[399]. Risso's dolphins have been sighted feeding over these reefs[400], possibly following their prey inshore.

There is much less information available for the other locations in the Irish Sea where Risso's dolphins are sighted. Young have been observed off Pembrokeshire and Anglesey between July and September[401] but beyond this, the relative importance of these locations is unclear.

Further research on Risso's dolphins is needed in the waters of north east Lewis and Bardsey Island to improve our knowledge of these important populations. Expanding the photo-ID catalogues in the surrounding areas will help us understand the wider-scale movements and possible connections between these populations.

[387] Pollock *et al*, 2000
[388] Atkinson *et al*, 1998
[389] Reid *et al*, 2003; Pollock *et al*, 2000
[390] Evans *et al*, 2003
[391] Baines and Evans, 2009
[392] WDCS, 2002, 2003, 2004, 2005a and 2006; De Boer, 2009
[393] De Boer, 2009
[394] *Ibid*
[395] WDCS, 2004
[396] WDCS, 2005a
[397] Wharam and Simmonds, 2008
[398] Atkinson *et al*, 1998; Wharam and Simmonds, 2008
[399] Wharam and Simmonds, 2008
[400] *Ibid*
[401] Baines and Evans, 2009

4.4.7 KILLER WHALE OR ORCA *(Orcinus orca)*

Killer whales are widely distributed over the continental shelf and the deep offshore waters of the north east Atlantic. In UK waters they are primarily seen north and west of Scotland and key areas appear to be the continental slope to the north and north west of Shetland, the northern North Sea to the east of Shetland, and coastal waters of Shetland and the Hebrides[402]. Killer whales are also reported around Orkney, Farne Islands (north east England), the Isle of Man, in the St. George's Channel and off south west England[403], but there are few data available about these animals, and their occurrence at these locations appears to be more sporadic. The presence of killer whales off Cornwall has been linked to that of basking sharks *(Cetorhinus maximus)*, a potential prey species[404]. Elsewhere around the UK sightings are considered rare[405].

No overall population estimate exists for the north east Atlantic. Only recently has research begun to shed light on the population structure of killer whales in this region. Comparisons of morphological traits, DNA and ecology of killer whales throughout the area have suggested that two types exist, with differing physical and ecological characteristics[406]. The first type appear to be generalists, feeding mainly on lipid-rich pelagic fish such as herring or mackerel, but with a subset of the population also persistently feeding on marine mammals[407]. The second type appears to be highly specialised, and it is suggested that their main prey may be other cetaceans[408]. Type one animals were found across the North Atlantic, from Norway to Newfoundland, whereas type two specimens were only sampled from Scotland and the Faroe Islands[409].

These two types overlap geographically and temporally. The existence of sympatric populations of killer whales has been seen elsewhere in the world, most notably in the north east Pacific. However in contrast, north east Pacific killer whales all appear to be highly specialised, either predating on fish or marine mammals, whereas in the north east Atlantic there seems to exist a 'generalist' type that will exploit fish, marine mammals and even seabirds at different times.

Killer whales have been observed in UK waters in every month of the year[410]. A strong peak in sightings occurs during June and July in Shetland coastal waters[411]. This timing is highly correlated with the harbour seal pupping season; killer whales have been observed hunting and feeding upon harbour seals, as well as grey seals and harbour porpoises in this area[412].

Photo-ID and connectivity analysis conducted between killer whales from Iceland, Norway, the Northern and Western Isles of Scotland and the northern North Sea, has indicated that there is a high degree of inter-annual site fidelity in all locations[413]. This work also concluded that there is movement between the Northern Isles, Scotland and East Iceland, and that killer whales predating seals around the Northern Isles are linked to those that exploit Icelandic herring[414]. This connection is supported by isotope analysis which has suggested that subsets of individuals within the Icelandic herring- and mackerel-eating killer whale population also persistently forage on marine mammals[415]. These initial investigations suggest that at least some of the killer whales found predating on seals off Shetland in the summer are of the 'generalist' type, and move to Icelandic waters for the winter to exploit fish resources. A high degree of inter-annual site fidelity was found for animals around the Northern Isles[416].

A peak in sightings occurs over the continental slope north and west of Shetland during May and June[417], slightly earlier than the peak in Shetland waters. This earlier peak may reveal the movement of killer whales into the area, as they travel from winter feeding grounds around Iceland.

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[402] Evans *et al*, 2003; Pollock *et al*, 2000; Stone, 1997, 1998, 2000, 2001, 2003, 2006; Evans *et al*, 1996; Luque *et al*, 2006
[403] Evans *et al*, 2003; Weir, 2002
[404] Weir, 2002
[405] Reid *et al*, 2003; Evans *et al*, 2003
[406] Foote *et al*, 2009
[407] *Ibid*
[408] *Ibid*
[409] *Ibid*
[410] Evans *et al*, 2003
[411] Bolt *et al*, 2009
[412] Weir, 2002; Bolt *et al*, 2009; Foote *et al*, 2010
[413] Foote *et al*, 2010
[414] *Ibid*
[415] Foote *et al*, 2009
[416] Foote *et al*, 2010
[417] Pollock *et al*, 2000; Reid *et al*, 2003 (monthly data)

Concentrations of killer whales are also noted for the northern North Sea, to the north and east of Shetland, from October to March. These animals exploit mackerel migrating through the area at this time. Killer whales are present often in large numbers and have been regularly observed feeding on the discards from vessels of the pelagic mackerel trawl fishery[418]. It has been suggested that this is a relatively recent adaptation, although whales in this area had previously been noted to interact with purse seiners in the early 1990s[419]. These animals do not appear to follow the migration of mackerel much further westward than Shetland, as the fish continue their journey into the spring[420]. The only information available for killer whales in the northern North Sea are observations from fisheries vessels and it is unclear at present what proportion of the population is engaged in this activity.

The Hebrides is another area where killer whales are sighted relatively regularly and analysis suggests that these are type two animals which are thought to prey mainly on cetaceans[421]. This needs to be confirmed with further research, but there is at least one record of a killer whale killing a harbour porpoise in the region[422], although others have noted seals being taken[423]. Sightings of killer whales are fewer for the Hebrides, possibly due to fewer observers[424], but also, this does appear to be a small population, with only ten individuals identified since 1992[425]. Key areas seem to be around Mull and the Treshnish Islands, south of Skye, and the Little Minch[426]. Although sightings records show peaks for the summer months, there is some evidence they may be present at other times of the year[427]. Connectivity analysis recently completed, along with phenotype differences, suggest that the killer whales seen in the Hebrides are isolated from the Northern Isles and North Sea animals[428]. Of significant concern, particularly if this community is indeed isolated, is the fact that no calves have been observed in the Hebridean community in 17 years of observation[429].

Individuals in the Hebridean community were found to exhibit high levels of site fidelity between years[430]. One distinctively marked individual (named 'John Coe') has been repeatedly and regularly sighted in the area for 16 years[431]. He has also been sighted as far away as Pembrokeshire and the north coast of Ireland[432].

Little appears to be known about the timing of breeding and calving in north east Atlantic killer whales with some suggesting births are likely for the spring[433], and others autumn to winter[434]. Observations of whales feeding from pelagic trawlers in the northern North Sea in January and February found most groups included calves and juveniles[435]. Other studies recorded calves to be present in July and August only[436].

Recent insights into the existence of different 'types' of killer whales in north east Atlantic waters, and the apparent isolation of communities as a result of their exploitation of different prey resources, could have implications for the conservation of this species in the region[437]. **Further research is required to determine population sizes for killer whales in the north east Atlantic, and confirm if there is reproductive isolation among sympatric types as research suggests, and as has been documented for north east Pacific killer whales**[438]. Small, isolated populations are intrinsically at a greater extinction risk due to demographic factors[439], and the need to limit other threats becomes more urgent.

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418 Luque *et al*, 2006; Foote *et al*, 2010
419 Couperus, 1993, in Luque *et al*, 2006
420 Luque *et al*, 2006
421 Foote *et al*, 2009
422 HWDT, www.hwdt.org. Checked Jan 2010
423 Evans, 1988
424 Weir, 2002; Evans *et al*, 2003
425 HWDT, www.hwdt.org. Checked Jan 2010; Foote *et al*, 2010
426 Reid *et al*, 2003; Bolt *et al*, 2009; Evans *et al*, 2003
427 Reid *et al*, 2003; Pollock *et al*, 2000
428 Foote *et al*, 2010
429 *Ibid*
430 *Ibid*
431 Foote *et al*, 2010; Dolman and Hodgins, 2009; Evans *et al*, 2003
432 HWDT, www.hwdt.org. Checked April 2010
433 Luque *et al*, 2006
434 Evans, 1988
435 Luque *et al*, 2006
436 Pollock *et al*, 2000
437 Foote *et al*, 2010
438 Ford *et al*, 2000
439 Melbourne and Hastings, 2008

4.4.8 ATLANTIC WHITE-SIDED DOLPHIN *(Lagenorhynchus acutus)*

The Atlantic white-sided dolphin is a deep water species and survey work suggests it is the most abundant dolphin species in UK offshore waters, although a lack of baseline data makes it difficult to assess its status[440]. Atlantic white-sided dolphins are predominantly recorded along or beyond the continental shelf edge, to the north and west of Scotland[441]. Through much of their range they overlap with the white-beaked dolphin, but in the eastern North Atlantic, white-beaked dolphins are much more numerous than Atlantic white-sided dolphins on the shelf, and the situation is reversed off the shelf[442]. It has been suggested that separation of the two species is based on water temperature and distance from the coast, and is likely driven by competition for prey[443].

Little information is available about the abundance of Atlantic white-sided dolphins in the region. No estimates are available for the north east Atlantic or UK waters. The SCANS and SCANS II surveys provided estimates for Atlantic white-sided and white-beaked dolphins combined. For SCANS this figure was 11,760 (CV 0.26; 95% CI = 5,867-18,528), and at least 7,856 (CV 0.30; 95% CI = 4,032-13,301) of these were white-beaked dolphins[444] (see Figure 4.24, below). SCANS II (with a larger survey area) produced a combined estimate of 37,981 (CV 0.36; 95% CI = 19,169-75,255), with white-beaked dolphins making up at least 22,664 (CV 0.42; 95% CI = 10,341-49,670) of this estimate[445] (see Figure 4.25, below). An unknown number of the difference between the combined and white-beaked estimates will be Atlantic white-sided dolphins, but white-beaked dolphins usually greatly outnumber Atlantic white-sided dolphins in shelf waters[446].

An abundance estimate for Atlantic white-sided dolphins of 74,626 (CV 0.72) and density of 1.65 animals/km^2 was calculated for the Faroe-Shetland Channel in the summer of 1998[447]. To the south of here, the same survey resulted in an abundance estimate of 21,371 (CV 0.54) for an area along and beyond the shelf edge to the west of the Outer Hebrides, and a density of 0.39 animals/km^2. Further south, in an area to the west of Ireland and into the Rockall Trough, a different survey conducted in 2000 obtained an abundance estimate of 5,490 (CV 0.43) and a density of 0.046 animals/km[448] (see Figure 4.26, p.52). Biases have been identified for these estimates[449] but they do show a gradient in abundance, increasing to the north and peaking in the Faroe-Shetland Channel[450].

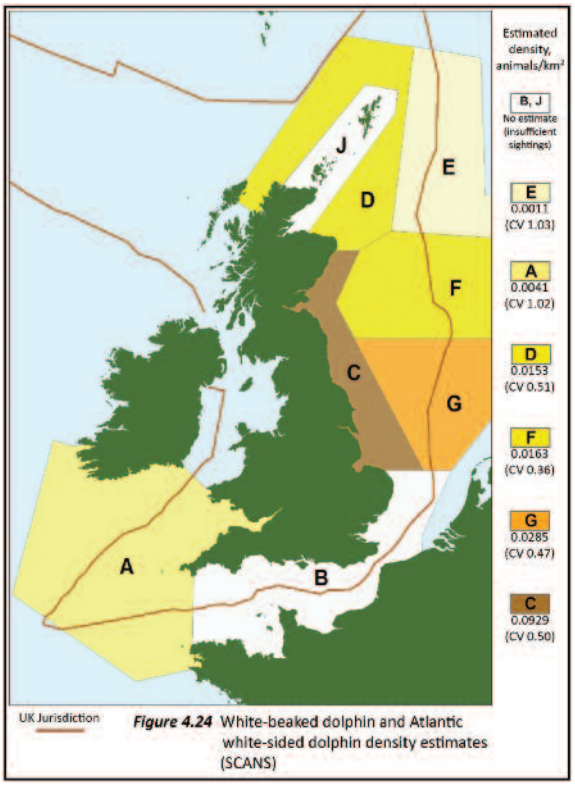

Figure 4.24 White-beaked dolphin and Atlantic white-sided dolphin density estimates (SCANS)

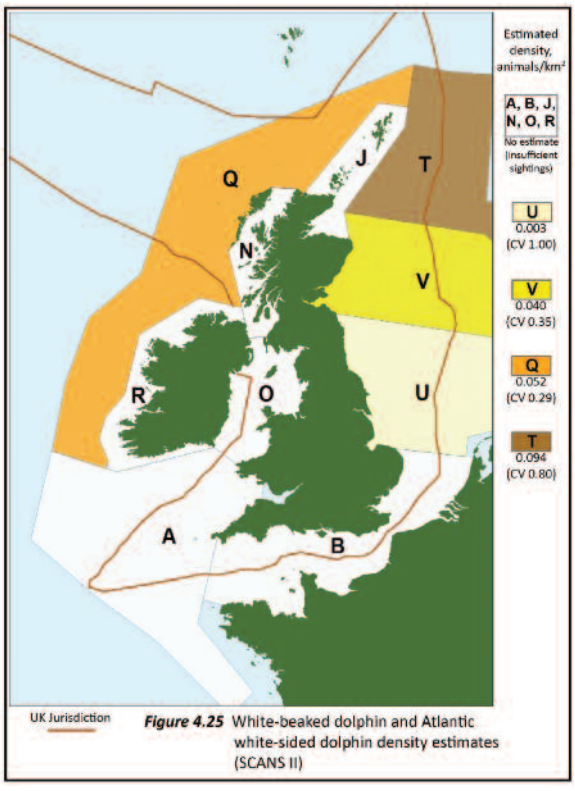

Figure 4.25 White-beaked dolphin and Atlantic white-sided dolphin density estimates (SCANS II)

[440] Harwood and Wilson, 2001; MacLeod, 2004; Pollock *et al*, 2000
[441] Reid *et al*, 2003; Northridge *et al*, 1997
[442] Northridge *et al*, 1997
[443] MacLeod *et al*, 2007
[444] Hammond *et al*, 1995
[445] SCANS II, 2006
[446] Hammond *et al*, 1995; Northridge *et al*, 1997
[447] MacLeod, 2004
[448] O'Cadhla *et al*, 2001 (in MacLeod, 2004)
[449] See MacLeod, 2004 for discussion
[450] MacLeod, 2004

These estimates are supported by a body of research reporting high relative abundance or clusters of sightings for the Faroe-Shetland Channel[451]. The reasons for the apparent importance of this area are unknown at present but are most likely prey related. A lack of data on fish distribution and abundance in this area hinders this understanding. The timing may also coincide with the breeding and calving season for Atlantic white-sided dolphins. **The importance of the Faroe-Shetland Channel for Atlantic white-sided dolphins as an area for calving and foraging should be further investigated**.

Some studies have also noted high sightings rates in the area further south, west of the Outer Hebrides, and modelling work has highlighted it as an area of predicted high density[452].

Atlantic white-sided dolphins have been recorded in UK offshore waters in every month[453] but they are more widespread and abundant between June and November[454]. In the summer months there seems to be a seasonal movement into shelf waters, particularly north of Scotland and into the northern and central North Sea[455]. There are several reports of large groups of Atlantic white-sided dolphins in the North Sea at this time, including mixed schools with white-beaked dolphins[456]. The lack of dedicated surveys, combined with the difficulties of identification in areas where white-beaked dolphins are prevalent, make pinpointing specific areas difficult but some studies report relatively high abundance of Atlantic white-sided dolphins in the northern Dogger Bank region[457]. At present, there is insufficient information for the central and northern North Sea to determine if important habitat exists in this area for Atlantic white-sided dolphins.

Juveniles are recorded between June and August, with a peak in July[458]. It has been suggested that the increase in numbers on the shelf during summer may correspond with the breeding and calving period for this species[459].

Atlantic white-sided dolphins feed on small pelagic schooling fish (e.g. mackerel and herring), and also squid. They are regularly recorded in association and feeding with other cetacean species, including long-finned pilot whales, fin and humpback whales, and bottlenose, white-beaked and common dolphins[460].

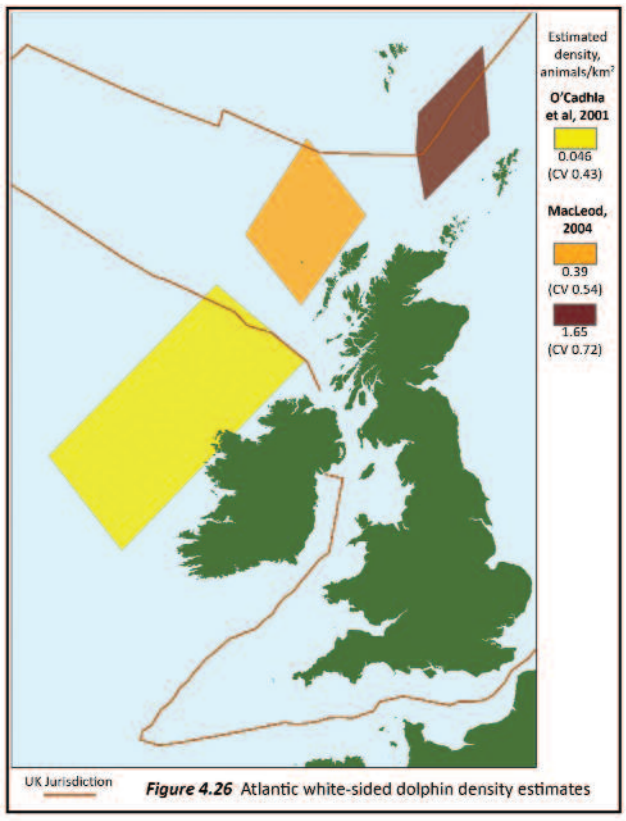

Figure 4.26 Atlantic white-sided dolphin density estimates

[451] Hastie *et al*, 2005; MacLeod, 2004; Pollock *et al*, 2000; Evans *et al*, 2003; Stone, 2003, 2006; Reid *et al*, 2003
[452] Embling, 2007; Reid *et al*, 2003
[453] Reid *et al*, 2003; Pollock *et al*, 2000
[454] Pollock *et al*, 2000
[455] Reid *et al*, 2003; Northridge *et al*, 1997
[456] See Northridge *et al*, 1997 and references therein
[457] Camphuysen *et al*, 1995; De Boer, 2010
[458] Pollock *et al*, 2000
[459] Pollock *et al*, 2000
[460] Pollock *et al*, 2000; Reid *et al*, 2003; Culik, 2004; Hammond *et al*, 2008

4.4.9 LONG-FINNED PILOT WHALE *(Globicephala melas)*

Long-finned pilot whales are a deep water species, and in UK waters are predominantly found off the continental shelf to the north and west of Scotland, and south east of the Faroe Islands[461]. South west of Britain and Ireland is another area where sightings are noted, although in fewer numbers, and again occurring off the edge of the continental shelf in deep waters[462].

A gregarious species often seen in large groups, long-finned pilot whales frequently associate with other cetaceans, particularly bottlenose dolphins and Atlantic white-sided dolphins, but also common and striped dolphins, as well as fin, sperm, northern bottlenose and killer whales[463].

Few sightings of young animals have been recorded for British waters, but those seen have occurred north and west of Scotland in the summer[464], November and March[465].

A population estimate for the North Atlantic of 778,000 (CV 0.3) was made from surveys in 1989[466] but is considered problematic because of the difficulties in estimating group size for this species[467]. It also did not extend fully into UK waters[468]. The recent CODA surveys of offshore European Atlantic waters produced an estimate for long-finned pilot whales of 25,101 (CV 0.33; 95% CI = 13,251-47,550) for the entire survey area[469] (see Figure 4.27, below). The highest density and abundance estimates were for the survey block covering the waters to the west of Scotland and Ireland, with 18,709 (CV 0.37) animals estimated and a density of 0.054 animals/km². This compares to an overall density for the whole survey area of about half this, 0.026 animals/km². Density surface modelling predicted the highest densities to be between 53° and 58°N, over the Rockall Bank and Hatton Rockall Basin (see Figure 4.28, below)[470]. The block to the south west of Britain and Ireland was found to have the second highest densities of long-finned pilot whales for the survey area but much lower than to the north. Distribution was predicted to be predominantly along the shelf edge.

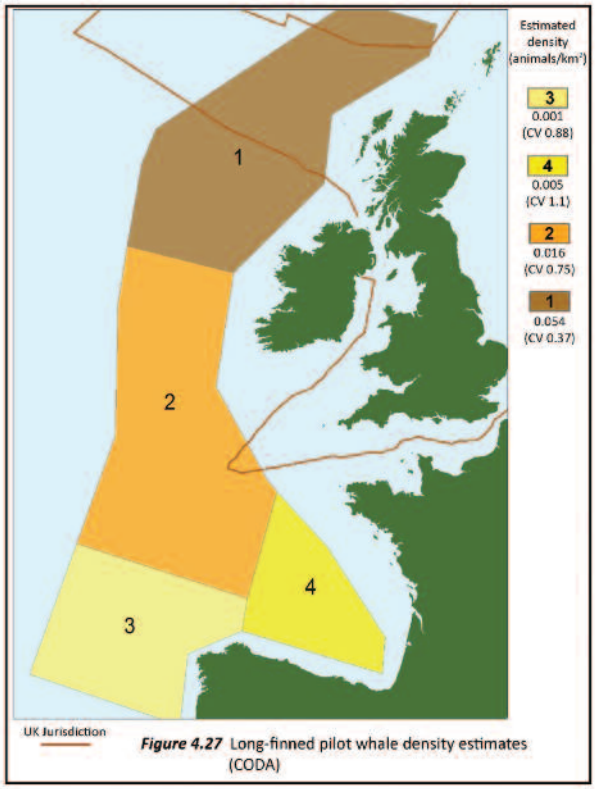

Figure 4.27 Long-finned pilot whale density estimates (CODA)

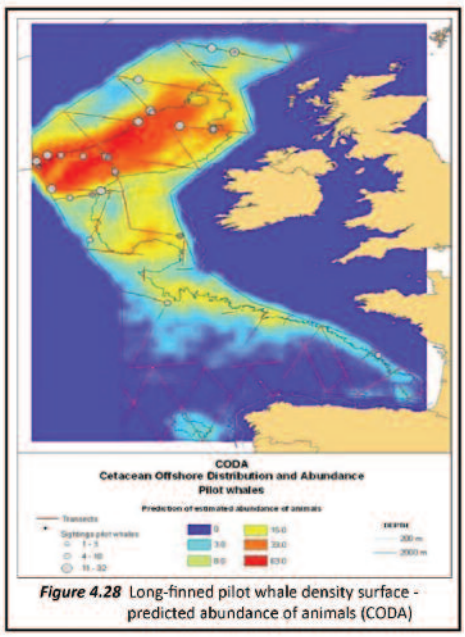

Figure 4.28 Long-finned pilot whale density surface - predicted abundance of animals (CODA)

[461] MacLeod *et al*, 2003; Pollock *et al*, 2000; Skov *et al*, 1995; CODA, 2009; Reid *et al*, 2003; Evans *et al*, 2003
[462] Evans *et al*, 2003; Reid *et al*, 2003
[463] Reid *et al*, 2003; MacLeod *et al*, 2007; Pollock *et al*, 2000
[464] MacLeod *et al*, 2003
[465] Evans, 1980
[466] Buckland *et al*, 1993
[467] JNCC, 2007; Evans *et al*, 2003
[468] Evans *et al*, 2003
[469] CODA, 2009
[470] Reproduced with permission CODA, 2009. Please note that density surface maps show estimated density derived from a spatial model and should not be over-interpreted, particularly at a fine spatial scale.

Diet mainly consists of squid, particularly *Todarodes sagittatus* which is widespread in north east Atlantic waters, but also *Gonatus* spp. and *Illex* spp.[471] Some fish will also be taken such as mackerel and blue whiting *(Micromesistius poutassou)*[472]. Studies on long-finned pilot whale diet in the Faroes indicate that they will prefer *T. sagittatus* but in years when this species is scarce they will switch to *Gonatus* spp. (most likely *Gonatus fabricii*)[473]. *T. sagittatus* is frequently caught in the deep waters west of Scotland and Ireland. Annual spawning events of this species are thought to occur in late winter-spring, in deep waters adjacent to the continental slopes.

There appears to be little seasonality in the sightings records generally for pilot whales in UK waters[474], although some report a peak from July to September[475].

Sightings of long-finned pilot whales are highly concentrated in the Faroe-Shetland and Faroe Bank Channel, Wyville-Thomson Ridge and north east Rockall Trough area[476]. This distribution is most likely linked to that of its squid prey[477]. The results of the CODA survey and others[478] indicate that Rockall Bank and Hatton Rockall Basin are also areas of high abundance and importance to this species, although less research has been focused on this area[479], hindering our understanding. High densities during the summer, the time of year when this species calves, may indicate the area is used for this function. **The importance of the Rockall Bank and Hatton Rockall Basin as foraging and calving habitat for long-finned pilot whales should be further investigated**.

[471] Reid *et al*, 2003; Bjørke, 2001
[472] Reid *et al*, 2003;
[473] Bjørke,2001 and references therein
[474] Reid *et al*, 2003
[475] Evans *et al*, 2003; Evans, 1992
[476] MacLeod *et al*, 2003; Pollock *et al*, 2000; Reid *et al*, 2003; Evans *et al*, 2003; Stone, 1997, 1998, 2003, 2006; MacLeod, 2001
[477] Pollock *et al*, 2000; Reid *et al*, 2003; Evans, 1980; Bjørke, 2001
[478] Skov *et al*, 1995; Evans *et al*, 2003; Reid *et al*, 2003
[479] for example, see Reid *et al*, 2003

4.4.10 SPERM WHALE *(Physeter macrocephalus)*

Globally, sperm whales are considered 'Vulnerable' as a result of intensive whaling in the past[480]. They occur in small numbers throughout the deep waters of the North Atlantic[481]. The majority of sperm whale records in northern Europe come from the British Isles[482] where they are the most frequently encountered large whale species, mainly found along and beyond the continental shelf edge to the north and west of Scotland[483].

A preference for shelf edges and other highly-productive areas, such as upwellings, fronts and eddies, has been noted in many parts of the world and is thought to be because an increase in primary productivity results in high densities of squid, their favoured prey[484]. Sperm whales typically dive to great depths to catch mainly medium to large mesopelagic squid[485]. In the north east Atlantic, *G. fabricii* has been found to be the main prey species taken[486].

Sperm whales exhibit seasonal segregation between the sexes, with females and young remaining in low latitudes throughout the year, while adult males spend the summer at high latitudes, returning to lower latitudes to breed[487]. The UK's northerly location would indicate therefore that only males would be present, and indeed, this is supported by whaling and stranding records which only report adult and sub-adult males[488].

Sightings occur throughout the year in UK and Irish waters, with peaks during the summer months[489]. However, this seems to be due to less effort and diminished visibility during the winter months as acoustic surveys in the autumn and winter have detected high numbers of sperm whales to the north and west of Scotland[490]. Strandings records during these months further support this and it is thought that small groups of males remain at high latitudes for the winter rather than travelling south to the breeding grounds[491].

No reliable population estimates exist for the North Atlantic. The CODA survey of offshore European Atlantic waters estimated abundance at 2,077 (CV 0.2) animals for the survey area, with 480 (CV 0.33) of these within the block to the west of the Hebrides[492] (see Figure 4.29, p.56). Spatial modelling of this data predicted localised areas of moderate density in the Rockall Trough, close to the shelf edge (see Figure 4.30, p.56)[493]. Acoustic data collection was not possible in this area because of technical difficulties[494]. This is unfortunate as the visual data indicate the existence of higher density areas for sperm and beaked whales in this block and these species are often easier to detect acoustically rather than visually due to the amount of time spent at depth.

In UK waters, sightings are concentrated in the Faroe-Shetland Channel, over the Wyville-Thomson and Ymir Ridges and north east Rockall Trough[495]. Less survey effort has occurred elsewhere in the Rockall Trough[496] but several studies report relatively high sightings or acoustic detection rates close to the shelf edge[497]. Spatial modelling studies have predicted higher density areas for sperm whales further south in the Trough, again, particularly for the area close to the shelf edge[498].

UK waters likely form part of the migratory route for those adult male sperm whales travelling to higher latitudes from breeding areas in the south. The Rockall Trough and Faroe-Shetland Channel may provide the deep water corridors for this movement, resulting in a greater number of sightings in these areas. With sightings and acoustic detections occurring throughout the year in this region, these waters may also be important for foraging. The high densities of sperm whales particularly noted in the Faroe-Shetland Channel may be because it offers productive foraging habitat[499].

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480 IUCN, 2010
481 Reid *et al*, 2003
482 Evans, 1997
483 Reid *et al*, 2003; Evans *et al*, 2003; Pollock *et al*, 2000
484 Davis *et al*, 2002; Skov *et al*, 2008; Embling, 2007; Waring *et al*, 1993; Jaquet, 1996
485 Reid *et al*, 2003; Evans *et al*, 2003
486 Santos *et al*, 1999, 2002
487 Evans, 1997
488 Evans, 1997; Berrow *et al*, 1993
489 Pollock *et al*, 2000; Stone, 2006; Evans *et al*, 2003; MacLeod, 2001
490 Lewis *et al*, 1998; Hastie *et al*, 2003
491 Berrow *et al*, 1993; Evans, 1997
492 CODA, 2009
493 Reproduced with permission. CODA, 2009. Please note that density surface maps show estimated density derived from a spatial model and should not be over-interpreted, particularly at a fine spatial scale.
494 CODA, 2009
495 Pollock *et al*, 2000; Reid *et al*, 2003; Embling, 2007; MacLeod *et al*, 2003
496 see for example, Reid *et al*, 2003
497 Reid *et al*, 2003; Evans *et al*, 2003; MacLeod *et al*, 2003; Lewis *et al*, 1998
498 CODA, 2009; Embling, 2007
499 Evans *et al*, 2003

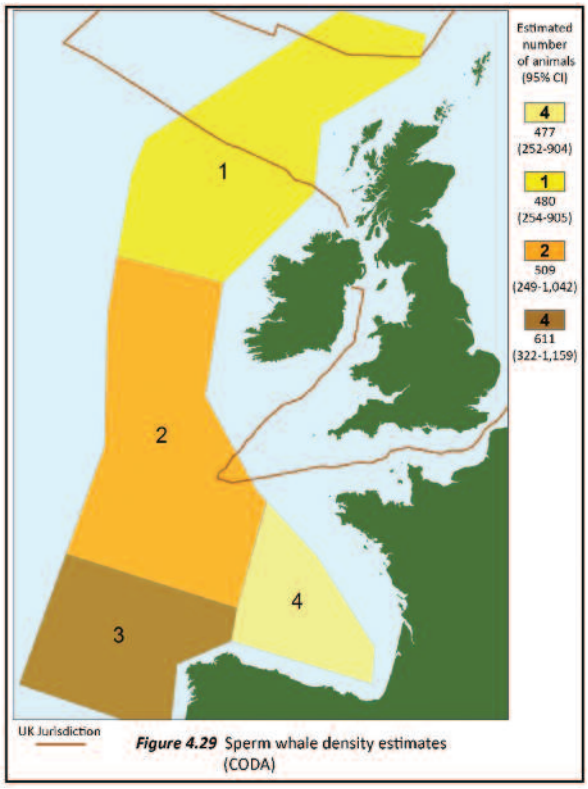

Figure 4.29 Sperm whale density estimates (CODA)

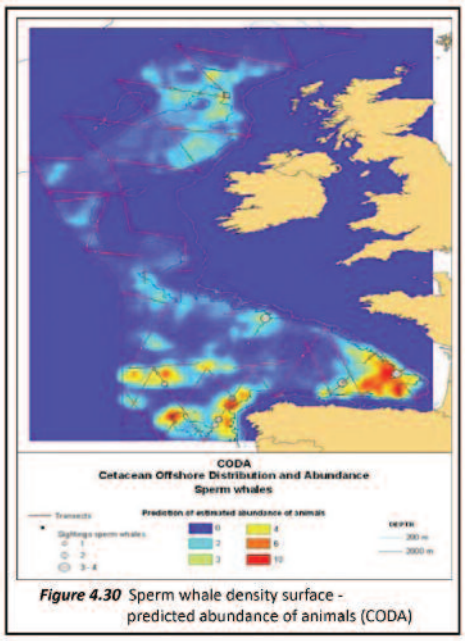

Figure 4.30 Sperm whale density surface - predicted abundance of animals (CODA)

Analysis of sperm whale teeth from the north east Atlantic suggests that after leaving natal groups in low latitudes, males disperse northward to temperate waters where they remain for a number of years before heading further north to highly-productive polar regions[500]. The presence of sub-adult 'bachelor schools' in UK waters is supported by the strandings records which show that since 1975 more than half of sperm whales stranded in UK waters have been males of less than 14m in length[501].

The suggestion that foraging takes place in the Faroe-Shetland Channel-north east Rockall Trough region is further supported by studies here that have detected foraging-associated vocalisations by sperm whales[502]. Although knowledge is limited about densities and distribution of squid in this area, a variety of deep sea squid species are known to occur, including *G. fabricii*, a favoured sperm whale prey[503]. The series of ridges and channels in this area create complex currents which appear to promote primary productivity[504] and may in turn provide a rich food supply for sperm whales.

[500] Mendes *et al*, 2007
[501] Evans, 1997
[502] Embling, 2007
[503] Hastie *et al*, 2006 and references therein
[504] Embling, 2007

4.4.11 BEAKED WHALES

NORTHERN BOTTLENOSE WHALE *(Hyperoodon ampullatus)*
CUVIER'S BEAKED WHALE *(Ziphius cavirostris)*
SOWERBY'S BEAKED WHALE *(Mesoplodon bidens)*
TRUE'S BEAKED WHALE *(Mesoplodon mirus)*
GERVAIS' BEAKED WHALE *(Mesoplodon europaeus)*
BLAINVILLE'S BEAKED WHALE *(Mesoplodon densirostris)*

On the whole, the beaked whales are a poorly known group of species, in part due to their pelagic distribution and strong preference for deep waters beyond the continental shelf edge. They are deep divers and spend little time at the surface, making observation and identification to a species level difficult, further hindering our understanding of them.

This preference for waters of 1000m deep or greater means that around the UK, the majority of beaked whale sightings comes from the Atlantic Frontier to the north and west of Scotland, and this is believed to be a key area for beaked whales[505]. Many strandings are reported for other areas, such as the North Sea and Irish Sea but it is thought they enter these shallower waters as they make their southerly migration, either because of navigational error, or because they are using it as a 'short cut' between deep water areas[506].

Their diet consists of deep-water cephalopods and fish, reflecting their distribution. Northern bottlenose whales show a strong preference for cephalopods of the *Gonatus* family, particularly *G. fabricii*[507]. Data are sparse for *Mesoplodon* species but it appears that as well as taking deep sea squid species, fish may also be important in their diet[508].

Six species of beaked whale have been recorded through sightings and strandings from the coasts of the UK and Ireland, with the northern bottlenose whale and Sowerby's beaked whale the most common of the six[509].

Due to their predominantly offshore distribution, beaked whales are rarely reported in surveys of British and Irish shelf waters (such as in SCANS and SCANS II). The recent CODA survey (in July 2007) of offshore European Atlantic waters, however, has provided important information for these species. Beaked whales were found to be strongly concentrated in the waters west of the Hebrides, with the second highest density and highest total abundance of beaked whales for the survey area recorded here[510]. Total abundance for the survey area was estimated to be 6,992 (CV 0.25; 95% CI = 4,287-11,403) with over 50% of these animals (3,512, CV 0.34) in the northernmost block (see Figure 4.31, p.58). Density surface modelling of the data to look at distribution at a finer scale predicted the highest densities to be in the north west part of the Rockall Trough[511] (see Figure 4.32, p.58)[512]. These results emphasise the importance of the Atlantic Frontier region for beaked whales. All sightings identified to a species level were northern bottlenose whales or Sowerby's beaked whales, with only one sighting of a Cuvier's beaked whale.

Acoustic data collection was not possible in this part of the CODA survey area because of technical difficulties[513]. This is unfortunate as the visual data indicates the existence of high density areas for sperm and beaked whales in this block and these species are often easier to detect acoustically rather than visually due to the amount of time spent at depth.

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[505] Pollock *et al*, 2000; MacLeod and Mitchell, 2006
[506] MacLeod *et al*, 2004
[507] Santos *et al*, 2001
[508] MacLeod *et al*, 2003
[509] Reid *et al*, 2003; MacLeod *et al*, 2004
[510] CODA, 2009
[511] CODA, 2009
[512] Reproduced with permission CODA, 2009. lease note that density surface maps show estimated density derived from a spatial model and should not be over-interpreted, particularly at a fine spatial scale.
[513] CODA, 2009

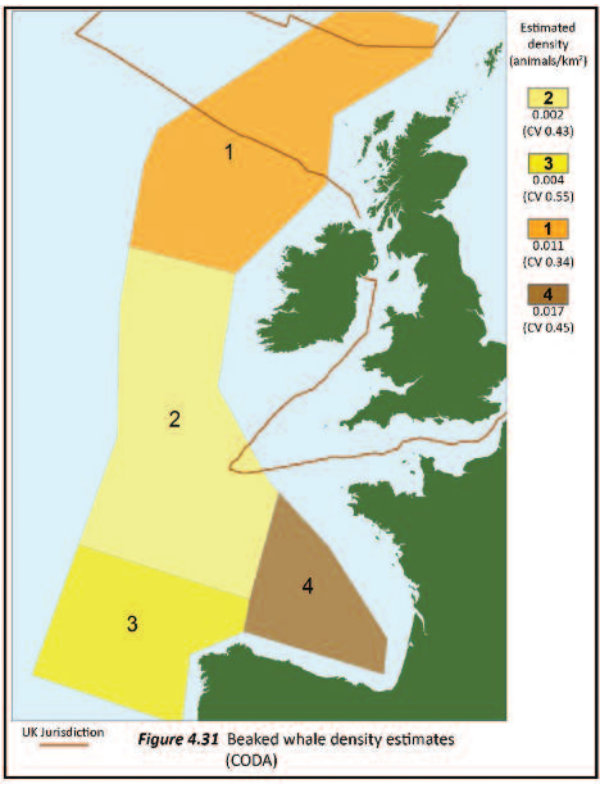

Figure 4.31 Beaked whale density estimates (CODA)

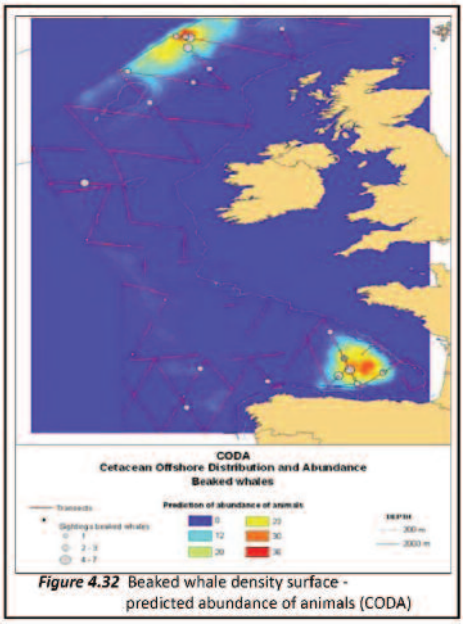

Figure 4.32 Beaked whale density surface - predicted abundance of animals (CODA)

Northern bottlenose whale sightings in the UK peak in April and again in August[514], which combined with the pattern and timing of strandings, suggest they migrate north to the Norwegian Sea in spring, and return south again in the late summer[515]. This is supported by the timing of sightings peaks in the Norwegian Sea and the Faroes, which occur one to two months earlier than around the UK and together indicate that movement is part of a larger-scale migration throughout the northern north east Atlantic[516]. The fact that sightings occur during most months of the year, however, suggests not all animals are migratory, and this also appears to be the case in the Faroes and north west Atlantic[517]. Northern bottlenose whales are known to be resident with high site fidelity in the Gully area off Nova Scotia in the north west Atlantic where an MPA was created for them in 2004[518].

