Updated Technical Report summarising information on marine mammals which occur in the Moray Firth

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1 Introduction

The Moray Firth is a roughly triangular inlet of the North Sea situated north and east of Inverness. It is the largest Firth in Scotland stretching from Duncansby Head in the north to Fraserburgh in the east and the Beauly Firth in the west. The Firth has more than 800km of coastline, much of which is cliffs. A number of rivers flow into the Moray Firth including the Ness, the Findhorn and the Spey. There are three main inlets in the Firth, the Beauly, Cromarty and Dornoch Firths. The Moray Firth is one of the most reliable places in the UK for observing marine mammals close to shore. It also contains the Beatrice oil field (58°08'N 3°06'W) and is the planned site for two deep-water wind farms. It supports a fishing industry much of which focuses on scallops (*Pectinidae*) and Norway lobsters (*Nephrops norvegicus*). Much of the inner Moray Firth (Figure 42) is designated as a Special Area of Conservation (SAC; Figure 1) for bottlenose dolphins and sandbanks which are slightly covered by sea water all the time.

The Moray Firth is home to two cetacean species which are present year round (bottlenose dolphin and harbour porpoise), one species which is present seasonally (minke whale), and seven other species whose presence is either unknown or occasional (Reid et al. 2003). It is also home to two seal species which are present year round (harbour seal and grey seal). These marine mammal species are listed in Table 1 along with information on their biology and designations.

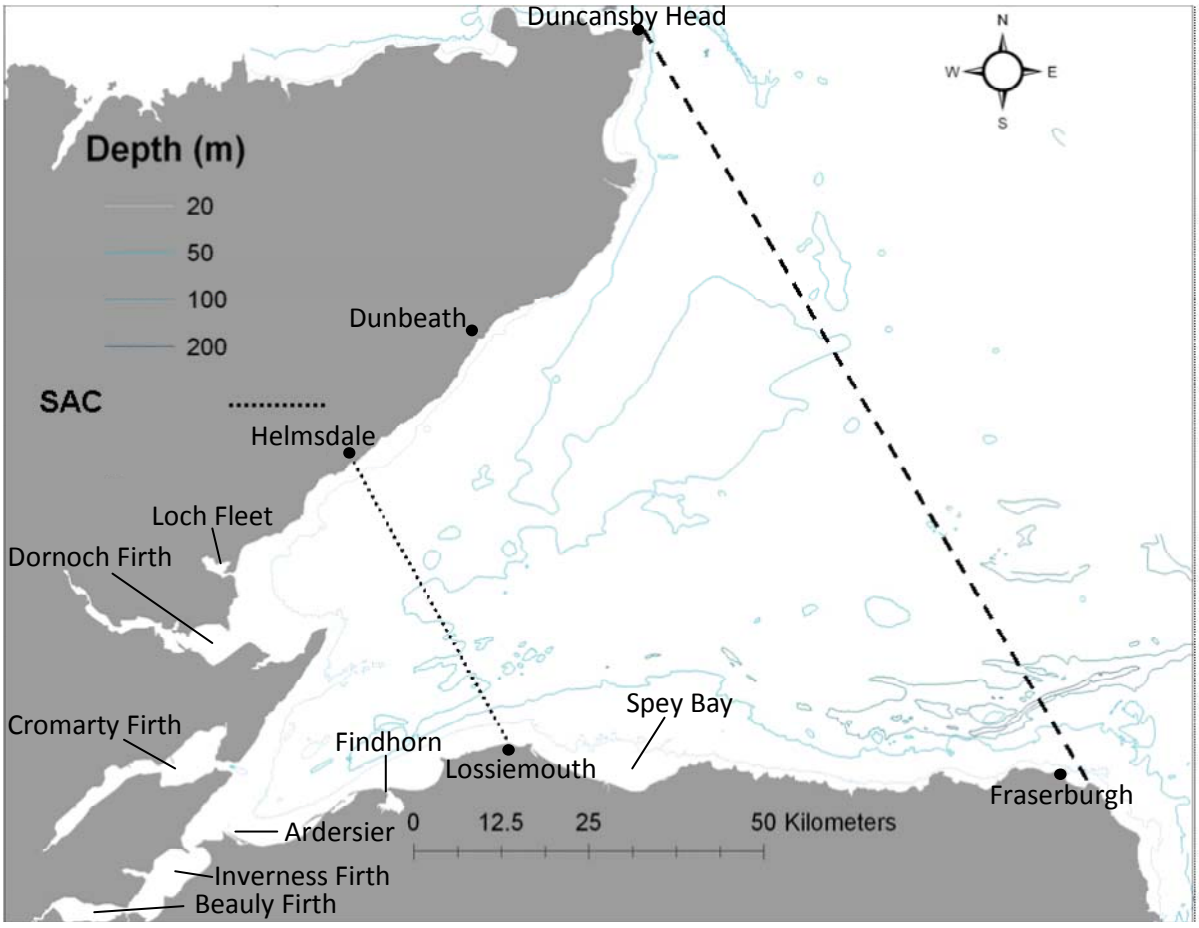

Figure 1. A map of the Moray Firth (limit shown by the dashed line) showing the bathymetry and the outer boundary of the Moray Firth SAC (taken from Thompson et al. 2010a and adapted).

Common name	Latin name	EU Habitats Directive			SAC designations within the Moray Firth	EPS	Moray Firth-specific information on:		
		Annex II[1]	Annex IV[2]	Annex V[3]			Abundance	Distribution	Presence
Bottlenose dolphin	*Tursiops truncatus*	✓	✓		✓	✓	193 (95% PI=162-245)[4]	Coastal	Year round
Harbour porpoise	*Phocoena phocoena*	✓	✓			✓	10,254 (CV=0.36)[5]	Coastal and offshore	Year round
Minke whale	*Balaenoptera acutorostrata*		✓			✓	835 (CV=1.02)[5]	Coastal and offshore	Seasonal
Common dolphin	*Delphinus delphis*		✓			✓	Unknown	Coastal and offshore	Unknown
White-beaked dolphin	*Lagenorhynchus albirostris*		✓			✓	682 (CV=0.86)[5]	Offshore	Unknown
Risso's dolphin	*Grampus griseus*		✓			✓	Unknown	Offshore	Unknown
Fin whale	*Balaenoptera physalus*		✓			✓	Unknown	Coastal and offshore	Occasional
Humpback whale	*Megaptera novaeangliae*		✓			✓	Unknown	Coastal and offshore	Occasional
Killer whale	*Orcinus orca*		✓			✓	Unknown	Coastal and offshore	Occasional
Long-finned pilot whale	*Globicephala melas*		✓			✓	Unknown	Coastal and offshore	Occasional
Harbour (or common) seal	*Phoca vitulina*	✓		✓	✓		~1,000[6]	Coastal and offshore	Year round
Grey seal	*Halichoerus grypus*	✓		✓			1,098[7]	Coastal and offshore	Year round

Table 1. Marine mammal species occurring in the Moray Firth.

[1] Species requiring designation of Special Areas of Conservation
[2] Species in need of strict protection
[3] Species whose taking from the wild can be restricted by European law
[4] The best available estimate of the number of bottlenose dolphins in the Scottish East Coast population (Cheney et al. 2011a)
[5] Estimate of the number of animals in SCANS II Block J (Moray Firth, Orkney and Shetland; http://biology.st-andrews.ac.uk/scans2/inner-finalReport.html)
[6] The number of harbour seals counted between Montrose and Cape Wrath (SCOS Main Advice 2009)
[7] The 2008 grey seal pup production estimate for Duncansby Head to Helmsdale (Duck and Morris 2010)

2 Designations and legislation

2.1 European Protected Species (cetaceans)

All cetaceans are European Protected Species (EPS) meaning that they are protected by the EU Habitats Directive and are listed in Annex IV (species of community interest in need of strict protection). This Directive was translated into law in Scotland under the Conservation (Natural Habitats, &c.) (Scotland) Regulations 1994. These Regulations supersede the Wildlife and Countryside Act 1981 which first offered protection to cetaceans within UK waters within the 12nmile limit. The Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2007 further strengthen the 1994 Act. Regulation 39 states that it is an offence to deliberately or recklessly capture, injure or kill a wild animal of an EPS. It is also an offence to disturb an EPS[8]. Outwith the 12nmile limit, the same protection is afforded to EPS by the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007[9]. In addition, cetaceans are listed as UK Biodiversity Action Plan priority species[10].

2.2 Seals

Both seal species which occur in Scotland are protected under Part 6 of the Marine (Scotland) Act 2010[11] which prohibits the taking of seals except under licence. This Act supersedes all existing seal legislation e.g. the Conservation of Seals Act 1970 and the Conservation of Seals (Scotland) Order 2004. Scottish Ministers may grant a licence authorising the killing or taking of seals under certain circumstances (e.g. for the protection of fisheries or aquaculture activities, or for scientific or welfare reasons). In addition, it is now an offence to disturb seals at designated haulout sites in Scotland. Although not afforded the protection given to EPS, both harbour and grey seals are listed on Annex II of the EU Habitats Directive. This listing means that the presence of these species can result in the designation of SACs. Harbour seals are also listed as a UK Biodiversity Action Plan priority species[10].

2.3 Natura 2000 sites

In addition to affording protection at a species level, European legislation also requires Member States to protect important habitats. This has led to the establishment of a network of sites that contribute to the protection of the habitats and species listed under Annexes I and II of the Directive. Bottlenose dolphins, harbour porpoises, harbour seals and grey seals are listed under Annex II, which means that the presence of these species can result in the designation of SACs (see Section 4.1.5 and Section 4.8.4 for those designated in the Moray Firth). SACs, combined with Special Protection Areas (SPAs; designated for birds under the EU Birds Directive), form a network of European protected sites known as Natura 2000 sites. SAC sites are chosen on the basis that they will make a significant contribution to species or habitat conservation. Where SACs have been established, care must be taken to (1) avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features and (2) ensure for the qualifying species that the following are established then maintained in the long term: Population of the species as a viable component of the site; distribution of the species within site; distribution and extent of habitats supporting the

[8] http://www.opsi.gov.uk/legislation/scotland/ssi2007/ssi_20070080_en_1#pt2
[9] http://www.opsi.gov.uk/si/si2007/uksi_20071842_en_1
[10] http://jncc.defra.gov.uk/page-5167
[11] http://www.legislation.gov.uk/asp/2010/5/part/6

species; structure, function and supporting processes of habitats supporting the species; no significant disturbance of the species.

3 Data collection methods and sources

3.1 Cetaceans

3.1.1 Surveys

Much of the survey data on cetaceans in the Moray Firth has been collected by the University of Aberdeen (UoA) through previous and ongoing work carried out in relation to the Beatrice Demonstrator Project and assessments of the impact of seismic surveys. There are two main datasets, one collected using boat-based line transect surveys and one collected using aerial line-transect surveys. Additional survey data were available from the boat-based seabird and marine mammal surveys that have been carried out by the Institute of Estuarine and Coastal Studies (IECS)[12] on behalf of BOWL (hereafter referred to as "BOWL boat surveys", and the resulting data as "BOWL boat survey data"). The University of Aberdeen data were collected during April-October while the BOWL boat surveys were carried out year-round. Each of the datasets was collected using broadly similar line-transect methods and effort data were collected in the form of transect distance surveyed. Location, species and number of animals sighted were recorded, but the number and experience of observers did vary between surveys. No deviation from the survey track line was made when animals were sighted.

3.1.2 Habitat association modelling

In general, habitat characteristics (such as depth, slope, sediment type etc.) can be used to predict the distribution and density of species in areas for which there are a lack of data (as long as there are enough data collected in other areas). These methods are as applicable to seals as they are to cetaceans.

3.1.3 Density estimates

Standard procedures available in the program Distance are often used to calculate density and abundance.

3.1.4 Passive acoustic monitoring (PAM)

Passive acoustic monitoring (PAM) is an increasingly useful tool for providing fine-scale spatial data on cetacean distribution and temporal trends in occurrence within key areas.

POrpoise Detectors (PODs)[13] continuously monitor within the 20-160 kHz range for possible cetacean echolocation clicks and record the centre frequency, frequency trend, duration, intensity and bandwidth of each detected click. They were originally designed to study harbour porpoises but can be programmed to detect a range of species. It has been estimated that harbour porpoises can be detected at distances of approximately 200m, while bottlenose dolphins can be detected up to 1200m away. Battery power limits the life of each device to several months; at this point devices will

[12] http://www.hull.ac.uk/iecs/
[13] http://www.chelonia.co.uk/

require servicing. An accompanying software program is used to post-process the recovered data, detect characteristic click trains and remove noises from other similar sources such as boat sonar. Resulting data on the number of cetacean click trains recorded in each minute can be used to determine the presence or absence of target species in the area where the POD was deployed, and the timing and duration of encounters with target species (Thompson and Brookes 2011 – see Appendix 1). It should be noted that these detections could be of dolphins of any species – PODs can differentiate between dolphin and porpoise clicks, but not clicks made by different dolphin species.

