

**Recommended Management Units for
Marine Mammals in Welsh Waters**

Peter G.H. Evans

CCW Policy Research Report No. 12/1

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Non Technical Summary

CCW is increasingly receiving requests from Government, regulators and developers for advice on the potential effects of human activities in the maritime environment on mammals in Welsh waters. To do this, an understanding is required of the geographical range of populations and sub-populations of mammal species occurring in Welsh waters, in order to provide advice on impacts at the most appropriate spatial scale. Knowledge is also required about the size, status and net productivity or growth rate of species' populations and sub-populations, to determine the likely consequences of any impacts. Furthermore, an understanding for the human pressures and sources of anthropogenically induced mortality already acting upon populations or sub-populations of marine mammals is required, in order to provide advice on the likely effects of additional or multiple activities and impacts.

This report focuses on the six main marine mammal species occurring in Welsh waters, namely; harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), short-beaked common dolphin (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*), minke whale (*Balaenoptera acutorostrata*) and Atlantic grey seal (*Halichoerus grypus*). Data and information are provided on the known geographical range of populations of each of these species and used in conjunction with environmental legislation pertaining to their protection, to recommend 'Management Units and Sub-Units' for each of the species in relation to Welsh waters at the most appropriate spatial scale.

The following Management Units and Sub-Units have been recommended for the six marine mammal species, of relevance to Welsh waters, based on available data and evidence, in conjunction with expert judgement;

Harbour porpoise, *Phocoena phocoena*

Celtic Sea Management Unit (includes the Irish Sea)

Bottlenose dolphin, *Tursiops truncatus*

Irish Sea Management Unit

Cardigan Bay SAC Management Sub-Unit

Pen Llŷn a'r Sarnau SAC Management Sub-Unit

Short-beaked common dolphin, *Delphinus delphis*

Eastern North Atlantic Management Unit

Risso's dolphin, *Grampus griseus*

Celtic Sea Management Unit (includes the Irish Sea)

Minke whale, *Balaenoptera acutorostrata*

North West European Shelf Seas Management Unit

Atlantic grey seal, *Halichoerus grypus*

Irish Sea Management Unit

Pembrokeshire Marine SAC Management Sub-Unit

Cardigan Bay SAC Management Sub-Unit

Pen Llŷn a'r Sarnau SAC Management Sub-Unit

Other significant moulting and feeding haul-out site possible Management Sub-Units

Where available, population estimates are provided for each of these Management Units and Sub-Units, as well as information on the status and net productivity, or growth rate and information on human pressures already acting upon these populations.

Recommendations and figures in this report are based on existing data, where possible, but since limited information is available on some species (particularly common dolphin, Risso's dolphin and minke whale, expert opinion and judgement have been used. Where this is the case, it is indicated in the report.

Crynodeb Annhechnegol

Mae Cyngor Cefn Gwlad Cymru yn cael mwy a mwy o geisiadau gan reoleiddwyr, datblygwyr a'r Llywodraeth am gyngor ar effeithiau posibl gweithgareddau dynol yn yr amgylchedd morol ar famaliaid yn nyfroedd Cymru. I wneud hyn, rhaid i ni ddeall ystod ddaearyddol poblogaethau ac is-boblogaethau rhywogaethau mamaliaid dyfroedd Cymru, er mwyn rhoi cyngor ar yr effeithiau ar y raddfa ofodol fwyaf priodol. Rhaid i ni gael gwybodaeth hefyd am faint, statws a chynhyrchiant net neu gyfradd twf poblogaethau ac is-boblogaethau rhywogaethau, er mwyn pennu goblygiadau tebygol unrhyw effaith. Yn ogystal â hyn, rhaid i ni ddeall y pwysau dynol a'r ffynonellau marwolaeth yn sgil gweithgareddau anthropogenig sydd eisoes yn effeithio ar boblogaethau neu is-boblogaethau mamaliaid morol, er mwyn rhoi cyngor ar effeithiau tebygol gweithgareddau ac effeithiau ychwanegol neu amryfal.

Mae'r adroddiad hwn yn canolbwyntio ar y chwe phrif rywogaeth o famaliaid morol yn nyfroedd Cymru, sef; y llamhidydd (*Phocoena phocoena*), y dolffin trwyn potel (*Tursiops truncatus*), y dolffin cyffredin pig fer (*Delphinus delphis*), dolffin Risso (*Grampus griseus*), y morfil pigfain (*Balaenoptera acutorostrata*) a morlo llwyd Môr yr Iwerydd (*Halichoerus grypus*). Darperir y data a'r wybodaeth ar ystod ddaearyddol hysbys poblogaethau bob un o'r rhywogaethau hyn, a chânt eu defnyddio ar y cyd â deddfwriaeth amgylcheddol yng nghyswllt eu gwarchod, er mwyn argymhell 'Unedau ac Is-Unedau Rheoli' ar gyfer pob un o'r rhywogaethau yng nghyswllt dyfroedd Cymru ar y raddfa ofodol fwyaf priodol.

Mae'r Unedau a'r Is-Unedau Rheoli canlynol wedi'u hargymhell ar gyfer y chwe rhywogaeth mamaliaid morol sy'n berthnasol i ddyfroedd Cymru ar sail y data a'r dystiolaeth sydd ar gael, ac ar y cyd â barn arbenigol;

Y llamhidydd, *Phocoena phocoena*

Uned Rheoli'r Môr Celtaidd (gan gynnwys Môr Iwerddon)

Y dolffin trwyn potel, *Tursiops truncatus*

Uned Rheoli Môr Iwerddon

Is-Uned Rheoli ACA Bae Ceredigion

Is-Uned Rheoli ACA Pen Llŷn a'r Sarnau

Y dolffin cyffredin pig fer, *Delphinus delphis*

Uned Rheoli Dwyrain Gogledd yr Iwerydd

Dolffin Risso, *Grampus griseus*

Uned Rheoli'r Môr Celtaidd (gan gynnwys Môr Iwerddon)

Y morfil pigfain, *Balaenoptera acutorostrata*

Uned Rheoli Moroedd Sgafell Gogledd Orllewin Ewrop

Morlo llwyd Môr yr Iwerydd, *Halichoerus grypus*

Uned Rheoli Môr Iwerddon

Is-Uned Rheoli ACA Sir Benfro Forol

Is-Uned Rheoli ACA Bae Ceredigion

Is-Uned Rheoli ACA Pen Llŷn a'r Sarnau

Is-Unedau Rheoli posibl safleoedd eraill lle gwelir y morlo yn bwrw blew ac yn bwydo

Pan fyddant ar gael, caiff amcangyfrifon poblogaeth eu darparu ar gyfer pob un o'r Unedau a'r Is-Unedau Rheoli hyn, yn ogystal â gwybodaeth am statws a chynhyrchiant net, neu gyfradd twf a gwybodaeth am bwysau dynol sydd eisoes yn effeithio ar y poblogaethau hyn.

Mae'r argymhellion a'r ffigurau yn yr adroddiad hwn yn seiliedig ar ddata cyfredol, lle bo'n bosibl, ond gan fod yr wybodaeth am rai rhywogaethau yn gyfyngedig (yn enwedig y dolffin cyffredin, dolffin Risso a'r morfil pigfain), rydym wedi defnyddio barn arbenigol. Pan fydd hyn yn wir, bydd yn cael ei nodi yn yr adroddiad.

1. BACKGROUND INFORMATION AND INTRODUCTION

1.1 Background

The Countryside Council for Wales (CCW) champions the environment and landscapes of Wales and its coastal waters as sources of natural and cultural riches, as a foundation for economic and social activity, and as a place for leisure and learning opportunities. CCW aims to make the environment a valued part of everyone's life in Wales.

CCW is increasingly receiving requests from Government, regulators and developers for advice on the potential effects of human activities in the maritime environment on mammals in Welsh waters. In order to provide robust advice, the best available current information on the size, distribution, range, status and net productivity, or growth rate, of marine mammal populations in Welsh waters is required. An understanding is also required of the pressures already acting on populations of marine mammals, in order to provide advice on the likely effects of additional or multiple activities.

1.2 Introduction to marine mammal species in Welsh waters

Eighteen species of cetacean have been recorded in Welsh waters since 1990, of which five species (harbour porpoise, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin and minke whale) are relatively common, whilst the grey seal is the only breeding pinniped in Wales (Baines and Evans, 2012). This report therefore focuses on the following six marine mammal species, as those most likely to be affected by human activities in the marine environment in Wales;

- Harbour porpoise, *Phocoena phocoena*
- Bottlenose dolphin, *Tursiops truncatus*
- Short-beaked common dolphin, *Delphinus delphis*
- Risso's dolphin, *Grampus griseus*
- Minke whale, *Balaenoptera acutorostrata*
- Atlantic grey seal, *Halichoerus grypus*

Limited information is available on the six species listed above (particularly common dolphin, Risso's dolphin and minke whale). Where possible, this report is based on relevant published information or data, but where information is not readily available, expert opinion has been provided.

To ascertain the effects of human activities on these six marine mammal species, an understanding is required for the size and geographical range of their populations.

Knowledge of the status of the species' populations and sub populations and their net productivity or growth rate is also required to be able to determine the likely consequences of any impacts. Furthermore, an understanding for the main sources of anthropogenically induced mortality already acting upon species is required, in order to provide advice on the likely effects of additional or multiple activities and impacts.

1.3 Introduction to legislation protecting marine mammals in Welsh waters

Bottlenose dolphin and grey seal are both Annex II species features of European Special Areas of Conservation in Wales, designated under the 1992 EC Habitats Directive (as amended). Bottlenose dolphin is a species feature of Cardigan Bay SAC and Pen Llŷn a'r Sarnau SAC, while grey seal is a species feature of Pembrokeshire Marine SAC, Pen Llŷn a'r Sarnau SAC and Cardigan Bay SAC. Regulation 61 of the Conservation of Habitats and Species Regulations 2010 (consolidating the various amendments made to the Conservation (Natural Habitats, &c.) Regulations 1994), which transpose the Directive into UK law, requires that plans or projects not directly connected with, or necessary to, the management of that site must be assessed to ascertain whether they are likely to have a significant effect on a European site (in this case, SAC) in view of that site's conservation objectives. Whilst the overall aim of SACs is to maintain the integrity of the site, Conservation Objectives for SACs are specific to features, so in the case of the three sites detailed above, they include objectives for the bottlenose dolphin and / or grey seal populations supported by these sites.

All cetaceans are European Protected Species, listed on Annex IV of the 1992 Habitats Directive (as amended). The Conservation of Habitats and Species Regulations 2010 make it an offence to kill, injure, capture or disturb European marine protected species, whilst the Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007 extend the offence to areas of UK jurisdiction beyond 12nm. It is now an offence under both Directives to deliberately disturb wild animals of a European Protected Species in such a way as to be likely significantly to affect: a) the ability of any significant group of animals of that species to survive, breed, rear or nurture their young; or b) the local distribution or abundance of that species.

1.4 Introduction to marine mammal Management Units

A pre-requisite to defining Management Units for marine mammals to achieve effective conservation management is an understanding of how best to define populations in a biologically meaningful manner. This in turn requires an understanding for the geographical range of distinct populations or sub-populations of species, which is determined by genetic studies and/or ecological information.

Knowledge of population structure is critical to defining Management Units for marine mammals. Population structure has been studied using tagging, radio and satellite tracking, allozymes, microsatellite and mitochondrial DNA analyses, photo-identification, morphometrics and chemical markers (e.g. Allen *et al*, 1995; Lahaye *et al*, 2005; Amaral *et al*, 2007; Fontaine *et al*, 2007; Anderwald *et al*, 2008). Most of these methods are limited; they can only show that two samples differ and thus that population structure is present, but they cannot be used to demonstrate in a definitive manner that population structure is absent. There is almost always some uncertainty in deciding how finely to divide Management Units, and one of the current challenges in marine mammal management is dealing with this uncertainty.

Following Evans & Teilmann (2009), a few generations (equivalent to low tens of years) is adopted as the appropriate timeframe for defining a Management Unit for marine mammals. Evans and Teilmann (2009) used the definition of a Management Unit as a group of individuals for which there are different lines of complementary evidence suggesting reduced exchange (migration/dispersal) rates. These may then give rise to groups that are demographically independent of one another. Annex I provides a more detailed explanation of the challenges in defining Management Units from various lines of genetic and ecological information that function at different time scales.

1.5 Introduction to marine mammal Management Sub-Units

The term 'Management Unit' has also been used to refer to a group of animals that is the target of some management action and so is spatially defined by the corresponding management objective. Such management objectives might relate to the protection of the wider marine environment, species' breeding sites, important foraging areas, moulting and haul out sites (pinnipeds) or zones of important interactions with fisheries or other marine activities. In this report, any such areas are referred to as 'Management Sub-Units', and are clearly distinguished from the species population and sub-population Management Units defined according to the rationale provide in Section 1.4 above.

Examples of where it might be appropriate to sub-divide Management Units for certain species include those marine mammals that are species features of Special Areas of Conservation (SAC) in Wales. For these species, it might be appropriate to identify Management 'Sub-Units' to account for the requirement of the 1992 Habitats Directive and Conservation of Habitats and Species Regulations 2010, to assess impacts on these species features at the site level (see Section 1.3 above). Where recommendations are made in this report to support the identification of Management Sub-Units for certain species, a rationale is provided.

2. OUTPUTS

2.1 Geographical range and size of populations of the six mammal species and determination of appropriate Management Units and Sub-Units

2.1.1 Harbour porpoise, *Phocoena phocoena*

The harbour porpoise is restricted to temperate and sub-arctic (mainly 11-14°C) seas of the northern hemisphere, occurring in both the Atlantic and Pacific. In the North Atlantic, the species occurs mainly from Central West Greenland and Novaya Zemlya in the north to North Carolina and Senegal in the south (Evans *et al.*, 2008). A geographically distinct population exists in the Black Sea (although there is evidence that it has not always been isolated – see Rosel *et al.*, 2003).

In European seas, it is common and widely distributed over the continental shelf (mainly at depths of 20-200m) from the Barents Sea and Iceland south to the coasts of France and Spain, although in the 1970s it became scarce in the southernmost North Sea, English Channel, and Bay of Biscay. Nevertheless, it remains the most widely distributed and frequently observed cetacean in North West European shelf seas, and since the 1990s, has returned to the southernmost North Sea, English Channel and French Biscay coast (Rogan and Berrow, 1996; Hammond *et al.*, 2002; Reid *et al.*, 2003; Evans *et al.*, 2003; Evans and Wang, 2003; Camphuysen, 2004; Kiszka *et al.*, 2004, 2007; Evans *et al.*, 2008; Hammond, 2008).

Although porpoises can be found in deep waters off the edge of the continental shelf (for example within the Faroe Bank Channel – see Pollock *et al.*, 2000), they are comparatively rare in waters exceeding 200 metres. The species frequently uses tidal conditions for foraging (see e.g. Evans, 1997; Pierpoint, 2008; Marubini *et al.*, 2009).

Population estimates do not exist for the entire North Atlantic range of the harbour porpoise, or even for the European range. The widest scale surveys were SCANS (Small Cetaceans Abundance in the North Sea and adjacent waters) undertaken in 1994, followed by SCANS-II (Small Cetaceans in the European Atlantic and North Sea) in 2005. From line transect SCANS surveys in July 1994 (Hammond *et al.*, 2002), an overall population estimate of 341,000 porpoises (CV=0.14; 95% CI: 260,000-449,000) was made, with the following regional estimates: the North Sea (c. 250,000), NW Scotland (c. 18,000), Baltic region (36,600 in Kattegat / Skagerrak / Belt Seas / Western Baltic Sea), Channel (0), and Celtic Shelf (36,300). Figure 1a shows the area covered by SCANS.

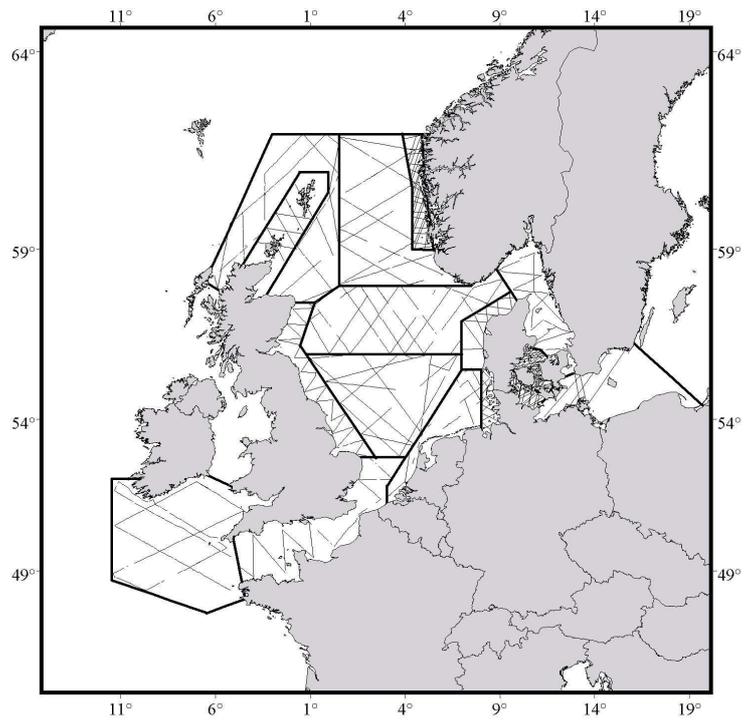


Figure 1a. Survey tracks for the SCANS survey (July 1994).
(Source: Hammond *et al.*, 2002).