According to sightings records for UK waters, positive identifications of Sowerby's beaked whales are relatively few. However, most if not all sightings of unidentified Mesoplodon species are believed also to be Sowerby's[519]. It has been suggested that they are likely the most abundant beaked whale species in the North Atlantic[520]. Sightings of confirmed and suspected Sowerby's beaked whales have occurred in most months of the year with a peak in August. This suggests that at least part of the population remains in UK waters all year, although the pattern and timing of strandings indicates they may undertake similar migrations to northern bottlenose whales[521].

The results of the CODA survey support the suggestion of non-migratory populations of beaked whales. The survey took place in July, outside the months with apparently migratory-related sightings peaks, and found high numbers of beaked whales present in the Atlantic Frontier area. This presence is likely connected to prey availability in July but there is little information available on the distribution and abundance of prey species in the region.

For northern bottlenose whales and Sowerby's beaked whales, most sightings occur along or beyond the 1000m isobath and are particularly clustered around the complex series of ridges and channels at the northern end of the Rockall Trough and the Faroe-Shetland Channel[522]. A study

[514] Pollock *et al*, 2000
[515] MacLeod *et al*, 2004
[516] MacLeod *et al*, 2004 and references therein.
[517] Pollock *et al*, 2000; Bloch *et al*, 1996
[518] Hoyt, 2005a (2nd edition in prep. for 2011)
[519] Pollock *et al*, 2000; Reid *et al*, 2003
[520] Harwood and Wilson, 2001
[521] MacLeod *et al*, 2004
[522] Pollock *et al*, 2000; Reid *et al*, 2003; Evans *et al*, 2003; MacLeod *et al*, 2006
[523] MacLeod *et al*, 2006

which looked at worldwide beaked whale distributional data classified the Atlantic Frontier, and particularly these two locations, as important areas for beaked whales[523]. They considered that deep water areas such as the Faroe-Shetland Channel may form corridors for movement, important for the migration of at least northern bottlenose whales and potentially other beaked whale species[524]. This has not yet been confirmed by tracking the movements of individual animals[525]. **The importance of this area for beaked whales should be further investigated**.

Large stocks of *Gonatus fabricii* (favoured prey of northern bottlenose whales) are known to be found in the deep, cold waters of the north east Atlantic, and this species is thought to be the most important of a variety of deep-water squid species present in the Faroe-Shetland Channel[526]. The series of ridges and channels that separates the Rockall Trough and Faroe-Shetland Channel create complex currents and these may act to concentrate a rich food supply here for beaked whales[527].

There are few data available for the far north east UK marine area, between the Faroe Islands and Norway, but it may also be of importance to beaked whales as they likely enter and leave the Faroe-Shetland Channel from here. It is also immediately south of an area where large numbers of northern bottlenose whales were taken by Norwegian whalers from 1939-1972[528].

There are only a small number of records of Gervais' and Blainville's beaked whales from the north east Atlantic; these species are thought to favour warm temperate and tropical waters rather than the colder waters around the UK[529]. True's beaked whales are a more northerly species[530] but also only known from a small number of records, with a handful of strandings on the Irish coast and a few sightings from Europe[531]. No seasonal peaks are obvious from the stranding records so it appears they may be present in UK waters throughout the year[532]. True's beaked whales occur more frequently along the east coast of North America than in the north east Atlantic but it has been suggested that due to their seemingly limited distribution, they may have only a small overall population[533].

Cuvier's beaked whales are recorded more frequently in British and Irish waters, but there have still been only a limited number of sightings at sea (six confirmed)[534]. Sightings have all occurred between June and September which may indicate they move into UK waters for the summer months or are more easily seen inshore then[535].

There are so few records of these four species in UK waters that it is not presently possible to draw any conclusions about the existence of important habitat in UK waters. It seems unlikely that critical habitat for Gervais' and Blainville's beaked whales would be located as far north as the UK. It may be that the deep offshore waters to the west of the UK and Ireland provide critical habitat for Cuvier's and True's beaked whales but more data will be needed for this to be established.

[524] MacLeod *et al*, 2006; MacLeod *et al*, 2004
[525] *Ibid*
[526] Hastie *et al*, 2006; Pierce *et al*, 2004
[527] Reid *et al*, 2003
[528] Bjørke, 2001
[529] MacLeod *et al*, 2004; Evans *et al*, 2003
[530] MacLeod, 2000
[531] Reid *et al*, 2003; Evans *et al*, 2003
[532] Reid *et al*, 2003
[533] MacLeod, 2000
[534] Reid *et al*, 2003
[535] Reid *et al*, 2003; Evans *et al*, 2003

4.4.12 LARGE BALEEN WHALES

HUMPBACK WHALE *(Megaptera novaeangliae)*
SEI WHALE *(Balaenoptera borealis)*
FIN WHALE *(Balaenoptera physalus)*
BLUE WHALE *(Balaenoptera musculus)*

In the UK, fin, blue, sei and humpback whales occur mainly in the deep offshore waters to the north and west of Britain, along the edge or off the continental shelf[536]. Sightings are rare for the North Sea and the English Channel in particular[537].

Large baleen whales were severely depleted by whaling in the North Atlantic and fin, blue and sei whales are still classified as 'Endangered' by the IUCN. The humpback whale was only recently re-classified from 'Vulnerable' to 'Least Concern', although some humpback populations in other parts of the world remain 'Endangered' (IUCN Red List, 2008). Population estimates are largely not available for the region. The best available estimates for the fin whale are 25,800 (CV 0.125) for the central North Atlantic; 4,100 (0.21) for the north east North Atlantic[538]; and 17,355 (CV 0.27) for Spain-Portugal-British Isles[539]. The more recent CODA survey, which took place in July 2007, estimated 9,019 (CV 0.11) fin whales for the entire survey area[540] (see Figures 4.33 and 4.34, below)[541]. Abundance was highest in Block 2, off the continental shelf to the south west of Ireland and the UK, and lowest in the northern block off north west Scotland[542]. Small numbers of fin whales were seen during SCANS (in July 1994) which only covered shelf waters. Those seen were mostly in the Celtic Sea[543].

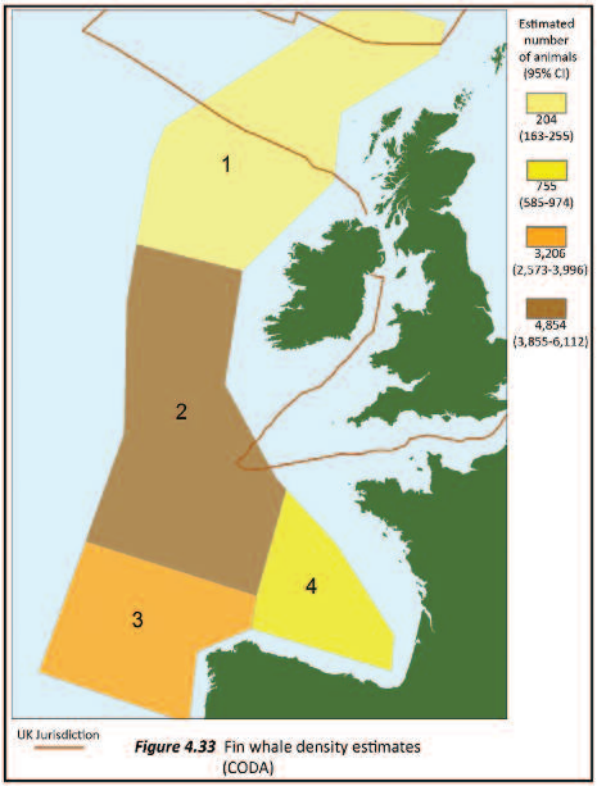

Figure 4.33 Fin whale density estimates (CODA)

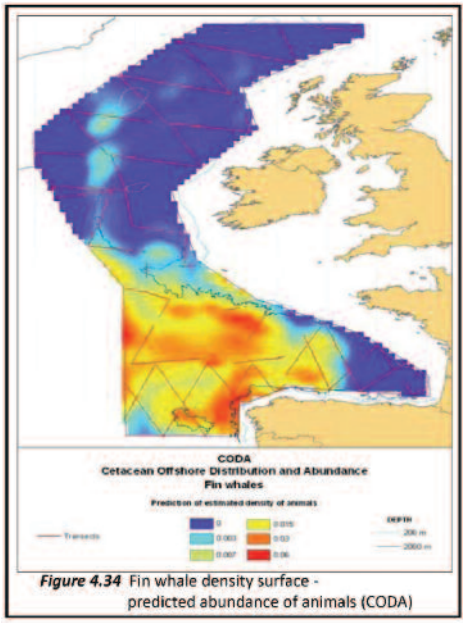

Figure 4.34 Fin whale density surface - predicted abundance of animals (CODA)

[536] Reid *et al*, 2003
[537] Reid *et al*, 2003; Van de Meij and Camphuysen, 2006
[538] Estimate for 1996-2001; IWC, 2007
[539] Estimate from 1989; Buckland *et al*, 1992
[540] CODA, 2009
[541] Reproduced with permission CODA, 2009. Please note that density surface maps show estimated density derived from a spatial model and should not be over-interpreted, particularly at a fine spatial scale.
[542] CODA, 2009
[543] Numbers were too few to calculate a population estimate. Hammond *et al*, 1995

There is no current population estimate for sei whales in the North Atlantic. The CODA survey produced an estimate of 366 (CV 0.33) for the survey area, but sei whales were only seen in Block 3, off north west Spain. Surveys of the central and north east Atlantic have produced population estimates of about 850 blue whales[544], with sightings centred off western Iceland. No population estimate is currently available for humpback whales in the eastern North Atlantic.

Preferred prey for fin whales in the northern hemisphere is the euphausiid, *Meganyctiphanes norvegica*, although other species of planktonic crustacean (such as *Calanus finmarchicus*) and schooling fish are also taken[545]. Blue whales in the North Atlantic feed on a few euphausiid species, including *M. norvegica* and *Thysanoessa raschii* [546]. Sei whales primarily feed on copepods although some small schooling fish and squid are also taken[547]. Humpback whales are generalists and eat a wide variety of small schooling fish and euphausiids[548].

Large baleen whale species generally undertake long annual migrations, travelling between summer high-latitude feeding grounds, and winter breeding grounds in warmer, low-latitude waters. This is thought to be true for those species that occur in north east Atlantic waters[549], although data for some species are incomplete or contradictory. Visual surveys of the Atlantic Frontier have recorded peaks in sightings for the summer months[550] which support this assertion. However, there has been little effort during winter and spring, and poor sea state and visibility at these times are known to reduce sightings rates significantly. In addition, ten years of extensive acoustic surveys have found detection rates for some species[551] peak in the winter and early spring, so at least a proportion of these populations remain at high latitudes during the winter[552].

Both visual and acoustic surveys have found fin whales to be the most frequently detected large baleen whale species in UK waters[553]. Most sightings occur between May and October, peaking in August[554], with a second peak around December occurring mainly in south west Britain[555]. This second peak is due to a proportion of the population overwintering south of Ireland and in the Western Approaches to the English Channel[556]. Observations and strandings of young calves and pregnant females have led to the conclusion that fin whales use this area to breed and nurse their young[557]. Data are generally sparse from this area, particularly for the winter months, but several surveys have recorded fin whales as present in summer[558] and winter[559].

Most sightings of fin whales are made along or beyond the edge of the continental shelf, north and west of the UK and Ireland[560]. It has been suggested that they may use the shelf edge as a migration channel to travel between breeding and feeding grounds[561]. Summer peaks in sightings close to the shelf edge may be related to seasonal peaks in principal prey species for fin whales, euphausiids such as *M. norvegica*, or the copepod *C. finmarchicus* which is prey to both fin whales and *M. norvegica*[562].

The Faroe-Shetland Channel has been highlighted as an area with regular fin whale sightings and relatively high encounter rates during the summer[563]. Acoustic monitoring in the Channel took place over May, October and December 2000 and found vocalising fin whales to be widely distributed throughout the Faroe-Shetland Channel in October, particularly over the deep waters of the central Channel[564]. It has been suggested that in addition to being used for migration, high encounter rates during the summer feeding season for fin whales may mean it is an important feeding ground for this species[565]. The Faroe-Shetland Channel is a key area in the north east Atlantic for the copepod, *C. finmarchicus*[566]. *M.norvegica* is also known to be abundant in this region[567].

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544 95% CI 358-1419 estimate from most recent 2001 survey; Pike *et al*, 2009
545 Aguilar, 2002
546 Sears, 2002
547 Reid *et al*, 2003
548 Clapham, 2002
549 Reid *et al*, 2003; Charif and Clark, 2009
550 Reid *et al*, 2003; Pollock *et al*, 2000
551 Only vocalising whales will be detected.
552 Charif and Clark, 2009; Reid *et al*, 2003
553 Reid *et al*, 2003; Charif and Clark, 2009
554 Pollock *et al*, 2000; Evans *et al*, 2003
555 Evans *et al*, 2003
556 Reid *et al*, 2003; Evans, 1992
557 Evans, 1992; Pollock *et al*, 2000; Reid *et al*, 2003
558 Hammond *et al*,1995; Rosen *et al*, 2000
559 De Boer *et al*, 2004; De Boer and Saulino, 2007
560 Reid *et al*, 2003; Evans *et al*, 2003; Pollock *et al*, 2000; Skov *et al*, 1995; MacLeod *et al*, 2003; Stone, 2003; Stone, 2006
561 Evans, 1987 (in Pollock *et al*, 2000)
562 Evans *et al*, 2003 and references within
563 Evans *et al*, 2003; Reid *et al*, 2003; MacLeod *et al*, 2003; Stone, 2003; Stone, 2006
564 Swift *et al*, 2002
565 Evans *et al*, 2003; Swift *et al*, 2002; MacLeod *et al*, 2003
566 Heath and Jonasdottir, 1999
567 Lindley, 1977

Ten years of acoustic surveys in the Atlantic Frontier and west of Ireland have recorded fin whales in every month throughout the region, with highest detection densities for December and January[568]. It may be that they are most vocal during the winter months because this is the mating period[569]. Results from this long-term study do not provide evidence of large-scale seasonal migratory movements, although a lack of tracking data for individual fin whales makes this harder to determine[570].

Sei whale sightings are much less frequent than for fin whales but follow a similar general pattern with sightings recorded mainly between May and October, peaking in August[571]. They tend to be recorded further offshore than fin whales and other baleen whales[572]. Most records come from the deep waters between the Northern Isles and the Faroes and again, the Faroe-Shetland Channel has been highlighted as an area with clusters of sightings[573]. As discussed above, the Faroe-Shetland Channel is an important area for *C. finmarchicus*, which is a primary prey species for sei whales.

As with fin whales, this area may be a feeding ground for sei whales during the summer months[574]. Sei whales are thought to migrate south in the autumn, returning to the Atlantic Frontier in late spring[575].

The Rockall Trough, close to the continental slope, is a further area where sightings of fin and sei whales appear to be more frequent[576].

Blue whales are rarely seen in UK waters although acoustic monitoring indicates they are present throughout the year[577]. Detections of their calls peak in November and December[578] which coincides with their mating season[579]. Tracking of individuals during this time indicates they are travelling in a southward direction, most likely headed to their winter breeding grounds. Detection densities decline through the spring to their lowest levels from April to June, and increase again from mid-July. During April to June, few blue whales could be detected and they were distant, travelling west of the survey area. This suggests that the northward migration route is further westward, and that fewer blue whales may sing during the journey north[580].

Sightings of blue whales are few but have occurred in small numbers from May to September, mainly in the Faroe-Shetland Channel and the Rockall Trough[581]. Given the overlapping prey preferences of fin and blue whales for euphausiids, if the Faroe-Shetland Channel is a feeding ground for fin whales it may also be used by blue whales for the same purpose. During September 2008, sightings of mixed aggregations of blue and fin whales foraging for the euphausiid *M. norvegica* were reported further south on the slopes of the Irish Shelf[582].

Records of humpback whales in UK waters are rare, and most are made in the deep waters of the Atlantic Frontier, along or beyond the continental shelf[583]. However, sightings on the continental shelf around the Britain Isles have increased over recent years, with most records coming from the Northern Isles, the Celtic Sea, and the northern Irish Sea and Firth of Clyde[584]. Most sightings are made between May and September but some extend through the winter[585].

Acoustic detections of singing humpback whales have been made between October and April in the offshore waters to the west of the UK and Ireland[586]. Monitoring over several years has shown these animals are travelling in a southwesterly direction, probably headed for their breeding grounds in the tropics[587]. A corresponding northward migration in spring has not been detected which suggests they either do not sing or they follow a route further west when they return[588]. It is not clear currently whether the humpback whales detected are a subpopulation that is resident and feeds in UK waters, or if they are animals migrating through from feeding grounds further north[589].

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[568] Charif and Clark, 2009
[569] Boran *et al*, 2002 (in Reid *et al*, 2003)
[570] Charif and Clark, 2009
[571] Pollock *et al*, 2000; Reid *et al*, 2003; Evans *et al*, 2003
[572] Reid *et al*, 2003; Evans *et al*, 2003
[573] MacLeod *et al*, 2003; Reid *et al*, 2003; Pollock *et al*, 2003; Evans *et al*, 2003;
[574] MacLeod *et al*, 2003
[575] Pollock *et al*, 2000
[576] Reid *et al*, 2003; Evans *et al*, 2003; Pollock *et al*, 2000; Stone, 1998, 2003
[577] Charif and Clark, 2009
[578] *Ibid*
[579] Sears, 2002
[580] Charif and Clark, 2009
[581] Evans *et al*, 2003; Reid *et al*, 2003; Stone, 1997, 2003
[582] Wall *et al*, 2009
[583] Reid *et al*, 2003; Pollock *et al*, 2000; Stone, 2003, 2006
[584] Reid *et al*, 2003; Evans *et al*, 2003
[585] Reid *et al*, 2003; Pollock *et al*, 2000;
[586] Charif and Clark, 2009; Charif *et al*, 2001
[587] Charif *et al*, 2001
[588] Charif and Clark, 2009
[589] Charif *et al*, 2001

4.5 SCOTTISH MPA GUIDELINES – STAGE 1 GUIDELINES

Under the draft Scottish guidelines[590] for MPAs to be considered as a conservation tool, a species must meet at least one of the Stage 1 guidelines (see Section 2). Either it must be under threat, or determined to be a 'key feature' and of conservation value at a national or international level, which is likely to mean:

- Scotland is a stronghold,
- it is of exceptional scientific importance, or
- the species is considered characteristic of Scotland's marine environment[591].

Annex I provides a summary of the status of UK cetacean species and their inclusion on UK, regional and international conventions and lists. This information was used alongside the species accounts to consider how each species may meet the Stage 1 guidelines.

A different (and at the time of writing unknown) set of criteria will be used to determine which mobile marine species are priority marine features between 12-200nm. As it will reportedly consider many of the same status lists, such as OSPAR and UK BAP, we have considered both inshore and offshore species in the discussion below[592].

Harbour porpoise

An estimated 90% of the European population[593] of harbour porpoises is found in UK waters[594] making the UK an important stronghold for this species. The SCANS[595] surveys have shown large numbers of harbour porpoises are found in Scotland's waters and many particularly important sites can be found here. As the most abundant coastal cetacean in Scotland and the UK, it can be considered characteristic of Scotland's marine environment. In the North Sea, the harbour porpoise is considered under threat because of high bycatch levels and is included on OSPAR's list of threatened and/or declining species.

Bottlenose dolphin

An estimated 60% of Europe's bottlenose dolphins are found in UK waters[596] making the UK a stronghold for this species. Scotland's waters are of particular importance as they are home to the most northerly resident populations of bottlenose dolphins in the world. These populations, especially the Moray Firth bottlenose dolphins, support a significant marine tourism industry and would be widely considered characteristic of these areas. The west coast is home to the smallest known resident population, including just 15 animals that reside within the Sound of Barra.

Short-beaked common dolphin

An estimated 50% of the European population of common dolphins are found in UK waters[597]. This population is focused mainly in waters off south west England but appears to be increasingly more common in Scotland's waters. They are commonly seen off the west coast of Scotland and could be considered characteristic of here at least. The status of this species in UK waters is unknown but in some areas, where observers occur on vessels or where strandings data exist, they are known to suffer high bycatch levels.

Common minke whale

An estimated 60% of Europe's minke whales are found in UK waters[598] and the waters of Scotland and north east England are the most important in the UK for this species. This is the largest cetacean species regularly seen off the coast and can be considered characteristic of Scotland's coastal waters. Given the apparent importance of sites on Scotland's east and west coasts for minke whales, Scottish waters are likely a stronghold for minke whales.

White-beaked dolphin

An estimated 80% of the European population of white-beaked dolphins are found in UK waters[599]. These animals have a predominantly northern distribution so most of this 80% will be located in the waters off Scotland and north east England. Scotland's waters are an important stronghold for this species. Although less well known by the general public, they should be considered characteristic of Scotland's marine environment.

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590 Marine Scotland, 2010
591 Defined as distinctive and/or representative.
592 All species included in this report and on the Scottish biodiversity list were considered.
593 Europe refers to the whole of Europe rather than just the EU.
594 UKBAP, 2008
595 Hammond *et al*, 2002; SCANS II, 2006
596 UKBAP, 2008
597 *Ibid*
598 *Ibid*
599 *Ibid*

Risso's dolphin

An estimated 86% of Europe's Risso's dolphins are found in UK waters[600] making it an important stronghold for this species. The most important identified location in Europe for Risso's dolphins is the north east Isle of Lewis (Outer Hebrides, west Scotland) where, unusually for this normally pelagic species, they are found close to shore and use these waters to feed and calve. They are a distinctive feature of this area and given this is a poorly-known species, of importance to science. Their status is unknown in UK waters[601].

Killer whale

An estimated 35% of the European population of killer whales is found in UK waters[602] and within the UK, Scotland's waters are the most important. As in other parts of the world, north east Atlantic killer whales appear to be made up of several ecologically different populations[603]. Some of these are specialised and in one case, very small populations regularly use Scottish waters, so these areas will be an important stronghold for these animals. Only ten individuals have been identified in the killer whale community in the Hebrides since 1992[604]. In the Northern Isles where they are seen more regularly, they could be considered a distinctive characteristic of the area. Their status globally and in UK waters is unknown[605].

Atlantic white-sided dolphin

An estimated 81% of Europe's Atlantic white-sided dolphin population is found in UK waters[606]. This species is predominantly found in northern waters so most of these animals will be in the waters off Scotland, particularly to the north and west. Scotland's waters are therefore a stronghold for Atlantic white-sided dolphins. As one of the most abundant species in the offshore environment, they can be considered characteristic of these deeper waters. Their status is unknown in UK waters[607].

Long-finned pilot whale

An estimated 88% of the European population of long-finned pilot whales is found in UK waters[608]. This species is predominantly found in the deep offshore waters off north and west Scotland so these animals will mainly be in Scottish waters. Scotland's waters are therefore a stronghold for this species. As another of the most abundant species in the offshore environment, they can be considered characteristic of these deeper waters. Their status globally and in UK waters is unknown[609].

Sperm whale

Less than 30% of Europe's sperm whales are estimated to be found in UK waters[610] but as a deep water species, these animals will mostly be found in the waters off north and west Scotland. This species is classified as 'Vulnerable'[611] due to the past effects of whaling, which increases the importance of any areas of habitat.

Cuvier's beaked whale

An estimated 75% of the European population of Cuvier's beaked whales is found in UK waters, although this is based on limited sightings and information. A recent survey conducted in the waters offshore west Scotland indicated that the beaked whale species found here were predominantly northern bottlenose whales and Sowerby's beaked whales[612]. Overall though, there is insufficient information on distribution or status for this species to determine if it meets the guidelines.

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600 UKBAP, 2008
601 JNCC, 2007
602 UKBAP, 2008
603 Foote *et al*, 2009; Foote *et al*, 2010
604 Foote *et al*, 2010
605 JNCC, 2007; IUCN, 2010
606 UKBAP, 2008
607 JNCC, 2007
608 *Ibid*
609 JNCC, 2007; IUCN, 2010
610 *Ibid*
611 IUCN, 2010
612 CODA, 2009

Northern bottlenose whale and Sowerby's beaked whale

35% of Europe's northern bottlenose whales and less than 30% of Sowerby's beaked whales are estimated to be found in UK waters. As a deep water species however, these will mostly be found in the waters off north and west Scotland. These offshore waters may be more significant than the estimates suggest. A recent survey in this area found it to be a high density area for beaked whales[613] and a study looking at worldwide beaked whale sightings highlighted it as a key area globally for beaked whales[614]. The status of these species in the UK and globally is unknown.[615]

True's beaked whale

Less than 30% of the European population of True's beaked whales is estimated to be found in UK waters[616] but sightings are so few everywhere for this species it is difficult to know how important the area really is. Their status in the UK and globally is unknown[617].

Blue whale, fin whale and sei whale

An estimated 37%, 25% and 53% respectively of European populations of these species are found in UK waters. Again, as these are predominantly deep-water species, the majority would be expected to be found in the waters off north and west Scotland. Sightings are few but acoustic surveys frequently detect their calls. These species are all classified as 'Endangered'[618] due to the past effects of whaling and this increases the importance of any areas of habitat. If allowed to recover their numbers, they may one day be considered characteristic of Scotland's offshore marine environment.

Humpback whale

An estimated 50% of the European population of humpback whales is found in UK waters and will mostly be in the deep waters off north and west Scotland. Although recently re-classified from 'Vulnerable' to 'Least Concern', in some parts of the world populations of the species remain endangered. Sightings are still relatively infrequent but acoustic surveys indicate the species is present in greater numbers. If allowed to complete its recovery, the humpback whale may become characteristic of Scotland's offshore waters.

False killer whale

Very few sightings of this species are made in UK waters. Their status globally and in UK waters is unknown[619].

North Atlantic right whale

At one time this species may have been characteristic to Scotland's waters but due to the effects of whaling they are among the rarest whale species in the eastern North Atlantic and number just a few animals.

[613] CODA, 2009
[614] MacLeod and Mitchell, 2006
[615] IUCN, 2010
[616] UKBAP, 2008
[617] IUCN, 2010
[618] *Ibid*
[619] *Ibid*

5. THREATS TO CETACEANS AND USE OF MPAS AS A CONSERVATION TOOL

Numerous human activities are known or suspected to impact cetaceans in UK waters[620]. Considering where and how these impacts occur is an important component in determining how critical an area is to a cetacean population, and also whether an MPA would be an effective way of reducing the level of threat.

Section 5.1 considers the primary threats to cetaceans and the potential of an MPA to reduce impacts from these threats. Section 5.2[621] provides a brief summary of known and potential threats to cetaceans for each region of the UK and can be considered alongside the information presented in the species accounts of the previous section when determining how critical an area is for a cetacean population.

5.1 CAPABILITY OF MPAS TO ADDRESS THREATS TO CETACEANS

One potential reason for establishing an MPA is to reduce or eliminate impacts to marine species from human activities through the enactment of management measures within or in the vicinity of the MPA. An MPA will usually be one of a range of tools that could be used to address threats and determining which of these will be the most effective option, alone or in combination, will require consideration of the specific circumstances.

The capability of an MPA to address impacts depends in large part on whether the source or location of impact can be spatially defined and is considered in Table 5.1 below[622].

Table 5.1 **The capability of MPAs to address potential threats to cetacean populations**

Threat	Capability of MPAs to address potential threats		
	LOW	MODERATE	GOOD
Fisheries bycatch			✓
Collision with vessel			✓
Acoustic and physical disturbance, injury and mortality			✓
Prey depletion	✓	✓	
Habitat loss or degradation	✓	✓	
Chemical pollution	✓	✓	
Non-native species	✓		
Marine litter	✓		
Climate change	✓		
Cumulative and in-combination impacts			✓

LOW – The activity is difficult to define spatially and associate with a particular location. Its sources are dispersed and therefore spatial protection of an area is unlikely to prevent impacts to cetaceans.

MODERATE – In certain situations it will be possible to identify a point source for the threat, and spatial protection measures could help to reduce impact but not in all occasions.

GOOD – Provided sufficient information is available, the source of the threat can be identified and spatially defined. An MPA could potentially be used to manage the activity and prevent impact.

Even though an MPA may have a limited capability of averting direct impact from certain threats, cetaceans will still benefit from any improvements in ecosystem health and integrity experienced as a result of spatial protection to an area. Effective ecosystem management, as part of an MPA management plan, can improve the prospects for dealing with threats within an MPA. Also, MPA networks can improve effectiveness in dealing with widespread, longer-term threats such as climate change.

620 See for example, Parsons *et al*, 2010; Ross and Isaac, 2004; Shrimpton and Parsons, 2000
621 See also accompanying Annex III
622 Ratings based on a consideration of threats and how cetaceans are impacted. See also Notarbartolo di Sciara, 2008a; Notarbartolo di Sciara *et al*, 2008b; Wallace and Boyd, 2000; Reeves, 2002; Weilgart, 2006

Fisheries Bycatch

Fisheries bycatch (becoming entangled or caught in a live or ghost net or other gear) can result in suffering, serious injury and death of individuals, and in some areas, decreasing populations of cetaceans. Understanding the extent of fisheries impacts is challenging because often strandings data are the only evidence that exists to demonstrate impacts, and this can be just the tip of the iceberg – an indication of a much larger level of impact occurring at sea. Fisheries bycatch is documented to be the greatest single threat to cetaceans, with an estimated 300,000 or more animals being killed annually[623].

Capability of an MPA to address impact: Good
Fisheries bycatch can be addressed if an MPA management body and plan are able to restrict or change the fishing effort, location, time and/or gear type. For this to be a successful option, fishing effort cannot simply be displaced outside the boundaries of the MPA which could result in more intensive fishing pressure and increased bycatch in the waters adjacent to the MPA.

Collisions with Vessels

All sizes and types of vessels have been documented to hit cetaceans. Population level impacts appear greatest for small coastal populations of large whales and dolphins and can be a significant cause of mortality. Impacts vary widely depending on the species and the region. Most lethal or severe injuries of large whales are caused by ships travelling at speeds in excess of 10 knots. Research has shown that travelling at slower speeds doesn't substantially decrease the actual risk of striking a whale[624] but travelling at speeds of less than 10 knots does increase the survival chances of the whale that has been hit[625]. Highly impacted populations are those with ranges that overlap with areas of high shipping traffic or recreational water users[626].

Capability of an MPA to address impact: Good
Collisions with vessels can be regulated primarily by diverting vessel traffic away from sensitive areas as well as imposing speed restrictions and other monitoring and alerting systems.

Acoustic and physical disturbance, injury and mortality

Disturbance is generally considered a significant change in pattern of normal behaviour as a result of human activity. Behavioural change can occur as a result of disturbance, either by noise pollution or the physical presence of an activity, such as pile-driving (for coastal development, including marine renewable energy) or vessels, ranging from shipping traffic and recreational jet skis, but also including commercial boat-based cetacean watching activities. Behavioural changes have led to population level effects, where decreased reproductive success was recorded in bottlenose dolphins exposed to cumulative boat traffic[627].

Anthropogenic marine noise pollution comes from vessels, military activities, industrial developments (including oil and gas; marine renewable energy; ports and harbours), dredging and fisheries anti-predation devices. Documented impacts range from physiological (such as chronic stress) and behavioural to physical injury and death[628].

Capability of an MPA to address impact: Good
Acoustic and physical disturbance can by addressed by excluding or restricting physically disturbing or noise-making activities or imposing management measures such as vessel speed restrictions or mitigation measures, where these are shown to be effective. Note that sound travels much faster and farther underwater than in air, so that much larger MPAs or acoustic buffer zones may be necessary to reduce ensonification[629].

[623] Read *et al*, 2006
[624] Pace and Silber, 2005
[625] Vanderlaan and Taggart, 2007
[626] For more information see Laist *et al*, 2001
[627] For more information see Parsons *et al*, 2010; Bejder *et al*, 2006
[628] For more information see WDCS, 2004; Weilgart, 2007
[629] Agardy *et al*, 2007

Prey depletion

Prey depletion leads to changes in composition of marine prey species. 52% of the oceans' wild fish stocks are fully-exploited, 24% are depleted and only 23% are under or moderately exploited[630]. This widespread overfishing may result in shifts in distributions of cetaceans or changes to alternative prey sources.

Capability of an MPA to address impact: Low to Moderate
Localised causes of prey depletion can be addressed by restricting fishing effort. In studies of 'no take' MPAs or MPA zones, there is substantial evidence of spillover effects with increased biomass but there has been criticism of the quality of the research[631]. However, a good recent long-range study of lobsters in the Columbretes Islands Marine Reserve, for example, documented that harvested spillover offset the loss of yield resulting from the reduction of the fishing grounds set aside, producing a mean annual net benefit of 10% of the catch in weight[632].

Habitat loss or degradation

Habitat loss and degradation can occur due to fisheries activities, such as aquaculture or bottom trawling, or coastal and offshore development, including dredging, rebuilding harbours and the installation of offshore structures. Inland development that results in material washing downriver, such as clearing forests, can also result in degradation of the marine environment. Loss or degradation of marine habitats can happen suddenly or over an extended period as a consequence of land-use changes.

Capability of an MPA to address impact: Low to Moderate
If destructive activities can be regulated then prospects are good that an MPA can address the impact. When habitat degradation happens due to activities outside the MPA, other methods of regulation are needed, including marine spatial planning.

Chemical pollution

Domestic sewage, industrial discharges, agricultural run-off, accidents and spills at sea and operational discharges from oil rigs are some of the sources of chemical pollution. Eutrophication and contamination is the result, usually around populated areas. Of particular concern are the persistent organic pollutants (POPs) that accumulate and can lead to damage to reproductive and immune systems of cetaceans and other animals.

Capability of an MPA to address impact: Low to Moderate
Non-point sources can be difficult to address. MPAs have the potential to be successful if the MPA management body on its own or coordinating with other agencies has the power to eliminate or control point sources of toxic substances such as sewage outfalls, vessels and fish farms.

Cumulative and in-combination impacts

Cetaceans are often adversely affected not by individual threats identified in this report, but by a combination of them. Instead of managing human activities sectorally, the MPA management body can consider cumulative impacts to ensure the maintenance of a sustainable and functioning ecosystem and its component species, habitats and processes.

Capability of an MPA to address impact: Good
As part of a wider marine planning process, MPAs can be used to reduce the impacts from cumulative activities.

MPAs can only provide part of a solution to protect and restore marine species and habitats. They may be less effective in addressing widespread and non-point impacts such as climate change, the introduction of non-native species and most sources of toxic pollution. However, by reducing the impacts of multiple other stressors, ecosystems can be made more resilient and are better able to withstand the effects of climate change and other widespread impacts[633]. Other methods and strategies are required to reduce these widespread impacts such as MPA networks, marine spatial planning with ocean zoning, and large scale ecosystem-based management.

The impacts of climate change may be particularly important for those species at the edge of their northerly or southerly range in UK waters such as white-beaked dolphins, short-beaked common dolphins and bottlenose dolphins, as well as for endangered species such as blue, fin or sei whales. These impacts should be considered in MPA management plans, but will also need to be considered as a component of wider integrated ocean management.

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[630] FAO, 2005
[631] Stewart *et al*, 2008
[632] Goñi *et al*, 2010
[633] Game *et al*, 2009

5.2 AN OVERVIEW OF REGIONAL THREATS

A brief summary of the threats to cetaceans specific to each region around the UK is provided below, outlining where specific threats are known or suspected, and also the overall level of human activity in the area (see also Annex III). Figure 5.1 (below) shows the location of some of the key human uses of the UK marine area[634]. Due to the challenges and expense of collecting spatially explicit and detailed information on threats to cetaceans, this type of spatial data is rarely available. On the whole, our knowledge is patchy and incomplete, often based on post-mortems of stranded animals.

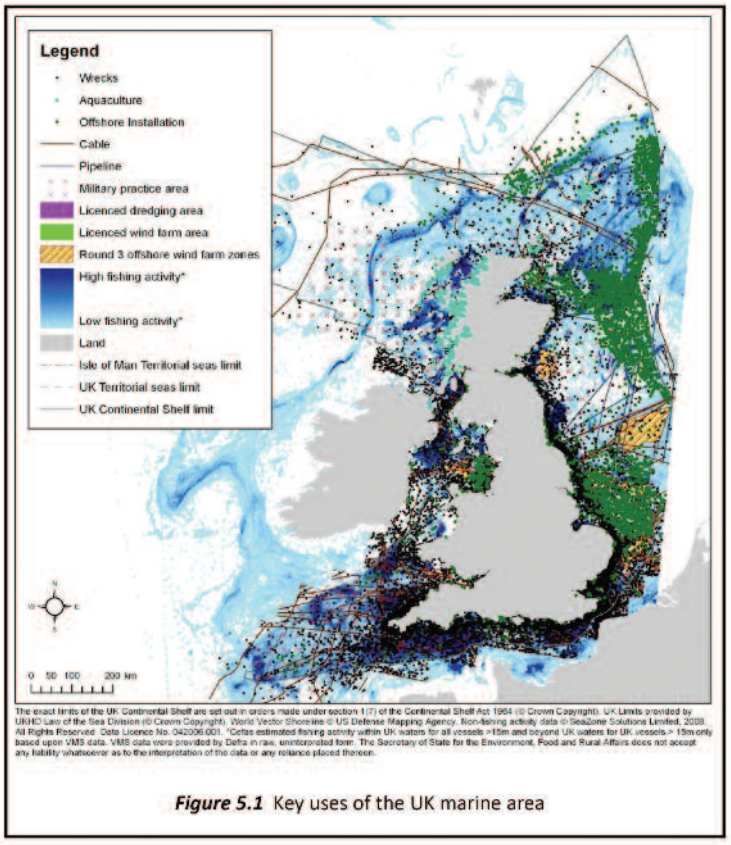

Figure 5.1 Key uses of the UK marine area

Determining the possible cumulative impacts from multiple activities is also difficult, as is assessing the level of impact in areas with little or no information. The results of a recent modelling study that incorporated data from multiple human uses[635] to estimate impacts to marine ecosystems were used to provide an indication of cumulative impact for each region. The model results are displayed in Figures 5.2 (below) and 5.3[636] (p.70). Noise pollution, a significant threat to cetaceans, was not included as an individual input to this model and so needs to be considered separately[637].