Other devices, such as Ecological Acoustic Recorders (EARs)[14], comprise hydrophones (underwater microphones) that monitor over the frequencies used by the different species in the area of interest and suitably broadband recording systems. Unlike PODs, these devices can be used to detect other noises made by cetaceans, such as whistles. The frequency spectrum of recorded whistles can be examined (using whistle detectors and whistle contour classifiers) and the whistles attributed to species (see Section 4.1.6). Towed hydrophone arrays are also commonly used on surveys, depending on the nature of the study.

3.2 Seals

3.2.1 Surveys

3.2.1.1 Harbour seals

Over the last 20 years, counts of harbour seals have been carried out at haulout sites throughout the Moray Firth by the University of Aberdeen (1988-2005) and SMRU (1994-2007) during both the breeding season (mid-June to mid-July) and moult (August). Harbour seals tend to spend longer at haulout sites during the moult and this is when the greatest and most consistent numbers are found ashore (Duck et al. 2008). Counts have either been made from land using a telescope or from the air using either thermal imaging or conventional photography. Where seals haul out onto sandbanks and are relatively easy to locate, surveys are normally carried out using a fixed-wing aircraft and hand-held oblique digital photography. Where they haul out onto rocky and seaweed shores and are well camouflaged, they are surveyed by helicopter using a thermal imaging camera.

Moult surveys of harbour seals around the Scottish coast are usually carried out by SMRU on an approximately five-yearly cycle, but the Moray Firth and Firth of Tay are surveyed annually (Duck et al. 2010). However, since the decline in harbour seal numbers in the North Sea (Lonergan et al. 2007), surveys in other areas of particular interest or importance have been carried out more often than every five years.

Not all individuals in the population are counted during surveys because at any one time a proportion will be at sea. The survey counts are normally presented as minimum estimates of population size. Telemetry-based, mark-recapture estimates suggest that approximately 60-70% of the population are counted during the moult surveys, leading to an estimate for the total British population of 40,000-46,000 animals (SCOS Main Advice 2010).

3.2.1.2 Grey seals

Every year between September and December, SMRU conducts aerial surveys of the major grey seal breeding colonies in Scotland to determine the number of pups born. Normally, these main breeding

[14] http://www.pifsc.noaa.gov/cred/ear.php

colonies are surveyed between four and six times during the breeding season (at approximately 10 to 12 day intervals) but a number of smaller, or more difficult to survey, colonies are surveyed three times during the breeding season. Approximately 40 additional colonies are surveyed once during the breeding season, on a two to four year rotation. Routine searches are also made for new colonies. Surveys are carried out using a light, twin-engine survey-modified aircraft (with the exception of the South Ronaldsay and Shetland colonies which are surveyed from the ground). A large-format camera is mounted in the floor of the plane and takes high resolution images of the areas used by breeding seals. Numbers of pups born (pup production) at the regularly surveyed colonies is estimated from counts derived from the aerial photographs using a model of the birth process and development of pups. A lognormal distribution is fitted to colonies surveyed four or more times and a normal distribution to colonies surveyed three times (Duck and Morris 2010).

SMRU reports pup production for the whole of the UK annually through the Special Committee on Seals (SCOS) which formulates scientific advice on matters related to the management of seal populations to government on behalf of the Natural Environment Research Council (NERC). "SCOS reports" are available to the general public via the SCOS section of the SMRU website[15].

Grey seals are also counted during the harbour seal moult surveys carried out by SMRU (see Section 3.2.1.1).

3.2.2 Telemetry

The distribution of UK seals at sea has predominantly been studied using VHF radio, SRDL (Satellite Relay Data Logger) and GPS phone tags developed by SMRU. Triangulation is used to locate animals fitted with VHF radio tags; SRDL and GPS phone tags collect and relay information that can be used to determine the location of individuals as well as individual dive information.

Seals are captured on or around their haulout sites using a variety of methods. All activity relating to catching and working with seals in the UK is licensed by the Home Office in accordance with the Animals (Scientific Procedures) Act 1986. The primary method of tag attachment is by gluing the tag with rapid setting epoxy resin onto the fur on the dorsal neck region. The tag will certainly detach during the annual moult (for grey seals January-March; for harbour seals August-September). However typical tag deployment is seldom greater than six months.

These tags transmit data on seal locations with the duration of data varying between individual deployments.

[15] http://www.smru.st-andrews.ac.uk/pageset.aspx?psr=411

4 Species accounts

4.1 Bottlenose dolphin

Bottlenose dolphins have a worldwide distribution and occur in both tropical and temperate seas in both hemispheres. Recent genetic, morphologic and physiologic studies suggest that revision of the genus may be necessary to acknowledge differences between forms from different oceans, as well as differences between forms in inshore vs. offshore habitats within ocean basins (Wells and Scott 2009). Along the Atlantic seaboard of Europe bottlenose dolphins are locally common off the coasts of Spain, Portugal, France, Ireland, Wales and Scotland (especially the Moray Firth; Figure 2). They also occur further offshore in deep waters of the North Atlantic (Reid et al. 2003).

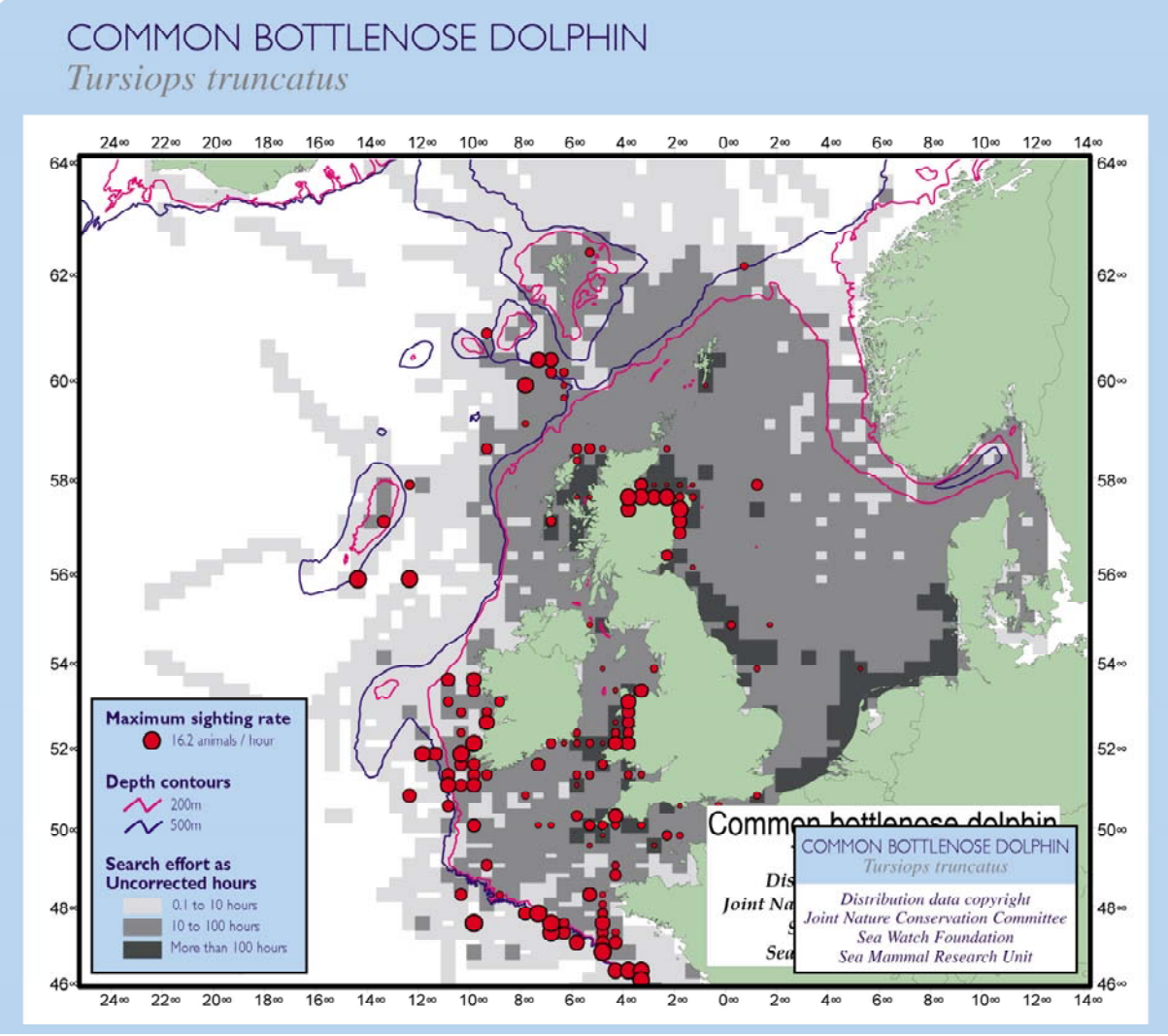

Figure 2. Sightings of bottlenose dolphins around the UK (1973-1997; taken from Reid et al. 2003).

4.1.1 Distribution

Bottlenose dolphins using the Moray Firth range as far afield as the Firths of Forth and Tay, and sometimes even as far south as the Tyne Estuary (Wilson et al. 2004; Thompson et al. 2011). The bottlenose dolphins throughout this range are referred to as the Scottish East Coast population.

There is also evidence that bottlenose dolphins which are regularly photographed and identified off the west coast of Scotland occasionally visit the Moray Firth (Cheney et al. 2011a).

4.1.1.1 Visual survey data

Available data from existing cetacean surveys in the Moray Firth were reviewed by the University of Aberdeen using information from peer-reviewed journals and the grey literature and unpublished data collected by various groups (Table 2; Thompson et al. 2010a). These data represent observations made over a period of 30 years, from 1980 to 2010 (Table 2), although coverage of the outer Moray Firth is patchy both spatially and temporally. Almost all bottlenose dolphin sightings were within 15km of the coast in the inner part of the Moray Firth SAC or the coastal strip along the southern Moray Firth coast. There were a few records of bottlenose dolphins in the outer Moray Firth - most sightings of dolphins in these offshore waters were of common, white-beaked or Risso's dolphins (Figure 3).

Two types of visual surveys were carried out over the BOWL site in 2010 - aerial surveys conducted by the University of Aberdeen (Figure 4) and the BOWL boat surveys (Figure 5).

All bottlenose dolphins encountered during the University of Aberdeen aerial surveys were located in the inner Moray Firth or within 10km of the southern Moray Firth coast (Figure 6). No bottlenose dolphins were encountered offshore. All offshore dolphins were other species (common, white-beaked and Risso's dolphins) or could not be identified to species (two sightings).

The BOWL bird and marine mammal boat surveys commenced in October 2009 and were carried out as part of a 21 month programme to support the BOWL OWF environmental impact assessment (EIA). Ten dolphin encounters were recorded during the BOWL boat surveys (Figure 5), four of which were identified as bottlenose dolphins (Figure 7). Apart from a couple of encounters, neither of which was within the BOWL site, this is the only time during the last 30 years that bottlenose dolphins have been encountered outwith the coastal strip in the inner part of the Moray Firth SAC or along the southern Moray Firth coast. While it is possible that bottlenose dolphins occur at the BOWL site, all other data collected over the last 30 years suggest that this is unlikely. In addition, only one encounter with any of the other dolphin species more commonly seen offshore was recorded by the BOWL boat survey observers. This suggests that the BOWL boat survey records of bottlenose dolphins may be a result of species mis-identification. Unfortunately the data were not collected in a way that could later be verified (e.g. good quality photographs, broadband acoustic recordings). Additionally, without good quality photographs of dorsal fins for photo-ID purposes, it is not possible to ascertain whether these animals were bottlenose dolphins from the Moray Firth SAC. The importance of using experienced observers to ensure data are of a high standard cannot be overstated. Collecting data in a way that can later be verified is also important (Grellier 2010).

There were insufficient data to produce habitat association models for each individual dolphin species, however the University of Aberdeen were able to use these survey data in classification trees to assess the likely species identity of dolphins that may be encountered in different parts of the Moray Firth, given its habitat characteristics (Thompson and Brookes 2011). This presence only method does not account for effort so, used alone, it cannot provide a prediction of the number of animals that might be found in an area. However, the approach does show the likely species composition in different areas if dolphins were present. The analysis was run twice, once with all of the data (Figure 8) and once excluding the BOWL boat survey data which, given the offshore location of the survey area, contained an atypically large number of bottlenose dolphin sightings relative to sightings of other species (Figure 9). Including the series of encounters made during the BOWL boat surveys meant that the model predicted a higher likelihood that dolphins encountered in this

specific offshore area are likely to be bottlenose dolphins (Figure 8; Figure 9). Given uncertainties over the reliability of species identification from the BOWL boat surveys, and supporting evidence from acoustic work (see Section 4.1.6), predictions from the second model which exclude these data provide a more robust picture of the likely species composition of groups of dolphins encountered in different parts of the Moray Firth (Figure 9). The results suggest that any dolphins encountered along the coastal strip of the Moray Firth are most likely to be bottlenose dolphins, but those encountered in offshore areas are, in general, more likely to be other species (Figure 9). Data on the likely presence of bottlenose dolphins vs. other dolphin species are presented separately in Figure 10.