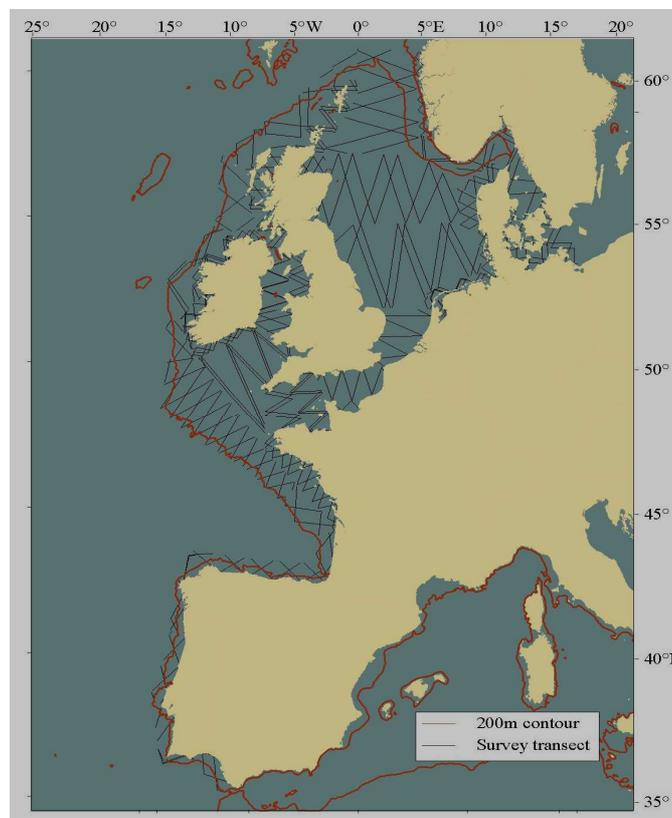


Figure 1b. Survey tracks for the SCANS-II survey (July 2005).
(Source: Hammond, 2008).

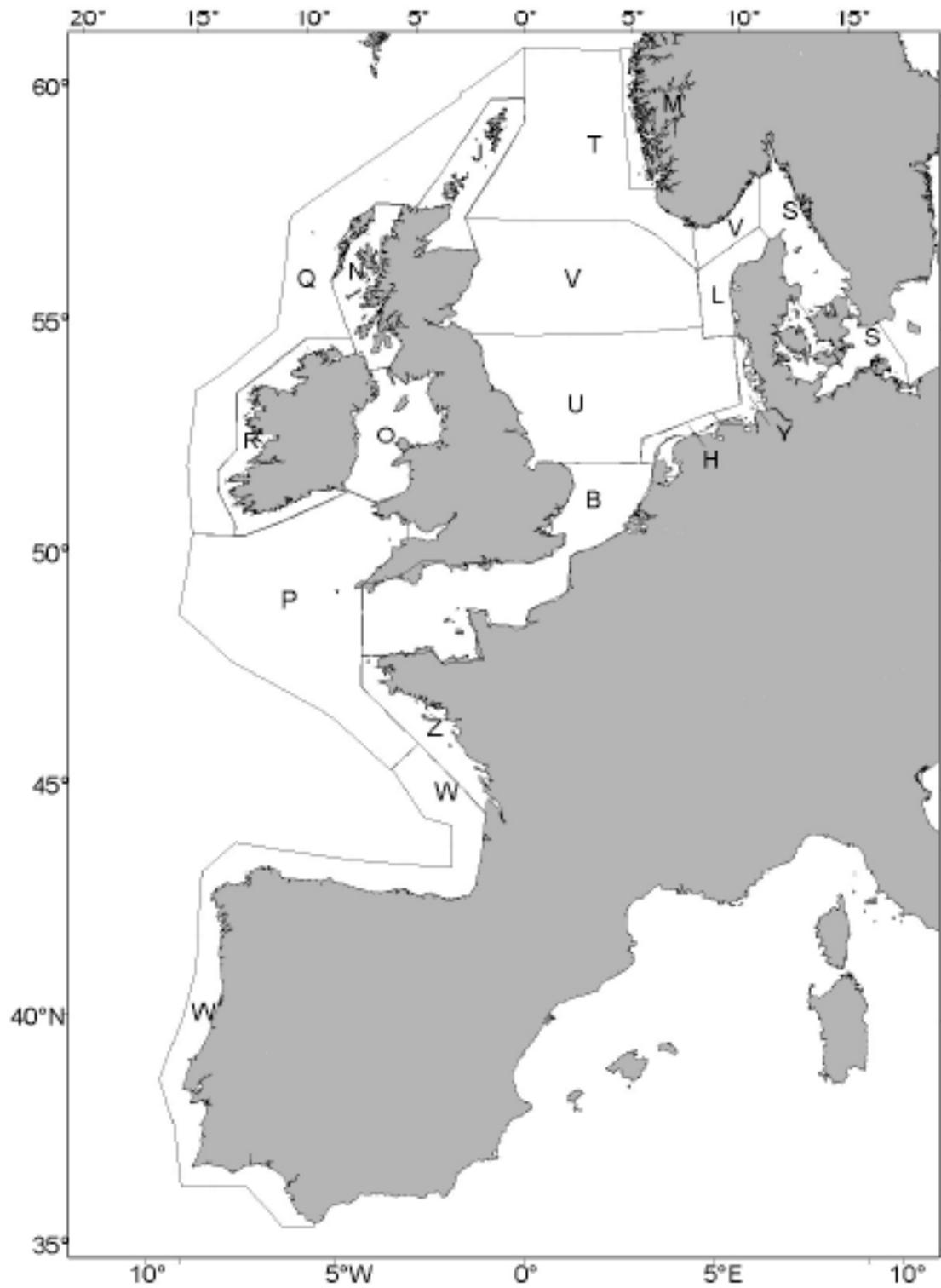


Figure 1c. Survey blocks defined for the SCANS-II survey. Those surveyed by ship were S, T, V, U, Q, P and W. The remaining strata were surveyed from aircraft.

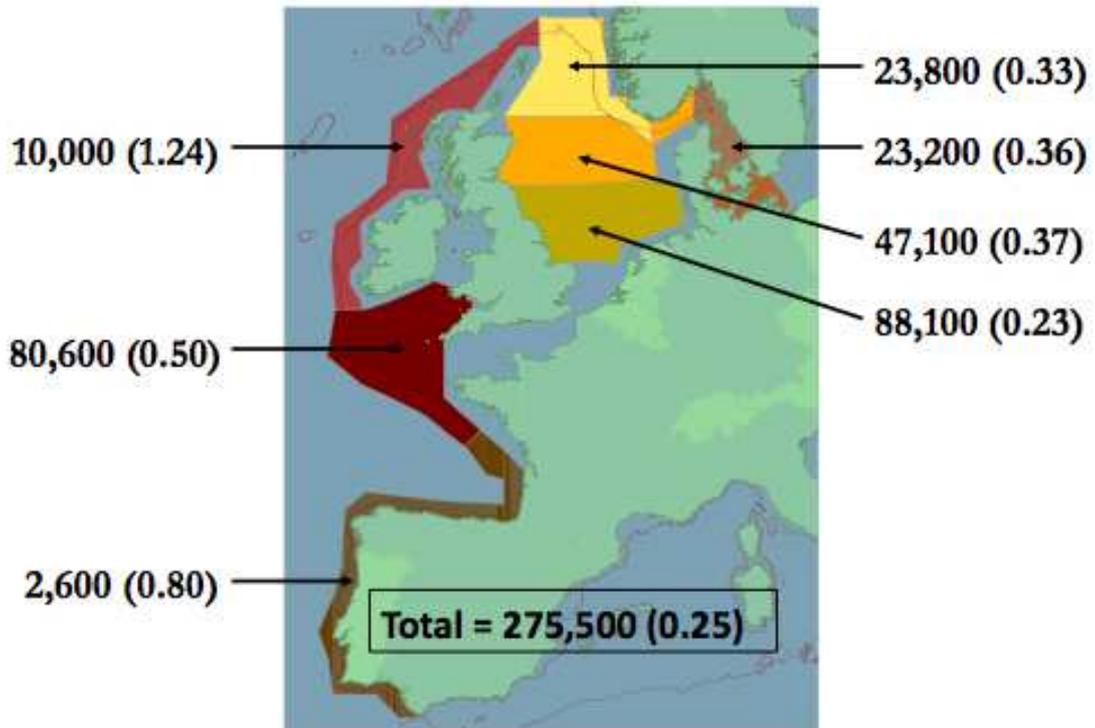


Figure 2a. Abundance estimates (and CVs) for harbour porpoise from the SCANS-II survey (shipboard), July 2005. (Source: Hammond, 2008).

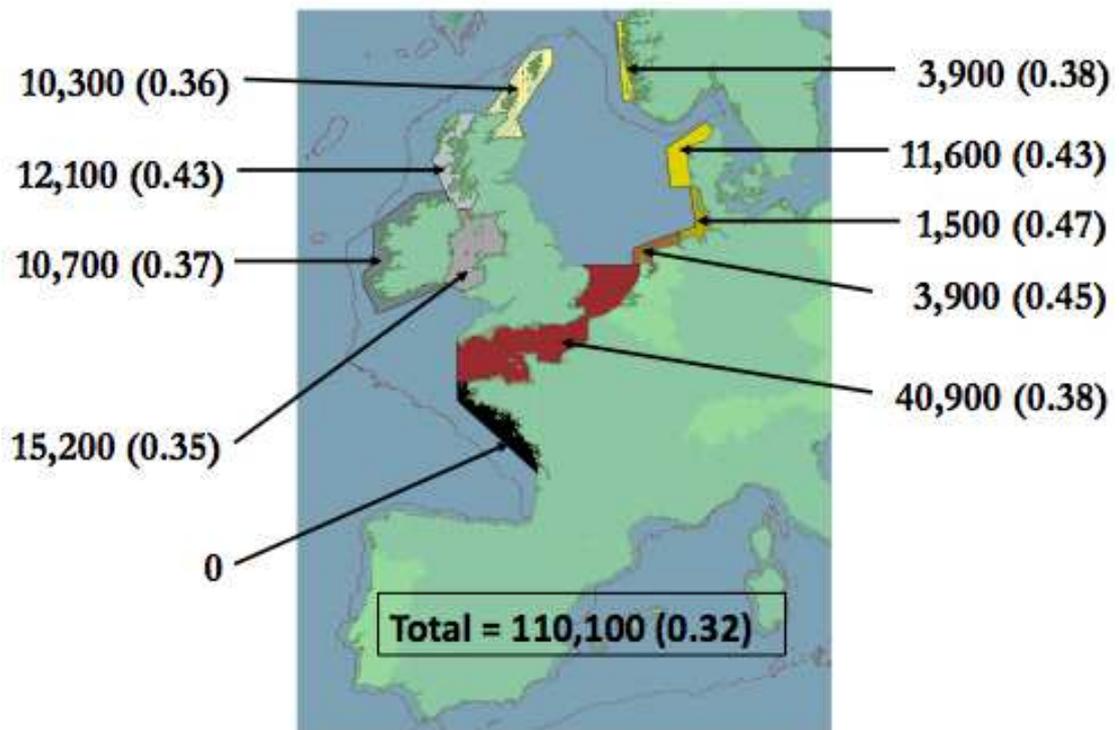


Figure 2b. Abundance Estimates (and CVs) for harbour porpoise from the SCANS-II survey (aerial), July 2005. (Source: Hammond, 2008).

The repeat survey in July 2005 (SCANS-II), covering a wider area (continental shelf seas from SW Norway, south to Atlantic Portugal), gave an estimate of 385,617 (CV=0.20; 95% CI: 261,300-569,200) (Hammond, 2008), with regional estimates: North Sea (c. 190,000), Baltic (23,800 in Kattegat / Skagerrak / Belt Seas / Western Baltic Sea), Channel (40,900), Celtic Shelf (80,600), Irish Sea (15,200), Atlantic Ireland and Scotland (32,800) and the Iberian Peninsula (2,600). Figure 1b shows the area covered by SCANS-II, Figure 1c the labelled survey blocks and Figures 2a & b, the abundance estimates for harbour porpoise derived from the shipboard and aerial surveys, respectively.

Comparing the two surveys, although the overall number estimated for the North Sea, Channel and Celtic Sea was comparable (341,000 in 1994, and 335,000 in 2005), numbers in the northern North Sea and Danish waters had declined from 239,000 to 120,000, whereas in the central and southern North Sea, Channel and Celtic Shelf, they had increased from 102,000 to 215,000. This is thought to represent a southwards range shift rather than actual changes in population size (Winship, 2009), at least for the month of July.

Elsewhere, in Norwegian waters, estimates of 11,000 porpoises (95% CI: 4,790-25,200) for the Barents Sea and Norwegian waters north of 66°N and 82,600 (95% CI: 52,100-131,000) for Southern Norway and the northern North Sea, were made during July 1989 (Bjørge and Øien, 1995).

The abundance estimate calculated from the July 2005 SCANS II survey for the Irish Sea was 15,230 (CV = 0.35) and for the Celtic Sea, it was 80,613 (CV = 0.50) (Hammond, 2008). The size of the population inhabiting Welsh waters is not known. In Cardigan Bay, line transect surveys of the SAC indicate that the harbour porpoise population has been increasing slightly over the period 2001 to 2008 (Pesante *et al.*, 2008a), whilst sighting rates show a significant increase since the 1980s (Evans *et al.*, 2003). The size of the population inhabiting Cardigan Bay SAC was estimated at 214 (CV = 0.20) in 2007 (Pesante *et al.*, 2008a). In the Irish Sea, harbour porpoises are widely distributed but with main areas of concentration in the outer Bristol Channel, off South-west Wales, the Llŷn Peninsula, north and west Anglesey, and off the east coast of Co. Dublin (Baines & Evans, 2012; see Figure 3).

Fifteen separate Management Units (MU) have been proposed for harbour porpoise in the North Atlantic (Evans and Teilmann, 2009). These include nine MUs within the ASCOBANS Agreement Area that encompasses most of North West Europe. One of these, encompasses Welsh waters, is referred to as the Celtic Sea MU. The Celtic Sea MU includes the Irish Sea, Western English Channel and Southwest Ireland – broadly speaking, equivalent to areas O & P from the SCANS-II survey (Figure 1c), although boundaries have not been clearly determined (Evans and Teilmann, 2009).

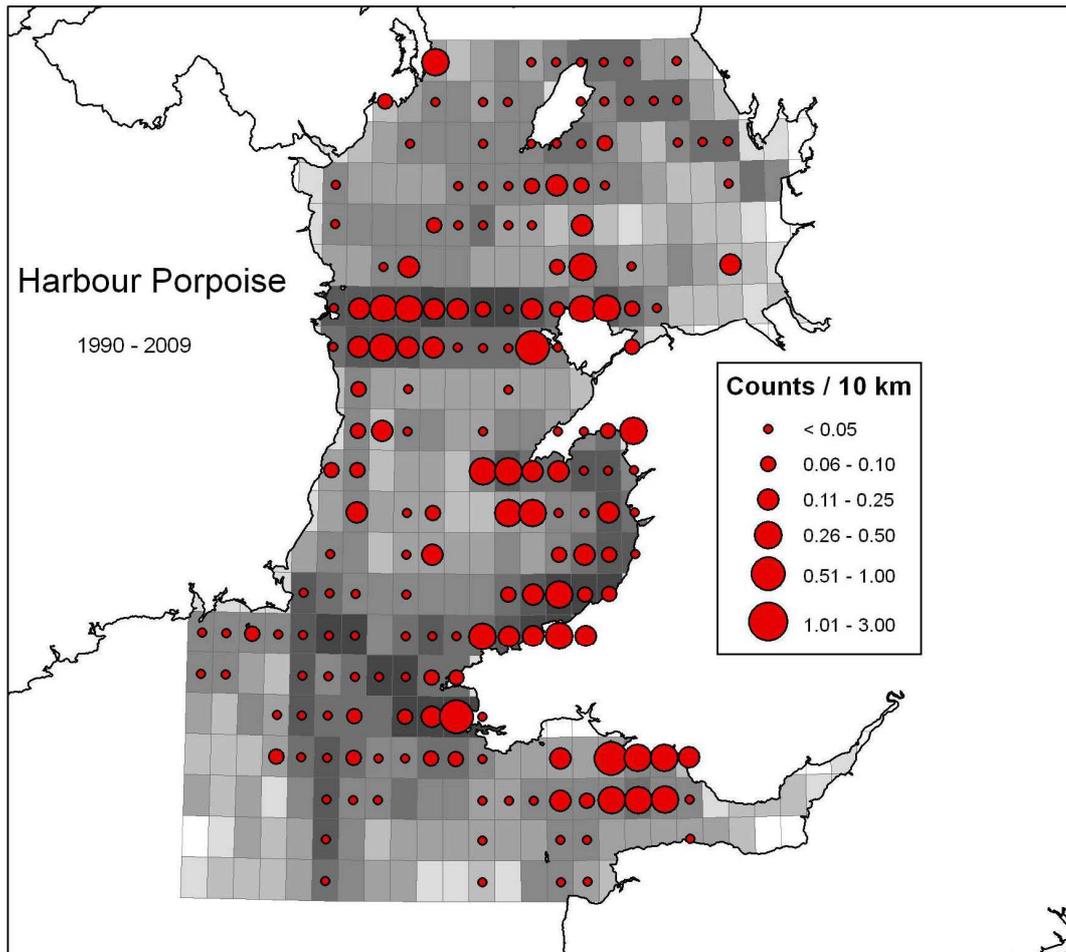


Figure 3. Long term count rates of harbour porpoise from vessel surveys, 1990-2009. (Source: Baines and Evans, 2012).