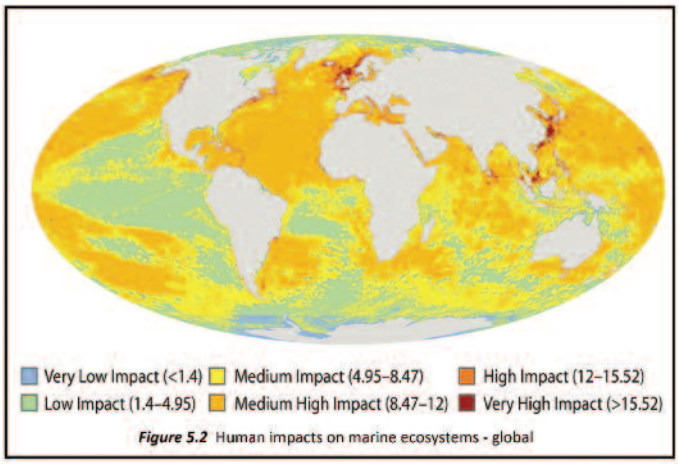

Figure 5.2 Human impacts on marine ecosystems - global

[634] From Defra, 2009b, reproduced under the terms of the Click-Use Licence
[635] Data layers included in the study: Nutrients, organic pollutants, inorganic pollutants, direct human (population density), fisheries (demersal, pelagic and artisanal, high and low bycatch), oil rigs, invasive species, ocean pollution, shipping, Sea Surface Temperature (SST), UV light, and ocean acidification.
[636] Reproduced with permission, Halpern *et al*, 2008
[637] Halpern *et al*, 2008

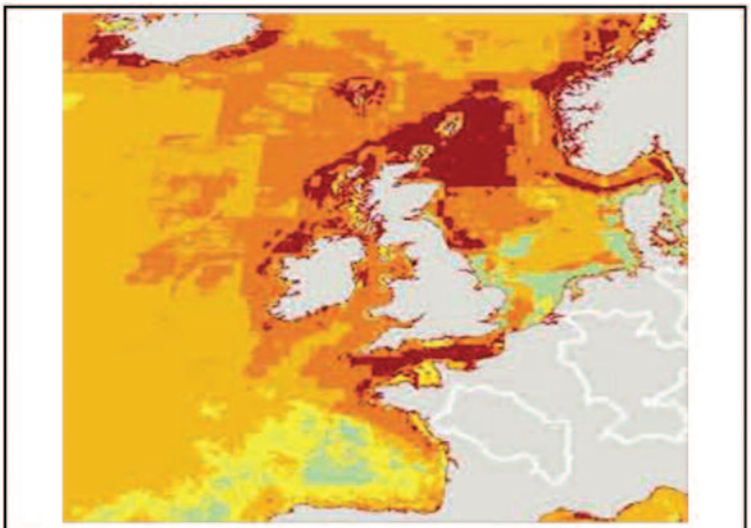

Figure 5.3 Human impacts on marine ecosystems - UK

It is important to note when reading this section that no evidence of impact does not mean there is no impact. Without in-depth knowledge of a population at a level rarely obtained for cetaceans, it is difficult to ascertain when changes occur in abundance, distribution or health – or more generally, population trends. Subtle impacts such as stress or reduction in immune or reproductive health are particularly hard to detect and teasing out clear cause and effect relationships from the complicated web of interactions that exist in the real world presents enormous challenges that are now just being recognised for cetaceans[638].

SCOTLAND

West and south west Scotland

As with each of the regions, threats to cetaceans in the west and south west of Scotland that can be partly addressed using MPAs come from various human activities. In territorial waters, these include military activities occurring on the west coast offshore exercise range, oil and gas exploration and production, widespread fisheries and extensive coastal aquaculture. Bycatch has been reported in the region for several species. With lower human population than other regions, overall the coastal region is not subject to such high levels of development and vessel traffic, although development is moderate in places. Recreational use is high along much of the coast and the area supports a significant marine ecotourism industry. Marine renewable energy (wind, wave and tidal) is likely to be important off the west coast in future years, with unknown consequences at present. In offshore waters it is difficult to assess the possible level of impact given the lack of data. In this region, the combined impacts of physical and acoustic disturbance or injury from shipping, industry (such as oil and gas exploration) and the military are probably of most concern. Data on cetacean prey species and predator-prey dynamics are lacking but the data suggest declines in sandeel populations may be impacting cetacean species, although to what degree is unknown. Cumulative human impacts on the marine environment in this area are thought to range from medium to very high[639].

Far west Scotland

Information on threats in this region is lacking. Military exercises take place here and the area has been subject to considerable seismic surveying due to interest in exploiting oil and gas resources. Vessel traffic is at a relatively low density. Fishing using net types and methods with higher risk of cetacean bycatch occurs in the area (gill nets and long soak times) but the level of impact is unknown. Deepwater fisheries have expanded in recent years in the region. Cumulative human impacts on the marine environment in this region are considered to be medium-high or high[640].

[638] See for example, Wright *et al*, 2007; Lusseau and Bejder, 2007; Williams *et al*, 2006
[639] Halpern *et al*, 2008 (see Figure 5.3)
[640] Halpern *et al*, 2008 (see Figure 5.3)

North Scotland

As in the west, threats to cetaceans in the north of Scotland that could be partly addressed using MPAs come from various human activities. These include military activities (e.g. Cape Wrath), large-scale oil and gas exploration and production, widespread fisheries and extensive coastal aquaculture. With lower human population than other regions, overall the coastal region is not subjected to such high levels of development and vessel traffic, although development is moderate in places. The oil terminal at Scapa Flow means high levels of tanker traffic. Marine renewable energy, especially wave and tidal in the Pentland Firth, is expected to expand rapidly in future years, with unknown consequences at present. In offshore waters it is difficult to assess the possible level of impact given the lack of data. In this region, the combined impacts of physical and acoustic disturbance or injury from shipping, industry (such as oil and gas exploration) and the military are probably of most concern. Data on cetacean prey species and predator-prey dynamics are lacking but the data suggest declines in sandeel populations may be impacting cetacean species, although to what degree is unknown. Cumulative human impacts on the marine environment are estimated to be very high throughout most of this region[641].

East Scotland

Threats to cetaceans in the east of Scotland that could be partly addressed using MPAs include large-scale oil and gas exploration and production in the North Sea as well as bycatch from widespread fisheries. There are also several large ports in the region. Development in the coastal region is moderate and significant in the Firths with associated recreational and commercial marine wildlife watching activities. Marine renewable energy, especially marine wind farms, is expected to expand rapidly in future years, with considerable noise from pile-driving and unknown long-term consequences. Disturbance incidences of cetaceans by fast-moving recreational vessels occur, with one prosecution in the Moray Firth and another case currently underway in Aberdeen. In parts of this region, the combined impacts of physical and acoustic disturbance or injury from shipping and industry, such as oil and gas exploration and development of marinas and harbours, are of most concern. Data on cetacean prey species and predator-prey dynamics are lacking but the North Sea is heavily fished, sometimes at unsustainable levels. Cumulative human impacts to the marine environment in this region are estimated to range from medium-high to very high[642].

ENGLAND

East England

The North Sea is the site of intensive human activity including shipping, oil and gas, considerable coastal development, recreational vessels around beach resorts (especially in summer months) and marine wind farms and fisheries, all of which can be addressed using MPAs. Bycatch is thought to be the primary cause of marine mammal mortalities in the North Sea and numbers of harbour porpoise deaths are particularly high. The cumulative impact of these activities is poorly understood. Data on cetacean prey species and predator-prey dynamics are lacking but the North Sea is heavily fished, sometimes at unsustainable levels. The level of impact on cetaceans is unknown. Cumulative human impacts to the marine environment in this region are estimated to range from low in some places to very high in others[643].

South east England

The North Sea is the site of intensive human activity including shipping (where the Straits of Dover represent one of the busiest waterways in the world), oil and gas, considerable coastal development, recreational vessels around beach resorts (especially in summer months), marine wind farms and fisheries, all of which can be addressed using MPAs. Bycatch is thought to be the primary cause of marine mammal mortalities in the North Sea and numbers of harbour porpoise deaths are particularly high. The North Sea is subject to high levels of fishing, sometimes at unsustainable levels. Overall, data on cetacean prey species and predator-prey dynamics are unavailable. Cumulative human impacts to the marine environment are estimated to range from medium to very high[644].

[641] Halpern *et al*, 2008 (see Figure 5.3)
[642] Halpern *et al*, 2008 (see Figure 5.3)
[643] Halpern *et al*, 2008 (see Figure 5.3)
[644] Halpern *et al*, 2008 (see Figure 5.3)

South west England

The south west offshore exercise area is used heavily and routinely for military exercises. In addition, shipping occurs, with moderate amounts of vessel traffic to and from the Bristol Channel due to large ports in this area. There is patchy development along the coast and high levels of recreational vessel activity in many places, peaking during the summer months. A tidal renewable device is in operation. Impacts from bycatch, particularly cumulative impacts from multiple fisheries, are a serious concern in this region, particularly for harbour porpoises and short-beaked common dolphins. Cumulative human impacts from human activities to the marine environment are estimated to be medium-high to very high[645].

Irish Sea

Liverpool Bay is an area with high levels of human activity including oil and gas production, operational marine wind farms (and more under construction), coastal development and several large ports. Moderate levels of vessel traffic transit the Irish Sea, including oil tankers. Impacts are possible from chronic inputs of hydrocarbon from oil and gas production and transportation, along with land-based sources. Fishing using net types with higher risk of cetacean bycatch occurs in the area (gill and tangle nets) but the level of impact is unknown. Cumulative human impacts to the marine environment from human activities are estimated to be high throughout most of the region[646].

WALES

Some shipping and military activities occur in Welsh waters. Liverpool Bay is a major site for oil and gas production and several wind farms are in operation or under construction in the eastern Irish Sea. Scallop dredging has a severe impact on important marine habitats and has recently been banned from parts of Cardigan Bay. Bycatch is reported, including from tangle nets set for demersal fish. Recreational use has increased in recent years and is now moderate to high along much of the coast. The area also supports a significant marine ecotourism industry. Cumulative human impacts to the marine environment from human activities are estimated to be high throughout most of the region[647].

5.2.1 CONSIDERATION OF NOISE POLLUTION AS A THREAT INDIVIDUALLY AND CUMULATIVELY

Noise pollution is not included as an individual data layer in the cumulative human impacts model used to make the summary assessments for each region[648]. Thus, several significant noise producing activities are not currently incorporated into the cumulative impact assessment and need to be considered additionally (e.g. military activities, seismic surveys, AHDs/ADDs[649]). Noise pollution is a significant consideration in its own right, as well as when considering the level of cumulative human impacts for each region.

[645] Halpern *et al*, 2008 (see Figure 5.3)
[646] Halpern *et al*, 2008 (see Figure 5.3)
[647] Halpern *et al*, 2008 (see Figure 5.3)
[648] Halpern *et al*, 2008 and Figures 5.2 and 5.3
[649] Acoustic Harassment Devices and Acoustic Deterrent Devices, used by aquaculture operations and fisheries

6. IDENTIFYING CRITICAL HABITAT IN UK WATERS

Using the information presented in the species accounts, an assessment was made as to whether critical habitat could be identified for each cetacean species. The definition of critical habitat used as the basis of this assessment was:

> Those parts of a cetacean species' range that are essential for day-to-day well-being and survival, as well as for maintaining a healthy population growth rate. Areas that are regularly used for feeding, breeding, raising calves and socialising, as well as, sometimes, migrating, are the key components of critical habitat[650].

Using this core part of the critical habitat definition, our assessment of the types and quality of data available for UK cetaceans, and taking into account the work completed in other fora defining and developing the critical habitat approach (see Section 3.1), the following criteria were developed to assist in the identification of critical habitat:

1. Concentrations of animals suggest the presence of critical habitat, but are not enough to determine whether an area is critical habitat and thus must be supported with further evidence of importance.

2. There must be evidence of the area being used for important life processes – feeding, breeding, raising calves and socialising. In some situations, areas used for migration and related rest areas may be determined to be critical habitat. An example is where migration occurs through an area of limited geographic extent (a 'bottleneck').

3. The confidence with which one can identify critical habitat is connected to the quality and quantity of the data available. To have the highest level of confidence, there must be recent data (less than 10 years old) from more than one year, and with evidence of use by high numbers of animals based on an absolute density estimate.

A scoring system was developed from these criteria to assess each area that came through the information review as potentially important.

For an assessment of cetacean critical habitat to be considered complete, it should also incorporate data on important areas for prey species[651]. However, this information is not readily available and a full review was beyond the scope of this project. **Future work could usefully look at incorporating important areas for prey species, recognising that areas important for prey often extend beyond cetacean feeding areas and might require extensions to MPAs or MPA networks and/or other protection measures**.

Following the identification of critical habitat, the level of threat to cetaceans in the area was also considered. The existence or strong suspicion that a threat(s) is impacting a population in an area of critical habitat increases how critical that location is determined to be. There is little spatially explicit threat information available which makes it difficult to incorporate a consideration of the level of threat in each specific area. For the analyses that follow, those threats known or strongly suspected to impact a cetacean population in an area are identified. Using the information in Section 5.2, possible cumulative impacts based on the level of human activity in the area are also considered.

Finally, the status of the species or population and the relative importance of UK waters, or a particular region, are considered if this information is known[652]. A poor or declining conservation status or high relative importance of an area would increase how critical an area is considered to be.

Please note that although the critical habitat scoring system does not include a consideration of data on prey species, the level of threats, and the status of the species or population and its importance within UK or regional waters, it is clear that these aspects are relevant to, and may figure in, management decisions regarding MPAs.

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[650] Adapted from Hoyt, 2005a (2nd edition in prep. for 2011)
[651] *Ibid*
[652] See also Annex I and Section 4.5

6.1 SCORING

Concentrations of animals	
High absolute density estimate	3
High relative density estimate	2
Known, small, nearshore populations* or a concentration of sightings**	2
Sub-total	Up to 3
Critical life processes	
Good evidence of importance	4
Moderate evidence of importance	3
Some evidence of importance	2
Sub-total	Up to 4
Data indicating importance are more than 10 years old with more recent evidence of a decline in numbers or use	-1
Total	Up to 7

* This score was applied to those populations of cetaceans that are known to be small so would not meet the high density criteria but should still be considered a concentration of animals. These populations are the bottlenose dolphins of the west coast of Scotland and the Hebridean killer whales.

** Only applicable to species that usually do not occur in sufficient numbers for relative or absolute density estimates to be calculated, e.g. killer whales, baleen whales and beaked whales.

A total score of at least **6** is required for an area to be designated **critical habitat**.

A total score of **4** or **5** suggests that the area is important to a species but there is too little information to conclude with confidence that it is critical habitat. These areas are designated **areas of interest** which means there is some evidence of importance for critical life processes and/or for concentrations of animals and they should be investigated further.

For details on the evidence used to score each area, readers are referred to the relevant species account and tables in Annex II.

Boundaries

Decisions on the location of the boundaries for critical habitat and areas of interest were not straightforward. Important areas for cetaceans are not usually focused on a 'feature' around which a boundary can be simply drawn. Ocean depth and slope may give broad indications for certain species but the precise physical or biological conditions that make an area important are usually not fully understood so hard boundaries cannot be delineated. The boundaries presented on the following maps represent an assessment of where studies reported areas of high density and the observed locations of important life processes. Thus to a degree, the exact placement of lines represents a judgement made by the authors and in reality the boundaries will not be a solid line between critical habitat to non, but will instead be a gradation from one area to the next. The boundaries are also influenced by the coverage of the relevant studies. For example, due to cost and logistical factors, most studies remain within a certain distance of the coast which contributes to a certain coastal bias for selection of areas. In some cases, close to shore as well as offshore, the lines drawn may be more representative of survey boundaries than critical habitat boundaries. With further research focused on areas identified as important, these boundaries can be defined with more precision.

Incomplete data

It is important to stress that information is often patchy and in some areas severely lacking. In an ideal world, assessments such as these would be undertaken using datasets that when combined provide complete and even coverage throughout the survey area. This level of information will not be available for many years, if ever, and decisions must be taken in the meantime using the data that are available. The results from this project will invariably be biased towards areas where we have information. **Areas not identified as 'critical habitat' or 'areas of interest' are not necessarily unimportant, there may just be little or no information available at present with which to make an assessment**. This particularly applies to offshore areas.

6.1.1 HARBOUR PORPOISE

West and south west Scotland

1. Area: The Inner Hebrides, The Minches and the Sea of the Hebrides (see Figure 6.1, p.81)
Time of year: All year

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Good evidence of importance	4
Total	7

Assessment: Critical Habitat
High absolute density estimates have been produced for all and part of the area. Observations of foraging activity and the presence of young calves have been noted by numerous surveys throughout the area. Spatial modelling of abundance data indicates that within this area there are locations of particularly high use.

2. Area: The Firth of Clyde (see Figure 6.2, p.81)
Time of year: At least summer

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Some evidence of importance	2
Total	5

Assessment: Area of Interest
High absolute density estimates have been produced for this area. Few data exist on importance for critical life processes but high density estimates have been recorded for the summer, the season when harbour porpoises breed and calve.

Threats, status and relative importance of the area (west and south west Scotland)
Specific information on the impacts of human activities on harbour porpoises in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic, military activities and aquaculture operations. Cumulative human impacts are likely to be high in much of this region[653], increasing the need to provide adequate protection to identified areas of critical habitat. There have been no documented declines in conservation status for harbour porpoises. Within Europe, UK waters are of particular importance to harbour porpoises and long-term evidence shows that this area is one of the most important in the UK. This, combined with the potential threat level, increases the importance of identified critical habitat.

[653] Halpern *et al*, 2008

North Scotland

3. Area: North of the Scottish mainland (see Figure 6.2, p.81)
Time of year: At least summer

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Some evidence of importance	2
Total	5

Assessment: Area of Interest
High absolute density estimates have been produced for this area. Few data exist on importance for critical life processes but the high density estimates were both recorded during the summer, the season when harbour porpoises breed and calve.

4. Area: South and east coasts of Shetland (see Figure 6.2, p.81)
Time of year: All of the year

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Moderate evidence of importance	3
Data indicating importance are more than 10 years old with more recent evidence of a decline in numbers or use	-1
Total	5

Assessment: Area of Interest
Data from the 1990s on abundance and habitat use indicate this area's importance for harbour porpoise but more recent information suggests fewer animals are present in the area now. The reasons for the apparent change are not yet understood.

Threats, status and relative importance of the area (north Scotland)
Specific information on the impacts of human activities on harbour porpoises in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and oil and gas production and exploration. The level of human use means impacts are potentially very high for much of the on-shelf region, and high further offshore[654]. Large-scale surveys have reported high densities for this region compared to other regions of the UK, indicating its relative importance. However, there have been observed declines in harbour porpoise sightings around Shetland in recent years which may be linked to reduced prey availability.

East Scotland

5. Area: South coast, Outer Moray Firth (see Figure 6.1, p.81)
Time of year: At least summer

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Good evidence of importance	4
Total	6

[654] Halpern *et al*, 2008

Assessment: Critical Habitat
High relative densities have been recorded for this area. Importance for breeding and calving is suggested by the regular presence of mothers and calves during the summer months.

6. Area: Moray Firth north coast (in the region of Helmsdale) (see Figure 6.2, p.81)
Time of year: At least summer

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Some evidence of importance	2
Total	4

Assessment: Area of Interest
High relative densities have been reported for this area and its importance for breeding and calving has been suggested due to high ratios of young animals.

7. Area: Offshore Outer Moray Firth (see Figure 6.2, p.81)
Time of year: All year

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Some evidence of importance	2
Total	4

Assessment: Area of Interest
High relative densities have been recorded for this area. Few data exist on importance for critical life processes but high relative densities have been recorded throughout the summer, the season when harbour porpoises breed and calve.

Threats, status and relative importance of the area (east Scotland)
The levels of fisheries bycatch of harbour porpoises in the North Sea are high and of concern. Other specific information on the impacts of human activities on harbour porpoises in this region is lacking but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and oil and gas production and exploration. The overall level of human use in much of the region means impacts from all activities combined are potentially very high[655]. This level of threat increases the importance of critical habitat identified for the region. There have been no documented declines in conservation status for harbour porpoises in this area. Within Europe, the UK's waters are of particular importance to harbour porpoises. Large-scale surveys have shown that at least in some years this region has high densities of porpoises and is relatively important compared to other areas.

[655] Halpern *et al*, 2008

East England

8. Area: Dogger Bank (see Figure 6.2, p.81)
Time of year: At least summer

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Some evidence of importance	2
Total	5

Assessment: Area of Interest
High absolute density estimates were recorded for this area and some data exist on use of the area for foraging.

9. Area: East of the Wash (Norfolk) (see Figure 6.2, p.81)
Time of year: At least summer

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Some evidence of importance	2
Total	4

Assessment: Area of Interest
High relative densities have been recorded for this area. Few data exist on importance for critical life processes but high relative densities have been recorded throughout the summer, the season when harbour porpoises breed and calve.

Threats, status and relative importance of the area (east England)
Levels of fisheries bycatch of harbour porpoises in the North Sea are high and of serious concern. Other specific information on the impacts of human activities on harbour porpoises in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and oil and gas production and exploration. Human use and impacts in the region range from moderate to very high[656]. There have been no documented declines in conservation status for harbour porpoises in this area. Within Europe, the UK's waters are of particular importance to harbour porpoises. Large scale surveys have shown that at least in some years this region has high densities of porpoises and is relatively important compared to other areas.

South west England

10. Area: North Devon (see Figure 6.2, p.81)
Time of year: All year

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Some evidence of importance	2
Total	5

Assessment: Area of Interest
High absolute density has been recorded for this area. Few data exist on importance for critical life processes but at least parts of the area appear to have importance for foraging.

[656] Halpern *et al*, 2008

11. Area: Off Land's End, Cornwall (see Figure 6.2, p.81)
Time of year: Winter/early spring

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Some evidence of importance	2
Total	4

Assessment: Area of Interest
High relative densities have been recorded for this area. Few data exist on importance for critical life processes but the area appears to have importance at least for foraging.

12. Area: Outer Bristol Channel, south to north west Cornwall (see Figure 6.2, p.81)
Time of year: At least summer

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Some evidence of importance	2
Total	5

Assessment: Area of Interest
High absolute density has been recorded for this area. Few data exist on importance for critical life processes but high relative densities have been recorded throughout the summer, the season when harbour porpoises breed and calve.

Threats, status and relative importance of the area (south west England)
Levels of fisheries bycatch of harbour porpoises in the Celtic Sea are high and of serious concern. Other specific information on the impacts of human activities on harbour porpoises in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and military activities. Human use and impacts in the region range from moderate to very high[657]. There have been no documented declines in conservation status for harbour porpoises in this area. Within Europe, the UK's waters are of particular importance to harbour porpoises. Large-scale surveys have shown that at least in some years this region has high densities of porpoises and is relatively important compared to other areas.

Irish Sea

13. Area: St. George's Channel (see Figure 6.2, p.81)
Time of year: At least summer

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Some evidence of importance	2
Total	4

Assessment: Area of Interest
High relative densities have been recorded for this area. Few data exist on importance for critical life processes but high relative densities have been recorded throughout the summer, the season when harbour porpoises breed and calve.

[657] Halpern *et al*, 2008

Threats, status and relative importance of the area (Irish Sea)
Specific information on the impacts of human activities on harbour porpoises in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic, oil and gas production and exploration and coastal development. Overall levels of human use and impacts in the region are high[658]. There have been no documented declines in conservation status for harbour porpoises in this area.

Coastal Wales

14. Area: Northern Pembrokeshire and southern Cardigan Bay (see Figure 6.1, p.81)
Time of year: All year

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Good evidence of importance	4
Total	6

Assessment: Critical Habitat
High relative densities have been frequently recorded for this area. Observations of foraging activity and the presence of young calves have been noted by numerous surveys. Suggestions that the area is used for breeding and calving are supported by the strandings records which show high proportions of freshly-stranded neonates. Behaviour indicating social interaction has also been recorded.

15. Area: Lleyn Peninsula and Bardsey Island (see Figure 6.1, p.81)
Time of year: At least spring and summer

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Good evidence of importance	4
Total	6

Assessment: Critical Habitat
High relative densities have been frequently recorded for this area. There are observations of foraging activity and a high proportion of sightings are mothers with young calves.

16. Area: North and west Anglesey (see Figure 6.1, p.81)
Time of year: At least summer

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Moderate evidence of importance	3
Total	6

Assessment: Critical Habitat
High absolute density has been recorded for this area and observations of large aggregations of feeding harbour porpoises suggest its importance for foraging.

[658] Halpern *et al*, 2008

Threats, status and relative importance of the area (coastal Wales)

Specific information on the impacts of human activities on harbour porpoises in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and coastal development. Impacts are likely to be high in this region[659], increasing the need to provide adequate protection to identified areas of critical habitat. There have been no documented declines in conservation status for harbour porpoises. Within Europe, the UK's waters are of particular importance to harbour porpoises and long-term evidence shows that this area is one of the most important in the UK. This, combined with the potential threat level, increases the importance of identified critical habitat.

Other areas

Other areas assessed for harbour porpoises that received a score of less than four include east of Northumberland, east Yorkshire, the western English Channel, the central Irish Sea and the Gower peninsula.

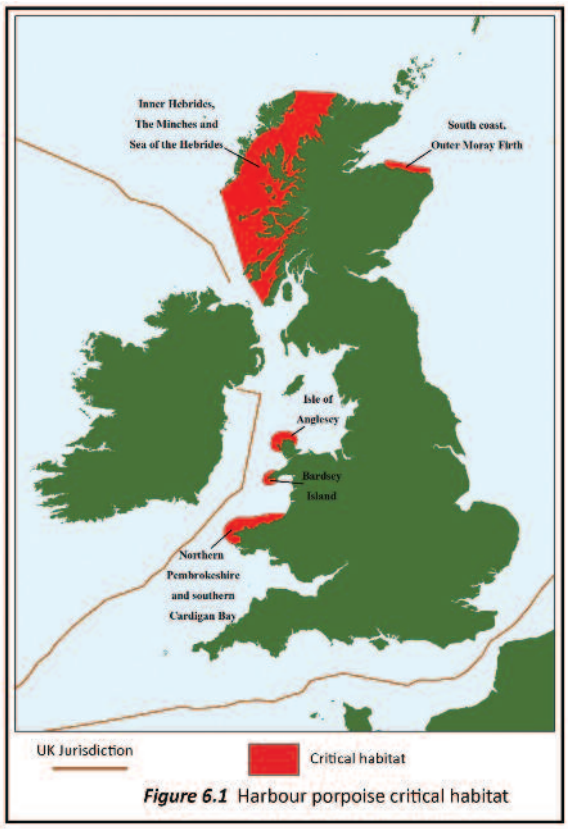

Figure 6.1 Harbour porpoise critical habitat

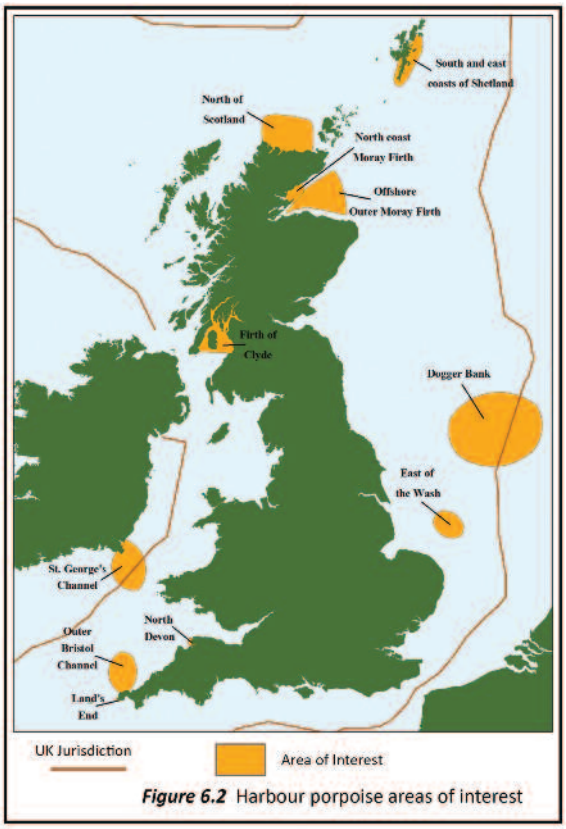

Figure 6.2 Harbour porpoise areas of interest

[659] Halpern *et al*, 2008

6.1.2 BOTTLENOSE DOLPHIN

West and south west Scotland

1. Area: Sound of Barra, north west Scotland (see Figure 6.3, p.84)
Time of year: Appears to be all year

Concentrations of animals	
Known, small, nearshore populations	2
Critical life processes	
Good evidence of importance	4
Total	6

Assessment: Critical Habitat
A small community of animals is resident here and appears to use this restricted area for all critical life processes.

2. Area: Inner Hebrides, north west Scotland (see Figure 6.3, p.84)
Time of year: Appears to be all year

Concentrations of animals	
Known, small, near shore populations	2
Critical life processes	
Good evidence of importance	4
Total	6

Assessment: Critical Habitat
A small community of animals is resident to the Inner Hebrides and appears to use these waters for all critical life processes.

Threats, status and relative importance of the area (west and south west Scotland)
Specific information on the impacts of human activities on bottlenose dolphins in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic, military activities and aquaculture operations. Cumulative human impacts are likely to be high in much of this region[660], increasing the need to provide adequate protection to identified areas of critical habitat. Resident coastal populations of bottlenose dolphins are only found in a limited number of places in the north east Atlantic. The two communities found off north west Scotland make up one of these. The status of both communities appears to be good, but very small in number which means any impact that resulted in a decline or reduced reproductive success could have serious implications on their future viability. These factors increase the importance of identified critical habitat.

[660] Halpern *et al*, 2008

East Scotland

3. Area: North east Scotland (see Figure 6.3, p.84)
Time of year: All year, but less intensively during the winter

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Good evidence of importance	4
Total	7

Assessment: Critical Habitat
This well-studied population is resident to the area. There is good information on population size and the importance of the area for all critical life processes. The dolphins' range has expanded in recent years and they are now regularly found as far south as St. Andrew's Bay and beyond. Studies indicate that within this area there are locations of particularly high use.

Threats, status and relative importance of the area (east Scotland)
Specific information on the impacts of human activities on bottlenose dolphins in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and oil and gas production and exploration. The overall level of human use in much of the region means impacts from all activities combined are potentially very high[661]. This level of threat increases the importance of critical habitat identified for the region. The status of this population may be stable but is still small. Any impacts could therefore have serious implications for this population, increasing the need to adequately protect their identified critical habitat.

Coastal Wales

4. Area: Cardigan Bay (see Figure 6.3, p.84)
Time of year: All year, but less intensively during the winter

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Good evidence of importance	4
Total	7

Assessment: Critical Habitat
This well-studied population is resident to the area. There is good information on population size and the importance of the area for all critical life processes.

Threats, status and relative importance of the area (coastal Wales)
Specific information on the impacts of human activities on bottlenose dolphins in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and coastal development. Impacts are potentially moderate to high in this region[662]. This population appears to be stable, but is still relatively small and any impacts could have serious implications for the population. The importance of protecting areas of critical habitat is therefore increased.

[661] Halpern *et al*, 2008
[662] Halpern *et al*, 2008

Other areas

Other areas assessed for bottlenose dolphins that received a score of less than four include the Celtic Sea, coastal south west England and Wyville-Thomson Ridge.

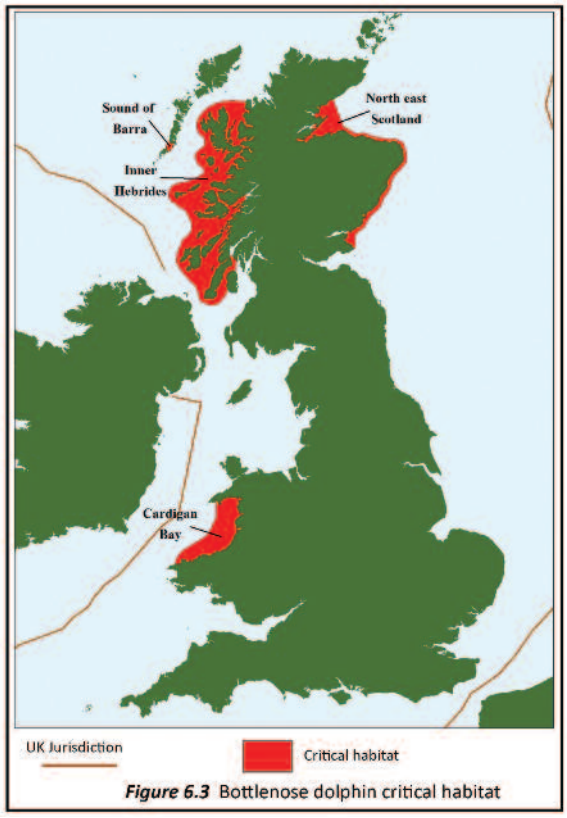

Figure 6.3 Bottlenose dolphin critical habitat

6.1.3 SHORT-BEAKED COMMON DOLPHIN

West and south west Scotland

1. Area: The Minches and the Sea of the Hebrides (see Figure 6.4, p.86)
Time of year: At least summer

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Some evidence of importance	2
Total	5

Assessment: Area of Interest

Spatial modelling of density data indicated a high density area for the Sea of the Hebrides. High relative density estimates have also been produced for The Minch. Few data on the importance of the area for critical life processes exist but observations of feeding common dolphins have been made in The Minch with high proportions of groups with young calves suggesting possible importance for raising calves.

Threats, status and relative importance of the area (west and south west Scotland)
Specific information on the impacts of human activities on common dolphins in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and military activities. Cumulative human impacts are likely to be high in much of this region[663]. The status of common dolphins in this area is unknown but these waters appear to be becoming increasingly important for this species.

South west England

2. Area: Celtic Deep (see Figure 6.4, p.86)
Time of year: May to November

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Moderate evidence of importance	3
Total	6

Assessment: Critical Habitat
Spatial modelling of absolute density data predicted a high density area over the Celtic Deep and other studies report high relative densities here. The area is thought to be important due to its high productivity, and observations of high proportions of groups with young calves suggest its importance for raising calves.

3. Area: Western English Channel (see Figure 6.4, p.86)
Time of year: All year, particularly winter

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Moderate evidence of importance	3
Total	6

Assessment: Critical Habitat
High absolute density has been recorded here. The area appears to be important for foraging at this time of year and large aggregations of prey are present.

4. Area: Celtic Sea (see Figure 6.4, p.86)
Time of year: All year, particularly winter

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Some evidence of importance	2
Total	4

Assessment: Area of Interest
High numbers of animals are in this region during the winter, likely for foraging opportunities but there are few data and low spatial resolution.

[663] Halpern *et al*, 2008

Threats, status and relative importance of the area (south west England)

Levels of fisheries bycatch of common dolphins in the Celtic Sea and English Channel are high and of serious concern. Other specific information on the impacts of human activities on common dolphins in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and military activities. Overall, human use levels and potential impacts range from moderate to very high in this region[664]. The UK's waters are relatively important within Europe for common dolphins and their distribution is centred around the waters of south west England. The threat from bycatch coincides in time and space with identified critical habitat for common dolphins, increasing the importance of protecting these areas.

Other areas

Other areas assessed for common dolphins that received a score of less than four include the areas along the continental shelf edge north west of Scotland and south west of England.

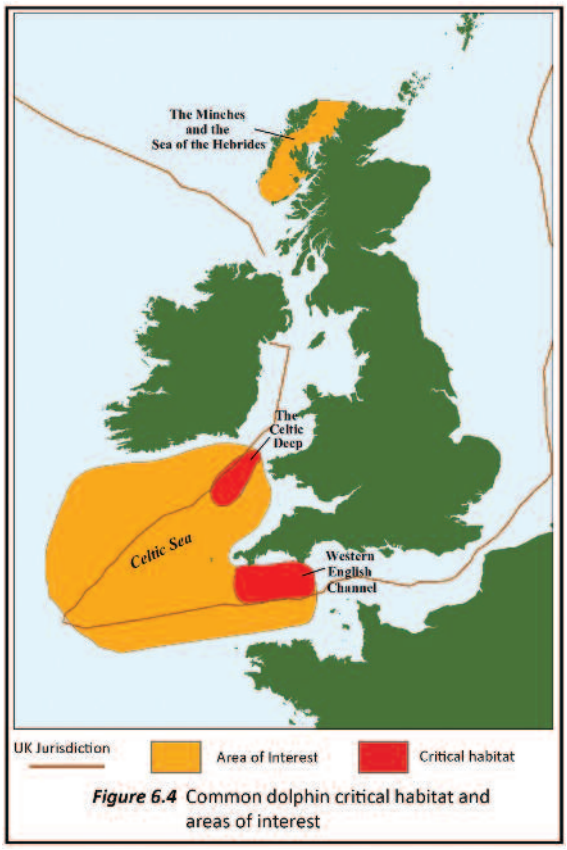

Figure 6.4 Common dolphin critical habitat and areas of interest

[664] Halpern *et al*, 2008

6.1.4 COMMON MINKE WHALE

West and south west Scotland

1. Area: Inner Hebrides (Isles of Mull, Coll and the Small Isles) (see Figure 6.5, p.88)
Time of year: May to October

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Good evidence of importance	4
Data indicating importance are more than 10 years old with more recent evidence of a decline in numbers or use	-1
Total	5

Assessment: Area of Interest
Up until the early 2000s high relative densities of minke whales were consistently reported for this area along with evidence that it was an important foraging area. Recent data have shown precipitous declines in sightings rates. The reasons behind this are not currently understood but may be prey related. It has been suggested that there may have been a localised shift in distribution with other areas of the Hebrides being used instead but this has not yet been confirmed.

Threats, status and relative importance of the area (west and south west Scotland)
Specific information on the impacts of human activities on minke whales in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic, military activities and aquaculture operations. Cumulative human impacts are likely to be high in much of this region[665]. Within Europe, the UK's waters are of particular importance to minke whales and within the UK their distribution is centred around Scotland and north east England. Previous to the recent noted declines in sightings, this area was thought of as a stronghold for minke whales.

East Scotland

2. Area: South coast, Outer Moray Firth (see Figure 6.5, p.88)
Time of year: May to October

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Good evidence of importance	4
Total	6

Assessment: Critical Habitat
High relative densities have been reported from this area which is used during the summer months for feeding.