By combining information on the likely species composition in different areas if dolphins were present (Figure 9 and Figure 10) with the density estimate of 0.066 dolphins per km^2 (i.e. 1.056 dolphins per 4x4km grid cell; see Table 4), the number of bottlenose dolphins in each 4x4km grid cell was predicted (Figure 11; Thompson 2011a – see Appendix 2). As stated in the report, it must be recognised that this density distribution remains very conservative when focussing on impacts in offshore areas and along the northern coast of the Moray Firth SAC, as this approach tends to underestimate the number of animals occurring in the inner Moray Firth and along the southern Moray Firth coast. i.e. whilst the total number of animals represented in this Figure (213) appear reasonable given current estimates of population size, these animals are predicted to be much more widely distributed outside their core areas than would be expected given other data on the number of animals typically found in the inner part of the Moray Firth SAC and along the Moray coast (e.g. Bailey and Thompson 2009; Thompson et al. 2011).

Dataset	**Year**
BOWL boat survey	2010
JNCC Seabirds at Sea	1980-1998
JNCC seismic MMO	1998-2006
MORL	2010
Crown Estate	2009-2010
UoA AFEN[16]	2001
UoA boat	2009
UoA aerial	2010
UoA SAC	2004-2005
UoA Photo-ID	1990-2010

Table 2. The datasets reviewed and collected by the University of Aberdeen (taken from Thompson and Brookes 2011).

[16] Data collected as part of a project funded by the Atlantic Frontier Environmental Network, a grouping of oil and gas companies and UK Government departments which aims to ensure sound management and regulation of oil and gas activities in the Atlantic Frontier.

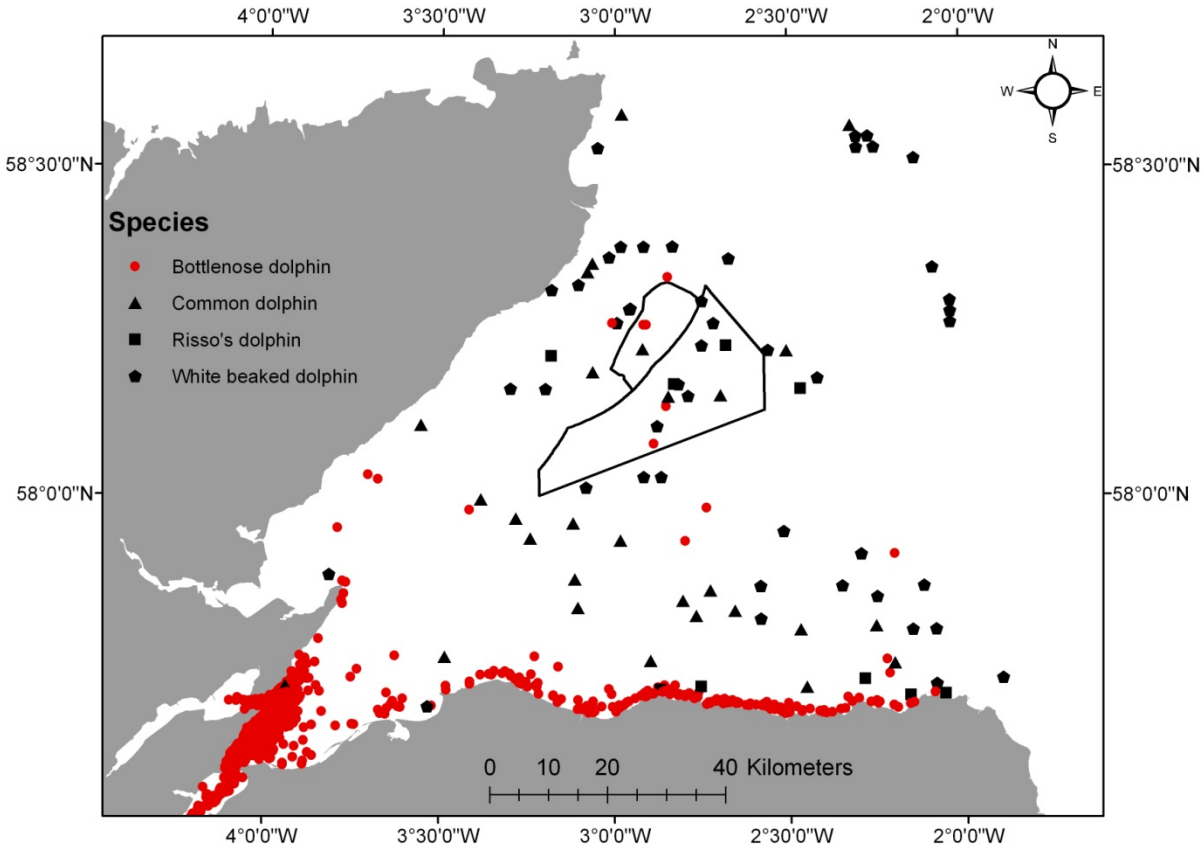

Figure 3. Sightings of dolphins from the datasets shown in Table 2 (taken from Thompson and Brookes 2011).

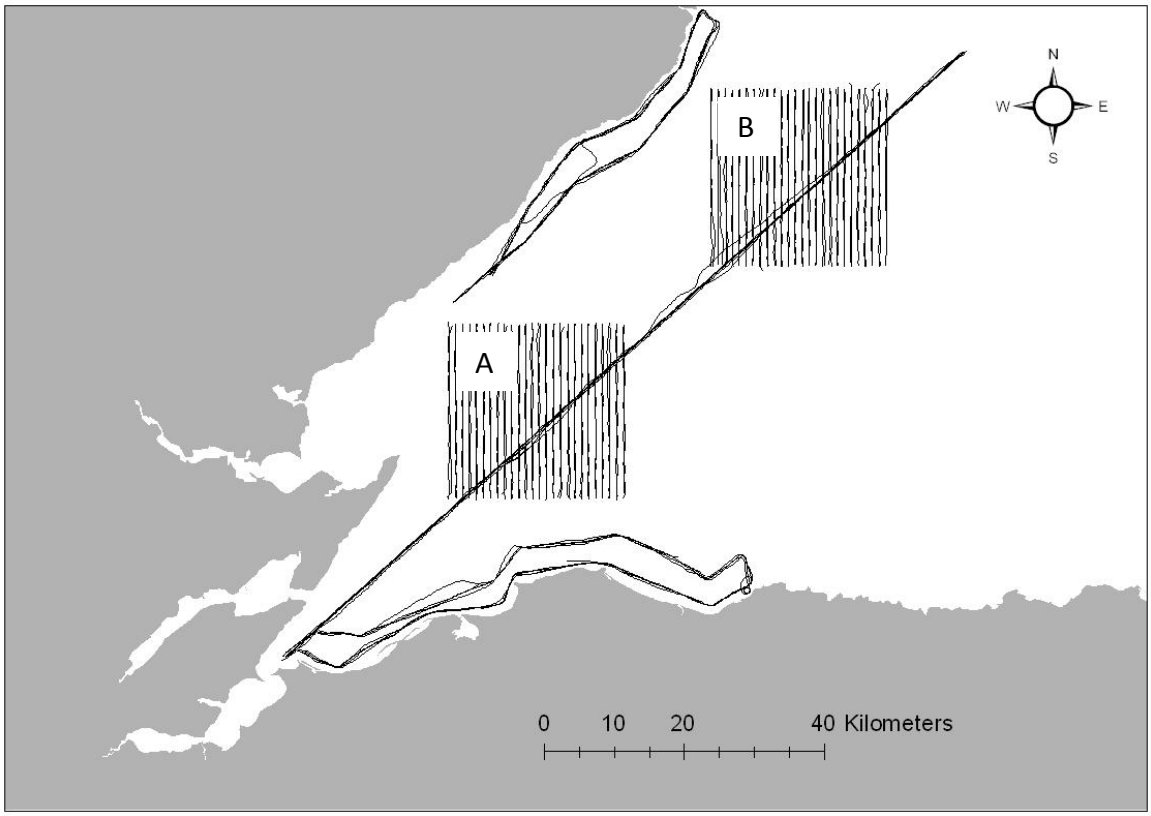

Figure 4. Map of track lines from the University of Aberdeen's August and September 2010 aerial surveys of the outer Moray Firth (taken from Thompson and Brookes 2011).

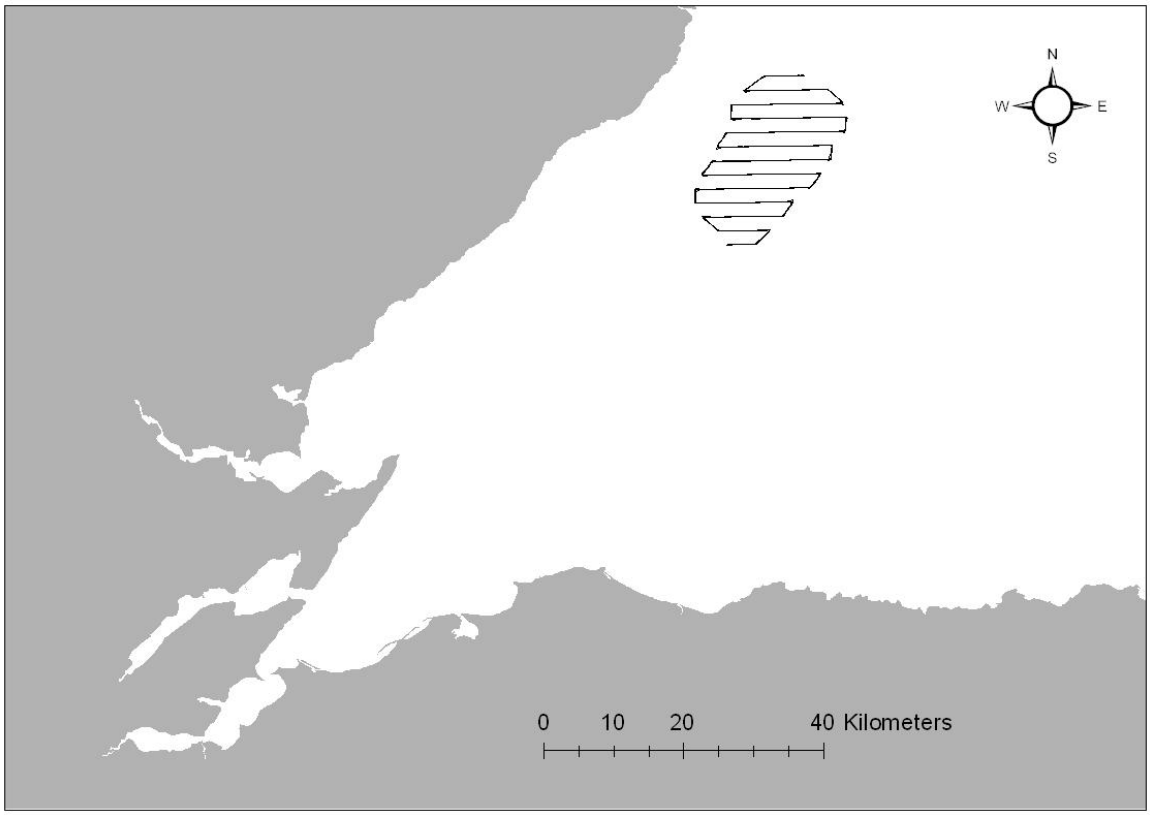

Figure 5. Map of the survey track followed on the BOWL boat surveys (taken from Thompson and Brookes 2011).

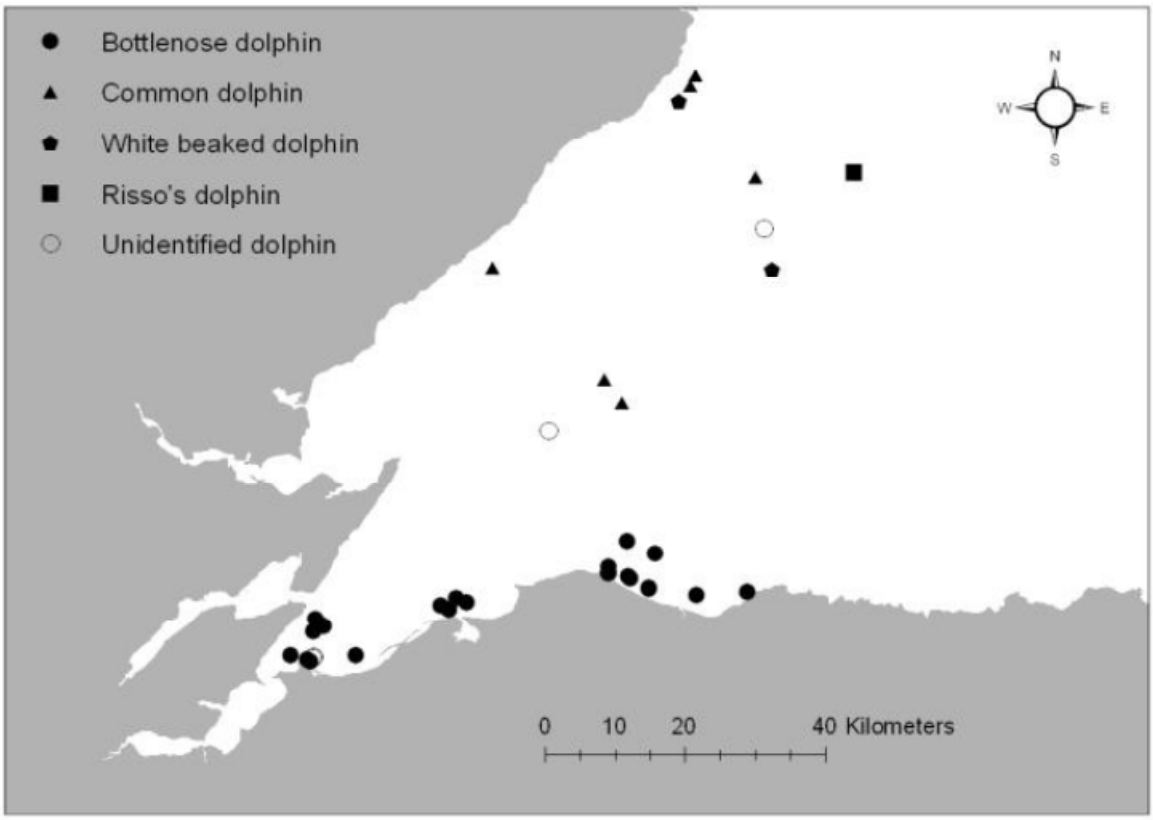

Figure 6. Sightings of dolphins made during the University of Aberdeen's 2010 aerial surveys of the outer Moray Firth (taken from Thompson and Brookes 2011).