Recommended Management Units for Harbour Porpoise (*Phocoena phocoena*) in Welsh waters

1. Celtic Sea Management Unit (includes the Irish Sea)

Rationale: Management Unit includes the SCANS-II blocks O & P (Hammond, 2008) i.e. Irish Sea, Celtic Sea, Western English Channel and Southwest Ireland – see Figure 1c, although boundaries have not been clearly determined (Evans and Teilmann, 2009). Differentiation from other Management Units has been based upon studies using mitochondrial DNA, micro-satellites, skeletal variation, tooth ultrastructure, as well as dietary and contaminant load differences (see Evans and Teilmann, 2009 for further details).

Population estimate for Celtic Sea MU: 95,843 (95% CI = 43,200 - 212,700; CV = 0.42). See Appendix I for further details.

2.1.2 Bottlenose dolphin, *Tursiops truncatus*

The bottlenose dolphin has a worldwide distribution in tropical and temperate seas in both hemispheres. In the North Atlantic, it occurs from Nova Scotia in the west and the Faroe Islands in the east (occasionally as far north as northern Norway and Svalbard), southwards to the equator and beyond (Wilson, 2008).

Along the Atlantic seaboard of Europe, the species is locally fairly common near-shore off the coasts of Spain, Portugal, north-west France, western Ireland (particularly the Shannon Estuary and Connemara), North-east Scotland (particularly Moray Firth south to the Firth of Forth), South-west Scotland, in the Irish Sea (particularly North and West Wales, including all of Cardigan Bay), and in the English Channel (Berrow *et al.*, 2001; Lahaye and Mauger, 2001; Pineau *et al.*, 2001; Evans *et al.*, 2003; Reid *et al.*, 2003). Smaller groups of bottlenose dolphins have also taken up residence at other localities – for example, around the Outer Hebridean island of Barra, and in the Inner Hebrides (Islay, Mull, Coll, Tiree and southern Isle of Skye) in West Scotland (Evans *et al.*, 2003; Cheney *et al.*, 2012).

The species also occurs offshore in the eastern North Atlantic, particularly along the shelf edge (where it occurs often in association with long-finned pilot whales), as far north as the Faroe Islands and even Svalbard (Evans *et al.*, 2003; Reid *et al.*, 2003). In the Bay of Biscay, Certain *et al.* (2008) have shown that bottlenose dolphin preferential habitat was over the outer shelf and the shelf break where they are thought to take a variety of pelagic fish species (blue whiting, whiting, hake, pouts, etc).

In coastal waters, bottlenose dolphins often favour river estuaries, headlands or sandbanks where there is uneven bottom relief and/or strong tidal currents (Lewis and Evans, 1993; Liret *et al.*, 1994; Wilson *et al.*, 1997; Rogan *et al.*, 2000; Liret, 2001; Ingram and Rogan, 2002). Offshore, the species occurs particularly along the continental shelf edge, seasonally entering near-shore waters around the Faroe Islands, northern and western Scotland, western Ireland, in the Bay of Biscay, and around the Iberian Peninsula (Galicia and coast of Portugal) (Evans *et al.*, 2003; Reid *et al.*, 2003; Certain *et al.*, 2008).

In Welsh waters, the bottlenose dolphin is the second most frequently recorded cetacean, after harbour porpoise, with a predominantly coastal distribution, although low densities have been recorded offshore, particularly in St George's Channel and the western sector of the Outer Bristol Channel (Baines & Evans, 2012; see Figure 4). The main concentrations of sightings occur in southern Cardigan Bay and further north in Tremadog Bay although the species is also found off the coast of North Wales, particularly north and east of Anglesey. Bottlenose dolphin are a Habitats Directive Annex II species feature of Cardigan Bay and Pen Llŷn a'r Sarnau Special Areas of Conservation (SAC). However, the animals associated with these protected sites are not considered to be closed populations, but are part of the wider Irish Sea population.

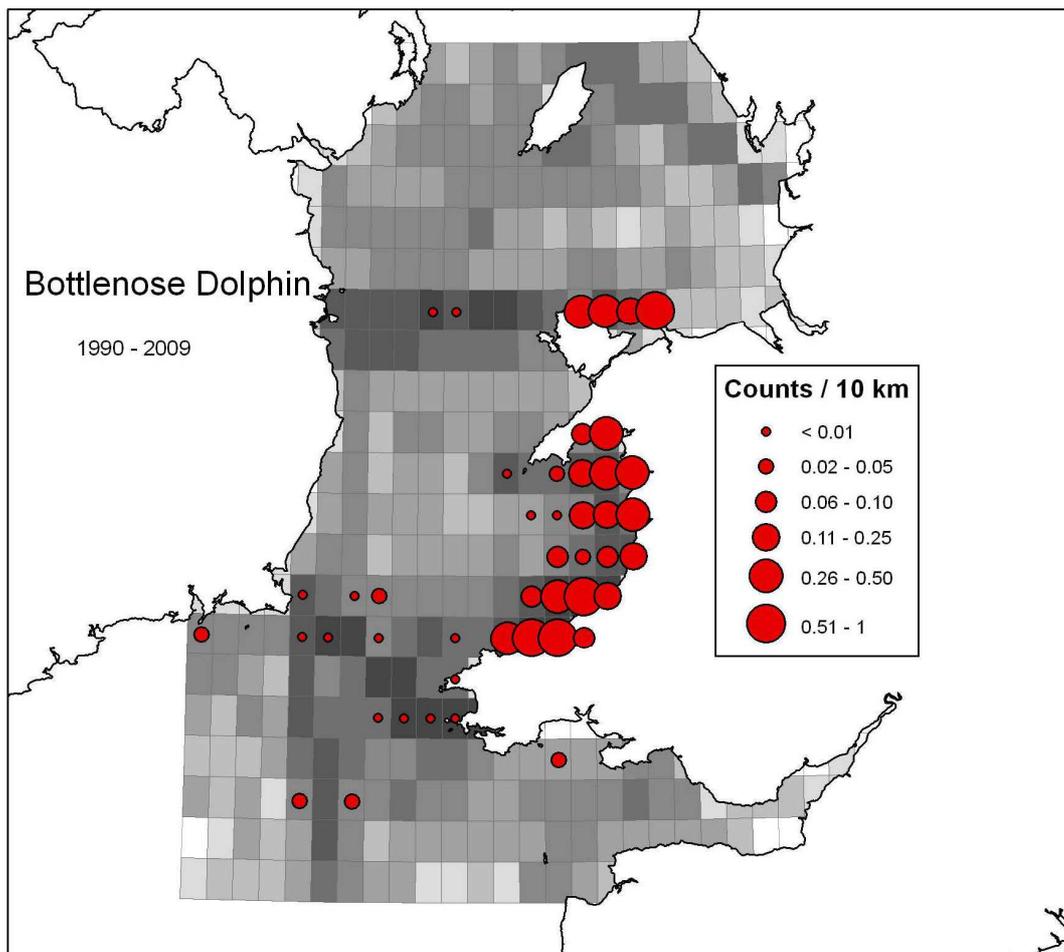


Figure 4. Long term sightings rates of bottlenose dolphin from vessel surveys, 1990-2009. (Source: Baines and Evans, 2012).

SCANS-II surveys of North West European shelf waters in July 2005 gave an overall abundance estimate for the survey area, as shown in Figure 1b of 12,645 (CV=0.27; 95% CI: 7,400-21,500) (Hammond, 2008), whereas, offshore, the CODA survey (July 2007) which covered the area immediately offshore of the shelf edge from north of Shetland to North-west Iberia, yielded an abundance estimate, uncorrected for $g(0)$ and responsive movement, of 19,295 (CV=0.25; 95% CI: 11,900-31,300) (Hammond *et al.*, 2009; P.S. Hammond, *pers. comm.*). These highlight the significant offshore population(s) of this species. The SCANS-II estimate for the Irish Sea was 235 individuals (CV=0.75; 95% CI: 100-900) (Hammond, 2008).

Coastal populations of bottlenose dolphins tend to be small (Wilson, 2008). Abundance estimates (mainly using photo-ID and mark-recapture) exist for both of the principal coastal populations in the UK. An estimated 129 (95% CI: 110-174) animals live in the Moray Firth (Wilson *et al.*, 1999), whilst the population in the Cardigan Bay SAC has been estimated from 2001-11 to vary in any particular year between 129 and 260 bottlenose dolphins (using a closed population model), and for the entire Cardigan Bay (between 2005-11, and using an

open population model) has varied between 127 and 221 (Pesante *et al.*, 2008; Veneruso & Evans, 2012). Neither the Moray Firth nor the Cardigan Bay population is confined to those areas nor is closed, and individuals may join up for periods of time from elsewhere. Closed population models can be used when the time interval between sampling is short so that population size can be assumed not to have changed; they allow for taking account of heterogeneity of gene frequencies and temporary emigration. Pollock's open population models rely upon a time series using closed models within years.

In Western Ireland, estimates of between 113 and 140 individuals have been reported as occupying the Shannon Estuary (Ingram 2000; Ingram and Rogan, 2003; Englund *et al.*, 2007, 2008), whereas substantial numbers range around the rest of Western and Southern Ireland but appear to be genetically isolated from the Shannon population (Mirimin *et al.*, 2011).

The limited information available at present suggests that bottlenose dolphins inhabiting offshore waters along the continental shelf edge and environs are best treated as a separate Management Unit. This is provisionally taken to include animals from around the Faroe Islands southwards along the shelf to the Iberian Peninsula. In particular, there may be a difference between truly oceanic areas and shelf break-outer shelf habitats.

The following eleven near-shore populations are each proposed as separate Management Units (although it is quite possible that some areas have overlapping communities with different movement patterns): 1) North Sea (Eastern Scotland from Caithness to the borders with England); 2) Outer Hebrides (Island of Barra); 3) Inner Hebrides; 4) Irish Sea; 5) Shannon Estuary; 6) Western Ireland; 7) Southern England; 8) Channel Islands and Normandy coast (North France); 9) Brittany coast and islands (West France); 10) Southern Galicia; and 11) Sado Estuary (Portugal) (Evans and Teilmann, 2009). Future studies may reveal further local populations along Irish, French, Spanish and Portuguese coasts.

At this stage, in relation to Welsh waters, the Irish Sea is considered to form a single Management Unit for bottlenose dolphins. However, mark-recapture studies (Pesante *et al.*, 2008) suggest that with further research, this may need to be split into separate MUs, reflecting different patterns of movement by particular groupings of animals. Some individuals appear to be very sedentary; others range seasonally over much wider areas; and a third grouping may not belong to Welsh waters but be transient visitors (Pesante *et al.*, 2008). At present, the spatial extent of possible separate MUs within the Irish Sea is not known.

Bottlenose dolphins are a Habitats Directive Annex II species feature of Cardigan Bay and Pen Llŷn a'r Sarnau SACs. Management requires an assessment of impacts on this species feature at the site level for each SAC, so additional SAC Management Sub-Units are

recommended, although the animals associated with these sites are not considered to be closed populations, but are part of the wider Irish Sea population.

Recommended Management Units and Sub-Units for Bottlenose Dolphin in Welsh waters

1. Irish Sea Management Unit

Rationale: Management Unit is based on photo-ID studies between 2001 and 2010. No matches have been found between animals within the Irish Sea and those elsewhere, comparing catalogues from Ireland, Scotland and SW England (Pesante *et al.*, 2008; Evans & Teilmann, 2009).

Note that mark-recapture analyses suggest the Irish Sea Management Unit may in future need to be split into three or more sub-units: Inshore, Offshore and Transient groups, but at present we have insufficient knowledge to know how to do this.

Population estimate for Irish Sea MU: 397 (95% CI = 362 - 414; CV = 0.23). See Appendix I for further details.

2. & 3. Cardigan Bay SAC and Pen Llŷn a'r Sarnau SAC Management Sub-Units

Rationale: Bottlenose dolphin are a Habitats Directive Annex II species feature of Cardigan Bay and Pen Llŷn a'r Sarnau Special Areas of Conservation, so management requires an assessment of impacts on this species feature at the site level for each SAC. However, the animals associated with these protected sites are not considered to be closed populations, but are part of the wider Irish Sea population. On the basis of current understanding therefore, population estimates for these two Management Sub-Units are as provided above for the wider Irish Sea Management Unit.

2.1.3 Short-beaked common dolphin, *Delphinus delphis*

The short-beaked common dolphin has a worldwide distribution in oceanic and shelf-edge waters of tropical, subtropical and temperate seas, occurring in both hemispheres. It is abundant and widely distributed in the eastern North Atlantic, mainly occurring in deeper waters from the Iberian Peninsula north to approximately 65°N latitude, west of Norway and the Faroe Islands (Reid *et al.*, 2003; Murphy *et al.*, 2008). It occurs westwards at least to the mid-Atlantic ridge (Doksaeter *et al.*, 2008; Cañadas *et al.*, 2009).

On the UK continental shelf, the species is common in the western half of the English Channel and the southern Irish Sea, and further north in the Sea of Hebrides and southern part of the Minch (Evans *et al.*, 2003; Reid *et al.*, 2003). It is also common south and west of Ireland, whilst off the edge of the continental shelf it can be found north to a latitude of about 65° N (though rare north of 62° N). In some years, the species occurs further north and east in

shelf seas - in the northern Hebrides, around Shetland and Orkney, and in the northern North Sea. It is generally rare in the central and southern North Sea and eastern portion of the English Channel, but is abundant in the Bay of Biscay (Evans *et al.*, 2003; Reid *et al.*, 2003).

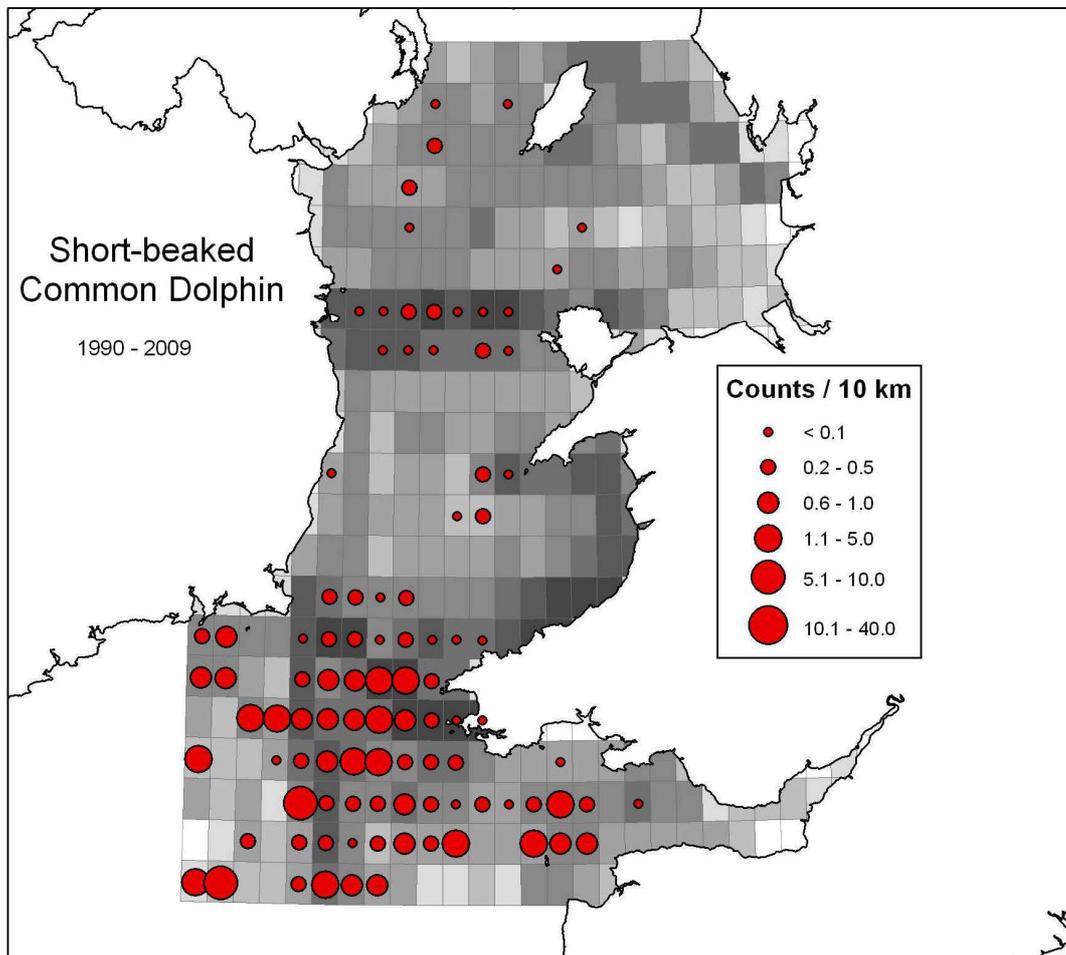


Figure 7. Long term sightings rates of short-beaked common dolphin distribution from vessel surveys, 1990-2009. (Source: Baines and Evans, 2012).