Threats, status and relative importance of the area (east Scotland)
Specific information on the impacts of human activities on minke whales in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and oil and gas production and exploration. The overall level of human use in much of the region means impacts from all activities combined are potentially very high[666]. There have been no documented declines in conservation status for minke whales in this area. Within Europe, the UK's waters are of particular importance to minke whales and within the UK their distribution is centred around Scotland and north east England. Large-scale surveys have shown this region to have high densities of minkes and to be relatively important compared to other areas.

[665] Halpern *et al*, 2008
[666] Halpern *et al*, 2008

East England

3. Area: Dogger Bank (see Figure 6.5, p.88)
Time of year: At least spring and early summer

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Some evidence of importance	2
Total	5

Assessment: Area of Interest

Data are limited for this area but high absolute densities have been recorded here, along with observations of foraging minke whales.

Threats, status and relative importance of the area (east England)

Specific information on the impacts of human activities on minke whales in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and oil and gas production and exploration. Human use and impacts in the region range from moderate to very high[667]. Large-scale surveys have shown that in some years at least this region supports high densities of minkes and is relatively important compared to other areas.

Other areas

Other areas assessed for minke whales that received a score of less than four include The Minch, the Outer Moray Firth and east coast of Scotland, and the Celtic Deep.

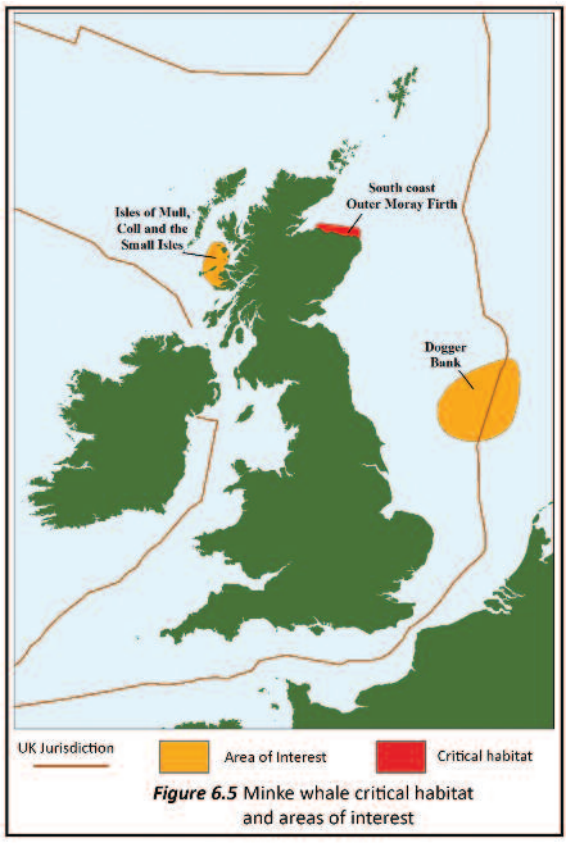

Figure 6.5 Minke whale critical habitat and areas of interest

[667] Halpern *et al*, 2008

6.1.5 WHITE-BEAKED DOLPHIN

West and south west Scotland

1. Area: The Minch, the Hebrides (see Figure 6.6, p.90)
Time of year: All year

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Some evidence of importance	2
Total	5

Assessment: Area of Interest
High absolute density estimates have been reported for the Hebrides and one study reported high proportions of groups with calves present suggesting the area's importance for calving and possibly breeding. Data are limited however.

Threats, status and relative importance of the area (west and south west Scotland)
Specific information on the impacts of human activities on white-beaked dolphins in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and military activities. Overall, human impacts are likely to be high in much of this region[668]. Within Europe, the UK's waters are of particular importance to white-beaked dolphins and within the UK their distribution is centred around Scotland and north east England. Large-scale surveys have shown this region to have high densities of white-beaked dolphins and is relatively important compared to other areas. There has been a suspected decrease of white-beaked dolphins in this region in recent years.

East Scotland

2. Area: Aberdeenshire coast (see Figure 6.6, p.90)
Time of year: Summer

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Moderate evidence of importance	3
Total	6

Assessment: Critical Habitat
High absolute density estimates have been produced for this area and studies suggest white-beaked dolphins move into this coastal area during the summer to calve, breed and possibly also to feed. High numbers of animals extend further than the Aberdeenshire coast but information on importance for critical life processes is mostly limited to the coastal waters.

Threats, status and relative importance of the area (east Scotland)
Specific information on the impacts of human activities on white-beaked dolphins in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and oil and gas production and exploration. The overall level of human use in much of the region means impacts from all activities combined are potentially very high. Within Europe, the UK's waters are of particular importance to white-beaked dolphins and within the UK their distribution is centred around Scotland and north east England. Large-scale surveys have shown this region to have high densities of white-beaked dolphins and it is relatively important compared to other areas.

[668] Halpern *et al*, 2008

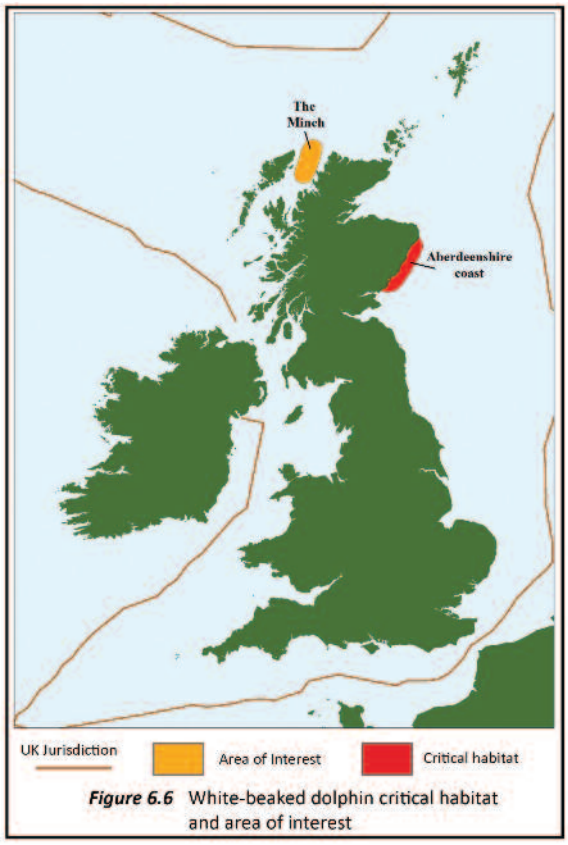

Figure 6.6 White-beaked dolphin critical habitat and area of interest

6.1.6 RISSO'S DOLPHIN

West and south west Scotland

1. Area: North east Isle of Lewis, Outer Hebrides (see Figure 6.7, p.91)
Time of year: All year

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Good evidence of importance	4
Total	6

Assessment: Critical Habitat
High relative density estimates have been repeatedly recorded here and studies indicate the area is used for foraging, calving, raising young and probably breeding. At least part of the population may be resident here throughout the year. Information on critical life processes is restricted to the area off the north east Isle of Lewis but high sightings rates are recorded for much of the Outer Hebrides and these areas may also prove to be of importance to Risso's dolphins.

Threats, status and relative importance of the area (west and south west Scotland)
Specific information on the impacts of human activities on Risso's dolphins in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and military activities. Overall, human impacts are likely to be high in much of this region[669]. Within Europe, the UK's waters are particularly important to Risso's dolphins. Their status is unknown. There are very few locations known worldwide where Risso's dolphins are regularly found close to the coast so the existence of a population that is at least semi-resident and the presence of a breeding and calving ground is exceptional.

[669] Halpern *et al*, 2008

Coastal Wales

2. Area: Bardsey Island, North Wales (see Figure 6.7, below)
Time of year: At least spring and summer

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Good evidence of importance	4
Total	6

Assessment: Critical Habitat

High relative density estimates have been recorded here during spring and summer, with some fluctuations between years. The importance of the area appears to be for feeding, calving and possibly breeding. Information on critical life processes is restricted to the nearshore waters of Bardsey Island but these animals clearly use a wider area than this and there may be other areas in the vicinity that are also important.

Threats, status and relative importance of the area (coastal Wales)

Specific information on the impacts of human activities on Risso's dolphins in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and coastal development. Human impacts are likely to be high overall in this region[670]. Their status is unknown. This is one of the very few coastal locations worldwide used regularly for critical life processes by Risso's dolphins, thus increasing the importance of this critical habitat.

Other areas

Other areas assessed for Risso's dolphins that received a score of less than four include the Outer Hebrides (except north east Lewis) and parts of the Irish Sea.

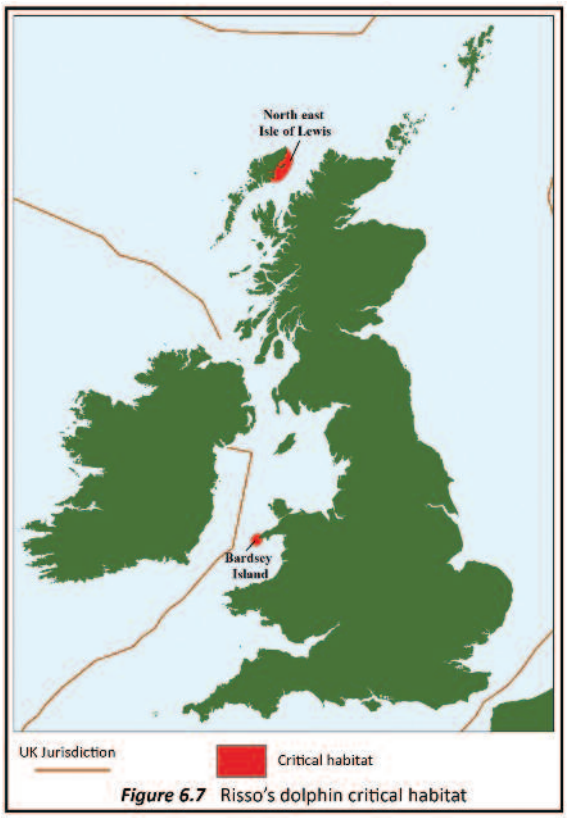

Figure 6.7 Risso's dolphin critical habitat

[670] Halpern *et al*, 2008

6.1.7 KILLER WHALE OR ORCA

West and south west Scotland

1. Area: Mull-Treshnish Islands-Skye and the Little Minch, Hebrides (see Figure 6.8, p.93)
Time of year: At least summer

Concentrations of animals	
Known, small, near shore populations	2
Critical life processes	
Some evidence of importance	2
Total	4

Assessment: Area of Interest
This very small population appears to be isolated from other killer whale populations in the region. Little is known about these animals but some foraging observations have been made.

Threats, status and relative importance of the area (west and south west Scotland)
Specific information on the impacts of human activities on killer whales in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and military activities. Impacts are likely to be high in much of this region[671]. This is a very small population and their status is a concern as no young have been observed for many years.

North Scotland

2. Area: Coastal waters, Shetland Isles (see Figure 6.8, p.93)
Time of year: Summer

Concentrations of animals	
Concentration of sightings	2
Critical life processes	
Moderate evidence of importance	3
Total	5

Assessment: Area of Interest
Information is fairly limited but these coastal waters provide foraging habitat each summer for a population of killer whales.

Threats, status and relative importance of the area (north Scotland)
Specific information on the impacts of human activities on killer whales in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and oil and gas production and exploration. There are concerns that declines in harbour seal *(Phoca vitulina)* populations in this area will negatively affect the killer whales that prey upon them. The level of human use means impacts are potentially very high for much of the on-shelf region, and high further offshore[672]. The status of this population is unknown.

Other areas

Other areas assessed for killer whales that received a score of less than four include the northern North Sea and the continental shelf north west of the Shetland Isles.

[671] Halpern *et al*, 2008
[672] Halpern *et al*, 2008

Figure 6.8 Killer whale areas of interest

6.1.8 ATLANTIC WHITE-SIDED DOLPHIN

North Scotland

1. Area: Faroe-Shetland Channel (see Figure 6.9, p.94)
Time of year: At least summer

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Some evidence of importance	2
Total	5

Assessment: Area of Interest
High absolute densities have been recorded for this area. Few data exist on importance for critical life processes but high density estimates have been recorded throughout the summer, the season when this species calves.

Threats, status and relative importance of the area (north Scotland)
Specific information on the impacts of human activities on Atlantic white-sided dolphins in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and oil and gas production and exploration. The level of human use means impacts are potentially very high for much of the on-shelf region and high further offshore[673]. The UK's waters are thought to be particularly important within Europe for Atlantic white-sided dolphins, and as a deep water species, north Scotland, as well as far west Scotland, are known focal areas for their distribution. Their status is unknown in UK waters.

[673] Halpern *et al*, 2008

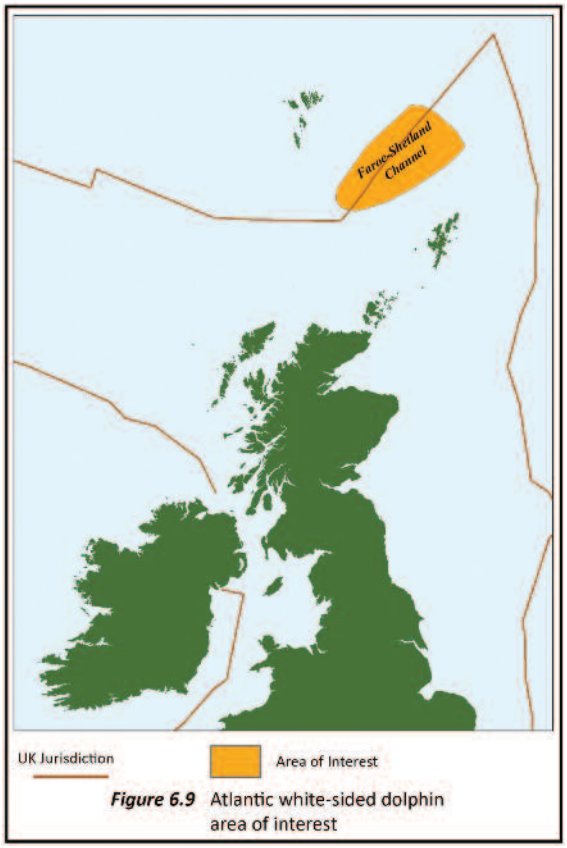

Figure 6.9 Atlantic white-sided dolphin area of interest

6.1.9 LONG-FINNED PILOT WHALE

Far west Scotland

1. Area: Rockall Bank and Hatton Rockall Trough (see Figure 6.10, p.95)
Time of year: At least summer

Concentrations of animals	
High absolute density estimate	3
Critical life processes	
Some evidence of importance	2
Total	5

Assessment: Area of Interest
High absolute densities have been recorded for this area. Few data exist on importance for critical life processes but high relative densities have been recorded throughout the summer, the season when this species calves.

Threats, status and relative importance of the area (far west Scotland)
Specific information on the impacts of human activities on long-finned pilot whales in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and oil and gas exploration. Human impacts in this area are expected to be moderate to high[674]. The status of long-finned pilot whales in UK waters is unknown. Within Europe, the UK's waters are very important for long-finned pilot whales and within the UK, this distribution will be predominantly here and in the waters of north Scotland.

[674] Halpern *et al*, 2008

Other areas

One other area was assessed for long-finned pilot whales but received a score of less than four – the Faroe-Shetland and Faroe Bank Channel, Wyville-Thomson Ridge and north east Rockall Trough region.

Figure 6.10 Long-finned pilot whale area of interest

6.1.10 SPERM WHALE

North Scotland

1. Area: Faroe-Shetland Channel and Wyville-Thomson and Ymir Ridges (see Figure 6.11, p.96)
Time of year: All year

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Some evidence of importance	2
Total	4

Assessment: Area of Interest
High relative densities have been recorded here. There is little information on importance for critical life processes but the data available suggest the area is used for foraging and migration.

Threats, status and relative importance of the area (north Scotland)
Specific information on the impacts of human activities on sperm whales in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and oil and gas production and exploration. The level of human use means impacts are potentially high for this offshore region[675]. This species is considered 'Vulnerable' globally. Within the UK, these waters and those of far west Scotland are the most important for this deep water species.

[675] Halpern *et al*, 2008

Far West Scotland

2. Area: Rockall Trough (see Figure 6.11, below)
Time of year: All year

Concentrations of animals	
High relative density estimate	2
Critical life processes	
Some evidence of importance	2
Total	4

Assessment: Area of Interest

High relative densities have been recorded here. There is little information on importance for critical life processes but the data available suggest the area is used for foraging and migration.

Threats, status and relative importance of the area (far west Scotland)

Specific information on the impacts of human activities on sperm whales in this region is lacking, but Section 5.2 and Annex III provide a general assessment. Threats are likely to include acoustic and physical disturbance and habitat degradation from vessel traffic and oil and gas exploration. Human impacts are likely to be moderate or high for this region[676]. This species is considered 'Vulnerable' globally. Within the UK, these waters and those of north Scotland are most important for this deep water species.

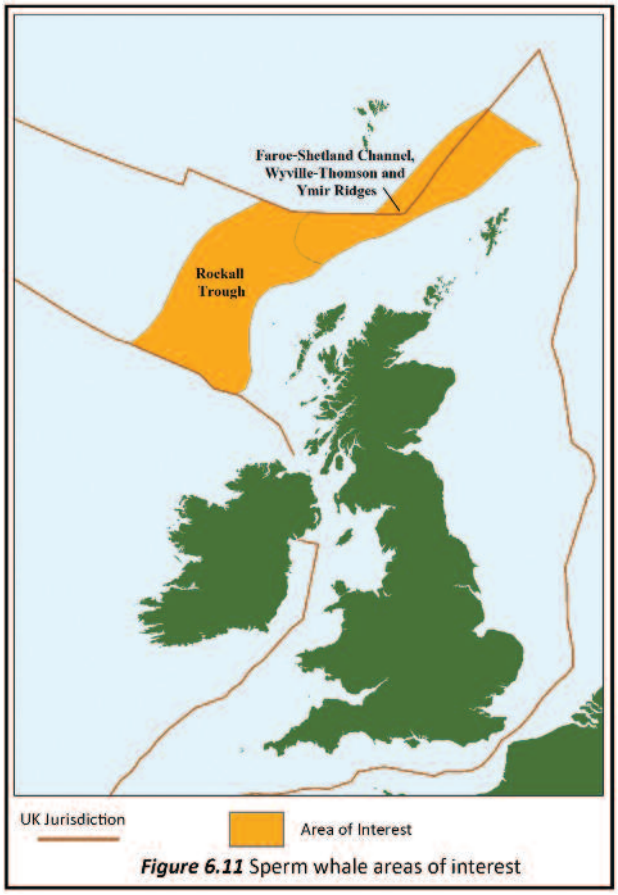

Figure 6.11 Sperm whale areas of interest

[676] Halpern *et al*, 2008

6.1.11 BEAKED WHALES

The northern Rockall Trough area and the Faroe-Shetland Channel, Wyville-Thomson and Ymir Ridges, were assessed for their importance to beaked whales but due to a lack of data both received a score of less than four. High absolute densities have been recorded in the north west Rockall Trough but no information is available on importance for critical life processes. Some studies show clusters of beaked whale sightings in the Faroe-Shetland Channel/north east Rockall Trough area and it appears to have importance for beaked whale prey species, suggesting possible importance for feeding. Beaked whales also migrate through this area and the relatively narrow deep water corridor of the Faroe-Shetland Channel may act as a bottleneck for travelling whales, possibly explaining the higher number of sightings here.

These areas did not receive a high enough score to be highlighted as areas of interest, but given the general paucity of information for these species we believe it is appropriate for a lower level of data to trigger interest in these areas; thus, they should still be viewed as potentially important for these species and further investigated (see Figure 6.12, below). Determining habitat requirements for beaked whales may be viewed as a difficult task, yet researchers in Canada have been able to document habitat use of three offshore Nova Scotia canyons by northern bottlenose whales. The main habitat, called The Gully, received MPA protection in 2004.

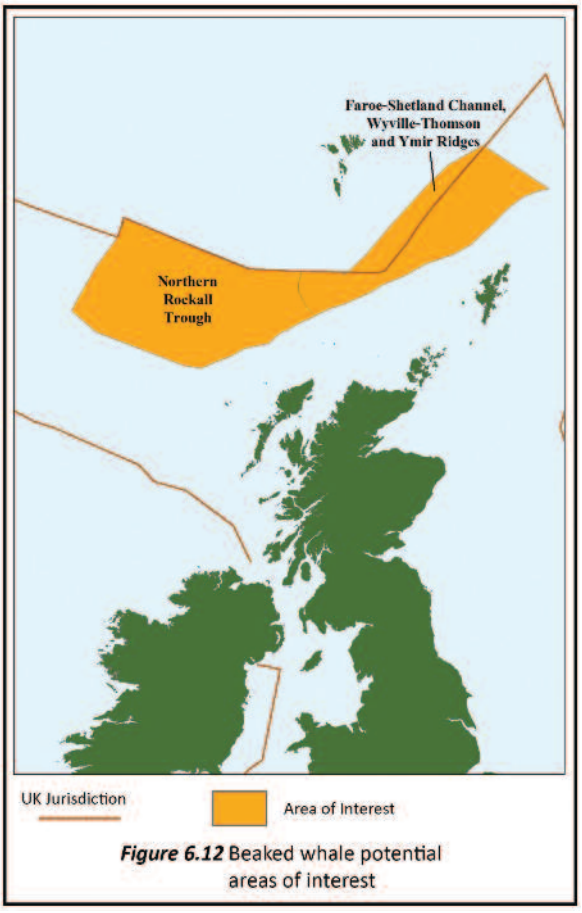

Figure 6.12 Beaked whale potential areas of interest

6.1.12 LARGE BALEEN WHALES

The Celtic Sea and the Western Approaches to the English Channel were assessed for their importance to fin whales, and the Faroe-Shetland Channel was assessed for its importance to fin whales and possibly blue whales. Both received scores of less than four due to a lack of data.

Data for baleen whales in UK waters are sparse due to small populations and predominantly offshore distributions. However, acoustic surveys have shown they are widespread in the deep waters north west of the UK. The information available suggests that the Atlantic Frontier – particularly the Faroe-Shetland Channel – may be important for large baleen whales, used for migration (autumn/winter) and feeding (summer). The relatively high sightings rates observed in the summer may be due to the area's importance for prey species. The relatively narrow deep water corridor of the Faroe-Shetland Channel potentially seems to act as a bottleneck for whales migrating through the area, and may explain the higher number of sightings. Given the endangered status of these whales, any area the data suggest may be important should be considered further (see Figure 6.13, below).

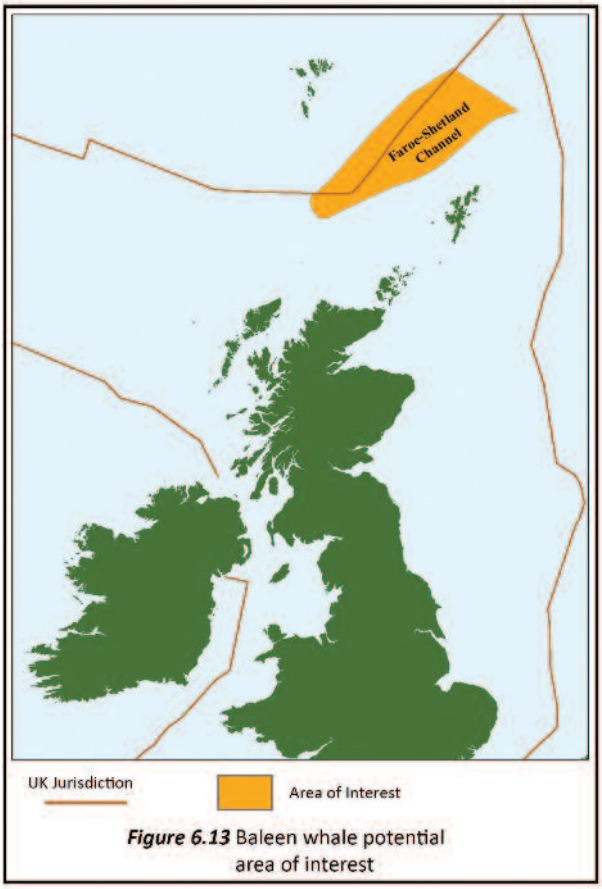

Figure 6.13 Baleen whale potential area of interest

7. PROTECTING CRITICAL HABITAT – REGIONAL SUMMARIES

In total, 15 areas were identified as critical habitat for six species of cetacean in UK waters (see Figure 7.1, below). Several more areas were identified as 'of interest' due to some evidence of importance, but there was insufficient information available to conclude with confidence that they were critical habitat.

The following areas were determined to be critical habitat:

Harbour porpoise

- the Inner Hebrides, The Minches and the Sea of the Hebrides (west and south west Scotland)
- south coast, Outer Moray Firth (east Scotland)
- northern Pembrokeshire and southern Cardigan Bay (coastal Wales)
- Lleyn Peninsula and Bardsey Island (coastal Wales)
- north and west Anglesey (coastal Wales)

Bottlenose dolphin

- north east Scotland (east Scotland)
- Cardigan Bay (coastal Wales)
- north west Scotland – Inner Hebrides (west and south west Scotland)
- north west Scotland – Sound of Barra (west and south west Scotland)

Common dolphin

- Celtic Deep (south west England)
- western English Channel (south west England)

Minke whale

- south coast, Outer Moray Firth (east Scotland)

White-beaked dolphin

- Aberdeenshire coast (east Scotland)

Risso's dolphin

- north east Isle of Lewis, Outer Hebrides (west and south west Scotland)
- Bardsey Island (coastal Wales)

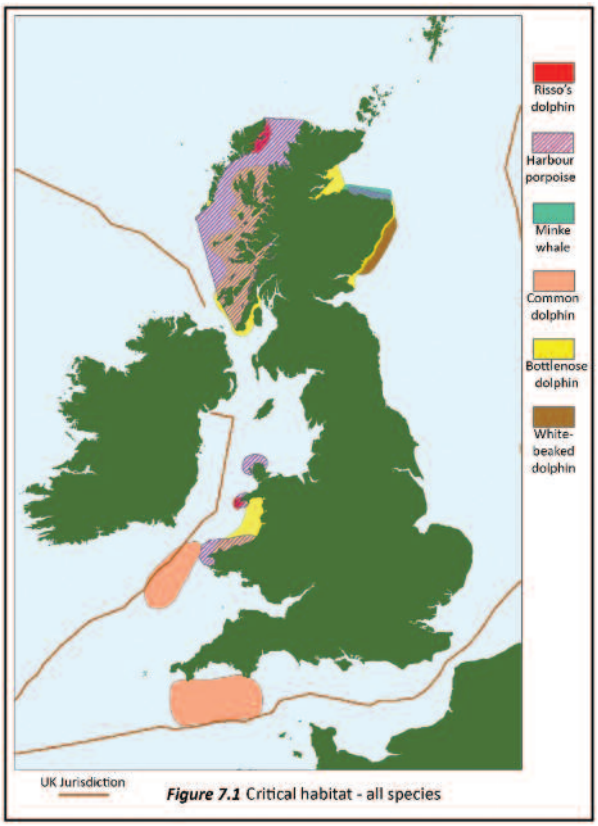

Figure 7.1 Critical habitat - all species

Taking each region in turn, the following sections consider whether an MPA would be appropriate to protect these important areas.

7.1 WEST AND SOUTH WEST SCOTLAND

Within the west and south west Scotland region, critical habitat was identified for the following species (see Figure 7.2, below):

- Harbour porpoise – the Inner Hebrides, The Minches and the Sea of the Hebrides
- Bottlenose dolphin – the Inner Hebrides and Sound of Barra
- Risso's dolphin – north east Isle of Lewis (The Minch)

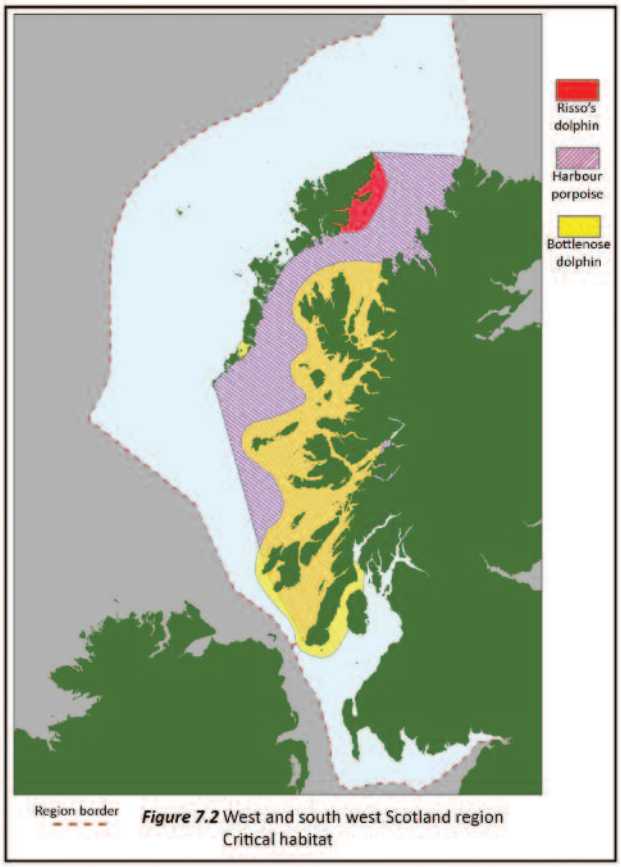

Figure 7.2 West and south west Scotland region Critical habitat

Under the draft Scottish guidelines for the creation of Nature Conservation MPAs[677], it would seem these three species could be considered 'key features'[678], meaning they could be considered for protection using MPAs. Harbour porpoises could also be considered as a feature under threat and included on the OSPAR Threatened and Declining list.

From the available information on threats, the most significant are probably the cumulative impacts from a range of activities that take place, including vessel traffic, military activities and aquaculture operations. These impacts may include acoustic and physical disturbance, and habitat degradation and loss. There is also the potential for further impacts from marine renewable energy if these develop as planned.

These threats can be spatially defined (unlike, for example climate change, or many forms of pollution) which makes the establishment of an MPA a useful approach to management for conservation[679]. The presence of a single, identifiable threat, such as fisheries bycatch, would probably make implementing management measures focusing on threat mitigation rather than creating an MPA the most appropriate solution. However, given that multiple threats are in operation and it is the cumulative impact that is most significant, an MPA could offer a useful mechanism to manage multiple activities in combination. Additionally, a number of different species need to be

[677] See Section 2
[678] See Section 4.5
[679] Reeves, 2000

considered in the area, each of which may be impacted in different ways by an activity and have different management requirements. An MPA with an appropriate management structure could provide the necessary oversight to manage multiple activities for the conservation of multiple species.

A further benefit of an MPA is that it would provide the opportunity to study baseline conditions and conduct scientific research for a number of cetacean species under relatively natural conditions[680]. As an area of high natural biodiversity, for cetaceans and other marine life, it could offer much needed research opportunities and a reference point against which to compare areas without similar protective measures in place.

Common dolphins, white-beaked dolphins, minke whales and a small population of killer whales were also identified as having 'areas of interest' in this region (see Figure 7.3, below). Although sightings have declined over recent years, for a long time this area appears to have been critical habitat for minke whales and may still be. There is overlap between these areas and the critical habitat identified for harbour porpoises, bottlenose dolphins and Risso's dolphins. At the least, an MPA would provide some benefit to these species and if further research reveals these areas are indeed critical habitat, these benefits could be significant. These species should therefore be considered in the development of an MPA, even if they are not a primary feature.

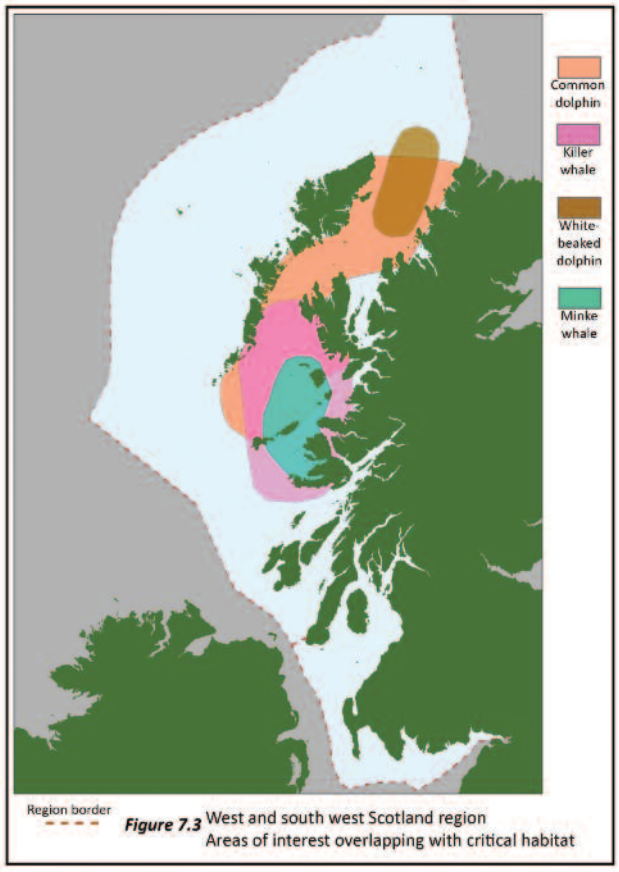

Figure 7.3 West and south west Scotland region
Areas of interest overlapping with critical habitat

Existing MPAs

One offshore Special Area of Conservation (SAC) and 22 mostly small SACs with marine components are in place in this region covering a variety of habitat types (e.g. reefs, sea cliffs) and species including otters and grey and common seals, but not cetaceans. Some of these SACs are in areas identified as critical habitat for cetaceans, including harbour porpoises and bottlenose dolphins, e.g. the Treshnish Isles, but they are not listed as features for these sites so their conservation needs will not be considered by the management plan.

[680] Reeves, 2000

7.2 FAR WEST SCOTLAND

It was not possible to identify any areas of critical habitat for this region. This is certainly due to a lack of information rather than the area being unimportant for cetaceans. On the contrary, the information that exists suggests this is an area of high significance to deep water cetaceans but the lack of data on critical life processes for these species hindered drawing conclusions about the location of critical habitat, or even areas of interest. There was sufficient information for two areas to be highlighted as 'of interest' – the Rockall Bank and Hatton Rockall Trough for long-finned pilot whales and the Rockall Trough for sperm whales (see Figures 6.10, p.95 and 6.11, p.96). Although there was insufficient data to classify the Rockall Trough for beaked whales, we suggest it should still also be considered as potentially important to these species.

Given that far west Scotland appears to be a diverse and important area for cetacean species and that there are such significant gaps in our knowledge, it will be particularly important to act in a precautionary manner when permitting or managing activities in this area.

Existing MPAs

One offshore SAC is in place in this region, an area of reef called the Darwin Mounds. A further SAC has been proposed for the north west Rockall Bank, again with reefs as the primary feature, but with harbour porpoises as a non-qualifying feature. An area of the Hatton Bank is also a draft SAC, considered for protection for its reefs.

7.3 NORTH SCOTLAND

It was not possible to identify cetacean critical habitat in this region with current levels of information. Several areas of interest were identified for this region - killer whales and harbour porpoises in the coastal waters of Shetland, harbour porpoises north of the Scottish mainland, and for Atlantic white-sided dolphins and sperm whales over the Faroe-Shetland Channel and Wyville-Thomson and Ymir Ridges.

It is clear that the coastal waters of Shetland provide foraging habitat for a population of north east Atlantic killer whales during summer months but there is little further information about this population. Gaining a greater understanding of how this population uses the area is required to support conservation efforts. The reported 40% decline in harbour seals in the area – prey for this killer whale population – increases the need to determine if it is critical habitat. Killer whales would appear generally to have large critical habitats (hundreds to thousands of km^2) although research in the north east Pacific has predicted that the protection of even small feeding areas as small as $7.4nm^2$ could provide valuable protection for killer whales in certain areas[681].

The comments made in relation to the far west Scotland region apply equally to offshore north Scotland — the lack of identified areas of critical habitat reflects more an absence of data than a lack of importance. The Faroe-Shetland Channel was highlighted as an area of interest for Atlantic white-sided dolphins and sperm whales, extending to include the Wyville-Thomson and Ymir Ridges also for sperm whales (see Figures 6.9, p.94 and 6.11, p.96). We suggest this area should also be considered as potentially important for beaked whales and baleen whales.

Again, considering this appears to be a diverse and important area for cetacean species and that there are such significant gaps in our knowledge, it will be particularly important to act in a precautionary manner when permitting or managing activities in this area.

Existing MPAs

Eight small SACs with marine components are in place in this region, covering a variety of habitat types (e.g. reefs, sandbanks) and species including otters. An offshore SAC has been proposed for the Wyville-Thomson Ridge for its reefs and includes bottlenose dolphins as a non-qualifying feature.

There is some overlap between SACs on the south and east coasts of Shetland and areas identified as areas of interest for harbour porpoises, but this species is not listed as a feature for these sites so their conservation needs will not be considered within the management plan.

[681] Ashe *et al*, 2009

7.4 EAST SCOTLAND

Within the east Scotland region, critical habitat was identified for the following species (see Figure 7.4, below):

- Harbour porpoise – south coast, Outer Moray Firth
- Bottlenose dolphin – Inner Moray Firth and NE Scottish coast to St. Andrew's Bay
- Minke whale – south coast, Outer Moray Firth
- White-beaked dolphin – Aberdeenshire coast

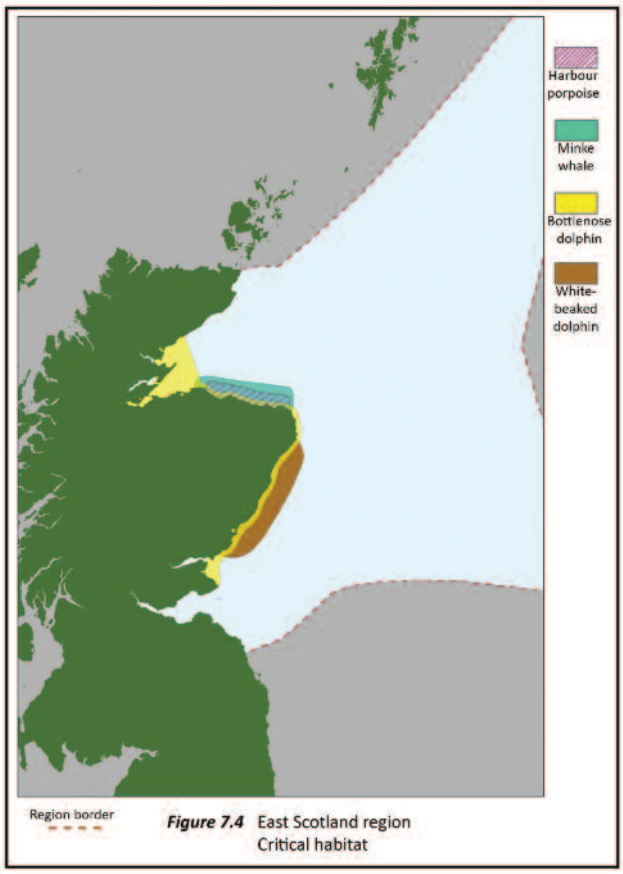

Figure 7.4 East Scotland region Critical habitat

As discussed in section 4.5, these species could be considered 'key features' under the Scottish draft guidelines.