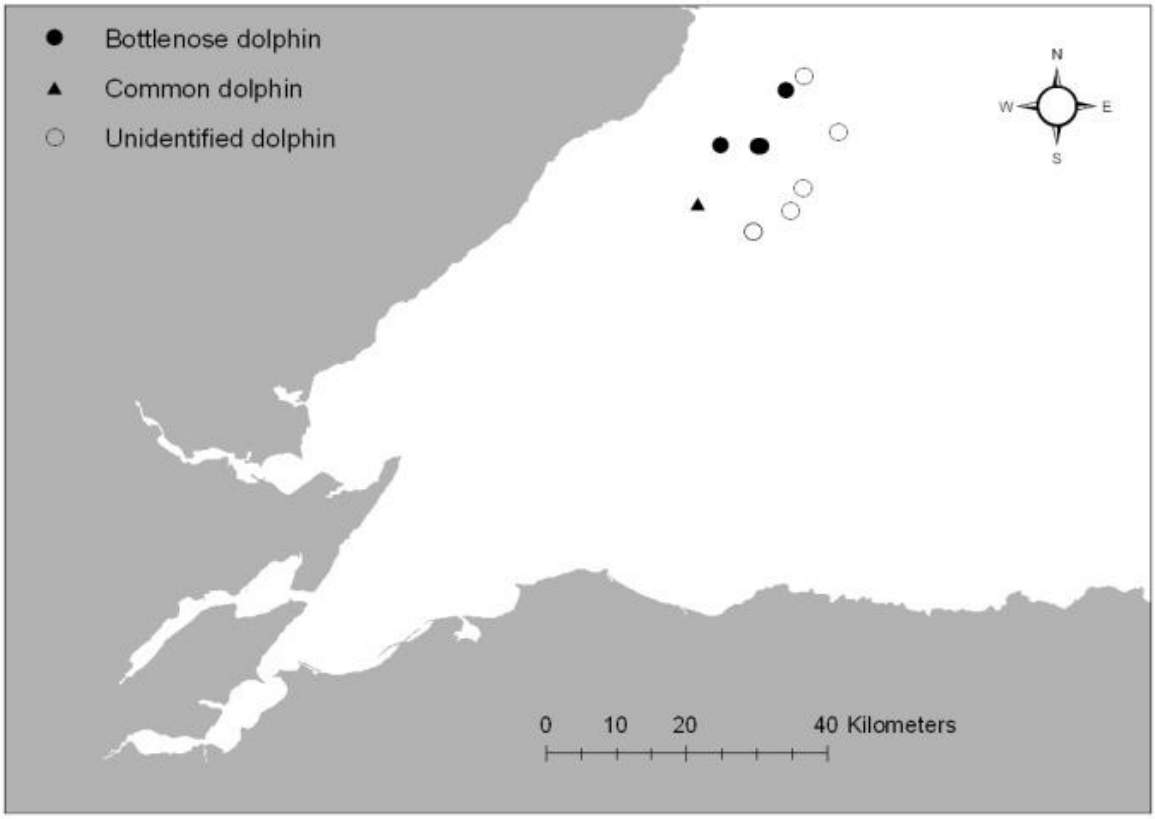

Figure 7. Sightings of dolphins made during the BOWL boat surveys between April and October 2010 (taken from Thompson and Brookes 2011).

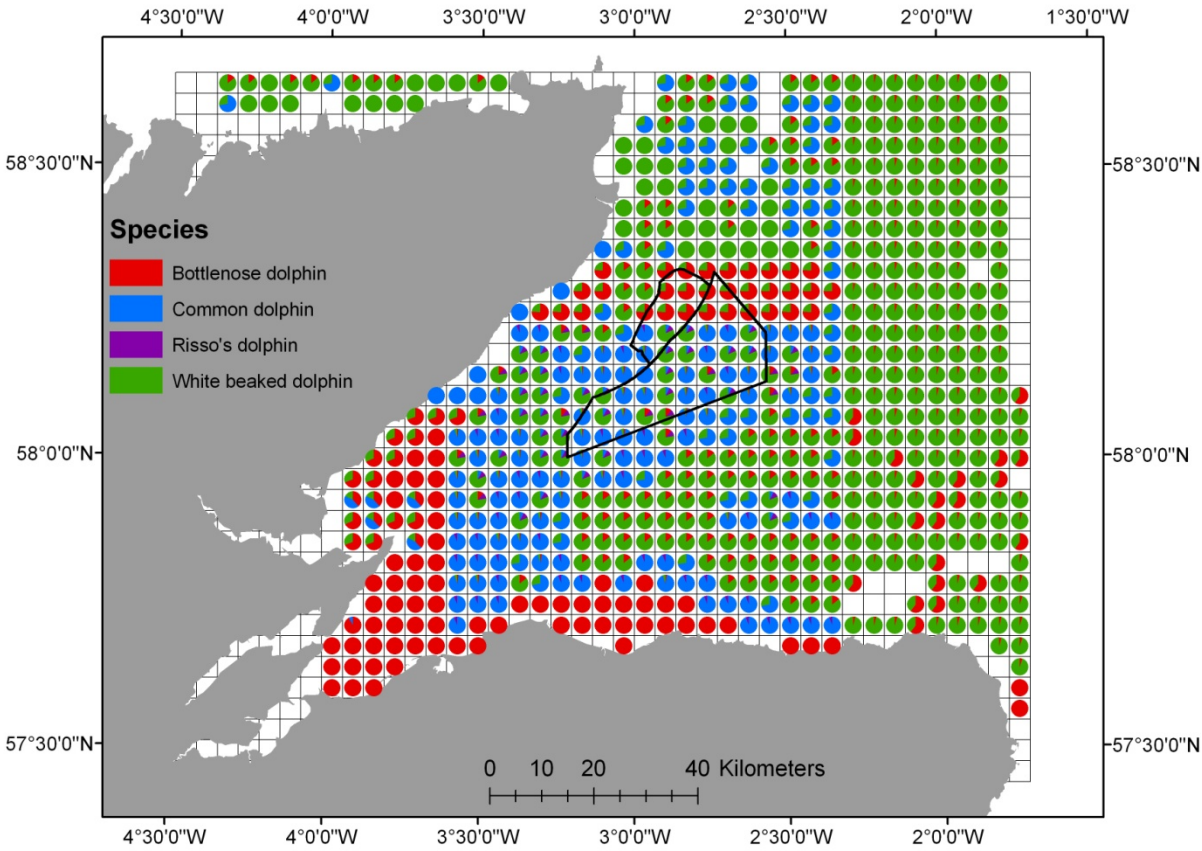

Figure 8. Prediction of the dolphin species composition within each 4x4km grid cell using all data (taken from Thompson and Brookes 2011).

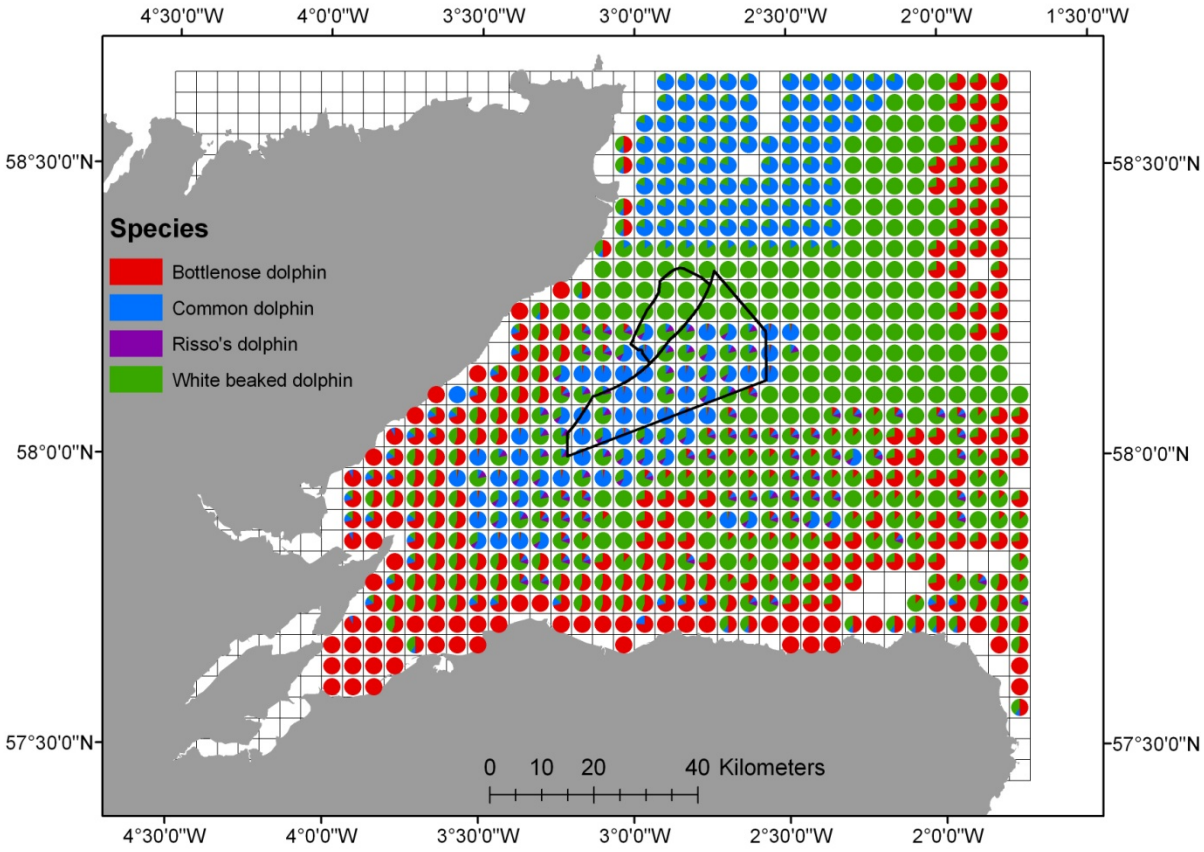

Figure 9. Prediction of the dolphin species composition within each 4x4km grid cell using all data except the BOWL boat survey data (taken from Thompson and Brookes 2011).