In Welsh waters, the species has a largely offshore distribution centred upon the Celtic Deep at the southern end of the Irish Sea, where water depths range from 50-150 metres (Baines & Evans, 2012; see Figure 7). This high-density area extends eastwards towards the coast and islands of west Pembrokeshire. Elsewhere in the Irish Sea, the species occurs at low densities mainly offshore, in a central band that extends northwards towards the Isle of Man (Baines & Evans, 2012; Figure 7).

Several surveys using line transect methods have estimated population abundance levels in the NE Atlantic. The MICA survey in the summer of 1993 estimated the population at 61,888 (95% CI: 35,461–108,010,) in the area where the French tuna driftnet fishery operated (Bay of Biscay, continental shelf W to c. 20°W, and S to c. 43°N) (Goujon *et al.*, 1993).

The SCANS survey in July 1994 included the Celtic Shelf to approximately 11°W and 48°S, and gave an estimate of 75,449 (CV = 0.67; 95% CI: 23,900–248,900) (Hammond *et al.*, 2002). Where the two surveys overlapped in area along the shelf edge (11°W-51°N to 8°W-48°N), the total summer population was estimated at c. 120,000 (Goujon, 1996).

During August 2002, the ATLANCET aerial survey covered 140,000 km² of continental shelf and shelf break in the Bay of Biscay overlapping with the SCANS survey area in the Southern Celtic Sea and gave an estimate of 17,639 (95% CI: 11,253-27,652) (Ridoux *et al.*, 2003; WGMME, 2005).

The NASS ship-based survey, in summer 1995, by the Faroese covered two large areas to the N and W of Ireland (NASS east and NASS west), and gave an estimate of 273,159 (95% CI: 153,392-435,104, CV=0.26) for the western block (an area of sea of 108,325nm² spanning 52-57.5° N, 18-28° W) (Cañadas *et al.*, 2009); this estimate was corrected for animals missed on the track-line ($g(0)$), and for responsive movement. Further east, the SIAR survey estimated 4,496 (95% CI: 2,414–9,320) within an area of c. 120,000 km² off West Ireland during August 2000 (Ó'Cadhla *et al.*, 2003).

The MICA, SIAR and SCANS 1994 surveys did not use a double-platform method, nor did they correct for animals missed on track line ($g(0)$), or for responsive movement. Therefore abundances estimates from these surveys probably require adjustment.

In 2005, the SCANS-II survey was undertaken, which surveyed the same area as SCANS in 1994, but increased this to include the Irish Sea, waters off western and northern Ireland, western Scotland, and continental shelf waters off France, Spain and Portugal. The total summer abundance of short-beaked common dolphin for those North East Atlantic shelf waters was estimated at c. 50,507 (CV = 0.29; 95% CI: 28,700-88,800) (Hammond, 2008). Within the Irish Sea proper, the estimate was only 825 (CV=0.78; 95% CI: 200-3,200) but in the Celtic Sea (which includes most of the St George's Channel as well as shelf seas south and west of Ireland and South West England), it was 11,141 (CV=0.61; 95% CI: 3,700-33,500) (Hammond, 2008).

As part of the EU NECESSITY project, abundance was estimated for a defined management area in relation to pelagic trawl fisheries in the North East Atlantic, which coincides with ICES Areas VI, VII, & VIII. As this area was not covered by a single survey, it was necessary to combine data from various surveys (including SIAR, SCANS & SCANS-II; MICA, NASS-95 E block, ATLANCET & PELGAS - see Burt, 2007). For surveys where the probability of detection on the track-line could not be estimated, it was assumed that $g(0)$ equals one. Responsive variables were latitude, longitude, slope, depth & distance from coast.

The estimated number of common dolphin schools was 28,791 (CV=0.24; 95% CI: 15,370–42,210), and the estimated number of animals was 248,962 (CV=0.18; 95% CI: 161,920–336,000) (Burt, 2007). It should be noted that this abundance estimate is specific to the management area described above, and does not cover the known range of the species. All sightings data used to calculate this abundance estimate were obtained during the summer time. Furthermore, the abundance estimate uses data obtained over a long temporal scale, and assumes that the density and distribution of common dolphins did not change during the 14-year sampling period (1993-2006).

Finally, the CODA offshore survey conducted in July 2007, covering an offshore strip beyond the continental shelf from Shetland to NW Spain, estimated a total abundance of 116,709 (CV=0.34; 95% CI: 61,400-221,800) (P.S. Hammond, *pers. comm.*).

In Welsh waters, summer surveys of a portion (area 3,134 km²) of the Celtic Deep west of Pembrokeshire gave estimates of 1,186 (CV=0.41; 95% CI: 520-2709), 1,644 (CV=0.27; 95% CI: 968-2792), and 2,166 (CV=0.17; 95% CI: 1541-3045) for the years 2004, 2005 & 2006 respectively (Evans *et al.*, 2007).

A study by Forcada *et al.* (1990), using a diverse data set collected both opportunistically and on dedicated surveys from a variety of platforms, reported a bimodal distribution of common dolphins in the NE Atlantic. As a result, they suggested the existence of two separate populations, one neritic and the other oceanic. Since then, analysis of more extensive data suggests the species could be more or less continuously distributed at least during the summer time, from coastal waters in the North East Atlantic to the mid Atlantic ridge, and as far south as the Azores (Cañadas *et al.*, 2009). In fact, it may be distributed across the whole North Atlantic, between 35° and 60°N (partially covering a region heavily influenced by the Gulf Stream/North Atlantic Drift). However, due to a lack of observer effort, beyond the mid Atlantic ridge, between approx. 30-40°W, its full distributional range in the North Atlantic is not fully known.

Genetic studies suggest that only one common dolphin population exists in the Eastern North Atlantic, ranging from waters off Scotland to Portugal, but with separate populations in the Western North Atlantic, and Mediterranean Sea (Amaral *et al.*, 2007; Natoli *et al.*, 2008; Mirimin *et al.*, 2009). On the other hand, stable isotope and contaminant analyses suggest there may be some structuring of common dolphin populations within this region, with a possible existence of neritic and oceanic ecological stocks (Lahaye *et al.*, 2005; Caurant *et al.*, 2006). Furthermore, genetic studies indicate structuring on the basis of oceanographic features such as sea surface temperature and chlorophyll concentration (Amaral *et al.*, 2012). However, at present there is insufficient information to determine separate Management Units (Evans and Teilmann, 2009). Analysis carried out to date suggests that the North East Atlantic population is in expansion. Common dolphins inhabiting waters off Scotland are in a

marginal position in the distributional range, and there may be less exchange between these individuals and common dolphins inhabiting other regions in the North East Atlantic.

Recommended Management Unit for Short-beaked Common Dolphin (*Delphinus delphis*) in Welsh waters

1. Eastern North Atlantic Management Unit

Rationale: Management Unit is based on genetic studies, which suggest that only one common dolphin population exists in the Eastern North Atlantic, ranging from waters off Scotland to Portugal (Amaral *et al.*, 2007; Natoli *et al.*, 2008; Mirimin *et al.*, 2009).

Note that stable isotope and contaminant burden analyses suggest there may be some structuring of common dolphin populations within the eastern North Atlantic region, with a possible existence of neritic and oceanic ecological stocks (Lahaye *et al.*, 2005; Caurant *et al.*, 2006), with common dolphins inhabiting offshore waters in the Bay of Biscay differing from those in adjacent coastal waters. If this were the case generally then one might expect there to be a Management Unit for western Britain (South-west Approaches, Celtic Sea, Irish Sea and West Scotland) that is distinct from those in pelagic seas beyond the shelf. There could even be further division between the Irish Sea/Celtic Sea and adjacent areas but that requires further study. Recent genetic studies also indicate structuring on the basis of oceanography although differentiation is mainly by distance (Amaral *et al.*, 2012). At present there is insufficient information to determine separate Management Units (Evans and Teilmann, 2009).

Population estimate for Eastern North Atlantic MU: 400,000 - 800,000 (no CV). See Appendix I for further details.

2.1.4 Risso's dolphin, *Grampus griseus*

The Risso's dolphin is widely distributed in tropical and temperate seas of both hemispheres (Evans, 2008). It occurs in small numbers along the Atlantic European seaboard from the Northern Isles south to the Iberian Peninsula and east into the Mediterranean Sea, favouring continental slope waters (Evans *et al.*, 2003; Reid *et al.*, 2003).

The major populations in northern European waters occur in the Hebrides but the species is regular also in Shetland & Orkney, and the Irish Sea, as well as in South West Ireland. It is rare in the North Sea and all but the western end of the English Channel. Elsewhere, it is present in North West France, the southern Bay of Biscay, around the Iberian Peninsula, and in the Mediterranean Sea (Evans *et al.*, 2003; Reid *et al.*, 2003).

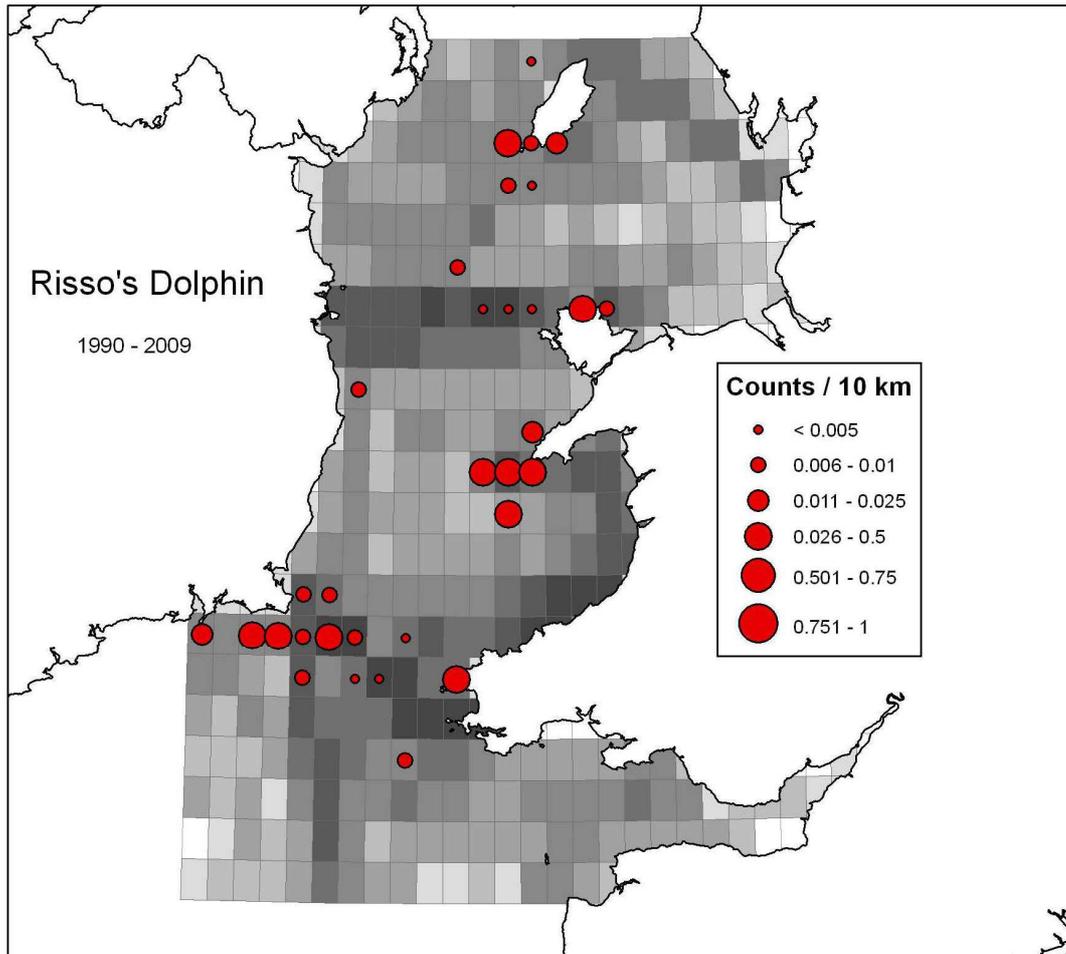


Figure 8. Long term sightings rates of Risso's dolphin distribution from vessel surveys, 1990-2009. (Source: Baines and Evans, 2012).

In the Irish Sea, Risso's dolphin has a relatively localised distribution, forming a wide band running SW-NE that encompasses west Pembrokeshire, the western end of the Llŷn Peninsula (including around Bardsey Island), and Anglesey, the South East coast of Ireland in the west, and waters around the Isle of Man in the north (Baines & Evans, 2012; see Figure 8). There have been only a few strandings, mainly in the western parts of Wales (Baines & Evans, 2012).

The only available studies of Risso's dolphin population differentiation are a genetic study comparing samples from stranded animals around the UK with biopsied and stranded animals from the Ligurian Sea in the western Mediterranean (Gaspari, 2004; Gaspari *et al.*, 2007) and a study comparing animals from the Hebrides with those from Italy (Benoldi *et al.*, 1997; Benoldi *et al.*, 1999). In both cases, statistically significant differences were found. However, there has been no sampling of populations in between.

In the Western North Atlantic, a population estimate of 20,479 exists for waters off Eastern USA and 1,589 in the Northern Gulf of Mexico (Waring *et al.* 2011). No population estimates

exist for any region in the Eastern North Atlantic. A study in the North Minches, Scotland, identified at least 142 individuals (Atkinson *et al.* 1997, 1998). Sightings during the SCANS, SCANS-II and CODA surveys were too few to derive realistic population estimates (Hammond *et al.*, 1995; Hammond, 2008; Hammond *et al.*, 2009). The same applies to the identification of Management Units. Without further study, it is impossible to know whether one or more Management Units exist in UK waters let alone within the Irish and Celtic Seas, so for the time being we regard the appropriate, precautionary, Management Unit as Celtic Sea (including the Irish Sea).

Recommended Management Unit for Risso's Dolphin (*Grampus griseus*) in Welsh waters

1. Celtic Sea Management Unit (includes the Irish Sea)

Rationale. Determining Management Units for this species on the basis of available survey data is impossible. A DNA study found genetic differences between Risso's dolphins sampled from the eastern North Atlantic and the Western Mediterranean (Gaspari, 2004; Gaspari *et al.*, 2007). At present, there is no evidence to suggest population sub-structuring within the North Atlantic, although it is likely to be the case given the strong site fidelity revealed from photo-ID. Photo-ID studies within the Irish Sea have produced catalogues numbering at least 100 individuals. For the time being, a precautionary Management Unit of the Celtic Sea has been recommended.

Population estimate for Celtic Sea MU: Low thousands (no 95% CI, no CV). See Appendix I for further details.

2.1.5 Minke whale, *Balaenoptera acutorostrata*

The minke whale is the commonest baleen whale both in the North Atlantic and around the British Isles. It occurs in small numbers along the Atlantic seaboard of Europe mainly from Norway south to France, and in the northern North Sea, although abundance is greatest in the north (Evans *et al.*, 2003; Reid *et al.*, 2003). The species is widely distributed along the Atlantic seaboard of Britain and Ireland, with numbers greatest off the west coast of Scotland and around the Hebrides (where aggregations of up to twenty have been recorded); it also occurs regularly in the northern and central North Sea as far south as Yorkshire, but is rare in the southernmost North Sea and eastern half of the English Channel (Evans *et al.*, 2003; Reid *et al.*, 2003). In the western English Channel, it is evenly distributed to the continental shelf edge, being largely absent from the deeper parts of the Bay of Biscay.