Human impacts of most concern in this region are probably the cumulative impacts and habitat degradation that result from high levels of oil and gas exploration and production, vessel traffic, coastal development and other activities. Fisheries bycatch is known to be impacting North Sea harbour porpoise populations. Prey depletion may also be a concern due to overfishing and other impacts.

In this situation, an MPA alone is not likely to be effective in offering protection against prey depletion or fisheries bycatch. Both will require action at a wider scale and are difficult to define spatially, at least with current levels of knowledge.

For other impacts, though, an MPA could be used to provide protection. An SAC is already in place for bottlenose dolphins in the Inner Moray Firth but over recent years, this population has expanded its range to include the south coast of the Outer Moray Firth and the north east Aberdeenshire coast south to St. Andrew's Bay and beyond. The recent range expansion of this population means at least part of this population is receiving less protection than previously as considerably more time is spent in unprotected waters. The same threats exist in these waters as for the Inner Moray Firth, so to continue to manage human activities for the conservation of these animals throughout

their range, the SAC could be expanded to incorporate the section of coast south to St. Andrew's Bay. Under SAC legislation, they are still officially protected even when they are outside the boundaries of the SAC but extending the designation would add management and protection options.

Within this area, there appear to be places of particular importance used for foraging and with consistently higher abundance of dolphins. These include Kessock Channel, the Chanonry Narrows, the Sutors, Lossiemouth, Spey Bay, Stonehaven and near Aberdeen harbour. These areas should be provided with the highest level of protection possible given their importance.

Expansion of the SAC to include all critical habitat for this population of bottlenose dolphins would have the advantage of covering also the key critical habitats of harbour porpoise, minke whales and white-beaked dolphins in north east Scotland. Although the needs of these species could not be directly incorporated into the management plan of the SAC because they are not listed species under the EU Habitats Directive (harbour porpoises could be added but are not included at present), there would be significant overlap between the management measures needed to protect all these cetacean species. A corresponding national MPA management structure could be established that builds on and extends the SAC structure, to manage activities for the conservation of all species with critical habitat in this area.

For white-beaked dolphins, information on use of the area for critical life processes is mostly only available for the coastal waters of eastern Aberdeenshire. However, studies indicate that there are high densities of animals over a wider area than this during the summer, which may indicate that further areas are important for breeding, calving and feeding. If further research shows this to be the case, protection should be extended to include these areas.

Existing MPAs

Six mostly small SACs with marine components are in place in this region for a variety of habitat types (e.g. reefs, sandbanks) and species including one SAC for bottlenose dolphins. Two small offshore SACs have been established to conserve submarine structures made by leaking gases.

7.5 SOUTH WEST ENGLAND

Within the south west England region, critical habitat was identified for common dolphins in the western English Channel and over the Celtic Deep (see Figure 7.5, below).

In the winter months, common dolphins are present in high abundance over a large area of the western English Channel and Celtic Sea. More information is available for the western English Channel, resulting in its identification as critical habitat but there are likely further areas in the Celtic Sea. The most pressing threat to this population is fisheries bycatch. An MPA is not being recommended at this time because the area of identified critical habitat (and the area of interest) is extensive and there is a lack of finer-scale information that might allow us to pinpoint places of particular importance or specific locations where conflicts with fisheries operations are occurring. Until these data gaps are filled, taking action to reduce bycatch may be the most effective conservation measure for common dolphins in this area. If such areas can be identified, an MPA may be an appropriate mechanism to reduce impact and provide some protection for these animals. In the meantime, bycatch reduction measures should be introduced with each fishery to include monitoring of fisheries for bycatch, collection of data on fisheries (effort, gear, location) and where necessary, gear modifications, and spatial and temporal closures and restrictions.

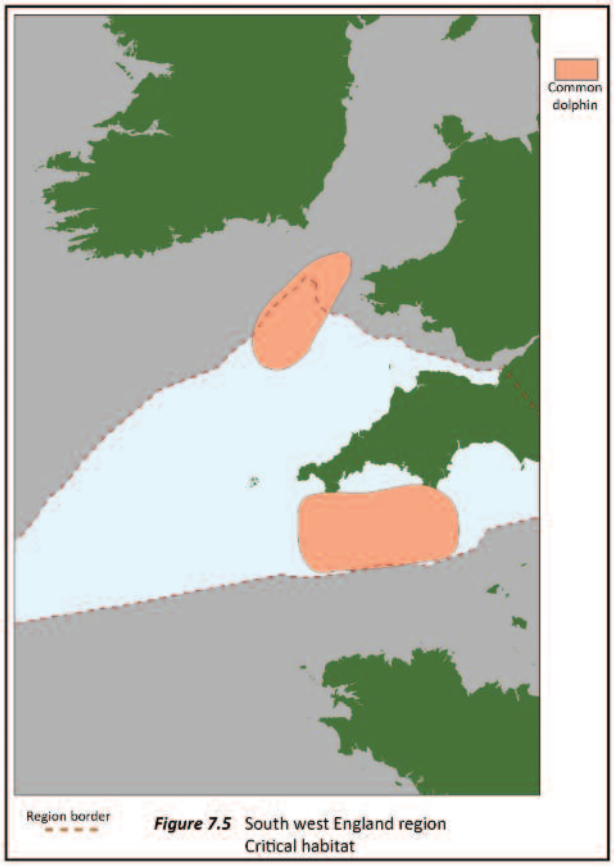

Figure 7.5 South west England region
Critical habitat

The Celtic Deep is another area of importance for common dolphins. In this area, the impacts of concern are the combined effects of physical and acoustic disturbance or injury from vessel traffic and other activities such as military exercises that take place weekly in the area. Bycatch of common dolphins seems to occur predominantly during the winter months, not during the time these animals are in the Celtic Deep region, although it may be the same population affected.

An MPA could be used to provide protection for common dolphins for the six months of the year when the area becomes important to them. The importance of the area appears to be connected to the front that forms in the Celtic Deep region at this time of year and may serve to enhance productivity and foraging opportunities. Establishing a seasonal MPA during this time should be considered. Overall, data are sparse for this area, and further research into understanding the area's importance would be necessary before spatial protective measures could be considered.

The Celtic Deep was also highlighted as an area of interest for minke whales and research is needed also to confirm this. If this area does prove to be critical habitat for minke whales, they should also be considered for inclusion if an MPA is to be established.

Existing MPAs

Nine mostly small SACs with marine components are in place in this region, and one offshore in the Celtic Sea, for a variety of habitat types (e.g. reefs, sand dunes) and some species such as grey seals.

7.6 COASTAL WALES

Within the coastal Wales region, critical habitat was identified for the following species (see Figure 7.6, below):

- Harbour porpoise – northern Pembrokeshire and southern Cardigan Bay; Lleyn Peninsula and Bardsey Island; and, north and west Anglesey
- Risso's dolphin – Bardsey Island
- Bottlenose dolphin – Cardigan Bay
- Common dolphin – Celtic Deep (considered in the south west England region).

Cumulative impacts from vessel traffic, coastal development and other activities, resulting in disturbance and habitat degradation, are some of the most significant concerns in coastal Welsh waters. Given that multiple threats are in operation and it is the cumulative impact that is most significant, an MPA would seem to offer a useful mechanism to manage multiple activities in combination.

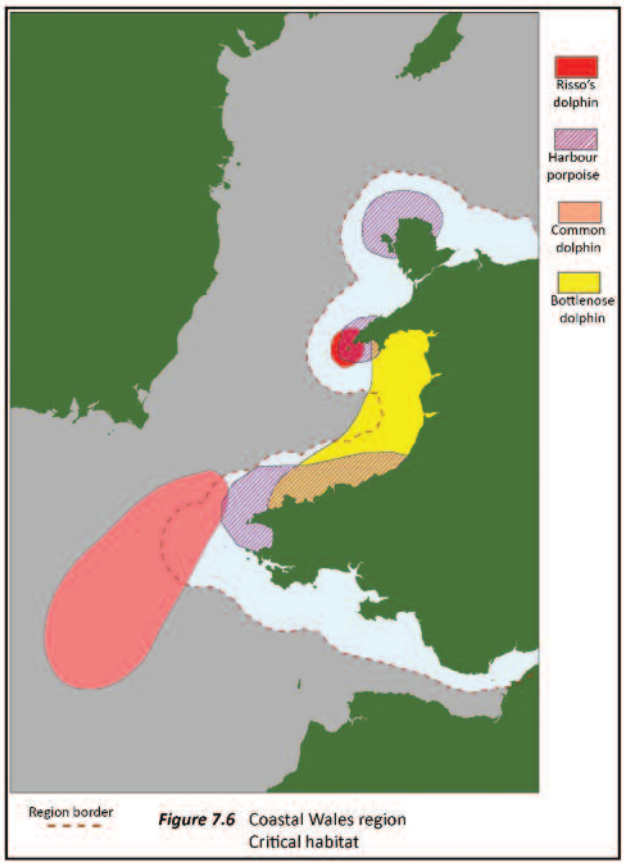

Figure 7.6 Coastal Wales region Critical habitat

An SAC is already in place for bottlenose dolphins in southern Cardigan Bay where they are listed as a primary feature, and a second site is located in the north where they are classified as a qualifying feature. Further research since these were designated has indicated that the area in the north is of sufficient importance for bottlenose dolphins for them to be listed as a primary feature. Together these two areas cover a significant proportion of the bottlenose critical habitat in the Bay although there are indications that more offshore areas are of importance during the winter and consideration should be given to expanding the SACs to cover these areas. Although protection follows the animals regardless of whether they are inside or outside of the SAC boundary, extending the SAC designation to cover a larger area would add management and protection options. Within this area of critical habitat, there appear to be locations of particular significance for bottlenose dolphins, such as Aberaeron to Cardigan and Tremadog Bay. These areas should be considered for the highest levels of protection given their apparent importance.

Harbour porpoises are not listed as a feature for either of the two Cardigan Bay SACs, or for the Pembrokeshire SAC (proposed for reefs, estuaries, large shallow inlets and bays and grey seals), despite the importance of these areas for this species. The addition of harbour porpoises as a feature of importance for both Cardigan Bay sites, and the Pembrokeshire SAC, would cover a large proportion of the identified critical habitat for this species in the area and allow them to be considered within the existing structure. However, the section between the southern Cardigan Bay and Pembrokeshire sites also requires protection as Strumble Head falls in this gap, a site of high importance for harbour porpoises. The northern part of the Isle of Anglesey should also be considered for SAC designation due to its importance for harbour porpoises.

Risso's dolphins are not listed under Annex II of the EU Habitats Directive so could not be included directly in the Pen Llyn a'r Sarnau site in northern Cardigan Bay. A corresponding national MPA management structure could be established that adds to or extends the SAC structure, to manage activities for the conservation of this species also within the area. At present, information is only available demonstrating the importance of the coastal waters of Bardsey Island. This appears to be a wide-ranging population however and there are likely additional areas of critical habitat for this species in the Irish Sea which will need to be investigated.

Existing MPAs

Eleven SACs with marine components are in place in this region, covering a variety of habitat types (e.g. reefs, sandbanks) and species including the bottlenose dolphins (Cardigan Bay SAC and Pen Llyn a'r Sarnau SAC).

7.7 OTHER REGIONS

It was not possible with current information to identify with confidence critical habitat for cetaceans in the regions of east England, south east England and Irish Sea. There are indications that important areas exist, particularly off east England, and these have been highlighted as areas of interest.

Existing MPAs

Nine SACs with marine components are in place in the east England region, for a variety of habitat types (e.g. reefs, sandbanks) and species including the common seal. Three proposed SACs are under consideration for sandbanks and reef communities in offshore waters. The Dogger Bank is a draft SAC, again for sandbanks, but with harbour porpoises as a non-qualifying feature.

In south east England six small SACs with marine components are in place and two offshore SACs have recently been consulted on. These are primarily for the protection of habitats such as reefs, estuaries and sandbanks.

Three SACs with marine components are in place for the Irish Sea to protect a variety of habitat types, such as reefs and mudflats.

7.8 EXCLUSION OF CETACEANS FROM UK MPA GUIDANCE

National MPAs represent an important mechanism for the protection of cetaceans. The identification of areas used for important life processes such as feeding, breeding and raising young, using current information about cetaceans in UK waters has formed the basis of much of this report and the capability of MPAs to deal with threats has been discussed (Section 5.1).

Yet all cetacean species are excluded from Natural England and JNCC's Ecological Network Guidance[682] upon which the MCZ network will be based. The guidance does not provide enough information to know which mobile species *'may be suitable for site-based protection',* but which *'lack spatial data to support inclusion in the network'*.

Unlike the English/Welsh guidance, the draft Scottish guidelines include some cetacean species. The technical process for identifying Nature Conservation MPAs, as laid out in the Scottish guidelines, requires a review of the *'potential contribution made by Natura and other spatial management measures to the conservation of priority marine features on the sub-list'*.

Annex II listed species (bottlenose dolphins and harbour porpoises) which do not meet the threshold for designation as EU Habitats Directive Special Areas of Conservation (SACs), but are important populations on a Scottish basis, should be included as 'priority marine features'. If, following objective scientific analysis, it is considered that Natura sites provide adequate coverage for nationally important populations in a given MPA region, there would be no need to designate further sites. Without recognition of bottlenose dolphins and harbour porpoises as priority marine features, nationally important populations of these species would receive at best only consequential protection, and in the absence of being located alongside other priority marine features, may receive no protection.

Annex II listed bottlenose dolphins and harbour porpoises are currently not on the proposed list of priority marine features in Scotland. There will be gaps in protection if they are not included in the list. Nationally important sites for bottlenose dolphins (outside of the Inner Moray Firth) and harbour porpoises will not be protected by SAC designations under the Habitats Directive, and additional sites would be required to complete a coherent network for these species.

Currently only the small population of dolphins in the Moray Firth numbering around 193 animals has SAC designation. This report has identified small and important populations of bottlenose dolphins off the west coast that may benefit from MPA designation (see Section 7.1). Scotland also has some of the highest densities of harbour porpoises in Europe and this report has identified areas of critical habitat that would benefit from MPA designation (see Section 7.1 and 7.4). Currently neither of these species will benefit by the new provisions for MPAs under the Marine (Scotland) Act, according to the current draft guidelines.

In the words of a draft 2010 report from the Scottish Association for Marine Science[683]:

> 'It is essential that…species already designated some level of protection under the EC Habitats Directive…are not…precluded from inclusion in MPAs for nationally important populations of marine species…especially where existing sites/protective measures are not deemed to provide adequate protection for nationally important populations…in a given region.'

[682] Natural England and JNCC, 2010
[683] Bell *et al*, 2010

7.9 SUMMARY

Four areas of identified cetacean critical habitat should be considered for immediate MPA protection, or have existing protection extended (see Figure 7.7, below):

The Hebrides

- the Inner Hebrides, The Minches and the Sea of the Hebrides – harbour porpoise
- north east Isle of Lewis – Risso's dolphins
- the Inner Hebrides and the Sound of Barra – bottlenose dolphins

Other species present here that could also benefit from protective measures put in place are common dolphins, white-beaked dolphins, minke whales and killer whales.

North east Scotland

- south coast, Outer Moray Firth – harbour porpoise
- Inner Moray Firth and north east Scottish coast to St. Andrew's Bay – bottlenose dolphins[684]
- south coast, Outer Moray Firth – minke whales
- Aberdeenshire coast – white-beaked dolphins

South west England

- Celtic Deep – common dolphins

Other species that may benefit from an MPA in this area include minke whales.

Coastal Wales

- northern Pembrokeshire and southern Cardigan Bay; Lleyn Peninsula and Bardsey Island; and, north and west Anglesey – harbour porpoises
- Bardsey Island – Risso's dolphins
- Cardigan Bay – bottlenose dolphins[685]

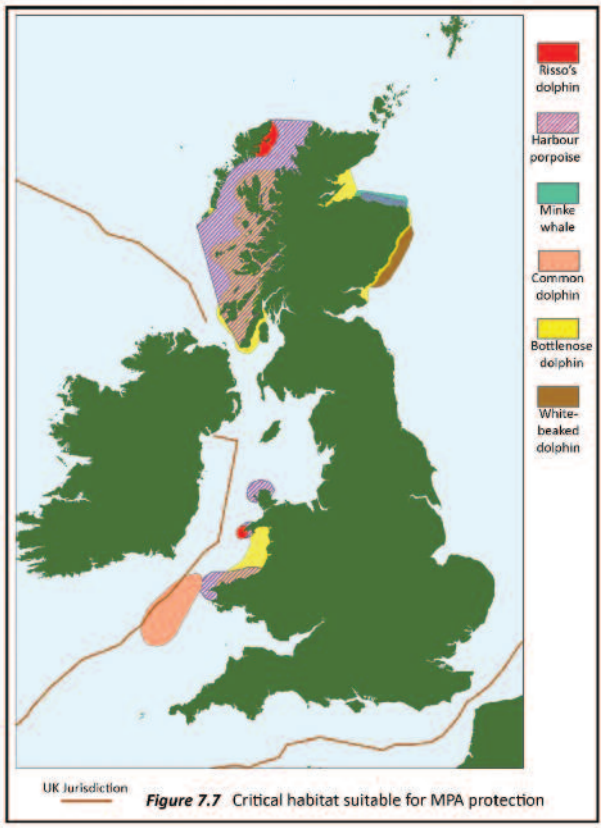

Figure 7.7 Critical habitat suitable for MPA protection

[684] An SAC is already in place for part of this area
[685] An SAC is already in place for part of this area

8. RECOMMENDATIONS ON RELATED MPA POLICY

Sections 8 and 9 contain the authors' science- and policy-based recommendations, based on this report, which are aimed at trying to fulfil the goal of developing an ecologically coherent network of MPAs that includes cetacean critical habitat.

Approach

An audit should be undertaken at a UK level, once the MPAs are proposed, to ensure that the sites are in the right places and that they will provide adequate coverage and will have effective management. Currently, the Scottish, English and Welsh approaches to designation of MPAs are different and it is difficult to see how guidance, management (plans), research and adaptive management of marine species whose ranges cross national boundaries can be achieved effectively. A joined up, coherent and comprehensive approach is necessary for the UK to achieve an ecologically coherent network of MPAs that include cetacean habitat, as well as habitat for other mobile marine species. This may be achieved by working within the devolved context to find ways to achieve joint approaches, where this is required.

Data

Appropriate levels of funding should be made available to the nature conservation agencies to employ enough staff to compile all existing data to allow full and detailed analysis of all relevant species and habitats. This will enable the designation of an ecologically coherent network in an efficient and effective way, in view of the 2012 international deadline targets.

Sufficient funds should also be made available from nature conservation agencies and other parts of government to conduct baseline surveys in areas where data gaps have been identified as a priority and where threats exist. More details are given in Section 9 below.

The UK, Scottish and Welsh governments should provide strong guidance that requires a commitment from all marine users to fund (independent) baseline and impact research. The data and findings from this work should be made publicly available, in a timely way, and there should be a requirement that these data and findings are fed into the relevant data archive centres, including the new JNCC monitoring database, to update and improve existing data sets.

Threats

i. Fisheries
Fisheries should be effectively managed with the Inshore Fishing (Scotland) Act (1984) in Scotland and other relevant legislation including the Common Fisheries Policy, to robustly meet the conservation objectives for MPAs. This is not currently the case for most SACs under the EU Habitats Directive, in which fisheries are not subject to Appropriate Assessment.

A better understanding of the impacts of fisheries within and beyond potential MPAs is required. The UK and Scottish governments should act on the recent International Council for the Exploration of the Sea (ICES) recommendation[686] to put in place measures to enable the establishment of specific conservation and management objectives to manage the impacts of fisheries on marine mammal and seabird populations.

ii. Military
The Ministry of Defence should undertake an Environmental Impact Assessment (EIA) of its existing offshore exercise areas, to include consideration of designated SACs and potential MPAs and to ensure that planned operations are in line with existing and future marine spatial planning processes.

iii. Other marine users
Governments should ensure that potential developers of all marine industries, including marine renewable energy, oil and gas, carbon capture and storage, aquaculture and harbour/marina (infrastructure and expansions, as well as new developments), and those conducting transient activities, such as shipping, scientific research and the marine tourism industry, are aware of and take full account of legislated environmental requirements.

Marine spatial planning is progressing under the Marine Acts in parallel with the identification and designation of a new network of MPAs. The appropriate considerations for spatial sensitivities, and resulting siting of developments, should be identified early in the spatial planning process and be taken into account, even where sites have not yet been designated. The planning system should be used to steer potentially harmful activities away from sensitive sites, including protected areas and sensitive areas outside of protected areas.

[686] ICES, 2010

iv. Licensing processes for industry
Existing licensing processes are inadequate in identifying and protecting cetaceans. There are considerable differences in the requirements depending on the industry and activity being licensed. For example, the existing expectations of the oil and gas industries are largely to conduct mitigation measures during seismic surveys. Yet, the government requirements are more stringent for the novel marine renewable energy industry, often requiring two years of baseline survey data before EIAs are finalised and decisions made. Such research requirements are appropriate and the same expectation should apply for all industries, especially the oil and gas industry when operating in offshore environments, where the fewest population data exist and, in the case of potential beaked whale habitat, where species occur that are the most vulnerable to noise pollution.

v. Cumulative impacts
Data on existing potential threats have been mapped under various Strategic Environmental Assessments (SEAs), including Carbon Capture and Storage, offshore wind and oil and gas at a UK level, wave and tidal for the west coast of Scotland, and a draft SEA for wind in Scottish territorial waters. However, more effort is required to overlay all of these, and to consider military exercise areas used over long (decadal) time periods. Whilst understanding potential cumulative impacts is a considerable challenge, it is essential if we are truly to protect cetaceans and other marine species which do not face these threats in isolation.

As part of the new planning requirements under the Marine Acts, there needs to be more emphasis on cumulative impacts. Comprehensive studies to investigate the potential cumulative impacts to cetaceans in UK waters should be a priority for governments. Establishing a suitable framework is necessary to bring together the assessment of these various developments and activities to understand the potential impacts on cetaceans at a regional level.

Populations

Existing population lists (for example the UK BAP list) do not take account of genetic variation within species in UK waters. Management to the subpopulation level is important, especially where subpopulations are small and/or where immediate threats have been identified.

In addition, there is little understanding of interactions with other species, population structure and dynamics, viability of populations and long-term disturbance including behavioural responses. Thus, important negative effects may not be considered in appropriate detail. There should be such management requirements as part of the existing processes for designation of MPAs in UK waters.

It is essential that bottlenose dolphins and harbour porpoises, both listed as Annex II species under the EC Habitats Directive, are not precluded from inclusion in MPAs for nationally important populations of marine species if existing sites and protective measures are unable to provide adequate protection for nationally important populations in a given region[687].

Management

Management measures for protected features should be appropriate to the ecological need of the feature, and such management measures should not be compromised by socio-economic considerations. Effective management plans with monitoring and enforcement regimes, clear and achievable conservation objectives and a transparent stakeholder process are required. To be effective, management must be continuous and science-based, incorporate ecosystem-based management and monitoring, include public participation with educational programs and take account of larger environmental issues, including those related to fisheries.

The integration of the management of MPAs with the wider marine environment means that the MPA implementation process must be taken into account as the wider marine planning requirements, as required under the Marine Acts, are taken forward.

Zoning

Zoning is a tool for spatially organising various uses of the sea and can be used to protect the critical habitat of a species, or an ecosystem, from ship traffic, destructive fishing activities, noise pollution, and many other spatially definable activities. Zoning can be employed as part of a marine spatial planning system or ocean zoning initiative, or it can be done within an MPA, such as in a biosphere reserve-type MPA. The biosphere reserve concept incorporates areas zoned for high, medium and lower protection depending on how critical the habitat is determined to be and this has proved a popular and effective model for MPA design whether or not the MPA is formally called a 'biosphere reserve'[688]. Areas that are deemed particularly sensitive, or of the highest conservation priority, should be given stricter levels of protection with fewer or no activities permitted (IUCN

[687] Bell *et al*, 2010
[688] Hoyt, 2005a (2nd edition in prep. for 2011)

Category I, see Section 1). Surrounding these are intermediate buffer zones with medium to lower protection levels, where activities compatible with the conservation objectives established would be allowed to occur (IUCN Category II-VI).

No matter what type of zoning scheme Is employed, the zones can be fixed year-round areas, seasonal, temporal or even moveable depending on identification of critical habitat, threats or other aspects that may change over time. Zoning for cetaceans requires knowledge of critical habitat, ideally over multiple years, with precautionary approaches to identifying boundaries for these areas, and in some cases flexibility must be built into the system, leaving room for changes in future. Whereas many cetacean populations will consistently use a particular area of sea year after year, others may shift their habitats temporarily within a season or from year to year. Over the past two decades, for example, two US MPAs — Glacier Bay National Park and Stellwagen Bank National Marine Sanctuary — have experienced several large-scale temporary shifts in whale distribution, with most whales leaving and then returning after one to two years in both cases[689]. The SCANS and SCANS II surveys that took place 10 years apart in UK waters suggested that in some areas harbour porpoises may have undergone a comparable shift, at least as viewed at the broad scale of these surveys — although more localised areas of high density may have persisted and remained undetected by these surveys. Designing MPAs to accommodate potential changes in distribution – through the creation of larger MPAs, networks of sites, and incorporating flexibility through zoning – could be highly beneficial for many cetacean populations.

The cetacean critical habitat areas identified in Section 7 are intended to represent highly-protected zones within what would be larger MPAs with buffer zones to encourage other compatible uses and allow for a more precautionary approach. In some cases the critical habitat areas for multiple species overlap — these areas must be given high priority, although there must be a consideration of the relative conservation status and coverage of the individual species featured. This critical habitat approach could then be productively extended to other marine species with conservation needs. In the Mediterranean, for example, there has been an effort to compare critical habitat and hotspot maps from cetacean, pinniped (monk seal), seabird, shark and tuna specialists[690].

This marine biodiversity approach using apex predators has provided a stronger rationale for many of the cetacean MPA proposals from the ACCOBAMS Scientific Committee while indicating some fine tuning of other proposals with improved indications of useful zoning. In several cases new hotspot areas have been identified from seabird data that have turned out to be cetacean critical habitat as well. Some preliminary mapping of threats in these areas has also proved useful as marine species may have common threats (e.g. driftnets and other fishing gear entanglements, pollution, ship strikes, etc.). The challenge with all of this work is that we need to make conservation decisions based on incomplete information; deciding where to draw the line between precautionary approach and simply needing more information before acting is difficult yet we must make these decisions, while continuing with research.

A precautionary approach would also suggest that some level of protection in zones be granted for areas of interest, as identified in this report, while further studies are undertaken; more about this comes in Section 9 to follow.

[689] Hoyt, pers. comm.
[690] Hoyt *et al*, 2006; Hoyt and Notarbartolo di Sciara, 2008; Hoyt, in Reeves, 2009

9. IDENTIFICATION AND PRIORITISATION OF DATA GAPS

This report has identified a lack of distribution and abundance data for many cetacean species. Whilst this lack of data should not prevent conservation measures from taking place in line with a precautionary approach, appropriate resources for research, monitoring and compliance will be essential to inform the marine planning system and ensure Ministers fulfil their duties under the Marine Acts and relevant European Directives. These recommendations are made with this in mind.

Data gaps

Lack of data is a serious hindrance to attempts to develop effective conservation measures for cetaceans. Particular data gaps that make identifying critical habitat difficult include:

- all aspects of offshore species (including distribution, abundance and habitat preferences); particularly information on critical life processes such as breeding, raising calves and feeding;
- data from outside the summer months (for most species we have little or no knowledge of important winter habitat);
- occurrence and level of threat, particularly at a fine-scale, and
- distribution and abundance of prey species, particularly those that are not commercially exploited, and predator/prey dynamics.

It is recommended that these gaps are prioritised in order for the results to be considered in critical habitat identification and MPA design.

The broad-scale offshore and shelf water surveys CODA and SCANS provide very important information on distribution and abundance, and if they continue to be repeated every 10 years, they will be able to provide essential information on trends and large scale changes in distribution over the longer term.

To complement this type of data, finer-scale seasonal investigations of areas are also necessary to enable the identification of critical habitat in finer detail. Spatial modelling of data, such as that completed for the SCANS and CODA datasets, provides predictions of high density areas and can be used to focus fine-scale investigations. These studies can then help ‘ground truth’ the modelling.

The 'areas of interest' identified for each species should also be used to focus research effort in UK waters:

Harbour porpoise (see Figure 6.2, p.81)

- Firth of Clyde (west and south west Scotland)
- north of the Scottish mainland (north Scotland)
- south and east coasts of Shetland (north Scotland)
- Moray Firth north coast (in the region of Helmsdale) (east Scotland)
- offshore outer Moray Firth (east Scotland)
- Dogger Bank (east England)
- east of the Wash (Norfolk) (east England)
- north Devon (south west England)
- off Land's End, Cornwall (south west England)
- outer Bristol Channel south to north west Cornwall (south west England)
- St. George's Channel (Irish Sea)

Short-beaked common dolphin (see Figure 6.4, p.86)

- The Minches and the Sea of the Hebrides (west and south west Scotland)
- Celtic Sea (south west England)

Minke whale (see Figure 6.5, p.88)

- Dogger Bank (east England)
- Isles of Mull, Coll and the Small Isles (west and south west Scotland)

White-beaked dolphin (see Figure 6.6, p.90)

- The Minch (west and south west Scotland)

Killer whale (see Figure 6.8, p.93)

- Mull-Treshnish Islands-Skye and the Little Minch (west and south west Scotland)
- coastal waters of Shetland (north Scotland)

Atlantic white-sided dolphin (see Figure 6.9, p.94)

- Faroe-Shetland Channel (north Scotland)

Long-finned pilot whale (see Figure 6.10, p.95)

- Rockall Bank and Hatton Rockall Trough (far west Scotland)

Sperm whale (see Figure 6.11, p.96)

- Faroe-Shetland Channel and Wyville-Thomson and Ymir Ridges (north Scotland)
- Rockall Trough (far west Scotland)

Beaked whales and baleen whales

We also recommend that the northern Rockall Trough, Faroe-Shetland Channel and Wyville-Thomson and Ymir Ridges should be considered as areas of interest for beaked whales, and the Faroe-Shetland Channel an area of interest for baleen whales, even though there were too few data to classify these as areas of interest (see Figures 6.12, p.97 and 6.13, p.98).

Immediate impact concerns

The extensive offshore areas of far west Scotland and north Scotland have many question marks regarding the identity, abundance and distribution of cetaceans. With their populations of large baleen and beaked whales, as well as various dolphins, far west and north Scotland are the UK's most diverse cetacean areas. Yet we know comparatively little about them. Building on the broad-scale CODA survey and other seasonal work, much more detailed research should be undertaken in these areas before any development should be considered. The far west and north Scotland present a strong case for precautionary protection.

Other areas where the lack of fine-scale data is of particular concern are the North and Celtic Seas. There are significant known and suspected impacts to cetaceans in these areas, and SCANS and other surveys have shown a high abundance of cetaceans here too. A lack of finer-scale data on the location of cetacean critical habitats and threats (where cetaceans come into conflict with human activities), makes it difficult to reduce impacts and put in place appropriate protection.

Acquiring data sources

Some UK cetacean data exist that were not able to be used in this study, as they were not in the relevant format or had not been analysed to a suitable standard. All stakeholders that have collected field research data should wherever possible make this available for inclusion in the work that is being undertaken by the nature conservation agencies to designate nature conservation MPAs. At the same time, nature conservation agencies should be amenable to inclusion of valuable data sets in their analysis towards designation of a coherent network.

Existing data for other mobile marine species (and habitats) should be collected and overlaid with the cetacean data presented here (including, for example, basking sharks, seabirds, seals) to identify areas or 'hot spots' that are important to a number of species. This will also help to enable the identification of 'cold spots' where industries can be guided, although caution must be taken to ensure that these are cold spots and not just areas where data are lacking.

Recommendations on particular data gaps

Recommendations on particular data gaps for each species were detailed in the species accounts and these are highlighted together below:

Harbour porpoises

- Large scale surveys in the North Sea have demonstrated that large-scale changes in harbour porpoise distribution have occurred in the area. The factors driving these need to be better understood and probably require a greater understanding of prey populations. Smaller-scale surveys are also necessary to determine if some areas remain important to harbour porpoises throughout these larger scale fluctuations.
- Several locations around the UK have been observed to have high densities of harbour porpoises during the summer months when this species is known to breed and produce young. This may indicate these areas have importance for these functions and should be investigated further.

Bottlenose dolphins

- In order to assess the viability of the small west coast bottlenose dolphin communities, studies into survivorship and stock structure are needed.
- Data suggest there are large populations of offshore bottlenose dolphins in UK waters but we have virtually no information about them. The Celtic Sea may be a useful place to focus initial research efforts as high densities have been recorded here.

Common dolphins

- Studies suggest the existence of two ecological stocks of common dolphins within the north east Atlantic – a coastal and a neritic stock. This needs to be investigated to ensure both are considered in conservation planning.

Minke whales

- Large decreases in minke whale sightings have been observed in recent years for the west coast of Scotland, possibly connected to prey availability. During a similar time frame, sightings in the Moray Firth have increased, leading to the suggestion that the two populations may be linked. This should be investigated along with the factors behind the potential shift.
- Overall, information on minke whale distribution and habitat use is poor considering there are high densities of animals in the UK's coastal waters for six months of the year. Effort should be focused on improving this situation in order to inform conservation efforts.

White-beaked dolphins

- As with minke whales, information is surprisingly poor considering the species abundance in UK waters. In order to inform conservation efforts, improving our knowledge of white-beaked dolphins should be a focus.

Risso's dolphins

- Further research is needed for the waters of north east Lewis and Bardsey Island to improve our knowledge of these important populations of Risso's dolphins. Expanding the photo-ID catalogues in the surrounding areas will help us understand the wider-scale movements and possible connections between these populations.

Killer whales

- Further research is required to determine population sizes for killer whales in the north east Atlantic and to confirm if there is reproductive isolation among sympatric types as research suggests and as has been documented for north east Pacific killer whales.

All offshore species

- For Atlantic white-sided dolphins, sperm whales, long-finned pilot whales, beaked whales and baleen whales, as noted above, there is an almost complete lack of data on foraging, breeding and other important life functions.

10. CONCLUSIONS

This project identified a number of areas of cetacean critical habitat in UK waters, sites used regularly for critical life processes such as feeding and raising young. Critical habitat was identified for harbour porpoises, bottlenose dolphins, white-beaked dolphins, Risso's dolphins, minke whales, and short-beaked common dolphins. For at least harbour porpoises, white-beaked dolphins, minke whales and common dolphins, given the importance of UK waters for these species, it is highly likely that further areas of critical habitat exist.

Insufficient data were available to allow the identification of critical habitat for other species. For many – particularly Atlantic white-sided dolphins, long-finned pilot whales, northern bottlenose whales, Sowerby's beaked whales, sperm whales and killer whales – the UK's waters provide significant areas of habitat and, within this, there will be areas of critical habitat, important for critical life processes such as breeding, calving and feeding. Several areas of interest were identified for these species, showing some evidence of importance, and these should be investigated further.

It is important to stress that information is often patchy and in some areas severely lacking. In an ideal world, assessments such as these would be undertaken using datasets that when combined provide complete and even coverage throughout the survey area. This level of information will not be available for many years, if ever, and decisions must be taken in the meantime using the data that are available. The results from this project will invariably be biased towards areas where we have information. **Areas not identified as 'critical habitat' or 'areas of interest' are not necessarily unimportant, there may just be little or no information available at present with which to make an assessment**.

To take this work further, the key next steps would be to incorporate a review of cetacean prey data and to give greater consideration to predator/prey dynamics as these will be important factors in refining as well as identifying additional locations of cetacean critical habitat. Also, overlaying cetacean data with data for other mobile marine species, such as basking sharks, seabirds, seals, may reveal 'hot spots' that are important to a number of species. In other areas of the world, notably the Mediterranean, this approach has revealed significant overlap and could be useful in selecting areas that achieve protection for multiple species[691].

The areas of critical habitat identified through this project meet the guidelines for establishing MPAs in UK waters[692]. Following a consideration of threats present in these areas, we recommend that four areas should be considered for MPA protection, or have existing protection extended:

The Hebrides

- the Inner Hebrides, The Minches and the Sea of the Hebrides – harbour porpoise
- north east Isle of Lewis – Risso's dolphins
- the Inner Hebrides and the Sound of Barra – bottlenose dolphins

Other species present here that could also benefit from protective measures put in place are common dolphins, white-beaked dolphins, minke whales and killer whales.

North east Scotland

- south coast, Outer Moray Firth – harbour porpoise
- Inner Moray Firth and north east Scottish coast to St. Andrew's Bay – bottlenose dolphins[693]
- south coast, Outer Moray Firth – minke whales
- Aberdeenshire coast – white-beaked dolphins

South west England

- Celtic Deep – common dolphins

Other species that may benefit from an MPA in this area include minke whales.

[691] Hoyt, in Reeves, 2009
[692] See Section 2
[693] An SAC is already in place for part of this area

Coastal Wales

- northern Pembrokeshire and southern Cardigan Bay; Lleyn Peninsula and Bardsey Island; and, north and west Anglesey – harbour porpoises
- Bardsey Island – Risso's dolphins
- Cardigan Bay – bottlenose dolphins[694]

The UK's total marine area to the limits of its EEZ (Exclusive Economic Zone) equals some 867,000 km^2.[695] The combined cetacean critical habitat identified in this project and recommended for MPA protection amounts to 41,666 km^2 , less than 5% of the UK waters to the limit of its EEZ. This breaks down to 0.75% in England, 3.4% in Scotland, and 0.65% in Wales. As a percentage of each individual country's marine area,[696] these figures represent 2.6% of the marine area of England[697], 4.9% of Scotland[698] and 35% of Wales[699].

New legislation now in place for the UK and Scotland provides an important opportunity to provide potentially powerful conservation measures for cetaceans in UK waters, measures previously unavailable for many species. Considerable expertise has been developed in the nature conservation agencies over recent years through establishing and managing SACs for bottlenose dolphins. This experience and the management structures already in place can be used in the development of MPAs for these and other cetacean species.

Although there has existed a legal tool to create MPAs for harbour porpoises for several years through the EU Habitats Directive, to date no SACs for harbour porpoises have been put in place in the UK. There is good evidence that several sites around the UK meet the criteria outlined by the EC Habitats Committee[700] for SAC designation, as well as for inclusion in a national MPA network. UK waters are a stronghold for harbour porpoises with some of the highest densities in Europe. Locations such as the Hebrides (west Scotland), Pembrokeshire and southern Cardigan Bay (Wales) — where the strongest evidence exists of predictable regular use by concentrations of animals for critical activities such as feeding and raising calves — would be ideal candidates for SAC status, and this would certainly fulfill the criteria for MPA designation at a national level. In addition to offering protection to harbour porpoises in these critical habitats, it would provide the opportunity to conduct research into the effects of management measures put in place and monitor if they are beneficial to porpoise populations. If benefits for harbour porpoise populations were observed, further locations could be considered for protection.