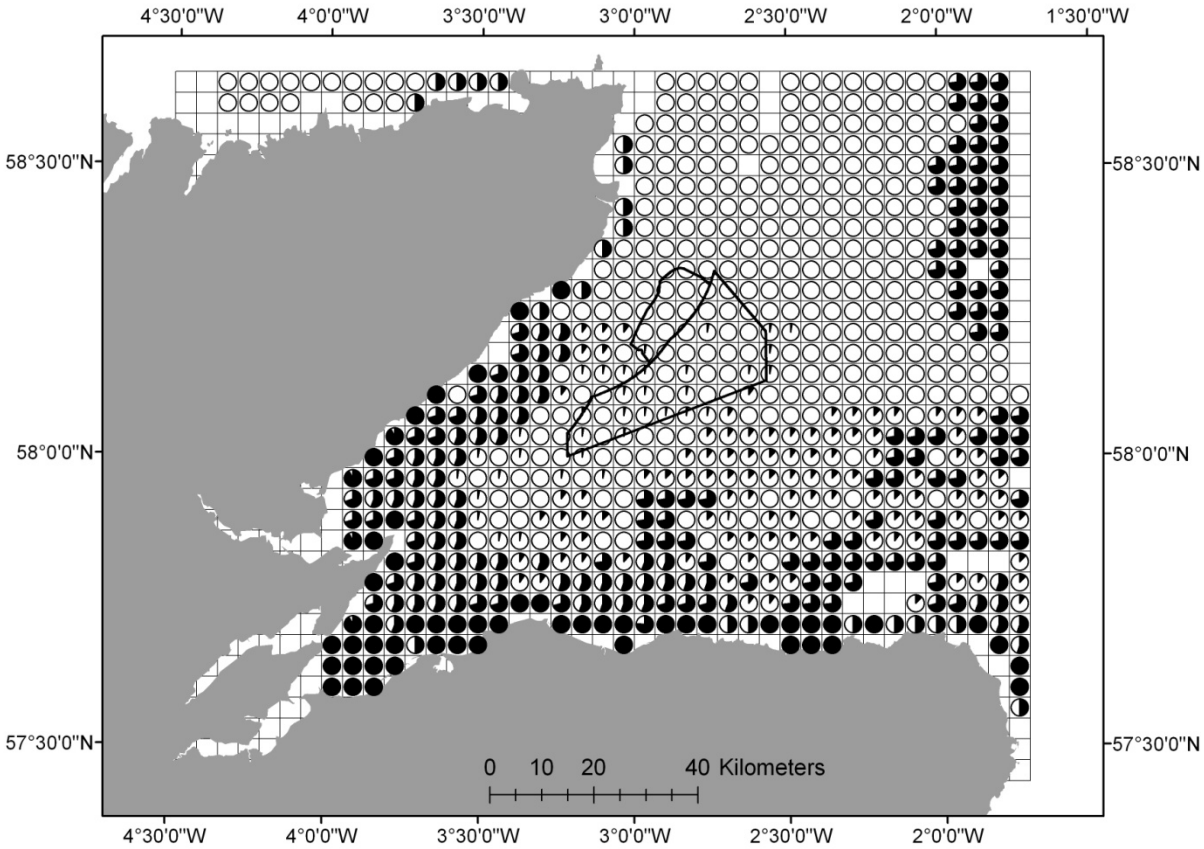

Figure 10. Prediction of the likelihood that dolphins encountered in each 4x4km grid cell are likely to be bottlenose dolphins. Data are as for Figure 9, but presented as bottlenose dolphins (black portion of pie chart) vs. all other species (taken from Thompson and Brookes 2011).

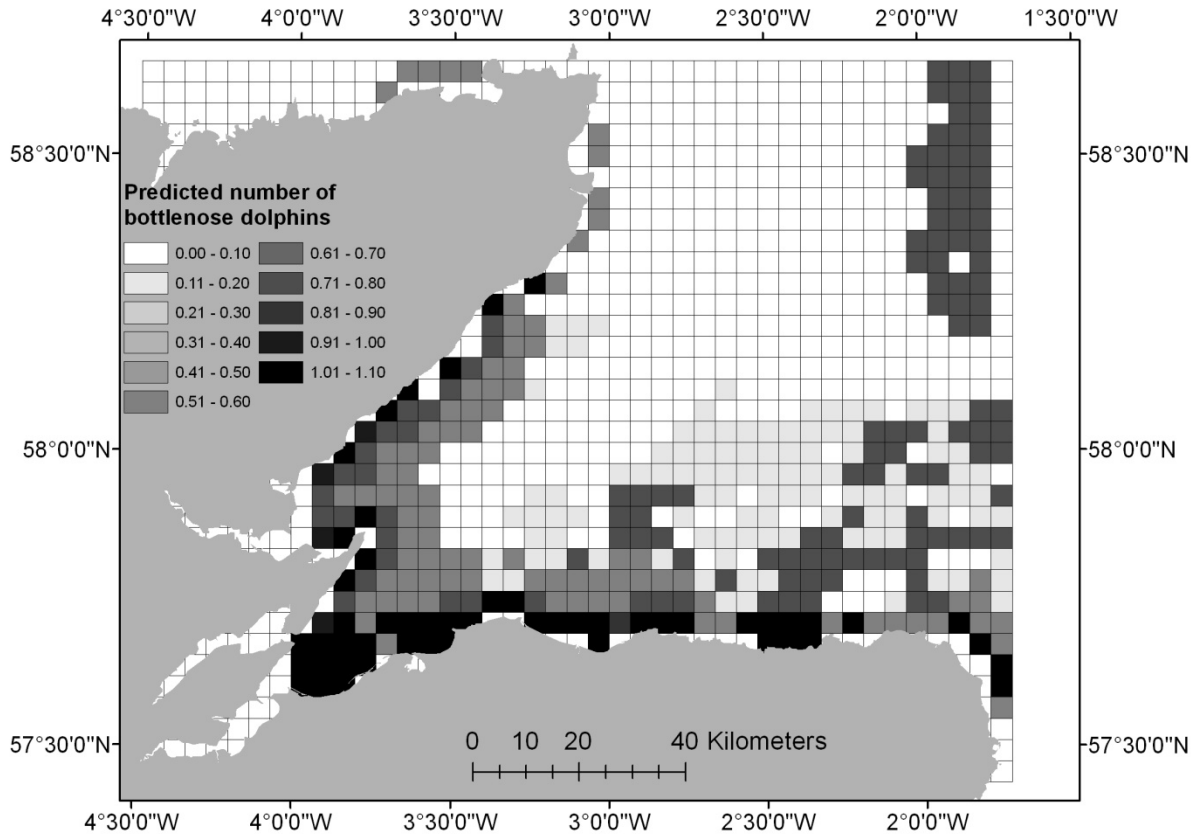

Figure 11. Predicted number of bottlenose dolphins in each 4x4km grid cell (taken from Thompson 2011a).

4.1.1.2 Acoustic survey data

An extensive array of PODs was deployed across the Moray Firth by the University of Aberdeen during their DECC funded study in 2009 (data recovered from 56 deployments) and 2010 (data recovered from 60 deployments; Thompson et al. 2010a; Thompson and Brookes 2011) and their MORL/BOWL funded studies in 2009 to 2011 (data recovered from 24 deployments; Thompson and Brookes 2011; Figure 12). Dolphins were detected on all PODs at least once during their deployments, but the proportion of days on which they were detected varied considerably (Figure 12). It is not possible to use click characteristics to determine which species of dolphins have been detected, and it is likely that detections in different areas represent different species. Dolphins were detected regularly in the inner Moray Firth and along the southern Moray Firth coast, but detections were less frequent in the central part of the Moray Firth. However, dolphin detections increased again at more offshore locations, including those around the BOWL site (Figure 12).

The longest time-series of passive acoustic monitoring data was available from the Beatrice Demonstrator site, where devices were deployed by the University of Aberdeen between August 2005 and December 2007. After a break in studies during 2008, devices were again deployed at this site in May 2009 and data collection is anticipated to continue until at least Autumn 2011. There have been some gaps in the time-series due either to equipment loss or failure but these data provide a unique opportunity to explore longer-term temporal change in the occurrence of dolphins at an offshore site (Thompson and Brookes 2011). Overall, dolphins were detected only rarely (<6% of deployment days). On those days that dolphins were detected, they were recorded for a median of 1 hour (IQ range=1-1; Figure 13).

Passive acoustic monitoring data are also available from two sites within the BOWL development area for a period of almost two years, and from three additional sites for the final nine months of the study (Thompson and Brookes 2011). Inspection of these data indicates that dolphin detections were low (Figure 17) and, on the days that they were present, they were generally detected for only 1 or 2 hours a day (Figure 13).

Broadband sound recordings were made (using EARs) at the BOWL and MORL sites in 2010 with the purpose of identifying whether the dolphin activity recorded by the PODs was due to the presence of bottlenose dolphins or other dolphin species. Twenty two whistle classification events were recorded over 88 days, but none were attributed to bottlenose dolphins (Figure 23). These results are detailed in Section 4.1.6 and support previous evidence that bottlenose dolphins are generally not present at the BOWL site, at least during the July-October sampling period used in the acoustic study.

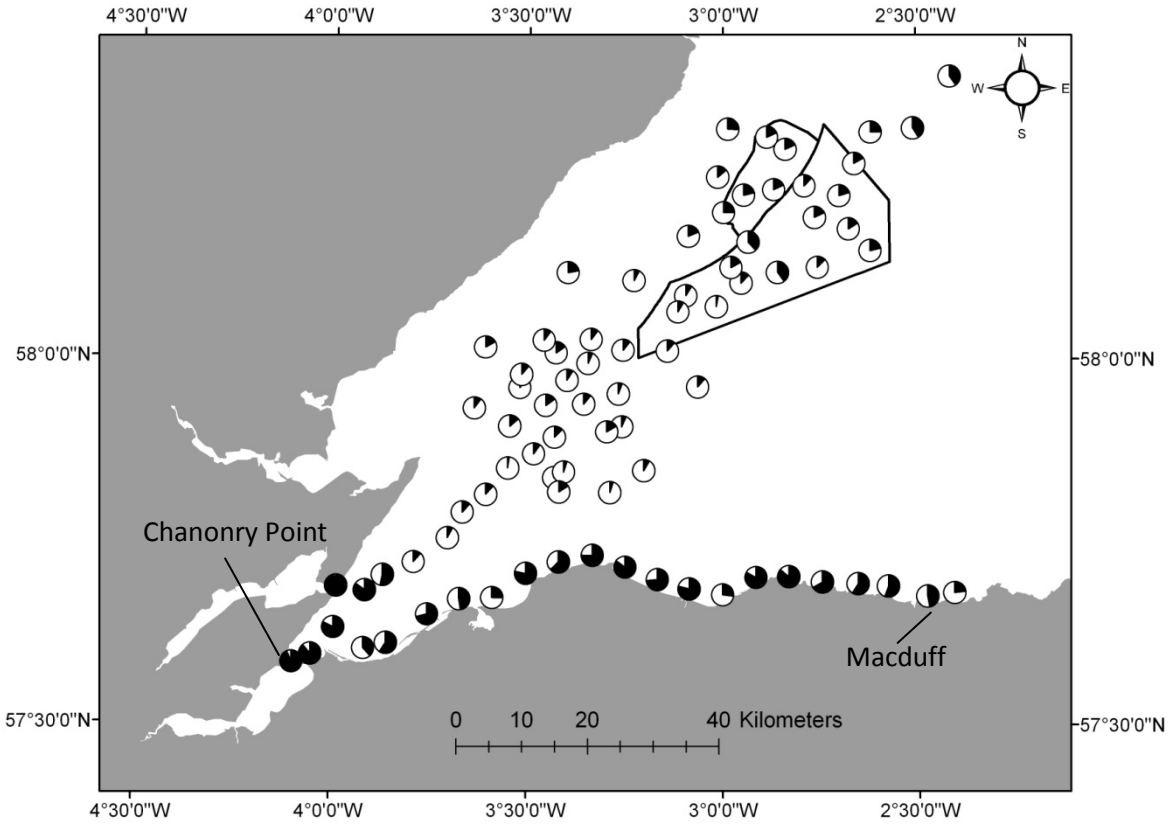

Figure 12. Spatial variation in the occurrence of dolphins in April-October of 2009 and 2010. The pie charts show the proportion of days that dolphins were detected on PODs at each sampling location (taken from Thompson and Brookes 2011).

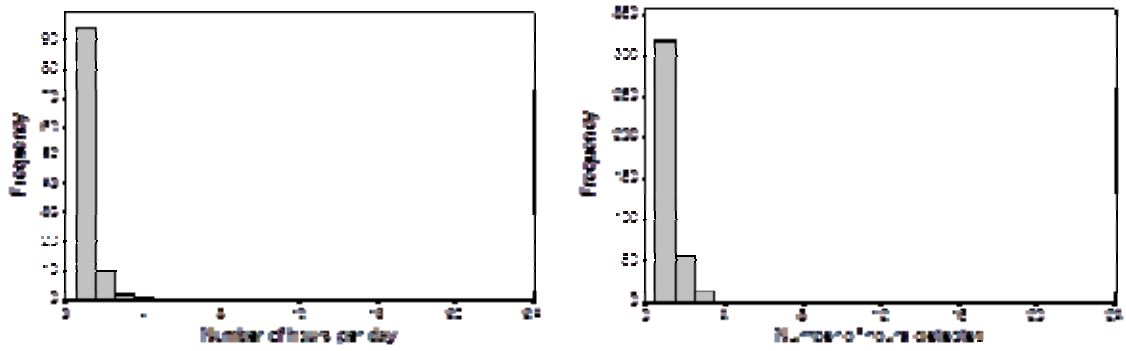

Figure 13. Frequency histogram showing the number of hours per day that dolphins were detected on PODs deployed at the Beatrice Demonstrator site from 2005-2010 (left) and within the BOWL site from 2009-2011 (right) (taken from Thompson and Brookes 2011). This Figure only includes those days on which any animals were detected.

4.1.1.3 In the southern Moray Firth (in relation to the cable route)

The University of Aberdeen's POD data show that dolphins are present along the southern Moray Firth coast (from Chanonry Point in the inner Moray Firth along the coast to the east of Macduff) on a high proportion of days (≥75% of days at half of the POD deployment sites), at least between April and October (Figure 12). Visual survey data (see Table 2 for data sources) show that dolphins sighted along this coast were almost exclusively bottlenose dolphins (Figure 3; Figure 6). When the likely species composition in different areas of the Moray Firth was assessed, results showed that any dolphins encountered along the coastal strip of the Moray Firth were most likely to be bottlenose dolphins while those encountered in offshore areas were more likely to be other species (Thompson and Brookes 2011; Figure 9; Figure 10).