In the Irish Sea, the minke whale has a largely offshore distribution, with highest densities of sightings occurring in the area of the Celtic Deep, although the species is found also in deeper areas (generally >50 m) northwards towards the Isle of Man (Baines & Evans, 2012; see Figure 9).

The only published population estimates for minke whales in UK waters are from the SCANS, SCANS-II and CODA surveys. In July 1994, a survey of the North Sea, English Channel and Celtic Sea (SCANS) estimated 8,450 individuals (95% CI: 5,000-13,500) (Hammond *et al.*, 2002).

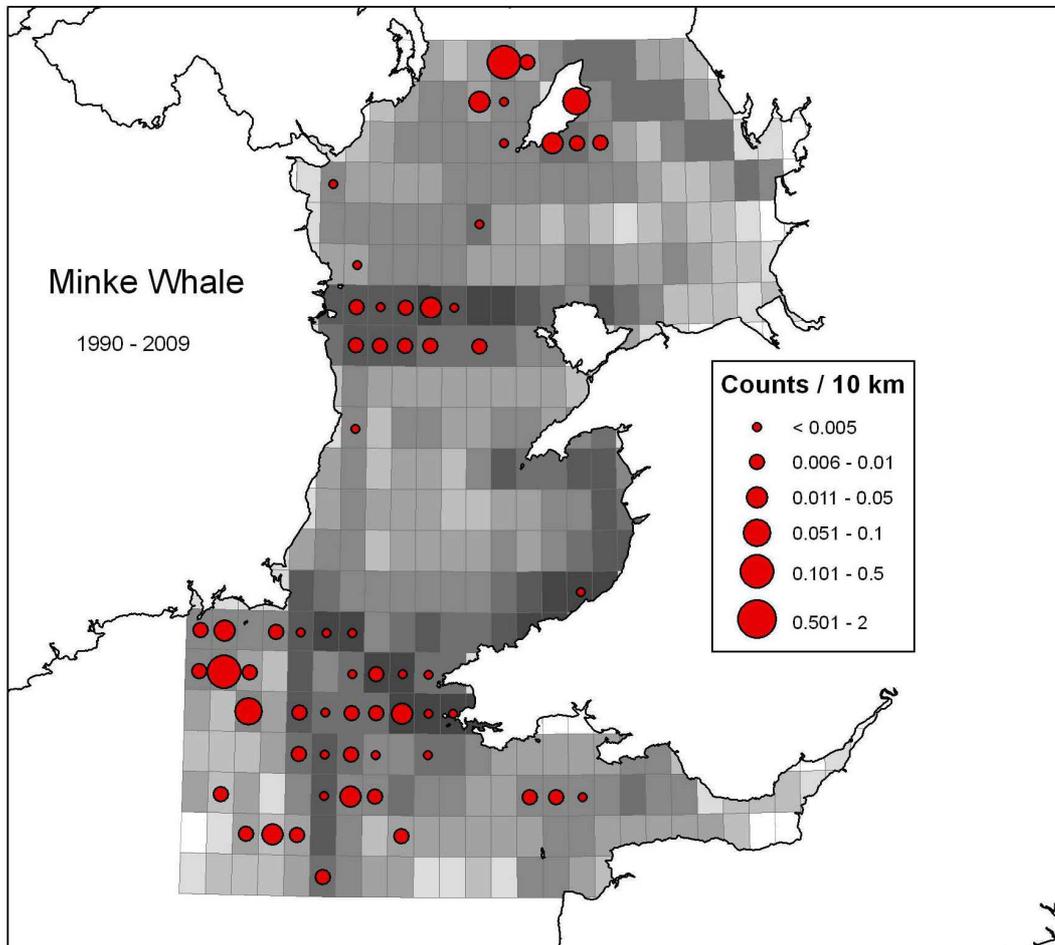


Figure 9. Long term sightings rates of minke whale distribution from vessel surveys, 1990-2009. (Source: Baines and Evans, 2012).

A more extensive line transect survey (SCANS-II) over the North West European continental shelf in July 2005 gave an overall estimate of 18,599 (CV=0.34; 95% CI: 9,700-35,800) (Hammond, 2008). The abundance estimate for the Irish Sea was 1,719 (CV=0.43; 95% CI: 800-3,900), and for the Celtic Sea 1,070 (CV=0.91; 95% CI: 200-4,900). The 2007 offshore CODA survey gave a population estimate of 6,765 (CV=0.99; 95% CI 1,300-34,200) (Hammond *et al.*, 2009), though this estimate was uncorrected for animals missed along the track-line (i.e. $g(0)$), so is negatively biased. It also has very wide confidence intervals.

A population estimate for the entire Central and North Eastern North Atlantic (based upon data from 1996-2001) gave 174,000 individuals (95% CI: 125,000-245,000) (IWC website: www.iwcoffice.org; see also Lockyer and Pike, 2009). Previously, the stock seasonally inhabiting the Norwegian and Barents Seas was estimated at 86,700 individuals (95% CI:

61,000-117,000) (Schweder *et al.*, 1993). Assessing minke whale numbers is difficult and controversial, since the species is inconspicuous at sea, and often reacts to survey vessels.

There are three sub-species of minke whale in the world: *Balaenoptera acutorostrata acutorostrata* occurring in the North Atlantic, *B. a. scammoni* in the North Pacific, and a dwarf form (as yet un-named) in the southern hemisphere. There is some genetic evidence for two sympatric stocks existing in the North Atlantic, with overlapping ranges, but otherwise no evidence of population structure comparing putative populations in recognised management areas (Anderwald *et al.*, 2011). The implication is that minke whales range extensively across the North Atlantic seasonally, but segregate to some extent on at least two breeding grounds (as yet unidentified). This means that established stock boundaries in the North Atlantic, currently used for management, should be re-considered to ensure the effective conservation of genetic diversity (Anderwald *et al.*, 2011). Until breeding areas are elucidated, one Management Unit is recognized for the entire North East Atlantic. In the context of this project, the Management Unit used is North West European Shelf Seas, applying the combined abundance estimates from SCANS-II and CODA.

Recommended Management Unit for Minke Whale (*Balaenoptera acutorostrata*) in Welsh waters

1. North West European Shelf Seas Management Unit

Rationale: The IWC recognises ten management areas for minke whale within the North Atlantic (one of which spans the waters around the British Isles) based upon catch and sighting distributions, biological parameters (e.g. age and length distributions) and mark-recapture data on feeding grounds. Recent DNA analyses indicate no evidence of geographic structure suggesting there may be mixing within breeding areas (Anderwald *et al.*, 2011). For the time being, the recommended Management Unit is the North West European Shelf Seas.

Population estimate for North West European Shelf Seas MU: 25,364 (95% CI = 12,700-50,600; CV = 0.36). See Appendix I for further details.

2.1.6 Atlantic grey seal, *Halichoerus grypus*

The Atlantic grey seal is restricted to the North Atlantic, Barents Sea and Baltic Sea. Their main concentrations occur on the east coast of Canada and the USA, and in Northwest Europe. In the eastern North Atlantic, it is distributed from Brittany to the White Sea, with breeding locations in Northwest France, around the British Isles and Ireland, the Faroe Islands, Norway (north of Møre), Iceland and the Murmansk coast (Hammond *et al.*, 2008).

Outside the breeding season, grey seal distribution is more widespread, and the species can be seen almost anywhere around the British coast, particularly in Scotland (Hammond *et al.*, 2008). Studies using satellite telemetry show the distribution at sea to include most of the

continental shelf area to the north and west of Scotland, the western North Sea, the Channel and the Irish Sea (McConnell *et al.*, 1999; Matthiopoulos *et al.*, 2004).

Pup production in Wales is greatest in North West Pembrokeshire, particularly on Ramsey Island, but extending southwards to Skomer Island and northwards to southern Ceredigion (Baines & Evans, 2012; see Figure 5). Smaller concentrations occur around the Llŷn Peninsula and the coast of Anglesey. These areas, amongst others, are used as haul-out sites during the non-breeding season in addition to other non-breeding haul-outs (Figure 6). Grey seal are a Habitats Directive Annex II species feature of Pen Llŷn a'r Sarnau, Cardigan Bay and Pembrokeshire Marine Special Areas of Conservation (SAC). In addition, there are significant long-term concentrations of grey seals outside the breeding season at non-SAC designated sites, including the Dee Estuary, West Hoyle sandbank and Puffin Island in North Wales (Baines and Evans, 2012). Population estimates are not available for the SAC populations, or for significant non-breeding haul outs.

Telemetry studies suggest that seals may make foraging trips to highly localised areas, with animals from a particular locality tending to remain in that region. Studies also suggest that grey seals are quite tightly bound to particular pupping sites, whilst the use of haul out sites appears to be much more flexible.

Most of the North East Atlantic population of grey seal breeds around the British Isles. The latest population estimate for UK (derived from demographic models based upon pup production estimates) was made in 2009, in the region of 106,200 (95% CI: 82,000-138,700) (SCOS, 2010). Overall UK pup production was estimated to be 47,540 (SCOS, 2010). Most (c. 90%) of the UK breeding population is in Scotland; the remaining 10% is in England and Wales (Hammond *et al.*, 2008; SCOS, 2010). The main concentrations in Scotland occur in the Outer Hebrides and Orkney, but there are also breeding colonies in Shetland, on the north and east coast of mainland Britain, and in South West England and Wales (SCOS, 2010). The minimum Irish population has been estimated at between 5,509 and 7,083 individuals, with annual pup production estimated in 2005 at 1,600 (Ó'Cadhlá and Mackey, 2002; Ó'Cadhlá *et al.*, 2007; Ó'Cadhlá and Strong, 2007).

The UK grey seal population represents approximately 38% of the world population on the basis of pup production (SCOS, 2010). UK pup production was estimated in 2009 at c. 47,500; otherwise, the European total (excluding UK) was 9,200, and the World total 134,200 (SCOS, 2010). Pup production for Wales in 2009 was estimated at 1,650, based upon indicator sites assessed in 2004-05 and a multiplier derived from 1994 synoptic surveys (SCOS, 2010).

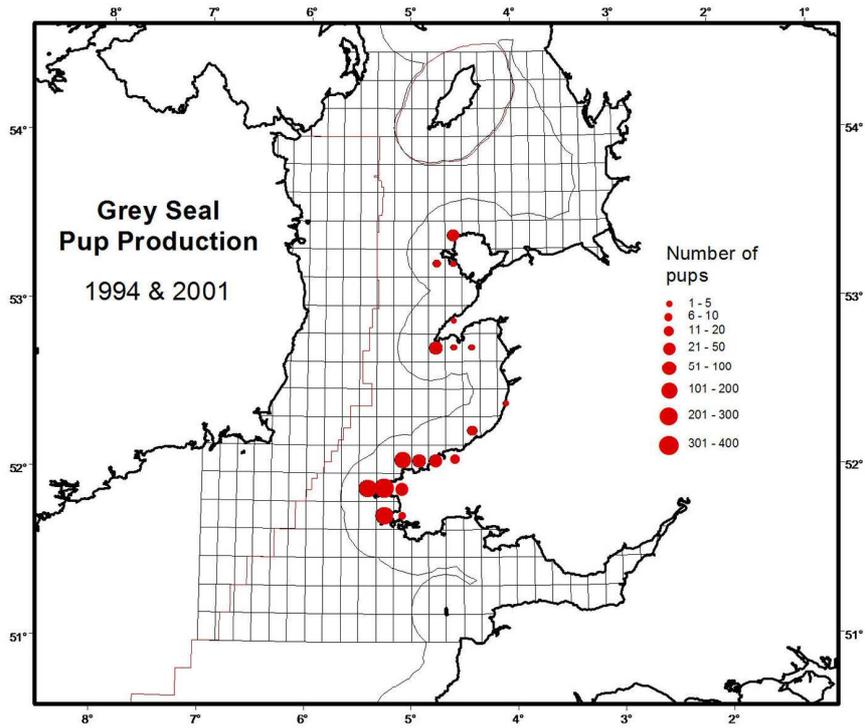


Figure 5. Grey seal annual pup production in Wales. (Source: Baines and Evans, 2012).

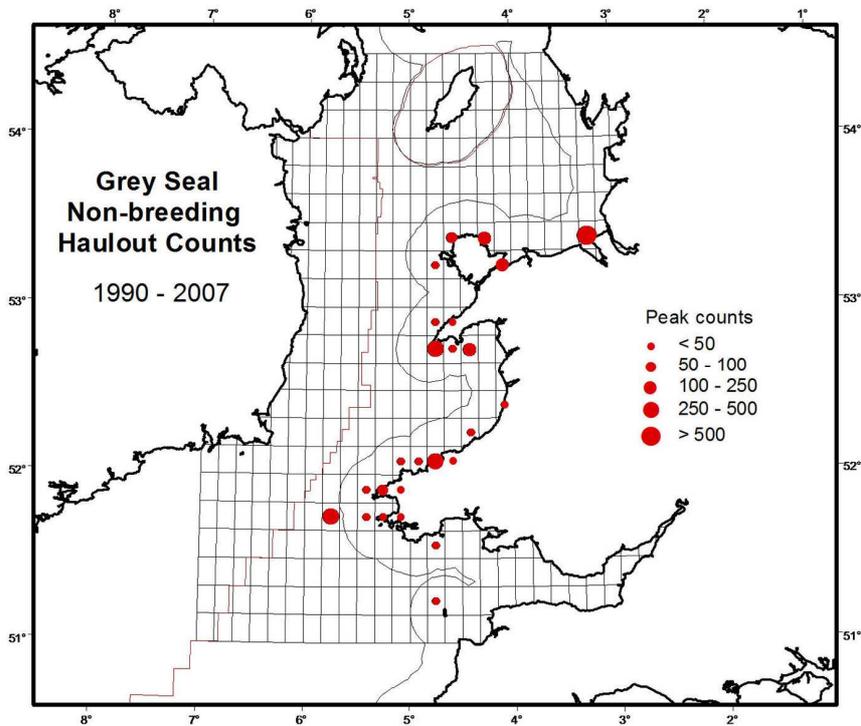


Figure 6. Counts at grey seal haul-out sites in Wales during non-breeding season. (Source: Baines and Evans, 2012).

Three reproductively isolated populations are recognised: one in the western North Atlantic, another in the eastern North Atlantic, and a third in the Baltic (Hammond *et al.*, 2008). In the UK, there is significant genetic variation between animals at sites around Scotland (Allen *et al.*, 1995) and between Scotland and South West Britain (SMRU, unpublished data; Hammond *et al.*, 2008). Tagging and telemetry studies indicate a degree of site fidelity, although pups tagged at breeding colonies have dispersed several hundred kilometres from natal sites (Mathiopoulos *et al.*, 2004). In Wales, for example, pups have moved from Ramsey Island (Pembrokeshire) to South West England, Ireland, France and Spain (Hammond *et al.*, 2005, 2008). Comparison of genetic data and tagging returns from North Rona and the Isle of May breeding colonies suggests a low-level of recruitment from non-natal sites into established breeding colonies (Allen *et al.*, 1995; Pomeroy *et al.*, 2000). Welsh studies indicate that although juveniles may wander between sites in Wales and beyond, with some remaining there, most appear to return to their natal sites; adults are also largely site faithful although some have been recorded moving between sites in Wales and more distant locations, including the Isles of Scilly, Ireland and the Solway Firth (Baines *et al.*, 1995; Kiely *et al.*, 2000; Hammond *et al.*, 2005; Rosas da Costa Oliver & McMath, 2011; Countryside Council for Wales, unpublished data; Sea Mammal Research Unit, unpublished data). The Irish Sea is recommended as the appropriate Management Unit for the grey seal inhabiting Welsh waters.

Grey seals are a Habitats Directive Annex II species feature of Pen Llŷn a'r Sarnau, Cardigan Bay and Pembrokeshire Marine SACs. Management requires an assessment of impacts on this species feature at the site level for each SAC, so additional SAC Management Sub-Units are recommended, although population estimates are not available for these sites. In addition, there are a number of significant haul-out sites around Wales, which although not used for breeding, are important for moulting or as resting sites between foraging bouts (see Appendix I and Figure 6 for further details). It may be appropriate to also consider these as Management Sub-Units for Atlantic grey seal.

Recommended Management Units and Sub-units for Atlantic Grey Seal (*Halichoerus grypus*) in Welsh waters

1. Irish Sea Management Unit

Rationale: Management Unit is based on tagging and telemetry studies, which indicate that whilst grey seals in the Irish Sea may move to South West England, North West France and the Channel (Mathiopoulos *et al.*, 2004; SMRU, unpublished data) most movements appear to be contained within the Irish Sea (Hammond *et al.*, 2005).

Population estimate for Irish Sea MU: 5000-6000 (best guess), no 95% CI, no CV. See Appendix I for further details.