MPAs are a work very much in progress. They are being used in many parts of the world for cetacean conservation, they are showing success, and they could provide similar benefits in the UK[701]. As highly-mobile marine species, cetaceans present certain challenges in attempts to develop conservation measures, particularly as there are many gaps in our knowledge. With this is mind, it will be important to develop MPAs in a precautionary manner. This means ensuring they are sufficiently large (at least in the early stages), flexible, and adaptive to new information in order to provide us with buffers against uncertainty and ensure critical habitats have been protected.

694 An SAC is already in place for part of this area
695 Frid and Paramor, 2006
696 Based on the area for which each country has MPA designation authority — England out to 200nm; Scotland out to 200nm (joint authority with JNCC, 12-200nm); Wales out to 12nm.
697 England's marine area is 248,381km^2. Area of critical habitat identified in English waters is 6,461km^2.
698 Scotland's marine area is 602,600km^2. Area of critical habitat identified in Scottish waters is 29,530km^2.
699 Wales's marine area is 15,992km^2. Area of critical habitat identified in Welsh waters is 5,667km^2.
700 14th December 2002, DG Environment. See Section 1 - continuous or regular presence of the species, good population density and high ratio of young to adults during certain periods of the year
701 Reeves, 2009; Hoyt, 2005a (2nd edition in prep. for 2011)

ANNEX I – STATUS OF UK CETACEANS

		Global Red List	International conventions	Regional conventions and legislation		National lists (after CBD)		UKBAP – Evidence for selection as priority species
Common name	*Scientific name*	IUCN	CMS	OSPAR[1]	EU Habitats Directive[2]	Scottish Biodiversity List	UK BAP List	Estimated % of European population in UK waters
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Least Concern	II**		IV	Y	Y	81%
Bottlenose dolphin	*Tursiops truncatus*	Least Concern	II**		II/IV	Y	Y	60%
Blue whale	*Balaenoptera musculus*	Endangered	I	All regions it occurs	IV	N	Y	37%
Short-beaked common dolphin	*Delphinus delphis*	Least Concern	II**		IV	Y	Y	50%
Cuvier's beaked whale	*Ziphius cavirostris*	Least Concern			IV	Y	Y	75% (limited records in the NE Atlantic & Europe)
False killer whale	*Pseudorca crassidens*	Data Deficient			IV	Y	N	-
Fin whale	*Balaenoptera physalus*	Endangered	I/II		IV	Y	Y	25%
Harbour porpoise	*Phocoena phocoena*	Least Concern	II**	I/II*	II/IV	Y	Y	90%
Humpback whale	*Megaptera novaeangliae*	Least Concern	I		IV	Y	Y	50%
Killer whale	*Orcinus orca*	Data Deficient	II		IV	Y	Y	35%
Long-finned pilot whale	*Globicephala melas*	Data Deficient	II**		IV	Y	Y	88%
Minke whale	*Balaenoptera acuturostrata*	Least Concern			IV	Y	Y	60%
Northern bottlenose whale	*Hyperoodon ampullatus*	Data Deficient	II		IV	Y	Y	35%
North Atlantic right whale	*Eubalaena glacialis*	Endangered		All regions it occurs	IV	Y	Y	0%
Pygmy killer whale	*Feresa attenuata*	Data Deficient			IV	N	N	-
Risso's dolphin	*Grampus griseus*	Least Concern	II**		IV	Y	Y	86%
Sei whale	*Balaenoptera borealis*	Endangered	I/II		IV	N	Y	53%
Sowerby's beaked whale	*Mesoplodon bidens*	Data Deficient			IV	Y	Y	Less than 30%
Sperm whale	*Physeter macrocephalus*	Vulnerable	I/II		IV	Y	Y	Less than 30%
Striped dolphin	*Stenella coeruleoalba*	Least Concern			IV	N	Y	25%
True's beaked whale	*Mesoplodon mirus*	Data Deficient			IV	Y	Y	Less than 30%

[1] CMS
Appendix I – Migratory species categorised as being in danger of extinction;
Appendix II – Migratory species that have an unfavourable conservation status

[2] EU Habitats Directive
Annex II – Species requiring that Special Areas of Conservation (SACs) be designated under the Natura 2000 programme;
Annex IV – Species to be strictly protected

* Regions I (Greater North Sea) and II (Celtic Sea)

** Only North Sea population (within UK)

ANNEX II - SPECIES ACCOUNTS SUMMARY TABLES

This series of tables summarises the papers used to prepare the species accounts. Only areas with significant amounts of data were included in the tables. All surveys are visual surveys unless otherwise stated.

HARBOUR PORPOISE

West and south west Scotland

			West Scotland		
Study	Temporal Resolution	Spatial Resolution	Continental shelf, W of the Outer Hebrides	Hebrides	Firth of Clyde
Hammond *et al*, 1995; Hammond *et al*, 2002; SCANS II, 2006	Jul 1994	North Sea and adjacent waters		Only the very N part of The Minch included. Density surface modelling predicted high porpoise density for the N Minch, along with N and E Scottish and NE English coastal waters.	
SCANS II, 2006	Jul 2005	North Sea and European Atlantic continental shelf waters	Low density recorded in this region, 0.067 animals/km^2.	Density estimate of 0.394 animals/km^2 and an abundance of 12,076 animals recorded for the Hebrides. One of the highest densities recorded for the NE Atlantic. Density surface modelling predicted high density for coastal Inner Hebrides waters.	
Goodwin and Speedie, 2008	May-Aug 2002-2004	W coast of the UK		Very high density estimate of 1.071 animals/km^2 (CV 0.208) recorded for the waters N of Skye, and S to Coll and Mull (2004 data). High relative abundance recorded for all years.	High density estimate of 0.823 animals/km^2 (CV 0.351) recorded for the Firth of Clyde (2004 data). High relative abundance recorded for all years.
Evans and Wang, 2002	All months, 1980-2001	NW European Continental Shelf	Recorded, but in lower numbers.	The Minch and S of Skye to Mull, rated of highest importance to harbour porpoises. Presence recorded throughout the year, with high abundance in several months.	Presence recorded but no concentrations noted.
Northridge *et al*, 1995	All months, 1979-1990	UK and Irish waters	Important concentrations of porpoises noted for W Scotland. Low relative density for the Hebrides shelf to the W.		
Bravington *et al*, 2002	Joint Cetacean Database up to 2000	UK waters	No hotspots identified.	No hotspots identified.	No hotspots identified.
MacLeod, 2001	All seasons, 1998-2000	Atlantic Frontier and the Hebrides	Recorded, but in lower numbers.	Presence recorded in all seasons, and areas of high relative abundance summer and autumn.	Presence recorded in all seasons.
Pollock *et al*, 2000	All months, 1979-1999	Atlantic Frontier	High relative abundance recorded W of the Uists and NE of Lewis (Nov to Mar).	Presence, and areas of relatively high abundance, recorded throughout the year.	Presence recorded for the outer Firth of Clyde throughout the year.
Lewis *et al*, 1998 (acoustic survey)	Dec 1997 to Mar 1998	NW of the Hebrides	High number of detections made NE of Lewis (Dec to Feb).		
Weir, 2008	Aug 2007	The Minch, NW Scotland		Widespread distribution throughout The Minch. Very high relative abundance in E Minch. High concentrations also in waters E of Skye.	
Marubini *et al*, 2009	Summer 1992-1998	The Hebrides, NW Scotland		Modelling of summer survey data predicted several areas of high abundance – SE Barra; E of Lewis; NE of Skye to Gairloch; and between Coll, the Small Isles and Ardnamurchan.	
Embling *et al*, 2010	Summer 2003-2005	S Inner Hebrides, NW Scotland		Modelling of summer survey data predicted several areas of high abundance – Sound of Jura; Firth of Lorne; nr the Small Isles; and W Mull.	

HARBOUR PORPOISE

Far west Scotland

Study	Temporal Resolution	Spatial Resolution	Far West Scotland
Pollock *et al*, 2000	All months, 1979-1999	Atlantic Frontier	Moderate encounter rate recorded for the Wyville-Thomson Ridge and Faroe Bank Channel. High encounter rate NE of Shetland, close to the continental shelf edge (Apr to Oct).
Evans and Wang, 2002	All months, 1980-2001	NW European Continental Shelf	High relative abundance recorded W of Wyville-Thomson Ridge.
Northridge *et al*, 1995	All months, 1979-1990	UK and Irish waters	Small numbers noted for the Rockall and Faroe Banks.
Skov *et al*, 1995	Jul-Aug 1987 and 1989	Offshore NE Atlantic (mainly around the Faroe Islands)	Cluster of sightings in the Faroe Bank Channel area, late summer.
MacLeod, 2001	All seasons, 1998-2000	Atlantic Frontier and the Hebrides	Present, but in low numbers between the Rosemary Bank and Wyville-Thomson Ridge, and the Faroe Bank Channel, in spring.

North Scotland

Study	Temporal Resolution	Spatial Resolution	Shetland	Orkney and Fair Isle
Hammond *et al*, 1995; Hammond *et al*, 2002; SCANS II, 2006	Jul 1994	North Sea and adjacent waters	Spatial modelling of the SCANS sightings data predicted a large area of high density covering the waters of E, NE and N Scotland.	
			The highest density recorded in UK waters was for the Northern Isles block, 0.783 animals/km^2, and an abundance of 24,335 animals. The adjacent block, covering the remaining waters of N Scotland had a moderate density of 0.363 animals/km^2.	
SCANS II, 2006	Jul 2005	North Sea and European Atlantic continental shelf waters	Spatial modelling of SCANS II sightings data predicted the area of high density identified 10 years previously had dispersed S to the waters off E England, but persisted and intensified to the N and NW of the Scottish mainland.	
			Density estimates were moderately low for the Northern Isles, 0.274 animals/km^2. Further offshore, densities decreased to 0.067 animals/km^2	
Evans and Wang, 2002	All months, 1980-2001	NW European Continental Shelf	Shetland, particularly E coastal waters, rated as a 'Category 1' site – of very high importance to harbour porpoises. Presence recorded throughout the year, with high abundance in at least four months of the important Apr-Sep period.	
Northridge *et al*, 1995	All months, 1979-1990	UK and Irish waters	Results are not fine scale and do not specifically refer to the coastal waters of the Northern Isles. Low relative densities noted for the shelf waters off N Scotland.	
Pollock *et al*, 2000	All months, 1979-1999	Atlantic Frontier	Relatively high abundance to the S and E of the Shetland, Apr to Oct.	Relatively high abundance in Orkney's coastal waters, Apr to Oct.
Evans, 1997	May-Oct, 1992-1994	Shetland Islands, N Scotland	High sightings rates on the E and S coasts, particularly Sumburgh Head, Mousa Sound, Noss Sound, and E Whalsay/Out Skerries.	

HARBOUR PORPOISE

East Scotland

Study	Temporal Resolution	Spatial Resolution	Moray Firth	Aberdeenshire coast
Hammond *et al*, 1995; Hammond *et al*, 2002; SCANS II, 2006	Jul 1994	North Sea and adjacent waters	Spatial modelling of the SCANS sightings data predicted a large area of high density covering the waters of E, NE and N Scotland.	
			The highest density recorded in UK waters was for the block covering the waters of the Northern Isles and the Inner Moray Firth, 0.783 animals/km^2, and an abundance of 24,335 animals. The adjacent block, covering the waters of N Scotland and the Outer Moray Firth had a moderate density of 0.363 animals/km^2.	A moderate density was recorded for the coastal waters of E Scotland and England, 0.387 animals/km^2.
SCANS II, 2006	Jul 2005	North Sea and European Atlantic continental shelf waters	Spatial modelling of SCANS II sightings data predicted the area of high density identified 10 years previously had dispersed S off E England, and further to the W of Scotland.	
			A moderately low density of harbour porpoises was recorded for the Moray Firth and the Northern Isles, 0.274 animals/km^2.	A moderately low density of 0.294 animals/km^2 was recorded for the waters off NE and E Scotland.
Evans and Wang, 2002	All months, 1980-2001	NW European Continental Shelf	The S coast of the Moray Firth and the NE Aberdeen coast rated a 'Category 2' site – of high importance to harbour porpoises. Presence recorded through most of the year, with high abundance in several months.	
Northridge *et al*, 1995	All months, 1979-1990	UK and Irish waters	Porpoises widely distributed through the N North Sea.	
Bravington *et al*, 2002	Joint Cetacean Database up to 2000	UK waters	Some evidence of a high density area existing E of the Moray Firth and the Firth of Forth.	
Thompson *et al*, 2010	Data review – 1980 to 2008 New surveys – May to Oct, 2009	Moray Firth	Present throughout inshore and offshore waters of the Moray Firth. Highest encounter rates recorded in the Outer Moray Firth. Acoustic survey detected porpoises at 97.5% of sites in the Outer Moray Firth, for a mean of 6.7 hours a day.	
Hastie *et al*, 2003	Inner Moray Firth – May to Sep 1990-2000 Outer Moray Firth – Jan and Oct 2001	Moray Firth	Porpoises were distributed throughout the Moray Firth with no significant difference in encounter rate between the SAC and the Outer Moray Firth. Within the SAC area, porpoises sightings were nearly all away from the coast.	
Robinson *et al*, 2007	May to Oct 2001-2005	S coast of the Outer Moray Firth	Harbour porpoises were the most commonly sighted cetacean. High relative abundance 1-5 km from the coast, particularly later in the season.	
Eisfeld *et al*, 2008	Feb, May, Aug and Nov 2008	Central Outer Moray Firth	Recorded in every season. Highest relative abundance in Aug, then May.	
Bailey and Thompson, 2009	Aug-Oct 2004, Apr-Jul 2005	Inner Moray Firth	Widely dispersed throughout survey area. Spatial modelling predicted highest relative densities towards the centre of the area, away from the coasts, and also off Helmsdale.	
Weir *et al*, 2007	March 1999 – Oct 2001	Aberdeenshire, NE Scotland		Present throughout the year. Highest relative abundance close to Aberdeen, and just to the S.

HARBOUR PORPOISE

East England

Study	Temporal Resolution	Spatial Resolution	East England
Hammond *et al*, 1995; Hammond *et al*, 2002; SCANS II, 2006	Jul 1994	North Sea and adjacent waters	Spatial modelling of this dataset predicted a large area of high density off E Scotland, stretching into the waters of NE England.
			Second highest density in UK waters was recorded for the N North Sea, 0.776 animals/km^2. A moderately high density of porpoises was documented for coastal E Scotland and England region, 0.387 animals/km^2. Offshore of E England, in the central/S North Sea, densities were moderate, 0.34 animals/km^2.
SCANS II, 2006	Jul 2005	North Sea and European Atlantic continental shelf waters	Spatial modelling showed a movement of the predicted high density area S, off the E English coast.
			Highest density for UK waters was recorded for the block off E England, in the central North Sea – 0.562 animals/km^2.
Evans and Wang, 2002	All months, 1980-2001	NW European Continental Shelf	Several areas in this region were assessed to be of importance to harbour porpoises – E of Northumberland and E of Yorks were rated 'Category 3 sites', meaning porpoises are present for several months of the year, with high sightings rates at certain times. E of the Wash (Norfolk) was rated a 'Category 2 site' as porpoises are present in most months of the year, with concentrations during the key Apr-Sep calving period.
Northridge *et al*, 1995	All months, 1979-1990	UK and Irish waters	Porpoises widely distributed through the central North Sea.
Bravington *et al*, 2002	Joint Cetacean Database up to 2000	UK waters	No hotspots detected.

HARBOUR PORPOISE

South West England

Study	Temporal Resolution	Spatial Resolution	Western English Channel	N Devon and Cornwall coasts and the Bristol Channel
Hammond *et al*, 1995; Hammond *et al*, 2002; SCANS II, 2006	Jul 1994	North Sea and adjacent waters	No high density areas were predicted by the model for SW England.	
			No porpoises recorded in the Channel.	A low density of harbour porpoises was recorded in the Celtic Sea and Bristol Channel, 0.18 animals/km^2.
SCANS II, 2006	Jul 2005	North Sea and European Atlantic continental shelf waters	Moderate densities were predicted for harbour porpoises in the Celtic Sea and the W edge of the Channel.	
			Moderate density was recorded in the Channel, 0.331 animals/km^2.	The second highest density for UK waters was recorded in the Celtic Sea and Bristol Channel, 0.408 animals/km^2.
Evans and Wang, 2002	All months, 1980-2001	NW European Continental Shelf	Not categorised due to insufficient effort related data but significant concentrations of porpoises were noted for the region in the first quarter of the year.	Several hotspots identified for this area. N Devon was rated a Category 1 site (one of only four for UK waters) due to the high concentrations of porpoises found in multiple months of the year, particularly during the Apr-Sep key calving period. NW Cornwall and the Outer Bristol Channel both were rated Category 2 sites, meaning porpoises were found to be present in most months of the year, with concentrations during the key Apr-Sep calving period.
Northridge *et al*, 1995	All months, 1979-1990	UK and Irish waters	No particular concentrations noted.	
De Boer and Simmonds, 2004; WDCS, 2005b	Jan-Mar, 2004 and 2005	W English Channel	Patchy distribution. Overall low relative abundance but sometimes large groups sighted.	
De Boer and Saulino, 2007	Dec-Mar, 2007	W English Channel	Most sightings in Mar. Important locations seem to be near Gwennap Head and Wolf Rock.	
Pikesley *et al*, IN PRESS	All months, 1991-2008	Coastal waters of Cornwall		Predominantly sighted off Land's End.
De Boer and Simmonds, 2003	Oct-Nov 2002	Wales and SW England		Second highest relative abundance recorded for the Outer Bristol Channel, with N coasts of Devon and Cornwall almost as high.

HARBOUR PORPOISE

Irish Sea

Study	Temporal Resolution	Spatial Resolution	Irish Sea
SCANS II, 2006[702]	Jul 2005	North Sea and European Atlantic continental shelf waters	Spatial modelling did not predict high density areas for this region.
			The Irish Sea/Cardigan Bay sector had a moderate density of porpoises, 0.335 animals/km^2.
Evans and Wang, 2002	All months, 1980-2001	NW European Continental Shelf	St. George's Channel (W of Pembrokeshire) Category 2 rated – high concentrations in some months, including during Apr to Sep.
Northridge *et al*, 1995	All months, 1979-1990	UK and Irish waters	Important concentrations noted for the S Irish Sea – St. George's Channel and off Pembrokeshire.
Bravington *et al*, 2002	Joint Cetacean Database up to 2000	UK waters	Possible hotspot in the central Irish Sea.
Baines and Evans, 2009	All months, 1990-2007	Irish Sea, St. George's Channel and NE Celtic Sea	No hotspots noted beyond those in coastal Welsh waters.
Weir and O'Brien, 2000	Aug 1998	Central Irish Sea	High relative abundance recorded in the region of the Irish Sea front; greatest concentrations found in the immediate area of the front and on the mixed side.

[702] SCANS (in 1994) did not cover the Irish Sea

HARBOUR PORPOISE

Coastal Wales

Study	Temporal Resolution	Spatial Resolution	Gower Peninsula	Pembrokeshire and Southern Cardigan Bay	Northern Cardigan Bay and Anglesey
Hammond *et al*, 1995; Hammond *et al*, 2002; SCANS II, 2006	Jul 1994	North Sea and adjacent waters	No high density areas were predicted by the model for SW England.		
			A low density of harbour porpoises was recorded for the Celtic Sea and Bristol Channel, 0.18 animals/km^2.		
SCANS II, 2006	Jul 2005	North Sea and European Atlantic continental shelf waters	Spatial modelling did not predict high density areas for this region.		
			The second highest density for UK waters was recorded in the Celtic Sea/Bristol Channel sector (including S Pembrokeshire, S St. George's Channel and the Gower), 0.408 animals/km^2. The Irish Sea/Cardigan Bay sector had a moderate density of porpoises, 0.335 animals/km^2.		
Evans and Wang, 2002	All months, 1980-2001	NW European Continental Shelf	Rated a Category 3 site. Concentrations in some months and present for most of the year.	Category 1 rated (most important) – high concentrations of porpoises in most months of the year, including throughout the Apr to Sep key calving period.	Lleyn Peninsula and N Cardigan Bay rated a Category 2 site; high concentrations in some months, including during the Apr to Sep period; Anglesey rated a Category 3 site with concentrations in some months and present for most of the year.
Northridge *et al*, 1995	All months, 1979-1990	UK and Irish waters	No concentrations noted.	Important concentrations noted for the S Irish Sea - St. George's Channel and off Pembrokeshire.	No concentrations noted.
Bravington *et al*, 2002	Joint Cetacean Database up to 2000	UK waters	No concentrations identified.	Strongest suggestion of a hotspot in UK waters found in the S Irish Sea, off the coast of Pembrokeshire.	No concentrations identified.
Baines and Evans, 2009	All months, 1990-2007	Irish Sea, St. George's Channel and NE Celtic Sea	Concentrations off the S coast of Wales - the Gower and Newport Bay (less so than Pembrokeshire and Anglesey).	Areas of high relative density off the Pembrokeshire coast and to a lesser extent in S Cardigan Bay.	Areas of high relative density around Anglesey and to a lesser extent off the S coast of the Lleyn Peninsula.
Pesante *et al*, 2008	Apr 2005 - Dec 2007	Cardigan Bay, Wales		Abundance estimates ranged from 167 to 214 (2005-2007) and present year round; densities higher in the S part of the Bay, with greater presence around New Quay head, Aberporth, Ynys Lochtyn, and between Cemaes Head and Ceibwr Bay.	
De Boer and Simmonds, 2003	Oct-Nov 2002	Wales and SW England		Highest relative abundance recorded around the Pembrokeshire Islands.	Lower relative abundance than further S; most sightings nr Bardsey Island and N Cardigan Bay.
Pierpoint *et al*, 1998	1992-1997 (months not specified)	Pembrokeshire		Highest sightings rates recorded at Strumble Head, followed by Ramsey Sound.	
WDCS, 2005a	Apr, Jul-Sep 2001-2005	Bardsey Island and the Lleyn Peninsula, N Wales			Very high relative abundance recorded for Apr; porpoises also seen in significant numbers throughout Aug and Sep.
Shucksmith *et al*, 2008	May-Sep 2002-2004	Anglesey, N Wales			Very high density found for South Stack (1.267 animals/km^2), high density at Point Lynas (0.815 animals/km^2) (N Anglesey coast). Density for total survey area 0.63 animals/km^2.
Watkins and Colley, 2004	Dec 2002-Feb 2004	S Wales coast	Highest relative abundance recorded for Mumbles Head and Burry Holms.		

BOTTLENOSE DOLPHIN

For the well-studied and documented areas of the Inner Moray Firth and southern Cardigan Bay, not all papers were included here. Only the most recent or relevant papers have been included in the table.

Study	Temporal Resolution	Spatial Resolution	East Scotland	West Scotland and the Atlantic Frontier	Irish Sea (including Cardigan Bay) and St. George's Channel	Celtic Sea and English Channel
CODA, 2009[703]	Jul 2007	Beyond the continental shelves of the UK, Ireland, France and Spain	Abundance estimate for the survey area was 19,295 (CV 0.25; 95% CI = 11,842-31,440).			
				Estimate of 5,709 animals (CV 0.35) for waters offshore of W Scotland, and a density of 0.016 animals/km^2.		Estimate of 11,536 animals (CV 0.33) for the waters offshore SW England and Ireland, and a density estimate of 0.034 animals/km^2. Highest density and abundance for the survey area.
Hammond *et al*, 1995; Hammond *et al*, 2002	Jul 1994	North Sea and adjacent waters	Insufficient sightings to produce an abundance estimate.			
			A few sightings for this area.			Scattered sightings throughout the Celtic Sea.
SCANS II, 2006[704]	Jul 2005	North Sea and European Atlantic continental shelf waters	Abundance estimate for the survey area was 12,645 (CV 0.27; 95% CI = 7,504-21,307).			
			An abundance of 412 animals (CV 0.86) and density of 0.011 animals/km^2 estimated for the NE Scotland sector.	An abundance of 246 animals (CV 1.04) and a density of 0.008 animals/km^2 estimated for the Hebrides sector. 1,128 animals (CV 0.68), and a density of 0.0075 animals/km^2 for the sector further offshore.	An estimate of 235 animals (CV 0.75) and a density of 0.0052 animals/km^2 for the Irish Sea.	Highest density and abundance for UK waters found for the Celtic Sea sector – 0.0272 animals/km^2; 5,370 animals (CV 0.49). Abundance of 395 animals (CV 0.74) for the channel and a density of 0.0032 animals/km^2.
Reid *et al*, 2003	All months, 1979-2003	NW European waters	High sightings rates for the Inner Moray Firth and S Outer Moray Firth.	Some sightings in the Hebrides. High sightings rate over the Wyville-Thomson and Ymir Ridges in offshore waters.	High sightings rates throughout Cardigan Bay. Lower levels for the St. George's Channel.	High sightings rates for the S coast of Cornwall. High sightings rates offshore, along the continental shelf edge.
Thompson *et al*, IN PREP	All months, 1989-2009	Scottish waters	E coast population estimate for 2006 is 193 animals (95% Probability Interval = 162-245). Covers the inshore waters from the Moray Firth to St Andrews Bay. Can be considered an appropriate estimate for the North Sea.	W coast population estimate for 2007 is 45 animals (95% Probability Interval = 33-66). Of these, 13-15 animals were only seen in the Sound of Barra.		
Stone 1997, 1998, 2003, 2006	All months, 1996-2002	UK and Irish waters	Offshore sightings mainly along continental shelf edge. Scattered sightings in other areas.			
MacLeod, 2001	All seasons, 1998-2000	Atlantic Frontier and the Hebrides		Only two sightings: one in The Minch, the other in the Rockall Trough.		
Pollock *et al*, 2000	All months, 1979-1999	Atlantic Frontier		Infrequently sighted. Found in coastal shelf waters during summer, and Sep-Mar seen offshore in deep waters, particularly along the Wyville-Thomson and Ymir Ridges.		

[703] Uncorrected for animals missed on the transect line
[704] Uncorrected for animals missed on the transect line

BOTTLENOSE DOLPHIN

Study	Temporal Resolution	Spatial Resolution	East Scotland	West Scotland and the Atlantic Frontier	Irish Sea (including Cardigan Bay) and St. George's Channel	Celtic Sea and English Channel
Skov *et al*, 1995	Jul-Aug, 1987 and 1989	Offshore NE Atlantic (mainly around the Faroe Islands)		Found to have an association with deep waters along the continental slopes.		
Shrimpton and Parsons, 2000	1979-1999	The Hebrides, NW Scotland		Widespread throughout the Hebrides, mainly in nearshore waters. Regularly-sighted group around Mull, Coll, Tiree and the Ardn amurchan peninsula. Resident group in the coastal waters of Barra.		
Boran *et al*, 1999	Jun-Sep 1992-1998	The Minches and Sea of the Hebrides		None reported.		
Dolman and Hodgins, 2009	May and Oct 2009	Gairloch, SE inshore area of The Minch, NW Scotland		Observed on three occasions in May.		
Grellier and Wilson, 2003	Sep 1995 and Jun 1998	Sound of Barra, Outer Hebrides, NW Scotland		Estimated 6-15 individuals inhabit the Sound.		
Robinson *et al*, 2007	May-Oct, 2001-2005	S Outer Moray Firth, NE Scotland	Only sighted close to the coast.			
Eisfeld *et al*, 2009	Feb, May, Aug and Nov 2008	Outer Moray Firth, NE Scotland	None sighted (survey took place away from the coast).			
Bailey and Thompson, 2009	Aug-Oct 2004; Apr-Jul 2005	Moray Firth, NE Scotland	Highest encounter rates, and highest predicted densities, along the coast and within the Inner Moray Firth.			
Culloch and Robinson, 2008	May-Oct, 2001-2004	S Outer Moray Firth, NE Scotland	Only encountered in the coastal region. Significant preference for W area, adjacent to the SAC, particularly the mouth of the River Spey.			
Stockin *et al*, 2006	All months (except Dec) 1999-2001	Coastal Aberdeenshire	Use these waters throughout the year. Aberdeen harbour seems to be an important feeding area.			
Pesante *et al*, 2008	Apr 2005 - Dec 2007	Cardigan Bay, Wales			With an open population model, estimates for the whole of Cardigan Bay in a particular year vary between 154 and 248. Coastal area from Aberaeron to Cardigan, around Fishguard, Tremadog Bay and several sandbanks of particular importance. Appear to be more offshore and N during winter, including off the Isle of Anglesey.	

BOTTLENOSE DOLPHIN

Study	Temporal Resolution	Spatial Resolution	East Scotland	West Scotland and the Atlantic Frontier	Irish Sea (including Cardigan Bay) and St. George's Channel	Celtic Sea and English Channel
Baines and Evans, 2009	All months, 1990-2007	Irish Sea, St. George's Channel and NE Celtic Sea			Mainly coastal distribution. Concentrations in S Cardigan Bay, and Tremadog Bay (N Cardigan Bay). Also N and E of Anglesey.	
De Boer and Simmonds, 2003	Oct - Nov 2002	Wales and SW England			Mostly seen in N Cardigan Bay. Some seen in the S also.	
Pierpoint *et al*, 2009	1994-2007	Cardigan Bay, Wales			High rates of site use during summer at Mwnt, New Quay Harbour and Aberporth.	
Doyle *et al*, 2007	1970-2007	SW England				Sightings uniformly distributed around the coast of Cornwall and Devon[705]. Significant decrease in sightings since 1990.
Pikesley *et al*, IN PRESS	All months, 1991-2008	Coastal waters of Cornwall				Significant decreases in sightings.
Wood, 1998	Aug 1993 - Jul 1996	Cornwall, SW England				Photo-identified over 50 dolphins. Found to be wide-ranging and resident to Cornish waters.

[705] Sightings not effort related

SHORT-BEAKED COMMON DOLPHIN

Study	Temporal Resolution	Spatial Resolution	Western approaches to the English Channel	Irish Sea, St. George's Channel and the Celtic Sea	NW Scotland
Hammond *et al*, 1995; Hammond *et al*, 2002;[706]	Jul 1994	North Sea and adjacent waters	None sighted.	Estimated abundance of 75,450 (95% CI 22,900 - 248,900) common dolphins; almost all common dolphin sightings for the survey were made in the Celtic Sea and St. George's Channel; density estimate, 0.374 animals/km^2 (CV 0.67).	Few sightings, but only the far N end of the Minch included in survey (too few to produce a density estimate).
SCANS II, 2006	Jul 2005	North Sea and European Atlantic continental shelf waters	Estimated abundance of 63,366 (CV 0.46; 95% CI 26,973 - 148,865) common dolphins in the survey area.		
			Second highest density for the survey recorded in the English Channel (0.1159 animals/km^2); abundance estimated at 14,349 (CV 1.66) animals; spatial modelling predicted an area of high density in the W channel.	Moderate density for the Celtic Sea and St. George's Channel (0.056 animals/km^2) and estimated abundance of 11,141 (CV 0.61) animals; low density further N in the Irish Sea (0.0081 animals/km^2); spatial modelling estimated an area of high density for NE Celtic Sea-S St. George's channel, and the continental shelf edge.	Moderately high density for the Hebrides (0.0758 animals/km^2) and an abundance estimate of 2,322 (CV 0.61) animals; low density further offshore N and W of Scotland and Ireland (0.01 animals/km^2); spatial modelling estimated an area of high density in the Sea of the Hebrides.
CODA, 2009	Jul 2007	Beyond the continental shelves of the UK, Ireland, France and Spain	Survey covered offshore waters W of the UK; second highest density (0.159 animals/km^2 (CV 0.54)) and the highest abundance (52,749 animals; 95% CI 25,054 - 111,059) recorded for the area SW of the UK. Spatial modelling predicted a high density area along the continental slope area, to the SW of the UK.		
Cañadas *et al*, 2004 and Cañadas *et al*, 2009 (NASS-95 survey)[707]	Jul 1995	W and NW of the UK and Ireland, extending far offshore			Abundance estimated at 273,159 animals (CV 0.26; 95% CI 153,392 - 435,104) for the W block, and a density of 1.36 animals/km^2; abundance estimate for the E block (including UK waters) considered unreliable; noted a lack of sightings N of 57°N, despite considerable effort.
O'Cadhla *et al*, 2004 (SIAR survey. In Cañadas *et al*, 2009)[708]	Aug 2000	Offshore waters W of Ireland		Density estimated at 0.039 animals/km^2, and an abundance for the survey area of 4,496 (95% CI 2,414 - 9,320).	
Goujon *et al*, 1993 (MICA survey. In Cañadas *et al*, 2009)	Jul-Aug 1993	Off the continental shelf, SW of Ireland and the UK		Density estimate of 0.187 animals/km^2, and an abundance estimate of 61,888 (95% CI = 35,461-108,010).	
De Boer *et al*, 2008	Jan-Mar 2004; Feb-Mar 2005	W approaches of the English Channel	Estimated abundance of 3,055 (95% CI=1,425-6,544) for the survey area; estimated corrected density of 0.74 individuals/km^2.		

[706] Insufficient data to correct for animals missed on the transect line or responsive movement.
[707] Not in UK waters but included for comparison
[708] Not in UK waters but included for comparison
[709] Largely not in UK waters and superseded by CODA, but included for comparison. Not corrected for animals missed on the trackline or responsive movement

SHORT-BEAKED COMMON DOLPHIN

Study	Temporal Resolution	Spatial Resolution	Western approaches to the English Channel	Irish Sea, St. George's Channel and the Celtic Sea	NW Scotland
Reid *et al*, 2003	All months, 1979-2003	NW European waters	High encounter rates in this area (Nov-Feb).	High encounter rates in the St. George's Channel, and throughout the Celtic Sea, particularly in the SW towards the shelf edge.	High encounter rates in the Inner Hebrides during summer; high encounter rates over offshore banks, ridges and the shelf edge during autumn (but effort very low).
Evans *et al*, 2003	All months, 1960-2003	UK and Irish waters	Common in the W half of the English Channel and the S Irish Sea (particularly around the Celtic Deep).		Common in the Sea of The Hebrides and S part of The Minch.
Stone 1997, 1998, 2003, 2006[710]	All months, 1996-2002	UK and Irish waters	Very little effort in this region.	Some sightings in St. George's Channel. Overall little effort in this region.	Sightings mainly along the shelf edge, W of Scotland.
Brereton *et al*, 2005	All seasons, 1995-2002	W English Channel and Bay of Biscay	High relative abundance in the W English Channel during winter. Ten-fold increase over spring and summer.		
Kiszka *et al*, 2007	Jul 1998 - Sep 2002 (mainly summer)	W English Channel to the Bay of Biscay	Highest encounter rates for the W Channel.		
MacLeod *et al*, 2009	All months, 1996-2006	English Channel and Bay of Biscay	In the winter most sightings are in the W Channel.		
Rosen *et al*, 2000	Aug-Oct 1997; Mar-Jun 1998	Celtic Sea and English Channel	Abundant in the W end of the Channel.	Abundant over the Celtic Deep; highest encounter rates recorded here.	
De Boer and Simmonds, 2003	Oct-Nov 2002	Wales and SW England		Abundant off the Pembrokeshire Islands, the Bristol Channel, and off S Cornwall.	
Baines and Evans, 2009	All months, 1990-2007	Irish Sea, St.George's Channel and NE Celtic Sea		High relative densities over the Celtic Deep; moderately high densities over the Celtic Shelf.	
Earl *et al*, 2005 and Earl *et al*, 2004	Mainly May-Nov 2001-2004	Pembrokeshire, Wales		Widespread throughout survey area; cluster of sightings to the W of The Smalls reef (by the Celtic Deep).	
Goold, 1998[711] (acoustic survey)	Sept-Dec 1994 and 1995	St. George's Channel		Decrease in detections after Sep.	
Pollock *et al*, 2000	All months, 1979-1999	Atlantic Frontier			Most sightings along or off the continental slope NW of the Hebrides, NE Rockall Trough, and just S of the Rosemary Bank.

[710] Sightings are not effort-related
[711] Abstract only seen

SHORT-BEAKED COMMON DOLPHIN

Study	Temporal Resolution	Spatial Resolution	Western approaches to the English Channel	Irish Sea, St. George's Channel and the Celtic Sea	NW Scotland
Skov *et al*, 1995	Jul- Aug 1987 and 1989	NE Atlantic (most effort around the Faroe Islands)			Cluster of sightings over the S side of the Rockall Bank.
Gill *et al*, 1997	May-Oct 1996	Isle of Lewis, Outer Hebrides			One sighting only.
Embling, 2007 (acoustic survey)	July 2004 and 2005	Atlantic Frontier			Model suggested delphinids[712] have a preference for the area S of the Wyville-Thomson Ridge, along the shelf edge, and between the shelf edge and Rosemary Bank.
Shrimpton and Parsons, 2000	1979-1999	The Hebrides, NW Scotland			Mainly sighted in the Sea of the Hebrides, S of Skye, in inshore and offshore waters. Stanton Banks and S and E Sea of the Hebrides of particular importance; widely distributed throughout the Hebrides.
Boran *et al*, 1999	Jun-Sep 1992-1998	The Minches and Sea of the Hebrides			Occurred mainly in the Sea of the Hebrides, S of the Isle of Skye.
Dolman and Hodgins, 2009	May and Oct 2009	Gairloch, SE area of The Minch, NW Scotland			One sighting in May.
Weir *et al*, 2009	Aug 2007	The Minch, NW Scotland			Wide distribution through The Minch.
MacLeod, 2001	All seasons, 1998-2000	Atlantic Frontier and the Hebrides			Highest encounter rates along the shelf edge and continental slope.