Additional surveys (to those listed in Table 2) have been carried out between May and October along the southern shore of the outer Moray Firth (between Lossiemouth and Fraserburgh) by the Cetacean Research and Rescue Unit[17] (CRRU; Figure 14). The location of dolphin sightings made between 2001 and 2008 are shown in Figure 15. Four dolphin species were seen but 94% of dolphin sightings made were of bottlenose dolphins (Robinson et al. 2007). However, bottlenose dolphins were only encountered on the survey route closest to the shore (Figure 14; Figure 15) in shallow waters rarely exceeding 25m depth (Robinson et al. 2007). Furthermore, they appeared to have a preference (see peak in encounter rate; Figure 16) for Spey Bay, at the western end of the survey area directly adjacent to the SAC (Culloch and Robinson 2008; Figure 16). Knowing which months these sightings occurred would aid understanding of why Spey Bay appears to be a preferred area. The preference may be food related: the River Spey supports a spawning population of Atlantic salmon, a known prey of bottlenose dolphins in this area (Harding-Hill 1993; Santos et al. 2001).

[17] http://www.crru.org.uk/

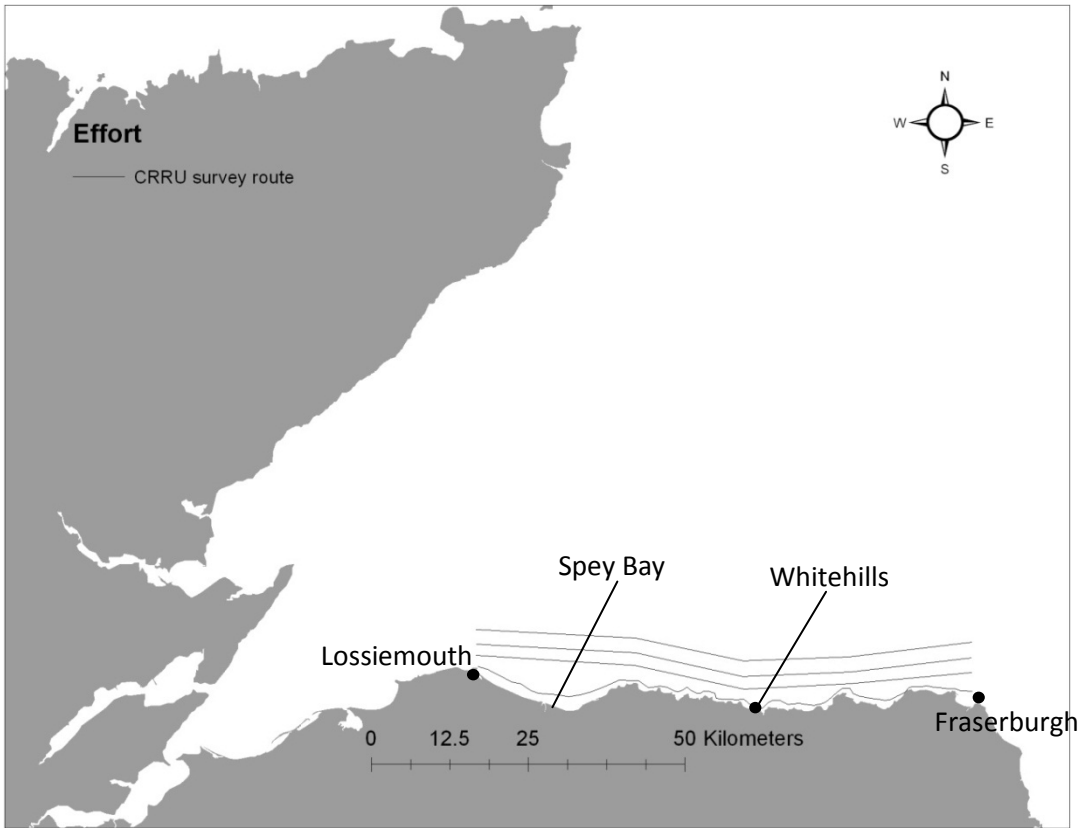

Figure 14. CRRU survey tracks extending from Lossiemouth (in the west) to Fraserburgh (in the east; taken from Thompson et al. 2010a).

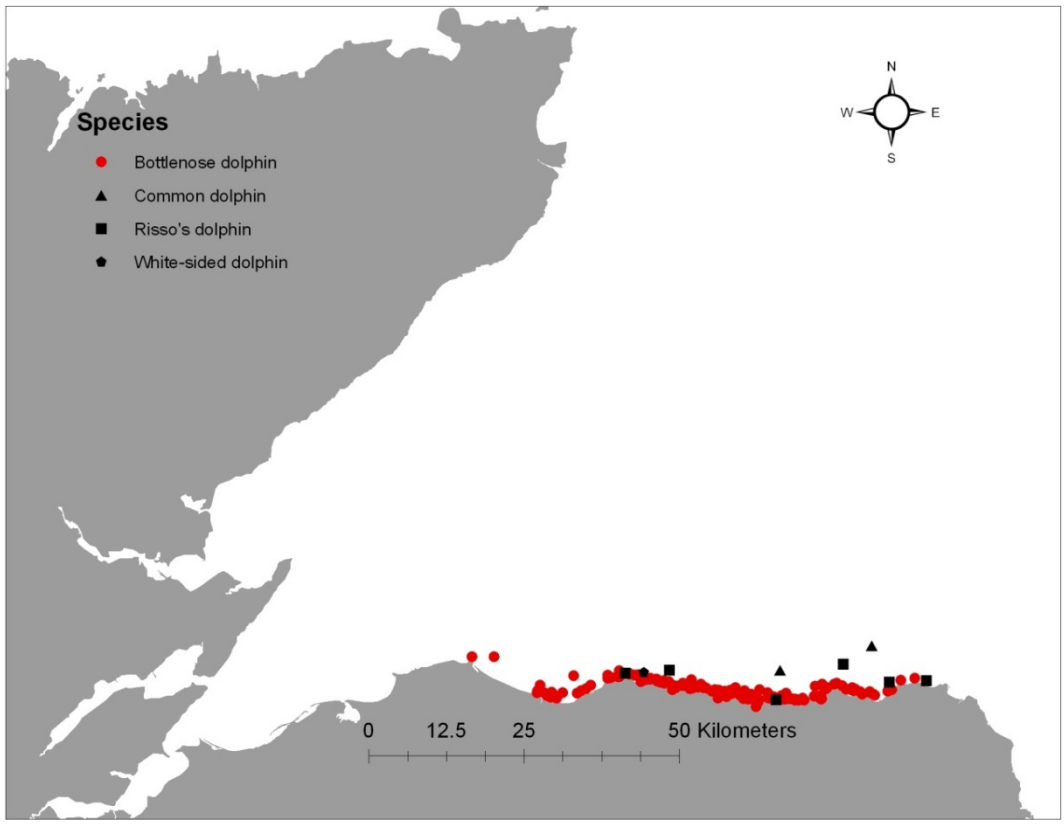

Figure 15. Dolphin sightings made by the CRRU between 2001 and 2008 (taken from Thompson et al. 2010a).

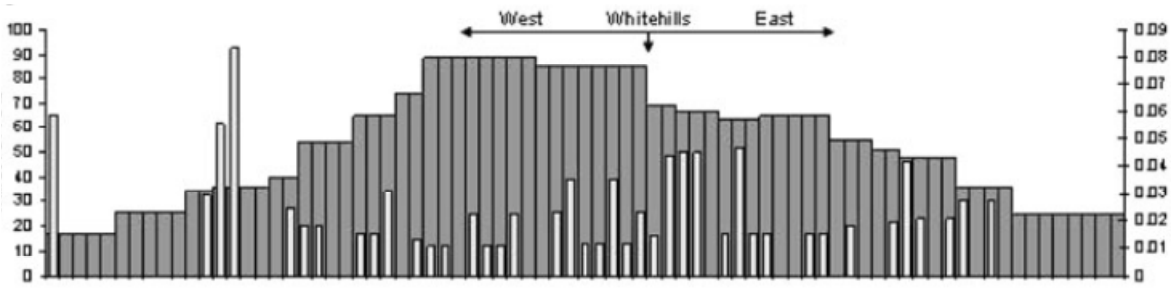

Figure 16. Bar chart showing the distribution of bottlenose dolphin encounters across the survey area (from Lossiemouth to Fraserburgh). The dark grey bars represent the number of visits to each 1km section of the coast (left y-axis). The encounter rate (right y-axis) is shown in pale grey (taken from Culloch and Robinson 2008).

4.1.2 Seasonal variation

4.1.2.1 Visual and acoustic (POD) data from the Scottish East Coast

Work carried out by Wilson et al. (1997) in the inner Moray Firth (Figure 42) in the early 1990s showed that although bottlenose dolphins were sighted in all months of the year, there were consistent seasonal fluctuations in the number of individuals present – numbers were low in Winter and Spring, and peaked in Summer and Autumn. Area use also changed with season – the outer part of the inner Moray Firth was used for most of the year while areas closer to the head of the Firth were only used seasonally.

The issue of reduced dolphin presence in Winter was re-visited by Cheney et al. (2011b), who found that the pattern documented in the 1990s appeared to have been conserved to the present time. Furthermore, other areas of high dolphin occurrence in the outer Moray Firth (Figure 42) and eastern coasts to the south (Spey Bay, Aberdeen and St Andrews Bay) also appeared to be used less in Winter. No new areas were discovered that were used by dolphins in Winter but not in Summer. It should be noted, however, that the power of this study to detect significant new areas of use was low, particularly in offshore areas. Dolphins continued to use their entire known Summer range in Winter, but with apparently lower rates of occupancy. The most obvious explanation is that the population increases its range in Winter to other areas that are, as yet, unknown. Without some indication of where those areas might be, it has proved extremely difficult to target sufficient search effort to find them (Cheney et al. 2011b). There is another possibility: dolphins maintain their Summer range but change their behaviour so that they are harder to detect. The most obvious way for this to occur would be by increasing their group sizes. This would produce lower visual sightings rates and lower rates of dolphin-positive days on the POD recorders. There is some evidence that dolphins increase their group sizes in Winter but the mark-recapture estimates of dolphin numbers in the inner Moray Firth in Winter suggest that this factor alone cannot entirely explain the apparent reduced occupancy rates (between around 25% (2007) and 45% (2006) fewer individual dolphins used the SAC in Winter compared with Summer; Cheney et al. 2011b).

4.1.2.2 Acoustic (POD) data from the BOWL site

Passive acoustic monitoring data are available from two sites within the BOWL development area for a period of almost two years, and from three additional sites for the final nine months of the study (Thompson and Brookes 2011). Dolphin detections (circles) remained relatively low throughout the year, with no obvious seasonal pattern (Figure 17).

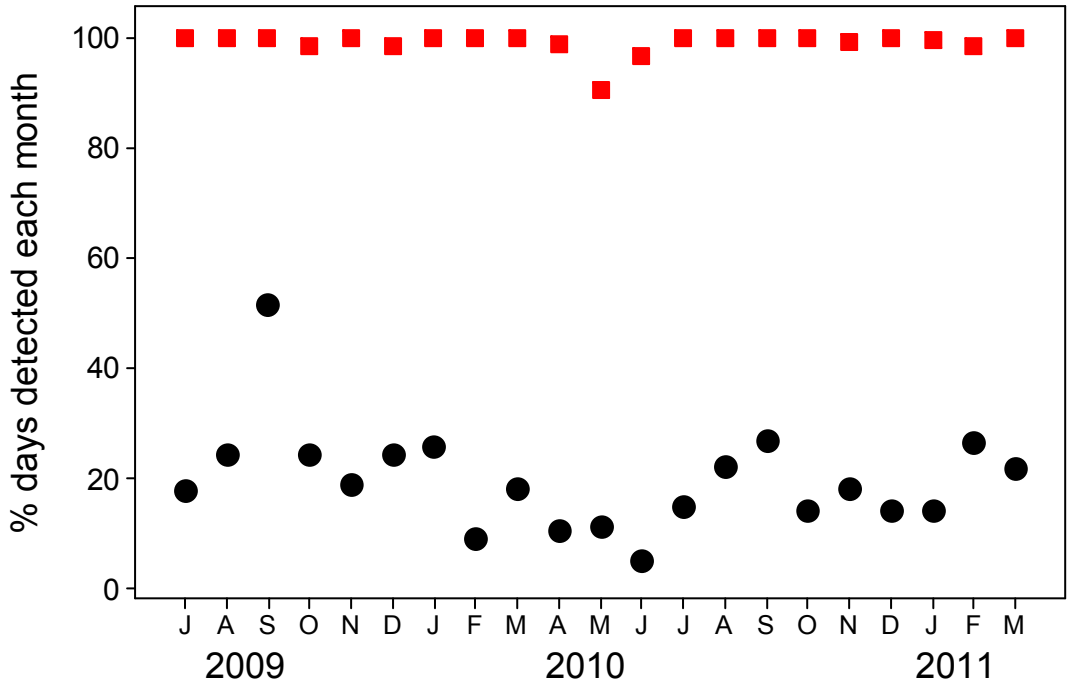

Figure 17. Monthly values for the % of days that dolphins (black circles) and porpoises (red squares) were detected by PODs deployed within the BOWL area (taken from Thompson and Brookes 2011).