Recommended Management Units and Sub-units for Atlantic Grey Seal (*Halichoerus grypus*) in Welsh waters (continued)

2. Pen Llŷn a'r Sarnau SAC Management Sub-Unit

Rationale: Grey seal are an Annex II species feature of Pen Llŷn a'r Sarnau Special Area of Conservation and so management requires an assessment of impacts on this species feature at the protected site level. An accurate population estimate is not available for the SAC population (see Appendix I for further details).

3. Cardigan Bay SAC Management Sub-Unit

Rationale: Grey seal are an Annex II species feature of Cardigan Bay Special Area of Conservation and so management requires an assessment of impacts on this species feature at the site level. Note, however, that an accurate population estimate is not available for the SAC population (see Appendix I for further details).

4. Pembrokeshire Marine SAC Management Sub-Unit

Rationale: Grey seal are an Annex II species feature of Pembrokeshire Marine Special Area of Conservation and so management requires an assessment of impacts on this feature at the site level. An accurate population estimate is not available for the SAC population (see Appendix I for further details).

5. Significant non-SAC winter / spring moulting and summer feeding haul-out site Management Sub-Units

Rationale: There are a number of significant haul-out sites around Wales, which although not used for breeding, are important for moulting or as resting sites between foraging bouts (see Appendix I and Figure 6 for further details). It may be appropriate to consider these as Management Sub-Units for Atlantic grey seal.

2.2 Conservation status of marine mammal populations and Management Units and Sub-Units in Welsh waters

Table 1 provides UK and site (where relevant) level assessments for each of the species, as reported by the Joint Nature Conservation Committee (JNCC) in the 2nd Habitats Directive reporting cycle (JNCC, 2007). Table 2 provides a rapid 'expert' assessment of the current status of each of the marine mammal Management Units, as determined in Section 2.1. It is assumed that unless data or expert judgement suggest otherwise, the conservation status of Management Units for each of the species will be as it was reported at a site (where applicable) or UK level in the 2nd Habitats Directive reporting cycle. Assessments of certainty for all judgements of conservation status are provided, (High, Medium, Low).

Table 1: UK and SAC Conservation Status of the six marine mammal species, at the 2nd Habitats Directive reporting cycle. UK assessments were compiled by JNCC (see JNCC, 2007 for further details), while SAC assessments were undertaken by CCW. Details of the author's opinion on the current status assessment of the populations are also provided, along with a rationale and confidence level in this assessment.

Species	Site or UK level?	2007 status assessment	Reliability of 2007 assessment ¹	2012 status assessment	Confidence in 2012 assessment	Rationale + evidence for 2012 status assessment
Harbour porpoise	UK	Favourable	Moderate	Favourable	High	See Hammond (2008) and Evans (2011).
Bottlenose dolphin	UK	Favourable	Moderate	Favourable	Medium	See Hammond (2008) and Evans (2011).
	Cardigan Bay SAC	Favourable (condition only)	High	Unfavourable (condition only)	Medium	Regional sightings surveys & photo-ID mark-recapture estimates indicate slight but insignificant increase in the Cardigan Bay population (Pesante <i>et al.</i> 2008a; Baines & Evans, 2012). Recent evidence suggests a declining population estimate in Cardigan Bay since 2008, with a possible shift to North Anglesey, as well as reduced birth rates and some evidence of animals seriously underweight (Veneruso & Evans, 2012). Some concerns over prey depletion and recreational disturbance but little evidence to assess (Evans & Pesante, 2008; CCW, 2009a).
	Pen Llŷn a'r Sarnau SAC	Favourable (condition only)	Low	Unfavourable (condition only)	Low / Medium	
Common dolphin	UK	Unknown	n/a	Unknown	Medium	Certainty of estimate of population size fair; status knowledge poor (Evans, 2011; P.S. Hammond <i>pers. comm.</i>).
Risso's dolphin	UK	Unknown	n/a	Unknown	Medium	See Hammond (2008) and Evans (2010 & 2011).
Minke whale	UK	Favourable	Moderate	Favourable	Medium	Expert judgement.
Grey seal	UK	Favourable	Moderate	Favourable	High	Several breeding sites have been censused, and the major ones have pup production estimates so that population trends are well known (SCOS, 2010).
	Pemb'shire Marine SAC	Favourable (condition only)	Medium	Favourable (condition only)	Medium	Possible disturbance/prey depletion concerns but no direct evidence (CCW, 2009c).
	Cardigan Bay SAC	Favourable (condition only)	Medium	Favourable (condition only)	Medium	Possible disturbance/prey depletion concerns but no direct evidence (CCW, 2009a).
	Pen Llŷn a'r Sarnau SAC	Favourable (condition & status)	Medium	Favourable (condition & status)	Medium	Possible disturbance/prey depletion concerns but no direct evidence (CCW, 2009b).

¹ Rationale for Reliability of 2007 assessments: High - expert opinion is that the concluding judgement accurately reflects the current situation based on a professional understanding of the species. Moderate – a greater understanding of the feature, or the factors affecting it, is required before a confident concluding judgement can be made by experts. Low – judgements, and comprising estimates, are based predominantly on expert opinion.

Table 2: Conservation Status of Management Units for the six marine mammal species in Welsh waters.

Species & Management Unit / Sub Unit	Conservation status	Rationale for assessment	Confidence in assessment	Rationale for confidence
Harbour porpoise: Celtic Sea MU	Favourable as in 2007 assessment)	Abundance estimates for the region and within Cardigan Bay SAC indicate stable or slightly increasing population.	Medium	SCANS & SCANS-II surveys; regional sightings surveys (Pesante <i>et al.</i> 2008a; Baines & Evans, 2012).
Bottlenose dolphin: Irish Sea MU	Favourable (as in 2007 assessment)	Abundance estimates for the region indicate stable or slightly increasing population. Whilst recent evidence suggests a possible decline in the Cardigan Bay population, photo-monitoring suggests this could just be a shift of animals to N Anglesey.	Medium	Regional sightings surveys & photo-ID mark-recapture estimates (Pesante <i>et al.</i> , 2008a; Baines & Evans, 2012; Veneruso & Evans, 2012).
Bottlenose dolphin: Pen Llŷn a'r Sarnau SAC MSUs	Favourable (as in 2007 assessment)	As Irish Sea MU	As Irish Sea MU	As Irish Sea MU
Bottlenose dolphin: Cardigan Bay SAC MSUs	Favourable (as in 2007 assessment)	As Irish Sea MU	As Irish Sea MU	As Irish Sea MU
Common dolphin: Eastern North Atlantic MU	Unknown (as in 2007 assessment)	Abundance estimates for the region indicate no decline in abundance in equivalent areas between 1994 & 2005; fishing pressure in region reduced in 2000s.	n/a	Wide confidence limits around SCANS regional abundance estimates; Irish Sea not fully surveyed in 1994 thus limiting a direct comparison (Evans <i>et al.</i> , 2003; Evans, 2010, 2011).
Risso's dolphin: Celtic Sea MU	Unknown (as in 2007 assessment)	Little or no evidence or data available.	n/a	Regional sightings surveys (Evans <i>et al.</i> , 2003; Reid <i>et al.</i> , 2003; Baines & Evans, 2012; Evans, 2010, 2011).
Minke whale: North West European Shelf Seas MU	Favourable (as in 2007 assessment)	Abundance estimates for the region indicate no decline in abundance in equivalent areas between 1994 & 2005.	Medium	SCANS & SCANS-II surveys; some concerns over entanglements in fishing gear & vessel strikes (Hammond, 2008; Evans, 2010, 2011).

Species & Management Unit / Sub Unit	Conservation status	Rationale for assessment	Confidence in assessment	Rationale for confidence
Grey seal: Irish Sea MU	Favourable (as in 2007 assessment)	Irregular counts of pup production at sample sites around the Irish Sea indicate stable or increasing populations.	Medium	Baines <i>et al.</i> , 1995; Westcott & Stringell, 2003, 2004; Strong <i>et al.</i> , 2006; Ó'Cadhla and Mackey, 2002; Ó'Cadhla <i>et al.</i> , 2007; Ó'Cadhla and Strong, 2007.
Grey seal: Pen Llŷn a'r Sarnau SAC MSU	Favourable (as in 2007 assessment)	Possible disturbance/prey depletion concerns but no direct evidence (CCW, 2009b).	Medium	CCW, 2009b
Grey seal: Cardigan Bay SAC MSU	Favourable (as in 2007 assessment)	Possible disturbance/prey depletion concerns but no direct evidence (CCW, 2009a).	Medium	CCW, 2009a
Grey seal: Pembrokeshire Marine SAC MSU	Favourable (as in 2007 assessment)	Possible disturbance/prey depletion concerns but no direct evidence (CCW, 2009c).	Medium	CCW, 2009c

2.3 Population growth rates for the six marine mammal species in Welsh waters

Table 3 provides an assessment of the net productivity, or growth rates, of each of the marine mammal Management Units determined in Section 2.1, based on available information and data. It is assumed that unless information or expert judgement suggest otherwise, the growth rates will be the same as default values provided in Wade (1998), of 0.04 for cetaceans and 0.12 for pinnipeds. Assessments of confidence in all growth rates estimates, including default values suggested in Wade (1998) are provided, with an accompanying explanation and rationale.

2.4 Pressures and sources of mortality acting upon populations of the six marine mammal species in Welsh waters

Table 4 provides preliminary expert opinion on the pressures likely to be acting on the populations (Management Units) of the six species and a brief consideration for whether each of the populations is subject to density dependent growth. Table 5 provides expert judgement on the most likely primary source of human pressure and anthropogenic-induced mortality for each of the Management Units determined in Section 2.1. Mortality levels have not been quantified for any of the species for any of the pressures, since reliable data are not available.

Table 3: Growth rates for Management Units (MU) and Management Sub-Units (MSU) of each of the six marine mammal species in Welsh waters.

Species & MU / SMU	Default Growth Rate (R_{max}) ²	Evidence for refinement of R_{max}	R_{max} for MU	Confidence in recommended R_{max} for MU	Rationale
Harbour porpoise Celtic Sea MU	0.04	Median R_{max} value of 0.46 provided in Moore and Read (2008).	0.046	Intermediate level of certainty for Celtic Sea MU, assuming assessments for ASCOBANS region at large apply to the smaller area.	Evidence based on Bayesian Analysis of HP population in Gulf of Maine / Bay of Fundy. Age at sexual maturity is 3-5 years with an inter-birth interval of 1-2 yrs and life span of 12 yrs (Evans <i>et al.</i> , 2008a).
Bottlenose dolphin Irish Sea MU	0.04	Growth rate is likely to be lower than harbour porpoise due to longer maturation period and lower reproductive rates. In absence of new published estimates, unable to refine.	0.04	Intermediate level of certainty for Irish Sea MU: in Cardigan Bay, photo-ID indicates crude birth rates of 7.7-9.4% of population over the period 2001-09, mean inter-birth interval of 3 (range 2-5 yrs, juvenile mortality of 20% (year 1), 25% (year 2) and 10% (year 3).	Age at sexual maturity is 10-15 years (males) and 5-13 yrs (females) with an inter-birth interval of 2-10 yrs and life span of 40-45 yrs (Wilson, 2008).
Bottlenose dolphin Pen Llŷn a'r Sarnau SAC MSU	0.04	As for Irish Sea MU	0.04	As for Irish Sea MU	As for Irish Sea MU
Bottlenose dolphin Cardigan Bay SAC MSU	0.04	As for Irish Sea MU	0.04	As for Irish Sea MU	As for Irish Sea MU
Common dolphin Eastern North Atlantic MU	0.04	Growth rate will likely be lower than for harbour porpoise due to longer maturation period and lower reproductive rates. In absence of new published estimates, unable to refine.	0.04	Low level of certainty for Eastern North Atlantic MU.	Age at sexual maturity is 11-12 years (males) and 9-10 yrs (females) with an inter-birth interval of 2-4 yrs and normal life span of 28 yrs (Murphy <i>et al.</i> , 2008).
Risso's dolphin Celtic Sea MU	0.04	Growth rate thought to be lower than harbour porpoise due to possible lower reproductive rates. In absence of new published estimates, unable to refine.	0.04	Low level of certainty for Celtic Sea MU.	Age at sexual maturity is 3-4 years; inter-birth interval unknown but likely to be 2-4 yrs and normal life span is 29 yrs (Evans <i>et al.</i> , 2008b).

² Default values for R_{max} provided in Wade (1998).

Species & MU / SMU	Default Growth Rate (R_{max}) ²	Evidence for refinement of R_{max}	R_{max} for MU	Confidence in recommended R_{max} for MU	Rationale
Minke Whale North West European Shelf Seas MU	0.04	Growth rate will likely be lower than for harbour porpoise due to longer maturation period. In absence of new published estimates, unable to refine.	0.04	Low level of certainty for North West European Shelf Seas MU.	Age at sexual maturity is 7-10 years; inter-birth interval is 1-3 yrs and normal life span is 40-50 yrs (Anderwald <i>et al.</i> , 2008).
Grey Seal Irish Sea MU	0.12	In absence of new published estimates, unable to refine.	0.12	Intermediate level of certainty for Irish Sea MU: pup production measured at selected sites.	Age at sexual maturity is 4-6 years (males) and 3-5 yrs (females) with an inter-birth interval of 1 yr and normal life span of 20 yrs (Hammond <i>et al.</i> , 2008).
Grey Seal Pen Llŷn a'r Sarnau SAC MSU	0.12	In absence of new published estimates, unable to refine.	0.12	Intermediate level of certainty for Irish Sea MU: pup production measured at selected sites.	Age at sexual maturity is 4-6 years (males) and 3-5 yrs (females) with an inter-birth interval of 1 yr and normal life span of 20 yrs (Hammond <i>et al.</i> , 2008).
Grey Seal Cardigan Bay SAC MSU	0.12	In absence of new published estimates, unable to refine.	0.12	Intermediate level of certainty for Irish Sea MU: pup production measured at selected sites.	Age at sexual maturity is 4-6 years (males) and 3-5 yrs (females) with an inter-birth interval of 1 yr and normal life span of 20 yrs (Hammond <i>et al.</i> , 2008).
Grey Seal Pembrokeshire Marine SAC MSU	0.12	In absence of new published estimates, unable to refine.	0.12	Intermediate level of certainty for Irish Sea MU: pup production measured at selected sites.	Age at sexual maturity is 4-6 years (males) and 3-5 yrs (females) with an inter-birth interval of 1 yr and normal life span of 20 yrs (Hammond <i>et al.</i> , 2008).

Table 4: Overview of the main current pressures acting on marine mammal Management Units (MU) and Management Sub Units (MSU) in Welsh waters.

Species & Management Unit	Potential pressures acting on population	Population subject to density dependent growth?	Rationale and confidence in assessment	Confidence in assessment of pressures
Harbour porpoise Celtic Sea MU	Analyses for causes of HP death in Wales between 1990 and 2009 shows bottlenose dolphin kills ³ to account for 22%, infectious disease 16%, bycatch 15%, and starvation 15% (see Evans & Hintner, 2012).	Unlikely	14% of PME of porpoises show starvation as cause of death, with an increasing trend, whilst bottlenose dolphin attacks (18%) may be linked to food shortages. Infectious disease is identified as the main cause of death but links to high PCB burdens may mean that contaminants are playing a role CSIP (Cetacean Strandings Investigation Prog.), unpubl. data, quoted in Evans & Hintner (2012). Direct observations & UK strandings scheme.	Medium
Bottlenose dolphin Irish Sea MU	Recreational disturbance, prey depletion, vessel strikes, pile driving, pollution & pathogens.	Possibly, yes	Direct observations & UK strandings scheme. Small population size, so could be food limited. Contaminants analysis of specimens from around UK has revealed potentially harmful levels of PCBs (exceeding those considered harmful to porpoises) (Deaville & Jepson, 2011).	Medium
Bottlenose dolphin Pen Llŷn a'r Sarnau SAC MSU	Recreational disturbance, pollution & pathogens, prey depletion (see CCW, 2009b).	Possibly, yes	See CCW (2009b)	Medium
Bottlenose dolphin Cardigan Bay SAC MSU	Recreational disturbance, pollution & pathogens, prey depletion, fisheries activities (see CCW, 2009a).	Possibly, yes	See CCW (2009a)	Medium

³ Whilst bottlenose dolphin attacks might be considered to be 'natural' sources of mortality they are thought to possibly have an anthropogenic link, through limited prey.