[712] Off the shelf, the most frequently encountered dolphins are long-finned pilot whales, Atlantic white-sided dolphins, white-beaked dolphins and short-beaked common dolphins

COMMON MINKE WHALE

All regions

Study	Temporal Resolution	Spatial Resolution	West Scotland	North Scotland	East Scotland and East England	Irish Sea, SW England and Coastal Wales
Hammond *et al*, 1995; Hammond *et al*, 2002; SCANS II, 2006	Jul 1994	North Sea and adjacent waters		Abundance estimate for the survey area of 8,445 animals (CV 0.24; 95% CI = 4,987-13,546). Spatial modelling of the data predicted the highest densities to be along the SE coast of Scotland.		
				Highest density and abundance for the survey found for the N Scotland block that included the N Minch and NE Scotland – 0.0286 animals/km^2 (CV 0.4); 2,920 animals (the rest of W Scotland was not included in the survey).	Second highest density and abundance recorded for the W part of the North Sea, adjacent to the E coast of England and Scotland; density estimate of 0.0245 animals/km^2 (CV 0.42) and abundance 1,073 animals.	
SCANS II, 2006	Jul 2005	North Sea and European Atlantic continental shelf waters	Abundance estimate of 18,614 animals (CV 0.35; 95% CI = 46,110-173,349) for the survey area. Spatial modelling of the data predicted high density areas for the Moray Firth (E Scotland), the N coast of Scotland, the central and N North Sea, and an area in the W English Channel.			
			Insufficient sightings to calculate density for the Hebrides. Offshore W of Scotland recorded moderately low densities, 0.012 animals/km^2 (CV 0.46).	Moderately high densities recorded for the Northern Isles, 0.0223 animals/km^2 (CV 1.02); the survey area further offshore from here recorded moderately low densities, 0.013 (CV 0.52) and 0.012 (CV 0.46) animals/km^2.	Highest abundance and second highest density of the survey recorded for the E coast of Scotland and N North Sea, 0.028 animals/km^2 (CV 0.45) and 4,449 animals. Moderately high densities recorded for the central North Sea (0.022 animals/km^2) and the Northern Isles and NE Scotland (0.0223 animals/km^2).	Moderately high densities recorded for the Irish Sea (0.0236 animals/km^2).
Reid *et al*, 2003	All months, 1979-2003	NW European waters	High sightings rates throughout the Hebrides. Cluster of sightings offshore, over Rockall Bank (Sept).	Moderate sightings rates immediately N of the Scottish mainland.	High sightings rates off the E coast of Scotland and N England.	Relatively low sightings rates.
Northridge *et al*, 1995	All months, 1979-1990	UK and Irish waters	Main concentrations of minkes off the Hebrides, and the NE coast of England to Orkney; generally coastal waters.			Scattered sightings.
Evans *et al*, 2003	All months, 1960-2003	UK and Irish waters	Sightings clustered throughout Hebrides.	Sightings clustered off the E and S coasts of the Shetland.	Widespread, scattered sightings in the Moray Firth and close to the E Scottish and NE English coastline.	Scattered sightings, mainly S of the Isle of Man, in the St. George's Channel and over the Celtic Deep.
MacLeod, 2001	All seasons, 1998-2000	Atlantic Frontier	Highest sightings rates NW of the Outer Hebrides and W of the Orkney Islands.			
Pollock *et al*, 2000	All months, 1979-1999	Atlantic Frontier	Sightings were most frequent along the E coast of Lewis in the N Minch, and S of the Isle of Skye.	Scattered sightings around the Northern isles.		
Stone 1997, 1998, 2003, 2006[713]	All months, 1996-2002	UK and Irish waters	Few sightings, but effort limited in nearshore waters.	Sightings to the W of Shetland and throughout the Faroe-Shetland Channel.	Sightings throughout the N North Sea.	Few, but effort limited in this area.

[713] Sightings are not corrected for effort

COMMON MINKE WHALE

West Scotland

Study	Temporal Resolution	Spatial Resolution	West Scotland
CODA, 2009	Jul 2007	Beyond the continental shelves of the UK, Ireland, France and Spain	Abundance estimate for the survey area of 6,765 animals (CV 0.99; 95% CI = 1,239-36,925); the block to the W of Scotland had the highest density of 0.016 animals/km^2 and an abundance of 5,547 (CV 1.03).
Shrimpton and Parsons, 2000	1979-1999	The Hebrides, NW Scotland	Widely distributed throughout nearshore waters in the Hebrides; high sightings rates in the coastal waters of North Coll, Ardnamurchan Point, the Small Isles, the E coasts of the Outer Hebrides from Harris down to Barra and North Raasay, and offshore along the edge banks in The Minches, Sea of the Hebrides and around St. Kilda.
MacLeod *et al*, 2004	Mar-Nov 1992-1999	Isle of Mull, Scotland	Present throughout survey area in summer; highest encounter rates in late summer/autumn.
Weir *et al*, 2009	Aug 2007	The Minch, NW Scotland	Distributed widely through The Minch, coastal and deeper waters.
Gill *et al*, 1997	May-Oct 1996	Isle of Lewis, Outer Hebrides	Regularly sighted off the E coast of Lewis.
Boran *et al*, 1999	Jun-Sep 1992-1998	The Minches and Sea of the Hebrides	Highest sightings rates between Coll and the Small Isles, off the E coast of Lewis, and W of the Isle of Skye.
Dolman and Hodgins, 2009	May and Oct 2009	Gairloch, SE inshore area of The Minch, NW Scotland	Regularly sighted in both survey months.

East Scotland and East England

Study	Temporal Resolution	Spatial Resolution	East Scotland and East England
Thompson *et al*, 2010	All months, 1989-2009	Moray Firth	Commonly encountered throughout the Outer Moray Firth.
De Boer, 2010	Mar-Jul 2007	NE of the Dogger Bank, Central North Sea	Relatively high densities of minkes recorded peaking in May.
Robinson *et al*, 2009	May-Oct 2001-2006	S coast Outer Moray Firth, NE Scotland	Fluctuations between years but relatively high sightings rates, particularly for 2005-6.
Eisfeld *et al*, 2009	Feb, May, Aug and Nov 2008	Outer Moray Firth, NE Scotland	No sightings Feb, low sightings rate Nov; Aug and May sightings made towards the centre of the Outer Moray Firth.
Weir *et al*, 2007	Mar 1999 - Oct 2001	Aberdeenshire NE Scotland	Infrequently sighted, only in Aug.

Irish Sea, SW England and Coastal Wales

Study	Temporal Resolution	Spatial Resolution	Irish Sea, SW England and Coastal Wales
Rosen *et al*, 2000	Aug - Oct 1997; Mar - Jun 1998	Celtic Sea and English Channel	Sightings mainly in the vicinity of the Celtic Deep.
Baines and Evans, 2009	All months, 1990-2007	Irish Sea, St. George's Channel and NE Celtic Sea	Highest sighting densities in the area of the Celtic Deep; also in the deep waters towards the Isle of Man.

WHITE-BEAKED DOLPHIN

Study	Temporal Resolution	Spatial Resolution	Northern Isles	Northern and Central North Sea	NW Scotland
Hammond *et al*, 1995; Hammond *et al*, 2002	Jul, 1994	North Sea and adjacent waters	Estimate for white-beaked dolphins of at least 7,856 (CV 0.30; 95% CI = 4,032-13,301) for the entire survey area. Estimate for Atlantic white-sided and white-beaked dolphins combined was 11,760 (CV 0.26; 95% CI = 5,867-18,528); this species greatly outnumbers Atlantic white-sided dolphins in the survey area (on-shelf).		
			Very few sightings close to the Northern Isles.	Highest densities of white-beaked dolphins for the survey in these blocks; sightings were widespread in waters offshore of NE England and SE Scotland.	Only the N part of The Minch included in this survey; sightings for this block clustered in the N Minch.
SCANS II, 2006	Jul, 2005	North Sea and European Atlantic continental shelf waters	Estimate for white-beaked dolphins of at least 22,664 (CV 0.42; 95% CI = 10,341-49,670) for the survey area; estimate for Atlantic white-sided and white-beaked dolphins combined was 37,981 (CV 0.36; 95%CI = 19,169-75,255); this species greatly outnumbers Atlantic white-sided dolphins in the survey area (on-shelf).		
			Moderate density recorded for this area.	High densities recorded for the N North Sea; sightings widespread in waters offshore NE and E Scotland.	Highest density in the survey area recorded for the Hebrides with all sightings for this block in the N part of The Minch, in the deep offshore waters; sightings also north of the Scottish mainland, W of the Northern Isles.
Reid *et al*, 2003	All months, 1979-2003	NW European waters	Areas of high relative abundance, particularly N of the Scottish mainland.	High relative abundance throughout N and central North Sea.	High relative abundance throughout The Minch and N and NW over the shelf; also W sector of the Sea of the Hebrides.
Northridge *et al*, 1995	All months, 1979-1990	UK and Irish waters	Sightings recorded throughout area.	Highest sightings rates off Outer Hebrides and in the North Sea from Orkney to NE England.	
Evans *et al*, 2003[714]	All months, 1960-2003	UK and Irish waters	Sightings particularly off SE Shetland and W of Orkney.	Sightings widespread off the coast of Aberdeenshire, E Scotland and NE England.	Sightings throughout The Minch and W Sea of the Hebrides.
Stone 1997, 1998, 2003, 2006	All months, 1996-2002	UK and Irish waters	Sightings but no particular clusters.	Clusters of sightings in the N North Sea.	Sightings but no particular clusters.
MacLeod, 2001	All seasons, 1998-2000	Atlantic Frontier and the Hebrides	Highest encounter rates recorded from N Minch to NW Orkney, particularly N of Cape Wrath.		Highest encounter rates recorded from N Minch to NW Orkney, particularly N of Cape Wrath and the area surrounding the Butt of Lewis (Isle of Lewis).
Pollock *et al*, 2000	All months, 1979-1999	Atlantic Frontier	Widespread through the area but at low to moderate relative abundance.		High relative abundance in the N part of The Minch and N of the Isle of Lewis.
Weir *et al*, 2009; Weir, 2008	Aug 2007	The Minch, NW Scotland			High relative abundance in the deep offshore waters of the N Minch.
Shrimpton and Parsons, 2000	1979-1999	The Hebrides, NW Scotland			Distributed mainly in the N Minch (coastal and offshore) and the W of the Sea of the Hebrides nr Barra.

[714] Sightings are not corrected for effort

WHITE-BEAKED DOLPHIN

Study	Temporal Resolution	Spatial Resolution	Northern Isles	Northern and Central North Sea	NW Scotland
Gill *et al*, 1997	May-Oct 1996	Isle of Lewis, Outer Hebrides			Sighted in the deeper waters of The Minch.
Boran *et al*, 1999	Jun-Sep 1992-1998	The Minches and Sea of the Hebrides			Sightings concentrated in the N end of The Minches; also some in the W sector of the Sea of the Hebrides.
Dolman and Hodgins, 2009	May and Oct 2009	Gairloch, SE inshore area of The Minch, NW Scotland			None sighted.
Camphuysen *et al*, 1995	May 1994	North Sea		Mass feeding associations of gannets, white-beaked and Atlantic white-sided dolphins at the Dogger Bank, central North Sea; highest dolphin abundance over the NW of the bank.	
De Boer, 2010	Mar-Jul, 2007	NE of the Dogger Bank, Central North Sea		Sightings of white-beaked dolphins.	
Weir *et al*, 2007	Mar 1999 - Oct 2001	Aberdeenshire, NE Scotland		Relatively high abundance recorded for Aberdeenshire coastal waters.	
Canning *et al*, 2008	May 2002 - Sep 2005	NE Scotland coastal waters		Relatively high abundance recorded but slightly lower than those recorded by Weir *et al*, 2007.	
Robinson *et al*, 2007	May-Oct, 2001-2005	Outer Moray Firth		No sightings.	
Evans *et al*, 1996	Jun-Sep, 1995	Coastal waters of Shetland	Low sightings rate.		

RISSO'S DOLPHIN

Study	Temporal Resolution	Spatial Resolution	Hebrides	Atlantic Frontier	Irish Sea and St. George's Channel
Reid *et al*, 2003	All months, 1979-2003	NW European waters	Most sightings for UK waters occur in W Scotland with the waters of the Outer Hebrides forming the centre of distribution.	A few records from the waters immediately over the shelf break.	Clusters of sightings in the S Irish Sea and off SW Ireland.
Evans *et al*, 1996	All months, 1960-2003	UK and Irish waters	Sightings clustered around the Outer Hebrides, and between Coll and Mull.	Few sightings.	Clusters of sightings around the Isle of Man, Anglesey, Bardsey, Pembrokeshire and the St. George's Channel.
Stone 1997, 1998, 2003, 2006[715]	All months, 1996-2002	UK and Irish waters	No sightings (but little effort in this area).	Some sightings to the W of Shetland.	No sightings (but little effort in this area).
MacLeod, 2001	All seasons, 1998-2000	Atlantic Frontier	In the summer, most frequently encountered around the Outer Hebrides.	Few sightings.	
Pollock *et al*, 2000	All months, 1979-1999	Atlantic Frontier	Sightings clustered around the NE of Lewis.	Some sightings, mostly over the continental slope.	
Weir, 2008	Aug 2007	The Minch, NW Scotland	Sightings made off the Eye Peninsula (Isle of Lewis), off Cape Wrath, and in the centre of The Minch.		
Atkinson *et al*, 1998	Aug-Sep 1995, May-Oct 1996	Isle of Lewis, Outer Hebrides	142 individuals identified, and 52 animals resighted between 1995 and 1996; surveys conducted between Kebock Head and Tolsta Head.		
Boran *et al*, 1999	Jun-Sep 1992-1998	The Minches and Sea of the Hebrides	Recorded mainly along the E coast of the Outer Hebrides, from the Butt of Lewis down to Barra Head.		
Shrimpton and Parsons, 2000	1979-1999	The Hebrides, NW Scotland	Predominantly distributed from the Butt of Lewis to Barra Head; strong fidelity to the Eye Peninsula and Tiumpan Head; also occurs towards Canna, Coll and Tiree and offshore W of the Outer Hebrides.		
WDCS 2002, 2003, 2004a, 2005b, 2006, 2009	Apr, Jul-Sep 2001-2009	Bardsey Island, North Wales			Risso's observed regularly, and at times in relatively large numbers; 133 individuals identified with a few resightings between years.

[715] Sightings are not corrected for effort

KILLER WHALE

Study	Temporal Resolution	Spatial Resolution	Hebrides	Shetland (inshore and to the east)	Atlantic Frontier (offshore)
CODA, 2009	Jul 2007	Beyond the continental shelves of the UK, Ireland, France and Spain			Killer whales sighted but low numbers; locations not provided.
Hammond *et al*, 1995; Hammond *et al*, 2002[716]	Jul 1994	North Sea and adjacent waters		Few sightings, some to the NE of Shetland.	Survey only covered this area to the N of Shetland; few sightings, some to the NW of Shetland, by the continental shelf edge.
SCANS II, 2006[717]	Jul 2005	North Sea and European Atlantic continental shelf waters	None reported.	One sighting to the far NE of Shetland.	(Survey only covered this area to the N of Shetland and W to the shelf edge) None reported.
Reid *et al*, 2003	All months, 1979-2003	NW European waters	Cluster of sightings, particularly in the Little Minch and S of Skye during the summer.	Sightings to the NW, and heading towards the continental shelf edge in July.	Cluster of sightings to the NW of Shetland, along the continental shelf edge and into the Faroe-Shetland Channel in May and June.
Evans *et al*, 2003	All months, 1960-2003	UK and Irish waters	Most common in N and W Scotland, and the N North Sea.		
Stone 1997, 1998, 2003, 2006	All months, 1996-2002	UK and Irish waters	No sightings, but less effort in the inshore waters of the Hebrides.	Concentration of sightings to the NE of Shetland; some inshore.	Concentration of sightings to the NW of Shetland, along the shelf edge; some scattered through the Faroe-Shetland Channel.
Pollock *et al*, 2000	All months, 1979-1999	Atlantic Frontier	A few sightings close to shore.	A few sightings close to shore.	Main concentration of sightings over the slope to the N and NW of Shetland (May and Jun); widespread the rest of the year.
MacLeod *et al*, 2003	Summer 1998	Atlantic Frontier			One possible sighting (no location given).
MacLeod, 2001	All seasons, 1998-2000	Atlantic Frontier and the Hebrides	None reported.	None reported.	None reported.
Shrimpton and Parsons, 2000	1979-1999	The Hebrides, NW Scotland	Regularly sighted throughout the Hebrides, mainly in the Little Minch, W of Skye and in the Sea of the Hebrides, around the Small Isles and S as far as the Mull of Kintyre; several individuals re-sighted year to year.		
Dolman and Hodgins, 2009	May and Oct 2009	Gairloch, SE inshore area of The Minch, NW Scotland	Group sighted in Oct.		

[716] Small cetaceans were the focus for this survey. Other cetacean species were recorded when it did not compromise data collection for the target species.
[717] See previous footnote

KILLER WHALE

Study	Temporal Resolution	Spatial Resolution	Hebrides	Shetland (inshore and to the east)	Atlantic Frontier (offshore)
Evans *et al*, 1993	Jun-Aug 1992	The Minches and Sea of the Hebrides, NW Scotland	Two sightings made, nr the Trishnish Islands and W of Canna; reports that killer whales are seen regularly in The Minches and Sea of the Hebrides.		
Boran *et al*, 1999	Jun-Sep 1992-1998	The Minches and Sea of the Hebrides, NW Scotland	Killer whales recorded but relatively infrequently.		
Gill *et al*, 1997	May-Oct 1996	Isle of Lewis, Outer Hebrides	Sighting of killer whales made in Sept from Lewis.		
Lewis *et al*, 1998 (acoustic survey)	Dec 1997 to Mar 1998	NW of the Hebrides	None detected.		One detection in Jan, over the Ymir Ridge.
Bolt *et al*, 2009	1991-1996 (Shetland) 1997 (Scotland)	Shetland, and all coastal Scotland (one year)	Sighted most frequently around Mull and the Treshnish Islands.	Sighted most frequently around Shetland and the Pentland Firth.	
Luque *et al*, 2006	Jan-Feb 2006	N North Sea		Most sightings made N and E of Shetland.	
Evans *et al*, 1996	All months, 1993-1995	Shetland inshore waters		94 sightings in Shetland coastal waters; particular areas favoured each year.	
Shetland Sea Mammal Group (reported in Luque *et al*, 2006)	All months, 1989-2006	Shetland inshore waters		Over 500 sightings of killer whales inshore around Shetland.	

ATLANTIC WHITE-SIDED DOLPHIN

Study	Temporal Resolution	Spatial Resolution	Atlantic Frontier	North Sea
CODA, 2009	Jul 2007	Beyond the continental shelves of the UK, Ireland, France and Spain	Sighted, but no information on location or abundance.	
Hammond *et al*, 1995; Hammond *et al*, 2002; SCANS II, 2006	Jul 1994	North Sea and adjacent waters	Estimates for Atlantic white-sided and white-beaked dolphins combined; 11,760 (CV 0.26; 95% CI = 5,867-18,528) estimated abundance for survey area; at least 7,856 (CV 0.30; 95% CI = 4,032-13,301) of these were white-beaked, with an unknown number of the remainder being Atlantic white-sided dolphins; white-beaked usually greatly outnumber Atlantic white-sided in the survey area (on-shelf).	
SCANS II, 2006	Jul 2005	North Sea and European Atlantic continental shelf waters	Estimates for Atlantic white-sided and white-beaked dolphins combined. 37,981 (CV 0.36; 95% CI = 19,169-75,255) estimated abundance for survey area; at least 22,664 (CV 0.42; 95%CI = 10,341-49,670) of these were white-beaked, with an unknown number of the remainder being Atlantic white-sided dolphins; white-beaked usually greatly outnumber Atlantic white-sided on the shelf.	
Reid *et al*, 2003	All months, 1979-2003	NW European waters	Distribution concentrated along and off the shelf edge, N and W of Scotland, particularly the Faroe-Shetland and Faroe-Bank Channels, Wyville-Thomson Ridge and NE Rockall Trough area. Cluster over the Rockall Bank (Sep).	Some sightings, mainly in the summer in the N North Sea.
Evans *et al*, 2003	All months, 1960-2003	UK and Irish waters	Sightings along the continental slope to the N and W of Scotland.	Concentrations around the Northern Isles and N and central North Sea.
Stone 1997, 1998, 2003, 2006[718]	All months, 1996-2002	UK and Irish waters	W of Shetland – over the continental slope and the Faroe-Shetland Channel.	N North Sea (NE of Shetland).
Camphuysen *et al*, 1995	May 1994	North Sea		Mass feeding associations of gannets, white-beaked and Atlantic white-sided dolphins at the Dogger Bank, central North Sea; highest dolphin abundance over the NW of the bank.
De Boer, 2010	Mar-Jul 2007	NE of the Dogger Bank, Central North Sea		Atlantic white-sided dolphins were the most frequently sighted dolphin species in the survey area.
Pollock *et al*, 2000	All months, 1979-1999	Atlantic Frontier	High relative abundance over the Faroe-Shetland Channel and the Faroe Bank Channel.	
MacLeod, 2004	Summer 1998	Atlantic Frontier	Highest density estimate found for over the Faroe-Shetland Channel, 1.65 animals/km^2; W of the Outer Hebrides density estimate of 0.39 animals/km^2 (sightings mostly in the N part of the stratum); abundance estimate of 74,626 (CV 0.72) for the Faroe-Shetland Channel, and 21,371 (CV 0.54) for the area W of the Outer Hebrides.[719]	
Embling, 2007 (acoustic survey)	Jul 2004 and 2005	Atlantic Frontier	Model suggested delphinids[720] have a preference for the area S of the Wyville-Thomson Ridge, along the shelf edge, and between the shelf edge and Rosemary Bank.	
Hastie *et al*, 2005 (acoustic survey)	May and Oct 2001, and Oct 2002	Faroe-Shetland Channel	Widespread throughout the Faroe-Shetland Channel in each survey.	
O'Cadhla *et al*, 2001 (in MacLeod 2004)	Aug 2000	W of Ireland and the Rockall Trough	Abundance estimate of 5,490 (CV 0.43)[721]; density estimate of 0.046 animals/km^2.	

[718] Sightings are not effort-related
[719] Estimates corrected for g(0). High CVs due to a small sample size.
[720] Off-shelf, the most frequently encountered delphinids are long-finned pilot whales, Atlantic white-sided dolphins, white-beaked dolphins and short-beaked common dolphins
[721] g(0) corrected using pooled dataset of Atlantic white-sided and short-beaked common dolphin sightings

LONG-FINNED PILOT WHALE

			Atlantic Frontier		
Study	Temporal Resolution	Spatial Resolution	NE Rockall Trough, Wyville-Thomson Ridge, and the Faroe-Shetland Channel	Rockall Bank and Hatton Rockall Trough	South West UK and Ireland
CODA, 2009	Jul 2007	Beyond the continental shelves of the UK, Ireland, France and Spain	Highest density and abundance estimate in the survey area recorded for the Atlantic Frontier region – 0.054 animals/km^2, 18,709 animals (CV 0.37). This is out of a total survey area abundance estimate of 25,101 (CV 0.33; 95% CI = 13,251-47,550).		Second highest density and abundance estimate in the survey area recorded for this block – 0.016 animals/km2, 5,566 animals (CV 0.75); modelling predicted distribution to be predominantly along the shelf edge, with medium level densities.
			Medium to low density prediction (survey did not extend past the S end of the Faroe-Shetland Channel). Highest sightings rates to the N and S of the Wyville-Thomson Ridge.	Predicted to be a high density area.	
Reid *et al*, 2003	All months, 1979-2003	NW European waters	Highest sightings rates to the N and S of the Wyville-Thomson Ridge.	Sightings recorded, particularly by the Rockall Bank but overall very low effort in this area.	Sightings noted along the edge of the continental shelf, S into the Bay of Biscay.
Evans *et al*, 2003	All months, 1960-2003	UK and Irish waters	Sightings mainly occur along the continental shelf slope, in the Faroe Bank Channel, Faroe-Shetland Channel and Rockall Trough.	Cluster of sightings in the Hatton Rockall Trough.	Sightings recorded but mostly on the continental shelf, in the SW approaches to the English Channel.
Stone 1997, 1998, 2003, 2006	All months, 1996-2002	UK and Irish waters	Sightings concentrated along the seaward side of the continental shelf edge, N and W of Scotland – the Faroe-Shetland Channel, NE and E Rockall Trough; few S of here, but less effort.	Virtually no effort in this area.	Few sightings, but also far fewer hours surveying.
Skov *et al*, 1995	Jul-Aug, 1987 and 1989	NE Atlantic (mainly around the Faroe Islands)	Some sightings in the NE Rockall Trough but little effort in this area.	Rockall Bank an area noted for concentrations of sightings.	
Pollock *et al*, 2000	All months, 1979-1999	Atlantic Frontier	Concentrated along the continental slope N of Scotland; highest relative abundance in the Faroe-Shetland Channel and Faroe Bank Channel.		
MacLeod *et al*, 2003	Summer, 1998	Atlantic Frontier	Highest relative abundance recorded in the Faroe-Shetland Channel.		
MacLeod, 2001	All seasons, 1998-2000	Atlantic Frontier and the Hebrides	Highest encounter rates in summer over the Wyville-Thomson Ridge and the S end of the Faroe-Shetland Channel.	Little effort this far W except in summer; sightings noted by Rockall Bank.	
Embling, 2007 (acoustic survey)	Jul 2003 - Oct 2005	Atlantic Frontier	Model suggested delphinids[722] have a preference for the area S of the Wyville-Thomson Ridge, along the shelf edge, and between the shelf edge and Rosemary Bank.		

[722] Long-finned pilot whales, Atlantic white-sided dolphins, white-beaked dolphins and short-beaked common dolphins

SPERM WHALE

Study	Temporal Resolution	Spatial Resolution	North and Far West Scotland
CODA, 2009	Jul 2007	Beyond the continental shelves of the UK, Ireland, France and Spain	Best estimate of abundance for the whole survey area was 2,077 (CV 0.2); survey block to the W of the Hebrides, estimate of 480 (CV 0.33); spatial modelling predicted localised areas of medium density to the W of the Hebrides, in the Rockall Trough close to the shelf edge.
Reid *et al*, 2003	1979-2003, all months	NW European waters	Beyond the edge of the continental shelf, N and W of Scotland; particularly, the Faroe-Shetland Channel, and S of the Wyville-Thomson Ridge (NE Rockall Trough).
Evans *et al*, 2003	1960-2003, all months	UK and Irish waters	Sightings mainly distributed along and beyond the shelf edge to the NW of Scotland.
Stone 1997, 1998, 2003, 2006	1996 -2002, all months	UK and Irish waters	Sightings concentrated on the Shetland Shelf close the shelf edge, in the Faroe-Shetland Channel, Wyville-Thomson Ridge and NE Rockall Trough region.
Pollock *et al*, 2000	1979-1999, all months	Atlantic Frontier	Concentrations particularly along the Ymir Ridge and N of Shetland in the Faroe-Shetland Channel.
MacLeod *et al*, 2003	Summer 1998	Atlantic Frontier	Sighted in the Faroe-Shetland Channel, over the Wyville-Thomson Ridge and on the edges of the Rockall Trough.
Skov *et al*, 1995	Jul-Aug 1987 and 1989	NE Atlantic (mainly around the Faroe Islands)	Sperm whales were reported to be widespread throughout the survey area.
Embling, 2007 (acoustic survey)	Jul 2003 to Oct 2005 (surveys took place during May, Jul, Sep and Oct)	W coast of Scotland	Detected mainly in the Faroe-Shetland Channel, Wyville-Thomson Ridge, and throughout the Rockall Trough; spatial modelling predicted highest densities in the S Rockall Trough, to the E of Anton Dohrn seamount, also along the shelf edges, deep Faroe-Shetland Channel, both deep sides of the Wyville-Thomson Ridge, and to the W of Bill Bailey's Bank.
Hastie *et al*, 2003 (acoustic survey)	May and Oct 2001, May 2002	Faroe-Shetland Channel	Sperm whales detected throughout the Faroe-Shetland Channel; highest density was over the deep water of the mid-channel.
Lewis *et al*, 1998 (acoustic survey)	Dec 1997 to Mar 1998	NW of the Hebrides	Relatively high numbers of sperm whales detected in the area; mainly in deeper waters, just off the continental edge and the S edge of the Wyville-Thomson Ridge.

BEAKED WHALES

Due to their predominantly offshore distribution, beaked whales are rarely reported in surveys of UK and Irish shelf waters (such as SCANS I and II) and therefore these surveys are not included in this table.

Study	Temporal Resolution	Spatial Resolution	Beaked whale (Unidentified)	Northern Bottlenose whale	Sowerby's beaked whale	Cuvier's beaked whale
CODA, 2009	Jul 2007	Beyond the continental shelves of the UK, Ireland, France and Spain	Abundance estimate for the survey area of 6,992 animals (CV 0.25; 95% CI = 4,287-11,403). The Atlantic Frontier region had the second highest density estimate in survey area (0.011 animals/km^2) and the highest number of animals (3,512; CV 0.34). High density area predicted for NW Rockall Trough area.	Beaked whales identified to species level in Atlantic Frontier region were northern bottlenose whales and Sowerby's beaked whales.		Only one seen in N blocks.
Reid *et al*, 2003	1979-2003, all months	NW European waters		Most sightings along the continental shelf edge >1000m deep.	*Mesoplodon* sightings thought to be Sowerby's with a cluster in the N Rockall Trough/Ymir Ridge/Wyville-Thomson Ridge area; records of juveniles suggest breeding takes place in these waters.	Six confirmed sightings, mostly off to the W of the UK.
Evans *et al*, 2003	1960-2003, all months	UK and Irish waters		Sighted primarily in the Faroe-Shetland Channel and Rockall Trough.	Rarely positively identified; sightings N and W of Britain and Ireland, and in the Channel approaches.	(See Reid *et al*, 2003).
Stone 1997, 1998, 2003, 2006	1996-2002, all months	UK and Irish waters	Sightings in the Faroe-Shetland Channel and NE Rockall Trough.	Sightings throughout the Faroe-Shetland Channel.	Sightings in the NE Rockall Trough and SW Faroe-Shetland Channel.	None reported.
Pollock *et al*, 2000	1979-1999, all months	Atlantic Frontier	All thought to be *Mesoplodon* sp., most likely Sowerby's.	Seven sightings. Seen in deep waters, >1000m. Peaks in Apr and Aug. Mostly Rockall Trough and Faroe-Shetland Channel.	Only one positively identified but all 62 unidentified sightings thought to be *Mesoplodon*, most likely Sowerby's; almost all in water >1000m, particularly seen S of Ymir Ridge.	None reported.
MacLeod *et al*, 2003	Summer 1998	Atlantic Frontier	None seen.	None seen.	None seen.	None seen.
MacLeod 2001	1998-2000, all seasons	Atlantic Frontier and the Hebrides		Two animals seen NW of Rockall Bank, summer.	Four animals seen close to Wyville-Thomson Ridge in Sept.	None seen.

BALEEN WHALES

Study	Temporal Resolution	Spatial Resolution	Fin whale	Sei whale	Blue whale	Humpback whale
CODA, 2009	Jul 2007	Beyond the continental shelves of the UK, Ireland, France and Spain	Abundance estimate for the survey area of 9019 (CV 0.11; 95% CI = 7,265 – 11,197). 204 animals (95% CI = 163-255) estimated for the most N block off NW Scotland, and 4,854 animals (95% CI = 3855-6112) for the block off SW Britain.	Abundance estimate for the survey area of 366 (CV 0.33; 95% CI = 176 – 762); sei whales only seen in Spanish block.	None reported.	None reported.
Hammond *et al*, 1995; Hammond *et al*, 2002[723]	Jul, 1994	North Sea and adjacent waters	A few animals sighted in the Celtic Sea.	None reported.	None reported.	None reported.
SCANS II, 2006[724]	Jul, 2005	North Sea and European Atlantic continental shelf waters	A few sightings off the edge of the continental shelf, by the Faroe-Shetland Channel.	None reported.	None reported.	None reported.
Acoustic monitoring with SOSUS hydrophones (Charif and Clark, 2009; Charif *et al*, 2001)	All months, 1996-2005	Deep waters N and W Britain and Ireland	Most frequently recorded species detected in every month, throughout region, with peaks in Dec-Jan; no clear evidence of migratory movement.	Not included in study.	Second most common species detected; found in all regions, with peaks in Nov-Dec; migrating S during autumn and winter but return migration not clearly indicated.	Least frequently detected; occurred mainly in 8 N regions, from Oct-Apr; migrating S during winter and return migration not detected.
Reid *et al*, 2003	All months, 1979-2003	NW European waters	Mainly distributed along the 500m depth contour, in the Faroe-Shetland Channel and Rockall Trough.	Most records from between the Faroe and Northern Isles, particularly in the vicinity of the Faroe-Shetland Channel and Faroe Bank Channel.	Small numbers in the Faroe-Shetland Channel and Rockall Trough.	Only isolated effort-related sightings; sightings mainly in the Northern Isles, Celtic Sea, and N Irish Sea and Firth of Clyde.
Evans *et al*, 2003	All months, 1960-2003	UK and Irish waters	In UK waters, most frequently seen in Faroe-Shetland channel, and Celtic Sea (including calves).	Sightings generally in offshore areas such as the Faroe-Shetland channel and Rockall Trough.	Most sightings in Faroe-Shetland Channel[725].	Same as Reid *et al*, 2003.
Stone 1997, 1998, 2003, 2006[726]	All months, 1996-2002	UK and Irish waters	Clusters of sightings in Faroe-Shetland channel and Rockall Trough, particularly where it meets Wyville-Thomson Ridge.	Clusters of sightings in the Faroe-Shetland channel; two sightings NE of Shetland (2001-02).	Few sightings, most occur in the Faroe-Shetland channel and the Rockall Trough.	Very few sightings, mostly occurring in the Faroe-Shetland channel and the Rockall Trough.

[723] Small cetaceans were the focus for this survey. Other cetacean species were recorded when it did not compromise data collection for the target species.
[724] See previous footnote
[725] All blue whale sightings reported are from Stone 1998
[726] Sightings are not effort-related

BALEEN WHALES

Study	Temporal Resolution	Spatial Resolution	Fin whale	Sei whale	Blue whale	Humpback whale
Pollock *et al*, 2000	All months, 1979-1999	Atlantic Frontier	All sightings on or beyond the 1000m isobath; distribution centred to the S and SE of the Faroe Islands.	Sightings concentrated to the SE of the Faroe Islands; aggregations occurring particularly in the Faroe-Shetland Channel.	None reported.	Very few sightings.
Skov *et al*, 1995	Jul-Aug 1987 and 1989	Offshore NE Atlantic (mainly around the Faroe Islands)	S side of the Rockall Bank.	None reported.	None reported.	None reported.
MacLeod *et al*, 2003	Summer 1998	Atlantic Frontier	Most common in the Faroe-Shetland Channel.	Most common in the Faroe-Shetland Channel.	None reported.	None reported.
Swift *et al*, 2002	May, Oct, Dec 2000	Faroe-Shetland Channel	Vocalising fin whales widely distributed throughout the channel in Oct; one recording in Dec, none for Mar.	Not included in study.	Not included in study.	None reported.
De Boer *et al*, 2004	Jan-Mar 2004	Celtic Sea and the W Approaches of the English Channel	Two individuals seen, plus casual sightings reported of feeding fin whales, including a group with a calf.	None reported.	None reported.	None reported.
De Boer and Saulino, 2007	Dec-Mar 2007	SW England	Three individuals seen off SW Cornwall.	None reported.	None reported.	None reported.

ANNEX III THREATS TO CETACEANS – REGIONAL SUMMARY TABLES

West and south west Scotland

Species of most relevance for this area: Killer whale, white-beaked dolphin, minke whale, bottlenose dolphin, harbour porpoise, Risso's dolphin and short-beaked common dolphin.

Key References used: Shrimpton and Parsons, 2000; Metoc, 2006; DECC, 2009; HWDT, 2008; Ross and Isaac, 2004; Dolman and Hodgins, 2009; Parsons *et al*, 2000; Anderwald and Evans, 2007; Embling *et al*, 2010.

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Acoustic and physical disturbance, injury and mortality.	Vessels (shipping, military, recreational, whale watching); coastal development (construction and operation of ports, marine renewable energy devices/arrays including wind farms etc); fisheries (AHDs and ADDs[727], pingers); military activities (sonar, explosives); oil and gas development (seismic surveys, drilling, decommissioning); dredging.	Acoustic – Potentially all, particularly deep diving species such as beaked whales. As low frequency specialists, large baleen whales are more at risk of impact from noise emitted by large vessels which is mostly low frequency. Harbour porpoise and minke whale, and potentially others, particularly coastal species that risk repeated exposure to these activities (Risso's dolphin, white-beaked dolphin).	Few data A number of necropsied stranded cetaceans in the UK show signs of potential noise-induced injury, including 3 out of 24 Risso's dolphins. Deep-diving species (e.g. Risso's dolphins, beaked whales) seem to be particularly affected. In UK waters, most cetacean species show avoidance reactions to seismic surveys including leaving an area and changing direction. A significant reduction in feeding activity has also been observed during surveys. The long-term effects of this are unknown. The onset of noise-producing military exercises has been correlated to decreases in minke whale and harbour porpoise sightings in the area.	Unknown, but a number of loud noise sources occur in the area. Vessel activity in the area is moderate overall. Seismic surveys for oil and gas exploration take place to the W of the Outer Hebrides. High level of marine-based military activity in the Hebrides including submarine activity, explosives and the use of sonar. Fish farms are widespread and numerous throughout the Inner and Outer Hebrides and AHDs are used extensively.
		Collisions – Potentially all.	No conclusive reports of death or injury as a result of vessel collisions but cetaceans with badly cut dorsal fins have been observed in the area.	Unknown. Vessel activity in the area is moderate overall.
		Physical disturbance – Potentially all.	No data.	Unknown but vessel traffic and coastal development are moderate in places so physical disturbance is likely. Vessel activity in the area is moderate overall. It includes high amounts of recreational vessels in places, and a large marine ecotourism industry. These activities peak in the summer months, coinciding with the breeding/calving season for most UK cetacean species. Coastal development is relatively low in many areas (particularly the Outer Hebrides), and moderate in others (such as the Firth of Clyde). W coast military exercise area is used for trials and exercises, including NATO's largest European exercise, Joint Warrior.

[727] Acoustic Harassment Devices and Acoustic Deterrent Devices, used at aquaculture facilities

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Chemical pollution.	Inputs from land (industry, agriculture, urban); and sea (ships, oil spills, aquaculture, sewer discharges).	Oil – Potentially all.	No data.	Oil tankers travel to the W of the Outer Hebrides and through The Minch. No large-scale spills have occurred to date. If a spill were to occur, effects could be very severe and long lasting. Impacts are possible from chronic inputs of hydrocarbons from terrestrial sources and vessels.
		Aquaculture – coastal species	No data.	Unknown Fish farms are widespread and numerous throughout the Inner and Outer Hebrides and introduce significant amounts of chemical and faecal pollution.
		POPs[728] – Potentially all, particularly coastal porpoise and dolphin species.	Levels of POPs are relatively low compared to levels in cetaceans world-wide.	Unknown, but even low levels of POPs may be capable of causing immune and reproductive system defects. Coastal species are likely to have greater exposure to POPs (and other chemicals) due to their proximity to human activities. Exposure could be direct, or indirect via their prey.
		POPs – Killer whale.	No data.	Killer whales in the area are thought to prey on marine mammals. Eating at a higher trophic level increases levels of POPs.
Fisheries bycatch.	Gill nets; tangle nets; creeling; pelagic trawls.	Potentially all.	No information available about the bycatch of many species but the potential exists.	Area is widely fished. Fishing effort by gear types typically dangerous to cetaceans (gill nets and pelagic trawls) is thought to be relatively low but bycatch is known to occur.
		Harbour porpoise.	Monitoring of gill and tangle net fisheries in waters W of the Hebrides indicated 100-200 harbour porpoise are caught each year. Thought to be fewer now because of reductions in fishing effort.	Unknown.
		Minke whale.	Some records of minke whale show entanglement in kreel lines and/or mooring lines.	Some mortalities have been identified, and sightings of animals with rope scars observed, but overall impact is unknown.
		Risso's dolphin.	Markings on stranded Risso's dolphins indicate they were bycaught.	Unknown.