4.1.2.3 In the southern Moray Firth (in relation to the cable route)

Bottlenose dolphins use their entire known Summer range in Winter but, with apparently lower rates of occupancy. For example, Spey Bay, an area of high dolphin occurrence, appeared to be used less in Winter (Cheney et al. 2011b). Bottlenose dolphins were sighted in all of the months in which CRRU surveys were carried out (May to October; Figure 18), with no significant difference in sightings rates between months (Culloch and Robinson 2008). However, acoustic detections of dolphins on PODs deployed along the southern Moray Firth coast (Figure 30) declined from mid-July to November (Thompson et al. 2010a).

Year-round POD data were available from two sites along the southern Moray Firth coast from the Summer of 2009 to the Spring (Spey Bay; n=628 days) or Summer (Lossiemouth; n=741 days) of 2011 (Figure 19; Thompson 2011). Dolphins were detected on 65% of days at Spey Bay and 63% of days at Lossiemouth. Visual sightings in these areas suggest that most of these detections were of bottlenose dolphins (Figure 15). There appeared to be seasonal patterns in dolphin detections at Spey Bay, with peaks in Summer and early Winter in both years (although it is not possible to tell if this pattern is real without a statistical analysis); this was less evident at Lossiemouth (Figure 20). Median values for the number of hours per day that dolphins were detected were broadly similar at the two sites (Figure 21). Typically, dolphins were detected for more hours per day at these coastal sites (Figure 21) than at the offshore sites (Figure 13).

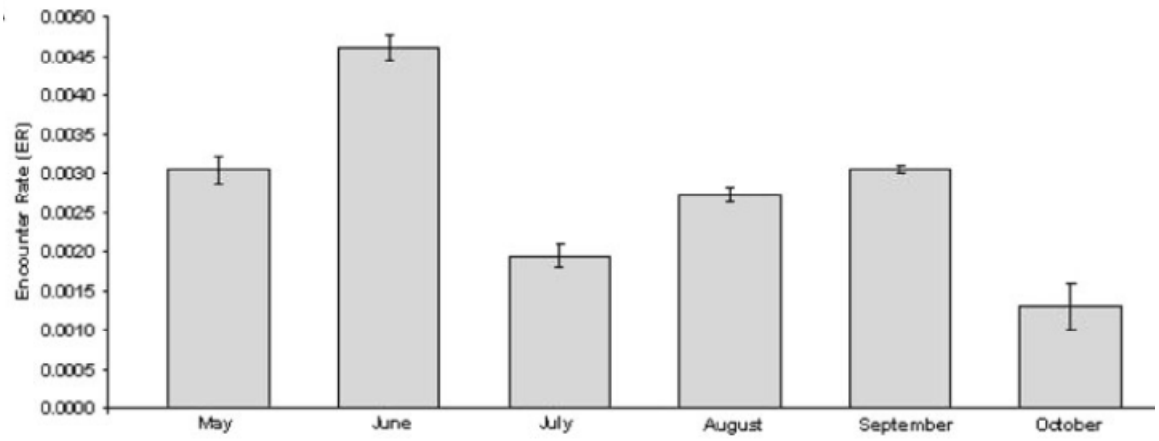

Figure 18. Frequency histogram of encounter rate for bottlenose dolphins across each survey month (+/- 95% confidence intervals; taken from Culloch and Robinson 2008).

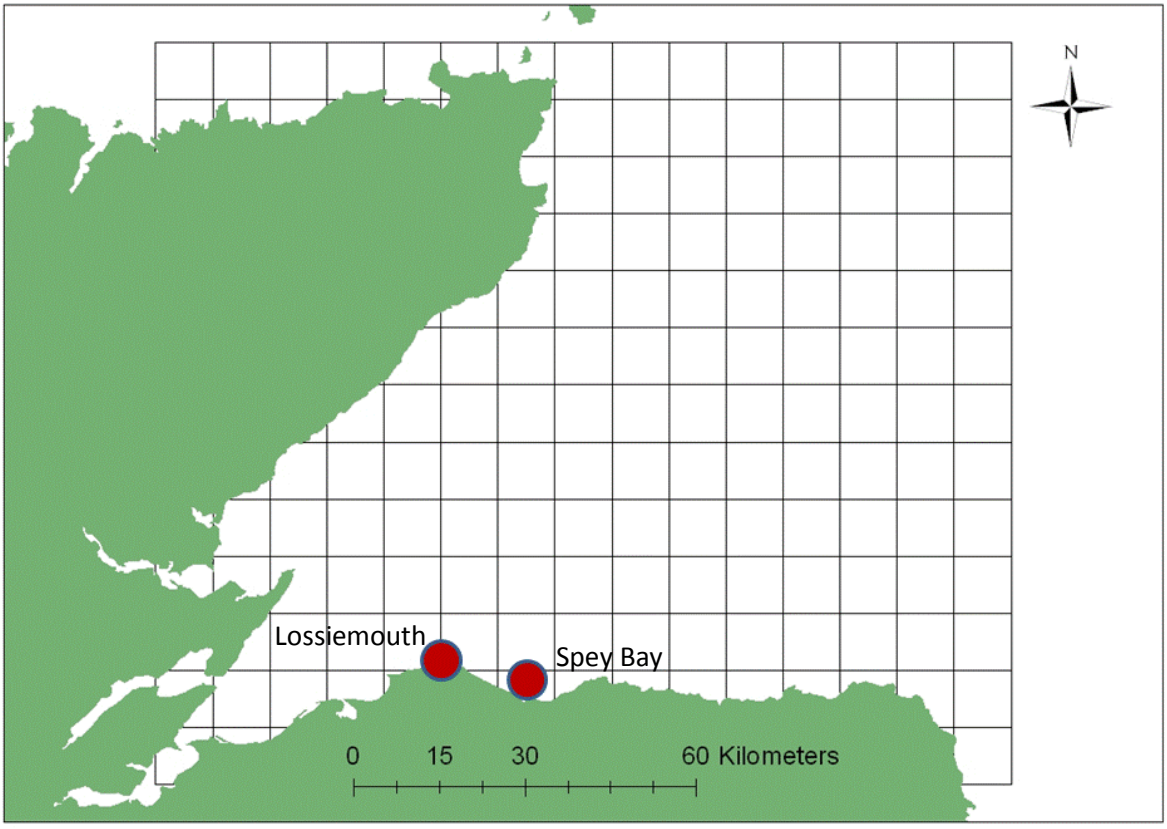

Figure 19. Map of the Moray Firth showing the location of the two POD sites at Lossiemouth (left) and Spey Bay (right) from 2009 to 2011 (taken from Thompson 2011).

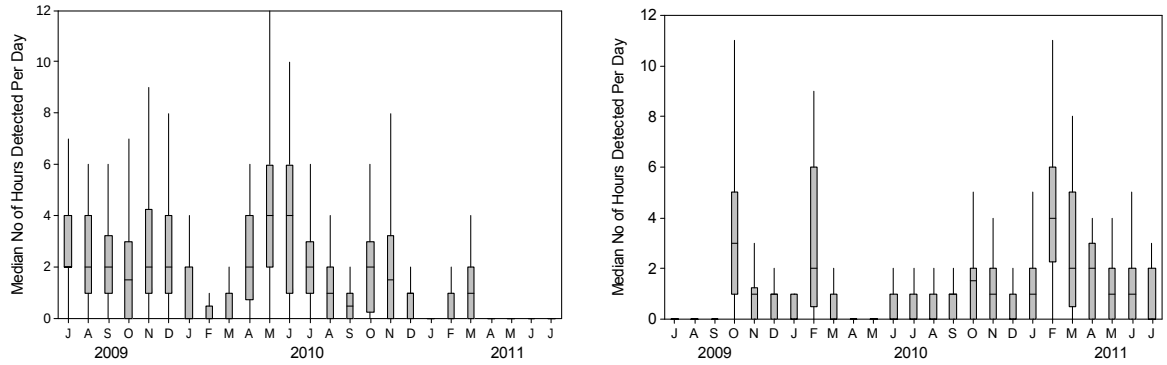

Figure 20. Monthly variation in the median number of hours that dolphins were detected at the Spey Bay (left) and Lossiemouth (right) POD sites from 2009 to 2011 (taken from Thompson 2011).

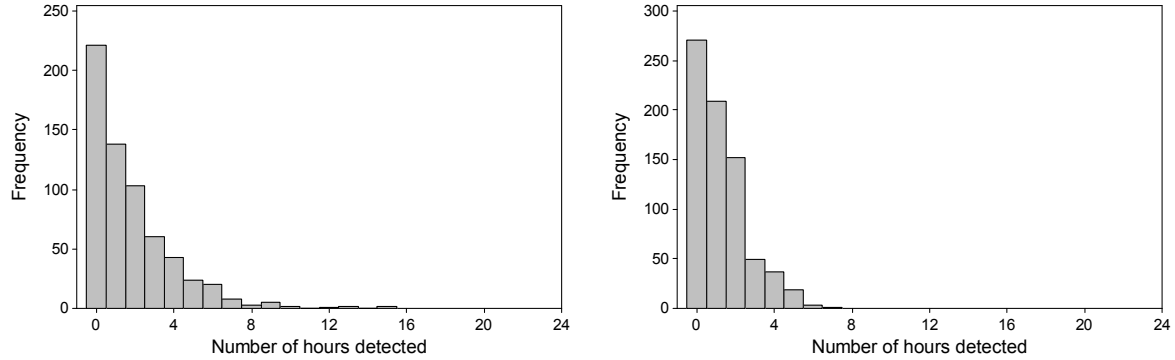

Figure 21. The median number of hours per day that dolphins were detected at the Spey Bay (left) and Lossiemouth (right) POD sites (taken from Thompson 2011).

4.1.3 Abundance

The size of the Scottish East Coast bottlenose dolphin population (and various subsets thereof) has been estimated regularly since the University of Aberdeen research started on a rigorous basis in 1990. Some estimates (e.g. Wilson et al. 1999; Cheney et al. 2011a) are of the whole population, while others (Corkrey et al. 2008; Culloch and Robinson 2008; Quick 2006) use data collected in only part of the population's range. The SCANS-II estimate (SCANS-II 2008) is based on data collected over an area wider than the population's range (including Orkney and Shetland). The available estimates are summarised in Table 3.

The 2006 estimate of 193 animals (95% PI 162-245; Cheney et al. 2011a) is considered to be the best available estimate of the number of bottlenose dolphins in the Scottish East Coast population. Although it is not the most recent estimate, it is more precise than the most recent (2007) one (Cheney et al. 2011a). Furthermore, the 2006 estimate was calculated using data from every research group that carries out photo-identification (photo-ID) work on bottlenose dolphins off the Scottish East Coast. This estimate is higher than the estimate of 129 animals (95% CI 110-174) calculated for 1992 data from the Moray Firth only (Wilson et al. 1999). However, it is important not to over-interpret the significance of this difference because of the difference in the area over which the data were collected (Moray Firth vs. Scottish East Coast) and the methodology used for

estimation (1992=the software program CAPTURE[18]; 2006=multi-site Bayesian mark-recapture analysis). Nevertheless, the difference does suggest that not all of the animals in the East Coast population use the Moray Firth (noted by Thompson et al. 2006; Thompson et al. 2009; Cheney et al. 2011a).

It is worth noting that while the SCANS-II estimate for bottlenose dolphins in survey Block J covers a wider area (Moray Firth, Orkney and Shetland), it is of the same order of magnitude (100s of animals) as the other estimates (Table 3; SCANS-II 2008).

Culloch and Robinson (2008) estimated the abundance of bottlenose dolphins in the southern outer Moray Firth in 2001-2004. The estimates ranged from 61 (95% CI=48-74) in 2004 to 108 (95% CI=87-129) in 2003. These estimates suggest that the southern outer Moray Firth is an important area for a large percentage of the population, with a substantial number of individuals using the area during each of the survey years.

Quick (2006) estimated the number of bottlenose dolphins in the St Andrews Bay area in 2003/2004 using two different methods. The best estimates were 89 (using the software program CAPTURE) and 112 (using Bayesian mark-recapture analysis) individuals. Both estimates suggest that a substantial proportion of the Scottish East Coast population uses the St Andrews Bay area, at least in Summer.

Although there is no apparent trend in abundance, there is no doubt that the Scottish East Coast bottlenose dolphin population is small and isolated.

Year	Area	Estimate	95% Confidence[1] or Probability[2] Interval (CI or PI)	Reference
1992	Moray Firth	129	110-174[1]	Wilson et al. 1999
2005	SCANS II Block J (Moray Firth, Orkney and Shetland)	412	90-1,888[1]	SCANS-II 2008
2006	Scottish East Coast	193	162-245[2]	Cheney et al. 2011a

Table 3. Abundance estimates for the Scottish East Coast bottlenose dolphin population.