Species & Management Unit	Potential pressures acting on population	Population subject to density dependent growth?	Rationale and confidence in assessment	Confidence in assessment of pressures
Common dolphin Eastern North Atlantic MU	Fisheries bycatch, prey depletion.	Unlikely	Direct observations & UK strandings scheme.	Medium
Risso's dolphin Celtic Sea MU	Recreational disturbance, prey depletion.	Unknown	Direct observations & UK strandings scheme.	Medium
Minke whale North West European Shelf Seas MU	Fisheries bycatch, prey depletion.	Unlikely	Direct observations & UK strandings scheme.	Medium
Grey seal Irish Sea MU	Recreational disturbance, fisheries bycatch, prey depletion, pile driving, DP vessels.	Possibly yes	Direct observations & UK strandings scheme. Breeding density dependence may occur. Most mortality involves pups and may result from stillbirths, mother-pup separation or starvation.	Medium
Grey seal Pen Llŷn a'r Sarnau SAC MSU	Disturbance of breeding and haul out sites, fisheries bycatch, effects of persistent chemicals, prey depletion.	Possibly yes, as Irish Sea MU	Countryside Council for Wales 'Regulation 35' advice (CCW, 2009b)	As Irish Sea MU
Grey seal Cardigan Bay SAC MSU	Effects of inert or toxic materials, including persistent chemicals, disturbance, fisheries bycatch, effects of persistent chemicals, prey depletion.	Possibly yes, as Irish Sea MU	Countryside Council for Wales 'Regulation 35' advice (CCW, 2009a)	As Irish Sea MU
Grey seal Pembrokeshire Marine SAC MSU	Disturbance, fisheries bycatch, effects of persistent chemicals, prey depletion	Possibly yes, as Irish Sea MU	Countryside Council for Wales 'Regulation 35' advice (CCW, 2009c)	As Irish Sea MU

Table 5: Primary source of anthropogenic mortality acting on mammal Management Units (MU) and Management Sub Units (MSU) in Welsh waters.

Species & MU / MSU	Primary cause of mortality	Quantified assessment of effects	Qualified assessment of effects
Harbour porpoise Celtic Sea MU	Fisheries bycatch	For 2008, the bycatch estimates of harbour porpoise in gill net and tangle net fisheries in the Irish and Celtic Sea areas were 498-1409 (SMRU, 2009; UK National Annual Report to ASCOBANS, 2010).	Fisheries bycatch has been significant in the Celtic Sea, though declining since 1990s. In England & Wales it still accounts for 18% of 1495 Post Mortem Examinations (PME) over the period 1990-2008 (SMRU, 2009; UK National Annual Report to ASCOBANS, 2010).
Bottlenose dolphin Irish Sea MU	Unknown as too few strand	Unknown	Unknown – expert judgement
Bottlenose dolphin Pen Llŷn a'r Sarnau SAC MSU	Unknown	Unknown	Unknown
Bottlenose dolphin Cardigan Bay MSU	Unknown	Unknown	Unknown
Common dolphin Eastern North Atlantic MU	Fisheries bycatch	For 2008, the bycatch estimates of common dolphins in gillnet and tangle net fisheries in the Irish and Celtic Sea areas (where bycatch is concentrated) were 279-1019 (SMRU, 2009; UK National Annual Report to ASCOBANS, 2010).	Fisheries bycatch appears to have been the most significant cause of death, particularly in the Celtic Sea, although there is evidence of a recent decline (probably due to lower fishing effort). 53% of PME of 468 animals between 1990-2008 had signs of bycatch (SMRU, 2009; UK National Annual Report to ASCOBANS, 2010).
Risso's dolphin Celtic Sea MU	Unknown as too few strand	Unknown	No obvious known threats in the MU. Most likely potential impact would be a reduction in cephalopod prey. One animal recovered in North Wales had gas emboli causing inflated spleen (Deaville & Jepson, 2011).
Minke whale North West European Shelf Seas MU	Fisheries bycatch	Unknown	Fisheries bycatch is probably the main unnatural source of mortality, followed by physical trauma from vessel strikes. Together, these form the majority of cases of recorded mortality in Wales (Evans & Hintner, 2012). However, too few PME have been conducted on this species for reliable estimates.
Grey seal Irish Sea MU	Fisheries bycatch	Unknown	Expert judgement
Grey seal Pen Llŷn a'r Sarnau SAC MSU	Unknown, possibly bycatch, as Irish Sea MU	Unknown	n/a

Species & MU / MSU	Primary cause of mortality	Quantified assessment of effects	Qualified assessment of effects
Grey seal Cardigan Bay MSU	Unknown, possibly bycatch, as Irish Sea MU	Unknown	n/a
Grey seal Pembrokeshire Marine MSU	Unknown, possibly bycatch, as Irish Sea MU	Unknown	n/a

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Appendix I: Survey estimates and determination of appropriate Management Units, with associated population estimates for the six marine mammal species in Welsh water. a) Harbour porpoise, b) Bottlenose dolphin, c) Short-beaked common dolphin, d) Risso's dolphin, e) Minke whale and f) Atlantic grey seal. Corresponding population estimates, minimum population sizes (Nmin – based on the lowest 20%ile, or the lower 60% confidence limit) are provided. Where only an estimate of Nmin is provided, certainty levels for Nmin are also provided.

a) Harbour porpoise, *Phocoena phocoena*

Survey Area	Population estimate (CV)	Nmin	Nmin best estimate	Certainty level for Nmin best estimate	Certainty level rationale	Data source
Celtic Sea	15,230 (0.35) 95% CI: 7,800-29,700	11,346	n/a	Low	SCANS-II (July 2005) figures are based upon a single point estimate (one month of one year), CV is moderate, the population estimate does not match the MU, and boundaries with adjacent MUs are unclear.	Hammond, 2008; Evans & Teilmann, 2009
Irish Sea	80,613 (0.50) 95% CI: 31,900-203,500	52,963	n/a	Low	As above	Hammond, 2008; Evans & Teilmann, 2009

Recommended Management Unit(s) for Harbour Porpoise and rationale:

Celtic Sea MU (as defined in Evans & Teilmann, 2009): includes the SCANS-II blocks O & P (Hammond, 2008) i.e. Irish Sea, Celtic Sea, Western English Channel and Southwest Ireland – see Fig. 1c, although boundaries have not been clearly determined (Evans and Teilmann, 2009). Differentiation from other MUs has been based upon studies using mitochondrial DNA, microsatellites, skeletal variation, tooth ultrastructure, as well as dietary and contaminant load differences (see Evans and Teilmann, 2009 for details).

Management Unit	Population estimate (CV)	Nmin	Nmin best estimate	Certainty level for Nmin best estimate	Certainty level rationale	Data source
CELTIC SEA MU	95,843 (0.42) 95% CI: 43,200-212,700	67,351	n/a	Low	As above	Hammond, 2008; Evans & Teilmann, 2009

Suggested additional priority work to refine Management Units for Harbour Porpoise:

Repeat surveys over a period of time will give a more precise population estimate with smaller CVs. However, an even more serious deficiency is the lack of information on the scale of movement between the Irish Sea and Celtic Sea, and between those areas and adjacent ones. The only way to establish movements of individuals is by tagging or telemetry studies, whereas reduced gene flow might be indicated from DNA sampling of animals throughout the region and adjacent areas.

b) Bottlenose dolphin, *Tursiops truncatus*

Survey Area	Population estimate (CV)	Nmin	Nmin best estimate	Certainty level for Nmin best estimate	Certainty level rationale	Data source
Celtic Sea	5,370 (0.49) 95% CI: 2,163-13,330	3,558	n/a	Intermediate	SCANS-II (July 2005) figures are based upon a single point estimate (one month of one year), CV is moderate	(Hammond, 2008)
Irish Sea	235 (0.75) 95% CI: 100-900	125	n/a	Low	SCANS-II (July 2005) figures are based upon a single point estimate (one month of one year), CV is high	(Hammond, 2008)
Entire Cardigan Bay (2007)	248 (0.07) 95% CI: 231-277	235	n/a	Intermediate	Photo-ID estimate (2007) based upon an open population mark-recapture model applied to all of Cardigan Bay; MU may require splitting into sub-units	Photo ID monitoring provides evidence that SAC animals range throughout inshore waters of Cardigan Bay and North Wales (Pesante <i>et al.</i> , 2008a, b)
Entire Cardigan Bay (2001-07)	397 (0.23) 95% CI: 362-414	327	n/a	Intermediate	Photo-ID overall estimate (2001-07) based upon an open population mark-recapture model applied to all of Cardigan Bay; MU may require splitting into sub-units	Photo ID monitoring provides evidence that SAC animals range throughout inshore waters of Cardigan Bay and North Wales (Pesante <i>et al.</i> , 2008a, b)
Cardigan Bay SAC	210 (0.56) 95% CI: 180-275	131	n/a	Intermediate	Photo-ID estimate (2007) based upon a closed population mark-recapture model applied to the SAC; this area was systematically surveyed but some movement exists between Cardigan Bay & PLAS SACs and adjacent areas	Photo ID monitoring provides evidence that SAC animals range throughout inshore waters of Cardigan Bay and North Wales (Pesante <i>et al.</i> , 2008a, b)

Recommended Management Unit (MU) and Management Sub Units (MSU) for Bottlenose Dolphin and rationale:

Irish Sea MU (as defined in Evans & Teilmann, 2009): On current knowledge, based upon photo-ID studies between 2001-10 where no matches have been found between animals within the Irish Sea and those elsewhere, comparing catalogues from Ireland, Scotland and SW England (Pesante *et al.*, 2008; Evans & Teilmann, 2009). Mark-recapture analyses suggest the Irish Sea MU may in future need to be split into three or more sub-units: inshore, offshore and transient groups, but at present we have insufficient knowledge to know how to do this.

Pen Llŷn a'r Sarnau SAC MSU and Cardigan Bay MSU: Bottlenose dolphin are a Habitats Directive Annex II species feature of Cardigan Bay and Pen Llŷn a'r Sarnau Special Areas of Conservation so management requires an assessment of impacts on this species feature at the site level for each SAC. However, the animals associated with these SACs are not considered to be closed populations, but are part of the wider Irish Sea population.

Management Unit / Sub Unit	Population estimate (CV)	Nmin	Nmin best estimate	Certainty level for Nmin best estimate	Certainty level rationale	Data source
IRISH SEA MU	397 (0.23) 95% CI: 362-414	327	n/a	Intermediate	Photo-ID overall estimate (2001-07) based upon an open population mark-recapture model applied to all of Cardigan Bay; MU may require splitting into sub-units	Photo ID monitoring provides evidence that animals range throughout inshore waters of Cardigan Bay and North Wales (Pesante <i>et al.</i> , 2008a, b)
PEN LLŶN A'R SARNAU SAC MSU	As Irish Sea MU					
CARDIGAN BAY SAC MSU	As Irish Sea MU					
<p>Suggested additional priority work to refine Management Units for Bottlenose Dolphin: Further photo-ID studies are required, with greater effort outside Cardigan Bay SAC and extending to cover all parts of the Irish Sea. Biopsy sampling for DNA analysis would provide additional valuable information on population structure and gender, particularly if combined with stable isotope and/or fatty acid analysis to establish whether different groups have different dietary signatures.</p>						

c) **Short-beaked common dolphin, *Delphinus delphis***

Survey Area	Population estimate (CV)	Nmin	Nmin best estimate	Certainty level for Nmin best estimate	Certainty level rationale	Data source
Celtic Sea	11,141 (0.61) 95% CI: 3,700-33,500	6,674	n/a	Low	SCANS-II (July 2005) figures are based upon a single point estimate (one month of one year), CV is high	Hammond (2008); MU based upon mainly genetic evidence (Evans & Teilmann, 2009)
Irish Sea	825 (0.78) 95% CI: 200-3,200	198	n/a	Low	SCANS-II (July 2005) figures are based upon a single point estimate (one month of one year), CV is high	Hammond (2008); MU based upon mainly genetic evidence (Evans & Teilmann, 2009)
Celtic Deep* * only northern portion was surveyed	2,166 (0.17) 95% CI: 1,541-3,045	1,871	n/a	High	Line transect survey estimate (2006) but uncorrected for g(0) and responsive movement, g(0) estimated at 0.79; CV is low	Based upon most precise estimate from three years of line transect survey (Evans <i>et al.</i> , 2006). MU based upon mainly genetic evidence (Evans & Teilmann, 2009)
Eastern North Atlantic	c. 400,000-800,000 (no CVs possible)	n/a	c. 400,000	Low	Estimate derived from line transect surveys conducted across overlapping areas at different times, most of which did not account for positive responsive movement that is likely to inflate estimates	Cañadas <i>et al.</i> (2009), Hammond (2008), Evans (2010). The combined SCANS-II & CODA surveys estimate for the species was 167,216 (CV = 0.25; 95% CI: = 103,000-271,300), but note that survey area is much less than the recommended MU (Evans, 2010)

Recommended Management Unit(s) for Common Dolphin and rationale:

Eastern North Atlantic MU: The currently recommended Management Unit for common dolphin is the entire eastern North Atlantic (Evans & Teilmann, 2009). However, there is some evidence (mainly from stable isotope signatures and contaminant burdens) that common dolphins inhabiting offshore waters in the Bay of Biscay differ from those in adjacent coastal waters. Thus if this were the case generally then one might expect there to be an MU for western Britain (South-west Approaches, Celtic Sea, Irish Sea and West Scotland) that is distinct from those in pelagic seas beyond the shelf. For the time being, this is the recommended Management Unit. There could even be further division between the Irish Sea/Celtic Sea and adjacent areas but that requires further study.

c) Short-beaked common dolphin, *Delphinus delphis* (continued)

Management Unit	Population estimate (CV)	Nmin	Nmin best estimate	Certainty level for Nmin best estimate	Certainty level rationale	Data source
EASTERN NORTH ATLANTIC MU	c. 400,000-800,000 (no CVs possible)	n/a	c. 400,000	Low	Estimate derived from line transect surveys conducted across overlapping areas at different times, most of which did not account for positive responsive movement that is likely to inflate estimates	Cañadas <i>et al.</i> (2009), Hammond (2008), Evans (2010). The combined SCANS-II & CODA surveys estimate for the species was 167,216 (CV = 0.25; 95% CI: = 103,000-271,300), but note that survey area is much less than the recommended MU (Evans, 2010)

Suggested additional priority work to refine Management Units for Common Dolphin:

Biopsy sampling for DNA analysis would provide valuable information on population structure, particularly if combined with stable isotope and/or fatty acid analysis to establish whether different groups have different dietary signatures. The most obvious comparison to be made is for common dolphins inhabiting shelf seas with those pelagic groups living beyond the shelf.

d) **Risso's dolphin, *Grampus griseus***

Survey Area	Population estimate (CV)	Nmin	Nmin best estimate	Certainty level for Nmin best estimate	Certainty level rationale	Data source
Celtic Sea	Low hundreds	n/a	100	Low	No abundance estimate; guesstimate based upon sightings rates, & group sizes + photo-ID	Baines & Evans (2012) for guesstimate
Irish Sea	Low hundreds	n/a	100	Low	No abundance estimate; guesstimate based upon sightings rates, & group sizes + photo-ID	Baines & Evans (2012) for guesstimate
Eastern North Atlantic	Thousands	n/a	Low thousands	Low	No abundance estimate; guesstimate based upon sightings rates, & group sizes + photo-ID	Reid <i>et al.</i> (2003), Evans <i>et al.</i> (2003), Hammond (2008), Evans (2011)

Recommended Management Unit(s) for Risso's Dolphin and rationale:

Eastern North Atlantic MU: No previous attempt has been made to determine Management Units for this species. A DNA study found genetic differences between Risso's dolphins sampled from the eastern North Atlantic and the Western Mediterranean. At present there is no evidence to suggest population sub-structuring within the North Atlantic, although it is likely to be the case. Photo-ID studies within the Irish Sea have produced catalogues numbering at least 100 individuals. For the time being, a precautionary Management Unit would be the Celtic Sea (including the Irish Sea).

Management Unit	Population estimate (CV)	Nmin	Nmin best estimate	Certainty level for Nmin best estimate	Certainty level rationale	Data source
EASTERN NORTH ATLANTIC MU	Thousands	n/a	Low thousands	Low	No abundance estimate; guesstimate based upon sightings rates, & group sizes + photo-ID	Reid <i>et al.</i> (2003), Evans <i>et al.</i> (2003), Hammond (2008), Evans (2011)

Suggested additional priority work to refine Management Units for Risso's Dolphin:

It is unlikely that line transects surveys will ever be able to produce a robust abundance estimate for the population (i.e. one without very wide CVs). There is potential for photo-ID using mark-recapture to provide a population estimate if sampling can be conducted throughout the major haunts of this species over a period of time. This will also elucidate the extent to which animals move around the Irish Sea (which seems very likely), as well as beyond (which is also likely).

e) **Minke whale, *Balaenoptera acutorostrata***

Survey Area	Population estimate (CV)	Nmin	Nmin best estimate	Certainty level for Nmin best estimate	Certainty level rationale	Data source
Celtic Sea	1,070 (0.91) 95% CI: 200-4,900	508	n/a	Low	SCANS-II (July 2005) figures are based upon a single point estimate (one month of one year), CV is high	Hammond (2008)
Irish Sea	1,719 (0.43) 95% CI: 800-3,900	1,198	n/a	Moderate	SCANS-II (July 2005) figures are based upon a single point estimate (one month of one year), CV is moderate	Hammond (2008)

Recommended Management Unit(s) for Minke Whale and rationale:

NW European MU: The IWC recognises ten management areas for minke whale within the North Atlantic (one of which spans the waters around the British Isles) based upon catch and sighting distributions, biological parameters such as age and length distributions, and mark-recapture data on feeding grounds, although recent DNA analyses indicate no evidence of geographic structure suggesting there may be mixing within breeding areas (Anderwald *et al.*, 2011). For the time being, the recommended Management Unit is the (mainly shelf) seas of North West Europe.