[728] Persistent Organic Pollutants - toxic and bioaccumulating chemicals

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Prey depletion.	Overfishing; climate change.	Potentially all.	No data.	Unknown but could be severe if alternative food sources are not easily available. Globally, there is good evidence of large-scale reductions in many fish species.
		Minke whale, harbour porpoise.	No direct evidence but decreases in minke whale numbers coincided with poor sandeel years. Large-scale breeding failures for seabirds were also recorded in these years. Sandeels are also important prey for harbour porpoise. Sandeel landings in the Hebrides have declined significantly in recent years.	Unknown.
Cumulative impacts of all activities (including habitat degradation and loss).		All.	Data on status and trends in most species are lacking. The inter-decadal large scale SCANS surveys have only taken place twice to date which is insufficient to determine trends. Bottlenose dolphin and killer whale populations in the Hebrides are small in number, but the reasons for this and the health or viability of the groups is unknown. Minke whales appear to have shifted their distribution in recent years, possibly as a result of changes in prey distribution, but again, the reasons for this are poorly understood.	Human impacts on the marine environment in this area are thought to range from medium to very high[729]. Activities such as military exercises, which are of significant concern for their introduction of loud noises, and widespread aquaculture developments which may result in habitat degradation and noise inputs (from AHDs), take place more intensively here than in other regions. Data on cetacean prey species and predator-prey dynamics are lacking but the data suggest declines in sandeel populations may be impacting cetacean species, although to what degree is unknown.

[729] Halpern *et al*, 2008 (see Figure 5.3)

Far west Scotland

Species of most relevance for this area: Beaked whales, baleen whales, Atlantic white-sided dolphin, long-finned pilot whale, sperm whale, short-beaked common dolphin, minke whale, bottlenose dolphin and Risso's dolphin.

Key References used: Hammond *et al*, 2006; DECC, 2009; Gordon, 2006; Metoc, 2006; Charif *et al*, 2009.

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Acoustic and physical disturbance, injury and mortality.	Vessels (shipping, military, recreational, whale watching); coastal development (construction and operation of ports, marine renewable energy devices/arrays including wind farms etc); fisheries (AHDs and ADDs[730], pingers); military activities (sonar, explosives); oil and gas development (seismic surveys, drilling, decommissioning); dredging.	Acoustic – Potentially all, particularly deep diving species such as beaked whales. As low frequency specialists, large baleen whales are more at risk of impact from noise emitted by large vessels which is mostly low frequency.	Few data A number of necropsied stranded cetaceans in the UK show signs of potential noise-induced injury, particularly deep diving species (Risso's dolphins, beaked whales). In UK waters, most cetacean species show avoidance reactions to seismic surveys including leaving an area and changing direction. A significant reduction in feeding activity has also been observed during surveys. The long-term effects of this are unknown.	Military exercises take place N and W of Scotland. Considerable interest in exploiting oil and gas resources in this area has led to intensive seismic surveying. Difficulties in sighting beaked whale species will reduce the effectiveness of mitigation measures developed to lessen the impacts of very loud activities such as military activities and seisimic surveys.
		Large baleen whales are most at risk from collisions with large vessels.	No data.	Relatively low density of vessel traffic through much of this area so any disturbance is unlikely to occur repetitively. No data on vessel traffic densities for the far W sector of the Atlantic Frontier.
Chemical pollution.	Inputs from land (industry, agriculture, urban); and sea (ships, oil spills, aquaculture, sewer discharges).	Potentially all.	No data.	Even in very deep waters, relatively high levels of POPs can be detected in some fish species.
Fisheries bycatch.	Gill nets; longlines; pelagic trawls.	Potentially all.	Lack of detailed information on fisheries operations for this area hinders assessment of impact from bycatch.	Few data are available. Concerns have been raised about ghost fishing by lost nets and long soak times of gill-netters fishing off the Rockall and Hatton Banks, but there is no information on cetacean bycatch.
Prey depletion.	Overfishing; climate change.	Potentially all.	No data.	Unknown. Globally, there is good evidence of large-scale reductions in many fish species. In recent years there has been an expansion in deep water fisheries in this region but the impacts of this are poorly understood.
Cumulative impacts of all activities (including habitat degradation and loss).		All.	The lack of data on population status, trends and effects of human activities is particularly acute for offshore species. This makes it very difficult to assess the effects of human activities.	Very difficult to assess the possible level of impact, given the lack of data. Human impacts on the marine environment in this region are considered to be medium-high or high[731]. The combined impacts of physical and acoustic disturbance or injury from shipping, industry (such as oil and gas exploration) and the military are probably of most concern.

[730] Acoustic Harassment Devices and Acoustic Deterrent Devices, used at aquaculture facilities
[731] Halpern *et al*, 2008 (see Figure 5.3)

North Scotland

Species of most relevance for this area: Harbour porpoise, white-beaked dolphin, minke whale, bottlenose dolphin, killer whale, Atlantic white-sided dolphin, baleen whales, beaked whales, long-finned pilot whale and sperm whale.

Key References used: Ross and Isaac, 2004; Hartley Anderson and AICSM, 2003; DECC, 2009; Gordon, 2003; Stone 2003, 2006; MacLeod *et al*, 2007; Charif *et al*, 2009; Jepson *et al*, 2005b; Evans *et al*, 1997; Bolt *et al*, 2009.

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Acoustic and physical disturbance, injury and mortality.	Vessels (shipping, military, recreational, whale watching); coastal development (construction and operation of ports, marine renewable energy devices/arrays including wind farms etc); fisheries (AHDs and ADDs[732], pingers); military activities (sonar, explosives); oil and gas development (seismic surveys, drilling, decommissioning); dredging.	Acoustic – Potentially all, particularly a concern for deep diving species such as beaked whales. As low frequency specialists, large baleen whales are more at risk of impact from noise emitted by large vessels which is mostly low frequency. Coastal species are more at risk from repeated exposure to activities.	Few data A number of necropsied stranded cetaceans in the UK show signs of potential noise-induced injury. Deep diving species (e.g. Risso's dolphin, beaked whales) seem to be particularly affected. In UK waters, most cetacean species show avoidance reactions to seismic surveys including leaving an area and changing direction. A significant reduction in feeding activity has also been observed during surveys. The long-term effects of this are unknown.	Unknown, but oil and gas production is considerable in this area and these activities are very noisy. High level of oil and gas production to the W of Shetland and in the N North Sea results in the production of noise through drilling and other activities. Considerable interest in developing oil and gas resources further, particularly in the Atlantic Frontier, have resulted in intensive seismic surveying in recent years. Oil-related vessel traffic is also considerable. Military exercises take place N and W of Scotland. Difficulties in sighting beaked whale species will reduce the effectiveness of mitigation measures developed to lessen the impacts of very loud activities such as military activities and seisimic surveys. Other vessel traffic includes ferries and moderate recreational use, mainly close to the Northern Isles. Fish farms are widespread and numerous in the Northern Isles and an unknown number of these use AHDs.
		Collisions – Potentially all, particularly large baleen whales.	No data.	Unknown. Oil and gas activities result in large vessel traffic moving to and from Shetland and Orkney. May result in ship-strikes, particularly with large baleen whales which are more susceptible.
		Physical disturbance – Potentially all, particularly coastal species.	No data. European Marine Energy Centre (EMEC) on Orkney is conducting monitoring studies to investigate potential impacts of marine renewable devices, no data are currently available.	Vessel traffic and coastal development are generally low although there will be areas of higher activity as a result of facilities and traffic related to oil and gas activities.
Chemical pollution.	Inputs from land (industry, agriculture, urban); and sea (ships, oil spills, aquaculture, sewer discharges).	Oil – Potentially all.	Spills have occurred in the past and could potentially occur again. The grounding of the oil tanker 'Braer' at Garth's Ness on the Shetland Islands in 1993 resulted in a spill of over 80,000 tonnes of crude oil. No impacts on marine mammals were investigated.	Oil tankers travel through the area. If a spill were to occur, effects could be very severe and long lasting. Impacts are possible from chronic inputs of hydrocarbons from terrestrial sources and vessels.
		Aquaculture – coastal species.	No data.	Unknown. Fish farms are extensive in the Northern Isles and use a wide range of chemical substances.

[732] Acoustic Harassment Devices and Acoustic Deterrent Devices, used at aquaculture facilities

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
		POPs[733] – Potentially all, particularly coastal porpoise and dolphin species.	Harbour porpoise and bottlenose dolphin in UK waters have been found to have high levels of contaminants. In harbour porpoises this was linked to increased mortality from infectious disease.	Unknown, but even low levels of POPs may be capable of causing immune and reproductive system defects. Coastal species are likely to have greater exposure to POPs (and other chemicals) due to their proximity to human activities. Exposure could be direct, or indirect via their prey.
		POPs – Killer whale.	No data.	Killer whale – thought to prey on marine mammals. Eating at a higher trophic level increases levels of POPs.
Fisheries bycatch.	Pelagic trawling; gill nets; tangle nets.	Potentially all, particularly harbour porpoise (bottom-set gill and tangle nets).	No data Lack of detailed information on fisheries operations for this area hinders assessment of impact from bycatch. Deep water fisheries operating in the area have not been monitored for bycatch.	Gill net and pelagic trawl fisheries operate in this area and are gear types known to be dangerous to cetaceans. Bycatch is suspected but levels are unknown.
Prey depletion.	Overfishing; climate change.	Potentially all.	Few data.	Unknown but could be severe if alternative food sources are not easily available. Globally, there is good evidence of large-scale reductions in many fish species.
		Harbour porpoise, minke whale.	Decreases in harbour porpoise numbers around the Shetland Islands coincided with poor sandeel years. Sandeels are also important prey for minke whales. Shetland fishery for sandeels has declined in recent decades and was closed for several years due to poor sandeel recruitment and breeding failures in dependent bird populations. It has been suggested that declines in sandeels, possibly due to climate change, maybe resulting in dietary changes for harbour porpoises with an increasing likelihood of starvation.	Unknown.
		Killer whale.	Estimated 40% decline in harbour seal numbers in the Northern Isles (prey of some North Atlantic killer whales).	No data are available at present. The waters of Shetland appear to be used as the summer foraging ground for a group of North Atlantic killer whales and the loss of this food source could have serious consequences.
Cumulative impacts of all activities (including habitat degradation and loss).		All.	Data on status and trends in most species are lacking. The inter-decadal large-scale SCANS surveys have only taken place twice to date which is insufficient to determine trends. Evidence suggests declines in sandeel populations led to changes in harbour porpoise distribution but the effects of this are unknown	Human impacts on the marine environment are estimated to be very high throughout most of this region[734]. In this region, the combined impacts of physical and acoustic disturbance or injury from oil and gas exploration, shipping and the military are probably of most concern. Data on cetacean prey species and predator-prey dynamics is lacking but the data suggests declines in sandeel populations may be impacting cetacean species, although to what degree is unknown.

[733] Persistent Organic Pollutants - toxic and bioaccumulating chemicals
[734] Halpern *et al*, 2008 (see Figure 5.3)

East Scotland

Species of most relevance for this area: white-beaked dolphin, minke whale, bottlenose dolphin, harbour porpoise, Atlantic white-sided dolphin and killer whale.

Key References used: Thompson *et al*, 2004; Stone 2003, 2006; Hammond *et al*, 2004; Hammond *et al*, 2002; Hartley Anderson and AICSM, 2004; Dykes *et al*, 2001; Rogers and Stocks, 2001; Ross and Isaac, 2004; MacLeod *et al*, 2007; Curran *et al*, 1996; Donovan *et al*, 2009; ICES, 2008.

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Acoustic and physical disturbance, injury and mortality.	Vessels (shipping, military, recreational, whale watching); coastal development (construction and operation of ports, marine renewable energy devices/arrays including wind farms etc); fisheries (AHDs and ADDs[735], pingers); military activities (sonar, explosives); oil and gas development (seismic surveys, drilling, decommissioning); dredging.	Acoustic – Potentially all.	Few data In UK waters, most cetacean species show avoidance reactions to seismic surveys including leaving an area and changing direction. A significant reduction in feeding activity has also been observed during surveys. The long-term effects of this are unknown.	Unknown. Oil and gas production is considerable in the N North Sea and these activities are very noisy. Loud noise sources include seisimic surveys and drilling. The North Sea contains some of the world's busiest shipping routes although it is quieter in the N and central North Sea than in the S. Oil and gas activities generate moderate vessel traffic, with approaches to the ports (e.g. Aberdeen) particularly busy. Recreational use is moderate in coastal waters. Dolphin-watching activities take place in the Inner and S Moray Firth. Two wind turbines are operational in the Outer Moray Firth. Development of hundreds more are anticipated in the coming decade.
		Acoustic – Coastal activities – harbour porpoise, minke whale, white-beaked dolphin, bottlenose dolphin.	Vessels – Boat presence has been shown to cause short-term behavioural reactions in bottlenose dolphin in the Moray Firth but the long-term effects of this are unknown. Impacts on other species are unknown.	Unknown, but vessel traffic is significant (see above).
			Windfarms – No data.	A windfarm is operational in the Outer Moray Firth.
		Collisions – Potentially all, particularly more coastal species (harbour porpoise, minke whale, white-beaked dolphin, bottlenose dolphin).	No conclusive reports of death or injury as a result of vessel collisions but cetaceans with badly cut dorsal fins have been observed in the Moray Firth.	Unknown. The North Sea contains some of the world's busiest shipping routes. North Sea oil and gas activities generate moderate vessel traffic. Approaches to the ports (e.g. Aberdeen) are particularly busy. Recreational use is moderate in coastal waters.
		Coastal development – harbour porpoise, minke whale, bottlenose dolphin, white-beaked dolphin.	No data.	Unknown. Significant coastal development in places, mainly in the large firths. Coastal development may already be at a level to have a significant effect on bottlenose dolphins in the inner Moray Firth.

[735] Acoustic Harassment Devices and Acoustic Deterrent Devices, used at aquaculture facilities

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
		Vessels – bottlenose dolphin.	Boat presence has been shown to cause short-term behavioural reactions in bottlenose dolphin in the Moray Firth but the long-term effects of this are unknown. More serious incidences of vessel disturbance – some warranting legal action – are also known to occur.	Unknown. Bottlenose dolphins are the focus of a significant dolphin watching industry (recreational and commercial) in the Inner and S Moray Firth. This activity peaks during the summer months, the main breeding/calving season for bottlenose dolphins and most cetacean species in the UK.
		Vessels – harbour porpoise and minke whale.	No data.	Other species are not the primary focus of marine wildlife watching activities but those regularly found in the area are also at risk of disturbance.
Chemical pollution.	Inputs from land (industry, agriculture, urban); and sea (ships, oil spills, aquaculture, sewer discharges).	Oil – Potentially all.	No data.	Oil tankers travel through the area. If a spill were to occur, effects could be very severe and long lasting. Impacts are possible from chronic inputs of hydrocarbons from terrestrial sources and vessels.
		POPs[736] – Potentially all, particularly coastal porpoise and dolphin species.	Levels of POPs are relatively low compared to levels in cetaceans world-wide.	Unknown, but even low levels of POPs may be capable of causing immune and reproductive system defects. Coastal species are likely to have greater exposure to POPs (and other chemicals) due to their proximity to human activities. Exposure could be direct, or indirect via their prey.
Fisheries bycatch.	Gill nets; tangle nets; creeling; pelagic trawls.	Potentially all.	Some monitoring has taken place but insufficient to determine level of bycatch in pelagic trawls.	Unknown. Bycatch is thought to be the primary cause of marine mammal mortalities in the North Sea.
		Harbour porpoise (bottom-set gill and tangle nets).	Observer monitoring has recorded high harbour porpoise bycatch levels, estimated to be around 8,000 per year in North Sea gill nets.	High, this level of harbour porpoise bycatch is of serious concern. Monitoring effort is insufficient to properly determine the level of threat.
		Minke whale	Reports of entanglement in pot lines	Unknown

[736] Persistent Organic Pollutants - toxic and bioaccumulating chemicals

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Prey depletion.	Overfishing; climate change.	Potentially all.	Few data. Past declines in herring appear to have led to a dietary shift for harbour porpoises to sandeels and gadoids. More recently it has been suggested that declines in sandeels, possibly due to climate change, may be resulting in dietary changes for harbour porpoise and an increasing likelihood of harbour porpoise starvation.	Unknown but could be severe if alternative food sources are not easily available. Several species of North Sea fish are considered close to or outside Safe Biological Limits, many of which are cetacean prey species (e.g. herring and whiting). Catch levels for many are considered most likely not sustainable. The sandeel fishery off E Scotland was closed for several years due to concern over low numbers and a link made to breeding failure in seabirds. In addition to fishing pressure, fish populations may also be impacted by pollution in the North Sea, and climate change.
Cumulative impacts of all activities (including habitat degradation and loss).		All.	Data on status and trends in most species are lacking. The inter-decadal large scale SCANS surveys have only taken place twice to date which is insufficient to determine trends. The cumulative impacts of fisheries bycatch, pollution and other threats is a particular concern for harbour porpoises	The North Sea sees intensive human activity including shipping, industry and fisheries. The cumulative impacts of these activities are poorly understood. Impacts to the marine environment in this region are estimated to range from medium-high to very high[737]. Data on cetacean prey species and predator-prey dynamics are lacking but the North Sea is heavily fished, often at unsustainable levels. Prey populations may also be impacted by other factors such as climate change and pollution. The level of impact on cetaceans is unknown.

[737] Halpern *et al*, 2008 (see Figure 5.3)

East England

Species of most relevance for this area: Harbour porpoise, white-beaked dolphin, minke whale, Atlantic white-sided dolphin and bottlenose dolphin.

Key References used: Hammond *et al*, 2002; DTI, 2002; DECC, 2009; Bennett *et al*, 2002.

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Acoustic and physical disturbance, injury and mortality.	Vessels (shipping, military, recreational, whale watching); coastal development (construction and operation of ports, marine renewable energy devices/arrays including wind farms etc); fisheries (AHDs and ADDs[738], pingers); military activities (sonar, explosives); oil and gas development (seismic surveys, drilling, decommissioning); dredging.	Acoustic – Potentially all.	Few data In UK waters, most cetacean species show avoidance reactions to seismic surveys including leaving an area and changing direction. A significant reduction in feeding activity has also been observed during surveys. The long-term effects of this are unknown.	Unknown. Oil and gas production is considerable in the central and S North Sea and these activities are very noisy. Loud noise sources include seisimic surveys and drilling. The North Sea contains some of the world's busiest shipping routes. North Sea oil and gas activities generate moderate vessel traffic. Approaches to the ports (e.g. Great Yarmouth) are particularly busy.
		Acoustics – Potentially harbour porpoise, possibly other coastal species.	No data.	Recreational vessel use is concentrated along the coast. Several windfarms are in operation or under construction in this area.
		Collisions – Potentially all.	No conclusive reports of death or injury as a result of vessel collisions but cetaceans with badly cut dorsal fins have been observed in the area.	The North Sea contains some of the world's busiest shipping routes. North Sea oil and gas activities generate moderate vessel traffic. Approaches to the ports (e.g. Great Yarmouth) are particularly busy. Recreational vessel use is concentrated all along the coast.
		Physical disturbance – Potentially all, particularly coastal species.	No data.	High levels of vessel traffic, particularly in coastal waters, could lead to repeated incidences of disturbance. Recreational vessel activity peaks during the summer months, typically breeding/calving season for most cetacean species in UK waters. Areas of considerable coastal development exist on the coastline alongside rural areas.
Chemical pollution.	Inputs from land (industry, agriculture, urban); and sea (ships, oil spills, aquaculture, sewer discharges).	Oil – Potentially all.	Spills have occurred in the past and could potentially occur again.	Oil tankers travel through the area. If a spill were to occur, effects could be very severe and long lasting. Impacts are possible from chronic inputs of hydrocarbons from terrestrial sources and vessels.
		POPs[739] – Potentially all, particularly coastal dolphins and porpoises.	Harbour porpoise and bottlenose dolphin in UK waters have been found to have high levels of contaminants. In harbour porpoise this was linked to increased mortality from infectious disease.	Unknown, but even low levels of POPs may be capable of causing immune and reproductive system defects. Coastal species are likely to have greater exposure to POPs (and other chemicals) due to their proximity to human activities. Exposure could be direct, or indirect via their prey.

[738] Acoustic Harassment Devices and Acoustic Deterrent Devices, used at aquaculture facilities
[739] Persistent Organic Pollutants - toxic and bioaccumulating chemicals

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Fisheries bycatch.	Gill nets; tangle nets; pelagic trawling; demersal trawling; pots.	Potentially all.	Lack of detailed information on fisheries operations for this area hinders assessment of impact from bycatch. Bycaught porpoises frequently recorded along the North Sea from Northumberland to Humberside.	Unknown. Bycatch is thought to be the primary cause of marine mammal mortalities in the North Sea.
		Harbour porpoise.	Observer monitoring has recorded high harbour porpoise bycatch levels, estimated to be around 8,000 per year in the whole of the North Sea.	High. This level of harbour porpoise bycatch is of serious concern. Monitoring effort is insufficient to properly determine the level of threat.
Prey depletion.	Overfishing; climate change.	Potentially all.	No data.	Unknown but could be severe if alternative food sources are not easily available. Several species of North Sea fish are considered close to or outside Safe Biological Limits, many of which are cetacean prey species (e.g. herring and whiting). Catch levels for many are almost certainly not sustainable. In addition to fishing pressure, fish populations may also be impacted by pollution in the North Sea.
Cumulative impacts of all activities (including habitat degradation and loss).		All.	Data on status and trends of most species are lacking. The inter-decadal large scale SCANS surveys have only taken place twice to date which is insufficient to determine trends. The cumulative impacts of fisheries bycatch, pollution and other threats is a particular concern for harbour porpoises.	The North Sea sees intensive human activity including shipping, industry and fisheries. The cumulative impacts of these activities are poorly understood. Data on cetacean prey species and predator-prey dynamics are lacking but the North Sea is heavily fished, often at unsustainable levels. Prey populations may also be impacted by other factors such as climate change and pollution. The level of impact on cetaceans is unknown. Impacts to the marine environment in this region are estimated to range from low in some places to very high in others[740].

[740] Halpern *et al*, 2008 (see Figure 5.3)

South East England

Species of most relevance for this area: Harbour porpoise, white-beaked dolphin, bottlenose dolphin and short-beaked common dolphin.

Key References used: Rogers and Stocks, 2001; DTI, 2002; Hammond *et al*, 2002; Ross and Isaac, 2004.

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Acoustic and physical disturbance, injury and mortality.	Vessels (shipping, military, recreational, whale watching); coastal development (construction and operation of ports, marine renewable energy devices/arrays including wind farms etc); fisheries (AHDs and ADDs[741], pingers); military activities (sonar, explosives); oil and gas development (seismic surveys, drilling, decommissioning); dredging.	Acoustic – Potentially all.	No data.	High traffic densities in these waters will result in high levels of noise. Several windfarms are in operation or under construction in this area.
		Collisions – Potentially all, particularly harbour porpoise and bottlenose dolphin as coastal species.	No data.	High traffic densities throughout this region with shipping, fishing vessels, ferries, and oil and gas related traffic. High recreational use throughout the English Channel and surrounding area.
		Physical disturbance – Potentially all, particularly harbour porpoise and bottlenose dolphin as coastal species.	No data.	Highly-developed coastal region, with several major ports and heavy vessel traffic. Recreational use peaks in the summer months, coinciding with the primary breeding/calving period for most UK cetacean species.
Chemical pollution.	Inputs from land (industry, agriculture, urban); and sea (ships, oil spills, aquaculture, sewer discharges).	Oil – Potentially all.	Spills have occurred in the past and could potentially occur again.	Oil tankers travel through the area. If a spill were to occur, effects could be very severe and long lasting. Impacts are possible from chronic inputs of hydrocarbons from terrestrial sources and vessels.
		POPs[742] – Potentially all, particularly coastal coastal porpoise and dolphin species.	Harbour porpoise and bottlenose dolphin in UK waters have been found to have high levels of contaminants. In harbour porpoise this was linked to increased mortality from infectious disease.	Unknown, but even low levels of POPs may be capable of causing immune and reproductive system defects. Coastal species are likely to have greater exposure to POPs (and other chemicals) due to their proximity to human activities. Exposure could be direct, or indirect via their prey.
Fisheries bycatch.	Gill nets; tangle nets; pelagic trawling; demersal trawling; pots.	Potentially all.	Lack of detailed information on fisheries operations for this area hinders assessment of impact from bycatch.	Unknown.
		Harbour porpoise.	Observer monitoring has recorded high harbour porpoise bycatch levels, estimated to be around 8,000 per year in the whole of the North Sea.	Harbour porpoise population is low in this area now so even a very low level of bycatch could have serious conservation implications. Gill nets are thought to be the primary cause of marine mammal mortalities in the North Sea.
		Common dolphin.	Pair trawlers of the winter sea bass fishery, operating mainly in the Channel, recorded 53 common dolphins in 12 tows.	High (see discussion in SW England table).

[741] Acoustic Harassment Devices and Acoustic Deterrent Devices, used at aquaculture facilities
[742] Persistent Organic Pollutants - toxic and bioaccumulating chemicals

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Prey depletion.	Overfishing; climate change.	Potentially all.	No data.	Unknown but could be severe if alternative food sources are not easily available. Several species of North Sea fish are considered close to or outside Safe Biological Limits, many of which are cetacean prey species (e.g. herring and whiting). Catch levels for many are almost certainly not sustainable. In addition to fishing pressure, fish populations may also be impacted by pollution in the North Sea.
Cumulative impacts of all activities (including habitat degradation and loss).		All.	Data on status and trends in most species are lacking. The inter-decadal large scale SCANS surveys have only taken place twice to date which is insufficient to determine trends.	The North Sea sees intensive human activity including shipping, industry and fisheries. The cumulative impacts of these activities are poorly understood. Impacts to the marine environment are estimated to be range from medium to very high[743]. Data on cetacean prey species and predator-prey dynamics are lacking but the North Sea is heavily fished, often at unsustainable levels. Prey populations may also be impacted by other factors such as climate change and pollution. The level of impact on cetaceans is unknown.

[743] Halpern *et al*, 2008 (see Figure 5.3)

South West England

Species of most relevance for this area: Harbour porpoise, bottlenose dolphin, short-beaked common dolphin, fin whale and minke whale.

Key References used: Ross and Isaac 2004 (and references within); Tregenza *et al*, 1997; Northridge and Kingston, 2009; RYA, 2007; Mackey *et al*, 2005; Metoc, 2007; Anon, 2002; DECC, 2009.

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Acoustic and physical disturbance, injury and mortality.	Vessels (shipping, military, recreational, whale watching); coastal development (construction and operation of ports, marine renewable energy devices/arrays including wind farms etc); fisheries (AHDs and ADDs[744], pingers); military activities (sonar, explosives); oil and gas development (seismic surveys, drilling, decommissioning); dredging.	Acoustic – Potentially all.	No data. A number of necropsied stranded cetaceans in the UK show signs of potential noise-induced injury. Deep diving species (e.g. Risso's dolphin, beaked whales) seem to be particularly affected.	Significant military activity, particularly naval, takes place in the region, including acoustic trials and aircraft training.
		Collisions – Potentially all.	No data.	High densities in the W Channel. Moderate amounts of vessel traffic to and from the Bristol Channel due to large ports in this area. Moderate levels of traffic from vessels travelling N and S through the Irish Sea. Moderate to high recreational use through much of the coastal area, and popular routes across the English and Bristol Channels. SW military exercise area is used for weekly exercise training involving naval warships and submarines.
		Physical disturbance – Potentially all, particularly coastal species.	No data.	High levels of recreational vessel activity in many places, peaking during the summer months, typically breeding/calving season for most cetacean species in UK waters. Moderate coastal development in parts, other areas more rural.
Chemical pollution.	Inputs from land (industry, agriculture, urban); and sea (ships, oil spills, aquaculture, sewer discharges).	Oil – Potentially all particularly coastal porpoise and dolphin species.	No data.	Impacts are possible from chronic inputs of hydrocarbons from terrestrial sources and vessels.
		POPs[745] – Potentially all, particularly coastal porpoise and dolphin species.	Harbour porpoise and bottlenose dolphin in UK waters have been found to have high levels of contaminants. In harbour porpoise this was linked to increased mortality from infectious disease.	Unknown, but even low levels of POPs may be capable of causing immune and reproductive system defects. Coastal species are likely to have greater exposure to POPs (and other chemicals) due to their proximity to human activities. Exposure could be direct, or indirect via their prey.

[744] Acoustic Harassment Devices and Acoustic Deterrent Devices, used at aquaculture facilities
[745] Persistent Organic Pollutants - toxic and bioaccumulating chemicals

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Fisheries bycatch.	Pelagic trawling; demersal trawling; gill nets; tangle nets.	Pelagic trawls – Small cetaceans.	Pelagic trawl fisheries operating in the area from the Bay of Biscay N to SW Ireland and in the W approaches to the English Channel recorded bycatch of common dolphin, Atlantic white-sided dolphin, bottlenose dolphin, white-beaked dolphin and long-finned pilot whale. No total numbers provided but given the fleet size the number may be significant. Much occurs during the late winter/early spring.	Unknown.
		Gill nets – harbour porpoises.	Observer monitoring has recorded high harbour porpoise bycatch levels in UK and Irish bottom-set gill net fisheries in the Celtic Sea, estimated to be around 2,200 per year. An estimated 590 common dolphin a year are also taken in gill and tangle net fisheries in the area. Other gill net fleets have yet to be monitored.	High. 2,200 harbour porpoises a year represents 6.2% of the estimated population in the Celtic Sea. International fora have deemed an annual bycatch of 1% of estimated abundance to be of concern for harbour porpoise populations, and 1.7% the threshold of an unacceptable level of interactions for small cetaceans[746].
		Pair trawls – common dolphin.	Pair trawlers of the winter sea bass fishery, operating mainly in the Channel, recorded 53 common dolphins in 12 tows. In 2004, bycatch from the UK fishery exceeded 400 animals but rates are thought to have declined since then.	Large numbers of common dolphins are present in the region during winter, the same time as the pelagic trawl for bass operates. The only winter population estimate for common dolphins in the region is 3,055 for a small area off SW England[747]. 1.7% of this is just 52 animals.
		Pelagic trawls – harbour porpoise.	Evidence from stranded harbour porpoises suggest this species is also being caught by pelagic trawl fisheries in the Celtic Sea area.	Combined with the large number of harbour porpoise bycaught in bottom-set gill nets, this adds to the serious conservation concern.
		Bottlenose dolphin.	Evidence of entanglement in fishing gear.	Unknown.
Prey depletion.	Overfishing; climate change.	Potentially all.	No data.	Unknown but could be severe if alternative food sources are not easily available. Globally, there is good evidence of large-scale reductions in many fish species.
Cumulative impacts of all activities (including habitat degradation and loss).		All.	Data on status and trends in most species are lacking. The inter-decadal large scale SCANS surveys have only taken place twice to date which is insufficient to determine trends. Large numbers of common dolphin and harbour porpoise bycatch victims wash up on SW beaches each year.	Impacts from bycatch, particularly cumulative impacts from multiple fisheries, are a serious concern in this region. Impacts from human activities to the marine environment are estimated to be medium-high to very high[748].

[746] IWC and ASCOBANS, see Ross and Isaac, 2004 for discussion
[747] See short-beaked common dolphin species account for details
[748] Halpern *et al*, 2008 (Figure 5.3)

Irish Sea

Species of most relevance for this area: Harbour porpoise, bottlenose dolphin, Risso's dolphin, short-beaked common dolphin and minke whale.

Key References used: Luddington and Moore, 2005; Mills and Eastwood, 2005; Hammond *et al*, 2005; DECC 2009.

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Acoustic and physical disturbance, injury and mortality.	Vessels (shipping, military, recreational, whale watching); coastal development (construction and operation of ports, marine renewable energy devices/arrays including wind farms etc); fisheries (AHDs and ADDs[749], pingers); military activities (sonar, explosives); oil and gas development (seismic surveys, drilling, decommissioning); dredging.	Acoustic – Potentially all.	No data.	Liverpool Bay is a major site for oil and gas production and these activities are very noisy. They also generate considerable vessel traffic. Several windfarms are in operation or under construction in the E Irish Sea.
		Collisions – Potentially all.	No data.	Moderate levels of traffic travel N-S through the Irish Sea, and servicing oil and gas operations in the region. Liverpool Bay contains several large ports.
		Physical disturbance – Potentially all, particularly coastal species (harbour porpoises and bottlenose dolphins).	No data.	Coastal development is most intense in the Liverpool Bay region. Liverpool Bay is also a major site for oil and gas production.
Chemical pollution.	Inputs from land (industry, agriculture, urban); and sea (ships, oil spills, aquaculture, sewer discharges).	Oil – Potentially all.	Spills have occurred in the past and could potentially occur again.	Oil tankers travel to and from the area. If a spill were to occur, effects could be very severe and long lasting. Impacts are possible from chronic inputs of hydrocarbons from terrestrial sources and vessels.
		POPs[750] – Potentially all, particularly coastal porpoise and dolphin species.	The harbour porpoise and bottlenose dolphin in UK waters have been found to have high levels of contaminants. In harbour porpoise this was linked to increased mortality from infectious disease.	Unknown, but even low levels of POPs may be capable of causing immune and reproductive system defects. Coastal species are likely to have greater exposure to POPs (and other chemicals) due to their proximity to human activities. Exposure could be direct, or indirect via their prey.
Fisheries bycatch.	Gill nets; tangle nets; demersal trawling; pelagic trawling.	Potentially all, particularly harbour porpoises with gill and tangle nets.	No data.	Use of gill and tangle nets has been increasing in the area. Only low levels of pelagic trawling found.
Prey depletion.	Overfishing; climate change.	Potentially all.	No data.	Unknown but could be severe if alternative food sources are not easily available. Globally, there is good evidence of large-scale reductions in many fish species.
Cumulative impacts of all activities (including habitat degradation and loss).		All.	Data on status and trends in most species are lacking. The inter-decadal large scale SCANS surveys have only taken place twice to date which is insufficient to determine trends.	The Irish Sea sees intensive human activity including shipping and industry. The cumulative impacts of these activities are poorly understood. Impacts to the marine environment from human activities are estimated to be high throughout most of the region[751].

[749] Acoustic Harassment Devices and Acoustic Deterrent Devices, used at aquaculture facilities
[750] Persistent Organic Pollutants - toxic and bioaccumulating chemicals
[751] Halpern *et al*, 2008 (see Figure 5.3)

Coastal Wales

Species of most relevance for this area: Harbour porpoise, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin and minke whale.

Key References used: DECC, 2009; Luddington and Moore, 2005; Mills and Eastwood, 2005; Hammond *et al*, 2005; De Boer, 2009; Pierpoint and Allan, 2006; WDCS, 2005a; Bennett *et al*, 2002.

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Acoustic and physical disturbance, injury and mortality.	Vessels (shipping, military, recreational, whale watching); coastal development (construction and operation of ports, marine renewable energy devices/arrays including wind farms etc); fisheries (AHDs and ADDs[752], pingers); military activities (sonar, explosives); oil and gas development (seismic surveys, drilling, decommissioning); dredging.	Potentially all.	Few data.	Some military activities take place here including bombing. Recreational vessel use has increased in recent years and peaks during the summer months, coinciding with the main breeding/calving season for UK cetaceans (including Risso's dolphin, bottlenose dolphin and harbour porpoise).
		Collisions – Potentially all.	15% of all Risso's dolphins photo-ID'ed off Bardsey Island (N Wales) showed severe wounds, some of which may have been caused by collisions with vessels and their propellers[753].	Overall, commercial shipping traffic is low in coastal Welsh waters. Highest densities are found in the NW and SW, with shipping and ferry routes connecting Welsh and English ports with Ireland. A military exercise area exists in coastal waters, although levels of activity are unknown. Moderate to high recreational use through much of the coastal area, particularly during the summer months, breeding/calving season for most cetacean species in the UK
		Physical disturbance – Potentially all, particularly coastal species.	No data.	Relatively low levels of coastal development throughout much of coastal Wales.
		Vessels – bottlenose dolphin, Risso's dolphin, harbour porpoise.	Observations of bottlenose dolphins and boat traffic in S Cardigan Bay have documented negative reactions from bottlenose dolphins, particularly when vessels do not follow the voluntary code of conduct in place for the area. Risso's dolphins appear particularly sensitive to disturbance from vessels, displaying negative reactions in response to vessel presence.	Unknown. Recreational use has increased in recent years and is now moderate to high along much of the coast. The area also supports a marine ecotourism industry.
Chemical pollution.	Inputs from land (industry, agriculture, urban); and sea (ships, oil spills, aquaculture, sewer discharges).	Oil – Potentially all.	Spills have occurred in the past and could potentially occur again.	Oil tankers travel to and from the area. If a spill were to occur, effects could be very severe and long lasting. Impacts are possible from chronic inputs of hydrocarbons from terrestrial sources and vessels.
		POPs[754] – Potentially all, particularly coastal porpoise and dolphin species.	Harbour porpoise and bottlenose dolphin in UK waters have been found to have high levels of contaminants. In harbour porpoise this was linked to increased mortality from infectious disease.	Unknown, but even low levels of POPs may be capable of causing immune and reproductive system defects.

[752] Acoustic Harassment Devices and Acoustic Deterrent Devices, used at aquaculture facilities
[753] It is not possible to ascertain where collisions may have occurred however
[754] Persistent Organic Pollutants - toxic and bioaccumulating chemicals

Actual or Potential Threat	Activity	Species Affected (Actual or Potential)	Evidence of Impact	Level of Impact
Fisheries bycatch.	Gill nets; tangle nets; demersal trawling; pelagic trawling.	Potentially all, particularly harbour porpoises in gill and tangle nets.	Bycaught porpoises frequently recorded in Wales. 15% of all Risso's photo-ID'ed off Bardsey Island (N Wales) showed severe wounds, some of which were indicative of entanglement with fishing nets[755].	Use of gill and tangle nets has been increasing in the area. Only low levels of pelagic trawling.
Prey depletion.	Overfishing; climate change.	Potentially all.	No data.	Unknown but could be severe if alternative food sources are not easily available. Globally, there is good evidence of large-scale reductions in many fish species.
Cumulative impacts of all activities (including habitat degradation and loss).		All.	Data on status and trends in most species are lacking. The inter-decadal large scale SCANS surveys have only taken place twice to date which is insufficient to determine trends.	Scallop dredging has a severe impact on important marine habitats and has recently been banned through parts of Cardigan Bay[756]. Disturbance and habitat degradation from vessel traffic, coastal development and other activities is probably the most significant cumulative impact in coastal Welsh waters. Impacts to the marine environment from human activities are estimated to be high throughout most of the region[757].

[755] It is not possible to ascertain where the entanglement may have occurred, however

[756] New Scallop Fishing Rules Announced, 4/02/10. http://www.ccw.gov.uk/about-ccw/newsroom/press-releases/new-scallop-fishing-rules.aspx

[757] Halpern *et al*, 2008 (see Figure 5.3)

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