Management Unit	Population estimate (CV)	Nmin	Nmin best estimate	Certainty level for Nmin best estimate	Certainty level rationale	Data source
NORTH-WEST EUROPEAN MU	25,364 (0.36) 95% CI: 12,700-50,600	18,745	n/a	Low	SCANS-II (July 2005) & CODA (July 2007) figures are based upon single point estimates (each one month of one year); CV is moderate and underestimated due to process error. The estimate contributed from CODA is uncorrected for animals missed on the track line and is therefore negatively biased in this respect; estimate applies only to SCANS, SCANS-II & CODA survey areas not to entire MU	Hammond (2008); Hammond in Evans (2010)

Suggested additional priority work to refine Management Units for Minke Whale:

Photo-identification of individuals both within the Irish Sea and beyond would enable some assessment of movements between areas and further afield around the British Isles. At present, the only catalogue comprising c. 100 individuals exists for Western Scotland. There is a need to obtain photographs of many more individuals within Welsh/Irish sea waters, bearing in mind that a relatively small percentage will be identifiable individually. Telemetry studies would also provide valuable information on movements (at present, suction cup tags have not been successful, the only method of attachment that has worked involving implanting into the blubber).

f) **Atlantic grey seal, *Halichoerus grypus***

Survey Area	Population estimate (CV)	Nmin	Nmin best estimate	Certainty level for Nmin best estimate	Certainty level rationale	Data source
Irish Sea	ca. 5,000-6,000 (best guess)	n/a	4,702 (3 yr mean)	Low	Estimates based on pup numbers. No CV for estimate	Baines <i>et al.</i> (1995)
Irish and Celtic Sea	95% CI: 5,198-6,976 (no CV available)	5,613	5,613	Low	Estimates based on Photo-ID No CVs available	Kiely <i>et al.</i> (2000) Unlikely to be a suitable Management Unit for grey seals in Welsh waters.
West Hoyle sandbank SU (moulting & feeding)	ca. 300-600 (highest summer count 330 in July 2003, but 518 counted at Hilbre Island in May 2003)	Unknown	Unknown	n/a	Low Tide Counts	Westcott (2002), Westcott & Stringell (2004), Hilbre Bird Observatory Reports
Anglesey SU N. Anglesey (moulting, feeding & breeding); Dulas & Puffin Islands (moulting & feeding)	ca. 200-300 (highest winter count 139 at Dulas Island and 130 at Puffin Island, both in Feb 2003)	Unknown	Unknown	n/a	Low Tide Counts	Westcott (2002), Westcott & Stringell (2004)
Pen Llŷn a'r Sarnau SAC	ca. 1,100 (maximum summer haul-out count) 67 pups produced in 2002-03 (SW Pen Llŷn & Bardsey Island)	Unknown	Unknown	n/a	Although pup production estimates exist for Bardsey Island, this cannot be used to derive a population estimate because of the high non-breeding element	Westcott (2002), Westcott & Stringell (2004), CCW (2009b)
Cardigan Bay SAC	Unknown Av. of 66 pups produced in 1992-94	Unknown	Unknown	n/a	No comprehensive counts exist, although sites were included in the West Wales Census	Baines <i>et al.</i> (1995), CCW (2009a)
Pembrokeshire Marine SAC	ca. 5,000 in SW Wales generally ca. 980 pups produced annually	Unknown	Unknown	n/a	Pup production estimates exist for the Pembrokeshire Islands, but difficult to derive an accurate population estimate	Strong <i>et al.</i> (2006), CCW (2009c)

Recommended Management Units and Sub-Units for Atlantic Grey Seal and rationale:

Irish Sea MU: Tagging and telemetry studies indicate that grey seals may move all around the Irish Sea as well as to Southwest England, Northwest France and the Channel, although some regional structure to foraging patterns has been observed (Mathiopoulos *et al.*, 2004; SMRU, unpublished data). Most movements appear to be contained within the Irish Sea (Hammond *et al.*, 2005), and it is therefore recommended that, for the time being, the Irish Sea be considered the most appropriate Management Unit.

Pen Llŷn a'r Sarnau SAC MSU, Cardigan Bay SAC MSU and Pembrokeshire Marine SAC MSU and significant winter/spring moulting & summer feeding haul-out sites:

Grey seal are an Annex II species feature of Pen Llŷn a'r Sarnau, Cardigan Bay and Pembrokeshire Marine Special Areas of Conservation and so management requires an assessment of impacts on this species feature at the site level for each SAC.

There are also important areas of high usage for moulting and feeding that have not qualified for designations as SAC (since designation is based on pup production), but that it may be appropriate to consider as Management Sub-Units.

Management Unit	Population estimate (CV)	Nmin	Nmin best estimate	Certainty level for Nmin best estimate	Certainty level rationale	Data source
IRISH SEA MU	ca. 5,000-6,000 (best guess)	n/a	4,702 (3 yr mean)	Low	Estimates based on pup numbers. No CV for estimate	Baines <i>et al.</i> (1995)
PEN LLŷN A'R SARNAU SAC MSU	No population estimate is currently available for the SAC (see above)					
CARDIGAN BAY SAC MSU	No population estimate is currently available for the SAC (see above)					
PEMBS MARINE SAC MSU	No population estimate is currently available for the SAC (see above)					

Suggested additional priority work to refine Management Units and Sub-Units for Atlantic Grey Seal:

Further telemetry studies will provide elucidation on movements between areas / haul-out sites and breeding colonies. However, the use of photo-identification offers potential for larger sample sizes from which mark-recapture analyses can provide both population estimates and measures of movement between areas.

Population estimates are required for SAC populations.

Further work is required to determine and characterise high use areas, to determine and define MSUs.

Annex I: An introduction to Management Units as applied to marine mammals (from Evans & Teilmann, 2009).

Understanding population structure is critical if conservation management is to be effective. The focus has generally been upon genetic markers (Hoelzel, 1991), from isozymes through to mtDNA sequences, nuclear microsatellite loci, and more recently, variation of the Major Histocompatibility Complex and Single Nucleotide Polymorphisms. However, the use of a suite of approaches has increasingly been advocated, with the distinction made between those that address evolutionary aspects of population separation (that may involve tens, hundreds or thousands of generations), and those that reflect contemporary structure (Evans, 1991; Dizon *et al.*, 1992; Taylor and Dizon, 1999).

A variety of criteria have been proposed by which conservation biologists assign population distinctiveness while incorporating molecular genetic data (Crandall *et al.*, 2000). Historically, this classification incorporated both ecological data and genetic variation to define 'evolutionary significant units' (ESU: Ryder, 1986; Waples, 1991). Some later ESU concepts were based more extensively on molecular phylogenies (Moritz, 1994, 1995). Crandall *et al.* (2000) then argued for a broader categorization of population distinctiveness that was based on concepts of both ecological and genetic exchangeability.

For differentiation that has been established over shorter time-scales, the identification of Management Units (MUs) was proposed (Moritz 1994). This was based on evidence for significant deviation from the assumption of panmixia, even without reciprocal monophyly at mtDNA (but see Waples and Gagliotti, 2005). More recently, there has been an effort to define demographically independent populations whose population dynamics depend largely on local birth and death rates rather than upon immigration (Palsbøll *et al.*, 2007). The implications of this when interpreting genetic data are that instead of focusing upon rejecting panmixia, one should assign MUs on the basis of the amount of genetic divergence at which populations become demographically independent. Thus emphasis is placed upon the contemporary dispersal rate of individuals rather than the historical amount of gene flow. However, it is important to recognize that dispersal rate estimates (based on physical or genetic tagging) and levels of contemporary gene flow may not be equivalent if immigrants are not contributing successfully to the local gene pool. Thus to define an appropriate threshold level of population genetic divergence at which populations should constitute separate MUs, it is proposed to establish the relationship between the demographic characteristics and population genetics dynamics of the target species, but for the present time linking biologically realistic demographic models with population genetic estimation remains challenging (Palsbøll *et al.*, 2007; Schwartz *et al.*, 2007).

In the past, the tendency has been to assume one large MU, and then to subdivide this once differences have been detected by various methods. However, a precautionary approach would be to start with a number of smaller MUs based upon preliminary evidence of differences, and then to pool these once one has data to show the differences are unlikely to be significant. We have tended to use this latter approach (as does the International Whaling Commission Scientific Committee – see, for example, Martien and Taylor, 2003; IWC, 2004).

A first step in considering populations as demographically distinct has been whether or not they are spatially separated. Thus an isolated population of harbour porpoise in the Black Sea might be considered as likely to be distinct from one in the North Atlantic. However, in most cases no such obvious geographical separation exists, and it becomes very difficult to use such initial criteria. Furthermore, whether or not populations are spatially distinct does not mean they are demographically or genetically so.

The strengths and limitations of the various methods for discriminating populations are detailed in Evans & Teilmann (2009). In summary, the two most commonly used genetic markers are the mtDNA control region and microsatellite DNA loci. The former (as with cytochrome *b*) is haploid and maternally inherited and therefore is associated with a four-fold smaller effective population size compared to nuclear by-parentally inherited markers. However, the lower mutational rate of the cytochrome *b* gene tends to make this marker more suitable than the control region for phylogenetic and taxonomic studies. By contrast, the mtDNA control region and nuclear microsatellite loci (generally found in non-coding regions) show higher levels of polymorphism due to a relatively high mutation rate, and so they tend to be more sensitive in detecting fine-scale population structure. Single nucleotide polymorphisms (SNPs) form a new set of markers that offer much potential due to their higher genotyping efficiency, data quality, genome-wide coverage and analytical simplicity (Morin *et al.*, 2004).

Most genetic analysis are based upon a demographically simple population model: random mating, constant population size, as well as constant migration rates among populations, equal reproductive success among individuals, non-overlapping generations, and equilibrium between drift and migration. Although this is too artificial for most natural populations, the impact of violating these assumptions can be assessed (and is often minor or not relevant to a particular analysis) and so working with this simplified model nevertheless provides useful information.

The relevant genetic analyses typically estimate parameters that result from the interaction between mutation, genetic drift and migration (though natural selection is also highly relevant for markers expressed phenotypically). The rate of change is influenced by the rate of mutation and migration, and by the effective population size (which influences the rate of

genetic drift – higher in small populations). The fact that most natural populations will be out of mutation-drift-migration equilibrium means that there can be a considerable lag between demographic changes and their reflection in parameter values assessed using molecular markers. In other words, traditional genetic estimates of migration rates (e.g. based on F_{ST}) and effective population sizes (based on genetic diversity) represent evolutionary means, which may not reflect the current population parameter values.

Many of the analyses summarised in Evans & Teilmann (2009) and presented in the literature, use Wright's Inbreeding Coefficient (F_{ST}) (which assumes an infinite mutation model) as a measure of population structure / genetic divergence, or the R_{ST} statistic (which assumes a step-wise mutation model). The calculation of F statistics requires prior assumptions as to what constitutes a 'population', which can lead to arbitrary designations based, for example, on political boundaries (though a signal for this can be detected by the 'Wahlund effect', where artificially pooled populations show a deviation from Hardy-Weinberg expectations). Furthermore, the value of the statistics for individual loci depends on sample size, the heterozygosity at a given locus (which is why multiple loci are typically used), and fluctuations in population size. The latter means it can be difficult to understand the biological meaning of F_{ST} or R_{ST} values without any knowledge of demographic history (although this can be assessed independently using molecular markers).

Another standard approach has been to ask "are the allele frequencies different?" which is the most common manner in which "stocks" have been defined from genetic data. Since the ability to detect a significant difference not only depends upon how genetically divergent two samples are but also on sample sizes, the number of genetic markers, and the specific markers used, then a comparison of A-B and A-C can be difficult, since different results may be due to non-biological aspects (i.e. sample size, etc). This incidentally also applies to all other kinds of analyses that simply go for assessing if samples are "different". This is why one needs to have a measure of *how* different the samples are, and thus ultimately a comparison of the degree of difference. This is demonstrated in the results from several of the genetic studies on harbour porpoise, where some F_{ST} values are as high within MUs as between them, suggesting that either (a) insufficient genetic data had been collected to obtain the necessary level of precision, or (b) that the MUs are incorrect.

Some recently developed methods address in part the problems described above. For example, assignment methods that assume equilibrium (e.g. Hardy Weinberg and linkage equilibrium) can partition populations without making any *a priori* assumption about population divisions by testing for deviations from equilibrium assumptions (e.g. as run in the program STRUCTURE; Pritchard *et al.*, 2000). There are also methods to assess migration rates based on the coalescent, which interprets historical lineage structure inferred from extant genotypes (e.g. see Beerli and Felsenstein, 2001). This method is less dependent on sample

size and can provide directional estimates of gene flow. And there are also non-equilibrium models, again based on the coalescent, that can estimate gene flow after some point of division (e.g. IM; Hey and Nielsen, 2004), though these often make strict assumptions that restrict gene flow to the pair of populations being assessed. Other applications allow the testing of different models including the incorporation of multiple populations (e.g. ABC; Excoffier *et al.*, 2005). In general, the application of multiple markers and analytical methods helps with the, often tricky, task of interpreting data in the context of model assumptions.

When no differentiation can be found at genetic markers, this does not mean that the populations cannot be diverging in a significant way (due to some of the factors outlined above). For example, it could mean that divergence is very recent or obscured by population expansion. Thus a range of other “ecological” approaches may be helpful as complementary evidence in informing us where structure exists. Some of these are likely to be more useful than others. Differences in diet or in certain life history parameters such as gestation periods or ones that are age or weight related, are less useful than those which provide signals of longer term differentiation (measured in years or decades). Some will be adaptive and reflect local environmental conditions – metrical differences may be related to growth conditions, for example, and such characters are often inter-correlated. For this reason, geometric morphometric approaches are preferable. Of other approaches, stable isotope signatures and levels of contaminants such as mercury in the liver, or cadmium in the kidney (which provides a long-term record measured in 10-15 years), are good candidates to discriminate diet or structure in populations. Differences in parasite loads, or the timing of reproductive events, or length at sexual maturity, all offer further indications of population differentiation, although it should be borne in mind for all of these approaches that similarities or differences may be coincidental, reflecting whether or not local environmental conditions happened to be similar or different. And we do not necessarily understand the underlying processes resulting in what we observe, so that it becomes difficult to model the expectations and how sensitive they are, or how exactly they relate to dispersal or migration rates.

A major limitation of many of the above approaches (both genetic and ecological) is that the location in which the animals were living is rarely known. Most result from biological samples obtained as strandings, whilst even if they derive from by-catches, their exact locations when alive may not be clear. And drift is not equivalent in different locations or areas. For example, in the North Sea, currents are predominantly from the north, in the Irish Sea from the south, and along Atlantic coasts from the west or south-west. Furthermore, researchers are usually confronted by small numbers of samples scattered over wide areas spanning long time periods, and they may analyse these by arbitrarily combining samples more on political than upon biological grounds. It would be more meaningful to use biological processes (which in turn may be influenced by physical processes such as features of bathymetry or ocean circulation) in hypothesis testing for defining Management Units, although identifying

appropriate ones remains a challenge since populations may be structured on the basis of parameters that we are unable to easily recognize. One approach of potential promise is to investigate how ecology may influence movement patterns and thus shape social and population structure. Where prey is sedentary, predictable, and persistent (as tends to occur with benthic or demersal fish and invertebrate species), forming localized areas of suitable foraging habitat for cetaceans, discrete local populations may arise. Where prey is pelagic and wide-ranging, population structure is much less likely to develop. If dietary specialization develops amongst individuals, there is potential for sympatric yet demographically (and ultimately genetically) distinct populations to occur.

More direct measures of dispersal can be obtained from techniques such as photo-ID of recognizable individuals, genetic tagging, or telemetry. However, these may not necessarily inform one about actual gene flow or even dispersal rates (unless this can be quantitatively assessed), and generally they involve limited numbers of individuals and/or relatively short time periods. Like all the other methods described, they are best used in combination to better inform one another. In general, the integration of both genetic and ecological markers is necessary to obtain the best possible indication of relevant stock structure. A major challenge that still needs fully addressing is how to integrate these rather different lines of evidence, and what time frame is most appropriate to consider here in the context of conservation management. For the time being, we consider a few generations (equivalent to low tens of years) as the appropriate time frame for defining a Management Unit, and we identify an MU as a group of individuals for which there are different lines of complementary evidence suggesting reduced exchange (migration/dispersal) rates. Ideally, one should set quantitative parameters (e.g. maximum of ten percent migration per generation), but in most cases we do not have the information as yet to do this, nor has the theoretical framework for integration of different evidence bases been fully developed.

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