4.1.3.1 In the southern Moray Firth (in relation to the cable route)

Bottlenose dolphin abundance in the southern Moray Firth was estimated annually between 2001 and 2004 using mark-recapture analysis (Figure 22). Although estimates were variable (e.g. 108 individuals in 2003 compared to 61 individuals in 2004; Culloch and Robinson 2008), between 32 and 56% of the population, which numbered 193 individuals in 2006 (Cheney et al. 2011a; Table 3), used the southern Moray Firth coast in each of the survey years. This suggests that that the southern Moray Firth is an important area for this population.

The median number of hours per day that dolphins were detected on PODs deployed in the southern Moray Firth was 1 (interquartile range 0.5-2; Thompson et al. 2010a).

[18] http://gcmd.nasa.gov/records/USGS_CAPTURE.html

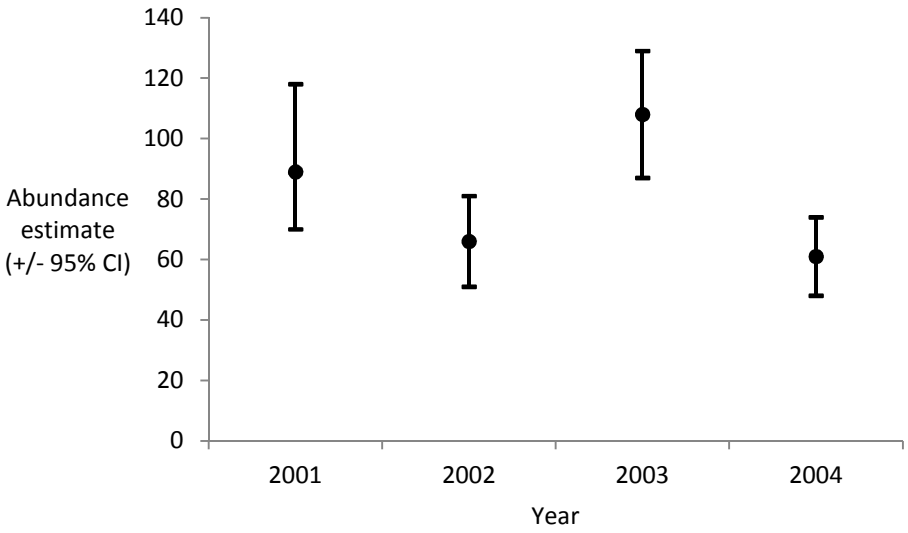

Figure 22. Annual abundance estimates (+/- 95% confidence intervals) of dolphins using the southern Moray Firth coast showing the degree of inter-annual variability (plotted using data from Culloch and Robinson 2008).

4.1.4 Density

The SCANS II density estimate for bottlenose dolphins in Block J (Moray Firth, Orkney and Shetland; 0.011 bottlenose dolphins per km^2) is similar to the densities estimated by the University of Aberdeen in their offshore aerial survey blocks (Block A: 0.012; Block B: 0.018 dolphins per km^2; Table 4). Dolphin density was greatest around the coast (0.259 dolphins per km^2; Table 4).

Multiplication of the density estimate from the University of Aberdeen's aerial survey Block B (0.018) by the area of the BOWL site (121km^2) gives an estimate of two dolphins in the BOWL site (Thompson and Brookes 2011). It was only possible to use these density estimates to estimate the combined abundance of all dolphin species. Nevertheless, viewed in conjunction with results from the classification tree (Figure 8; Figure 9), these analyses suggest that the numbers of any species of dolphin, and particularly bottlenose dolphin, in the vicinity of the proposed wind farm site are likely to be low.

Area	Density (animals per km^2)	Coefficient of variation (CV)	Reference
All areas surveyed	0.066	0.46	Thompson and Brookes 2011; see Figure 4 for areas
Block A	0.012	0.75	
Block B	0.018	0.63	
Coast	0.259	0.49	
SCANS II Block J (Moray Firth, Orkney and Shetland)	0.011	0.87	SCANS-II 2008

Table 4. Density estimates for dolphins in each of the University of Aberdeen 2010 aerial survey areas (Figure 4; Thompson and Brookes 2011) and for bottlenose dolphins in SCANS II Block J (Moray Firth, Orkney and Shetland; SCANS-II 2008).

4.1.5 The Moray Firth SAC

The Moray Firth Special Area of Conservation (SAC) is one of two areas in the UK that have been proposed as part of the Natura 2000 series to conserve bottlenose dolphins (the other is in Cardigan Bay, Wales). The SAC extends from the inner firths to Helmsdale on the north coast and Lossiemouth on the south coast (Figure 1), and includes areas that are regularly used by the population of bottlenose dolphins occurring along the East Coast of Scotland. As a result of this designation, SNH has a responsibility to report on the condition of the SAC for the conservation status of the bottlenose dolphin population every six years. In 2004, SNH entered into a Memorandum of Agreement with the University of Aberdeen to support their photo-ID studies and use these data to report on the condition of the SAC.

Bottlenose dolphin abundance estimates for the Moray Firth SAC for the years 2002-2007 can be found in two site condition monitoring reports (Thompson et al. 2006; Thompson et al. 2009; Table 5). A third site condition monitoring report is currently in preparation and draft estimates were made available by the University of Aberdeen (cited as University of Aberdeen unpublished data in Table 5). Annual estimates of the number of dolphins using a core-study area (where bottlenose dolphins are most frequently sighted) within the SAC show considerable variability from year-to-year (Table 5). Using estimates of total population size (Table 3; Wilson et al. 1999; Cheney et al. 2011a), these data indicate that a high proportion of this population of bottlenose dolphins use the SAC.

The current condition status assessment of the population is “Unfavourable (recovering)” (Thompson et al. 2006; Thompson et al. 2009). Previous work showed that there was a reduction in the use of the SAC by dolphins during the late 1990s, followed by a slight increase during the previous 2002-2004 reporting period (Thompson et al. 2006). Additional data collected since 2004 further highlights the degree of inter-annual variability in the number of dolphins using the core-study area within the SAC, complicating the assessment of condition status within the 3-year reporting windows.

Year	Area	Estimate	95% Confidence Interval	Reference
2001	SAC	91	87-106	University of Aberdeen unpublished data
2002	SAC	84	80-108	Thompson et al. 2006
2003	SAC	87	82-128	Thompson et al. 2006
2004	SAC	102	92-146	Thompson et al. 2006
2005	SAC	99	83-147	Thompson et al. 2009
2006	SAC	87	85-111	Thompson et al. 2009
2007	SAC	75	71-94	Thompson et al. 2009
2008	SAC	68	62-88	University of Aberdeen unpublished data
2009	SAC	102	98-118	University of Aberdeen unpublished data
2010	SAC	114	109-131	University of Aberdeen unpublished data

Table 5. Abundance estimates (from mark-recapture analysis of photographs) for the Moray Firth SAC core-study area for the last decade.

Acoustic monitoring using PODs was carried out by the University of Aberdeen to support efforts to monitor the amount of time that dolphins spend in the core-study area used for estimating abundance within the SAC (Thompson et al. 2009). Data from these devices have highlighted that dolphins were present in this area on almost all days during July and August, although there was also inter-annual variation in the amount of time they spent in the area each day. This method promises to provide a useful indication of the level of use of the SAC that complements photo-ID based abundance estimates.

4.1.6 Links between the Moray Firth SAC and the BOWL site

Information on the movement of bottlenose dolphin between the Moray Firth SAC and other areas have been summarised in Section 4.1.2.1 and Section 4.1.3 (Thompson et al. 2011). Photo-ID information has been used to link bottlenose dolphins using the SAC with those found off the Firths of Forth and Tay, however there are, to date, no photo-ID data linking bottlenose dolphins from the Moray Firth SAC to the BOWL site. With few visual observations of bottlenose dolphins at the BOWL site, and no photographs that can be used to confirm species or individual identity (or SAC linkage), another method was used to explore whether this link existed.

A new whistle classifier was constructed to distinguish bottlenose dolphins from the other dolphin species that might be encountered at the BOWL (and MORL) site, because it is not possible to differentiate between dolphin species using echolocation clicks/POD data (Booth et al. 2011).

Recordings of five dolphin species (bottlenose, Risso's, white-beaked, white-sided and common dolphins) were sourced from around Scotland to train the whistle classifier.

Two EAR deployments (E17 and E21) were made in 2010 in order to collect acoustic data from dolphins at the BOWL site; three more (A20, A22 and E16) were made at the neighbouring MORL site (Figure 23). Twenty two whistle classification events were recorded over 88 days, but none was attributed to bottlenose dolphins (Figure 23). These results support previous evidence that bottlenose dolphins are generally not present at the BOWL (or MORL) site, at least during the July-October sampling period used in this study.

For comparison, a sixth deployment was made in order to collect acoustic data from a core area that is regularly used by bottlenose dolphins within the Moray Firth SAC (D01; Figure 23). Twenty eight whistle classification events were recorded over 25 days, 79% of which were attributed to bottlenose dolphins.

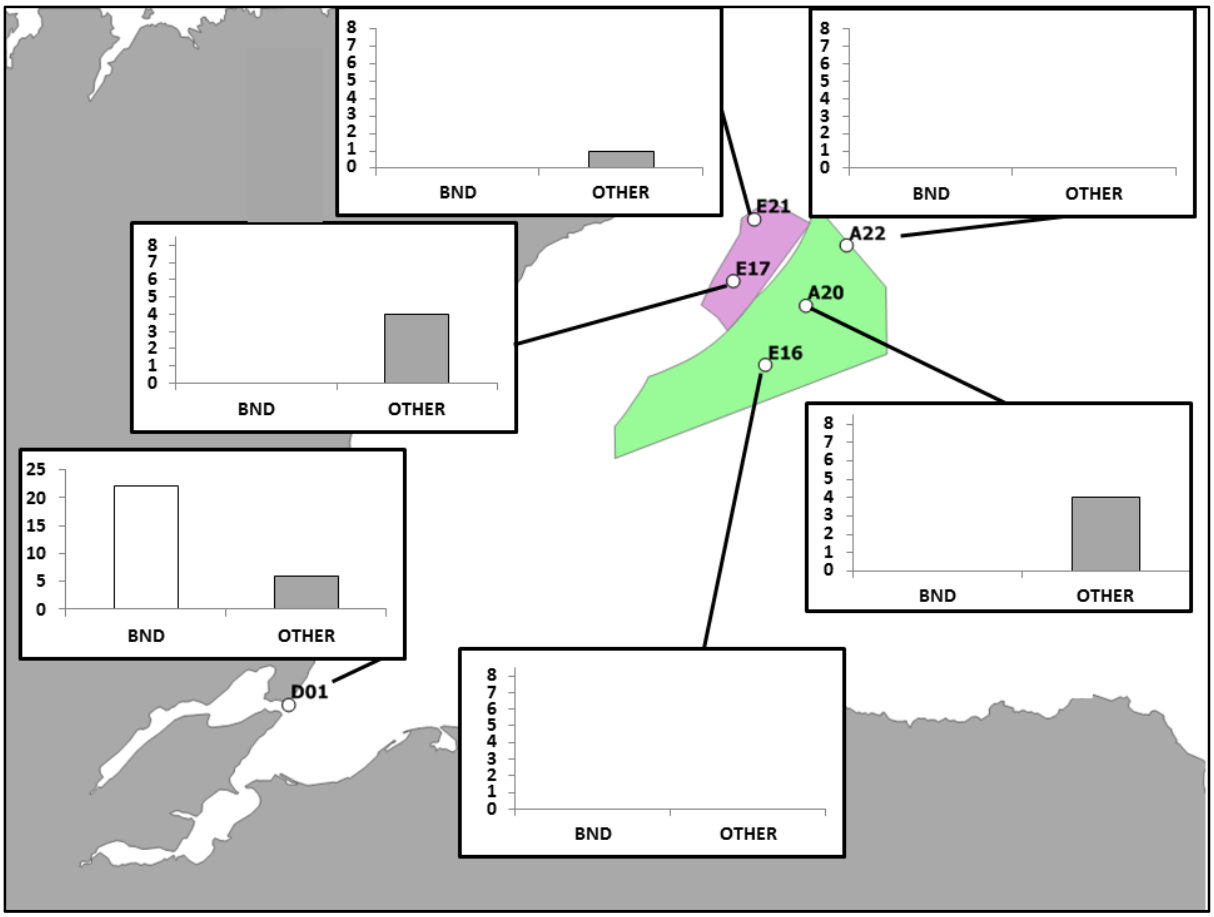

Figure 23. The results of the classification of whistle events in the EAR data using the whistle classifier. BND=events classified as bottlenose dolphins (white) and OTHER=events classified as 'other species' (grey). N.B. The scale of the y-axis for the 'D01' EAR is different to the EARs deployed on the BOWL and MORL sites (taken from Booth et al. 2011).

4.2 Harbour porpoise

Harbour porpoises occur primarily in temperate waters of the North Pacific and North Atlantic. They are the most numerous of the cetaceans found in north-western European continental shelf waters (Reid et al. 2003). They are mainly confined to shelf waters although sightings have been made in deep water (Figure 24).

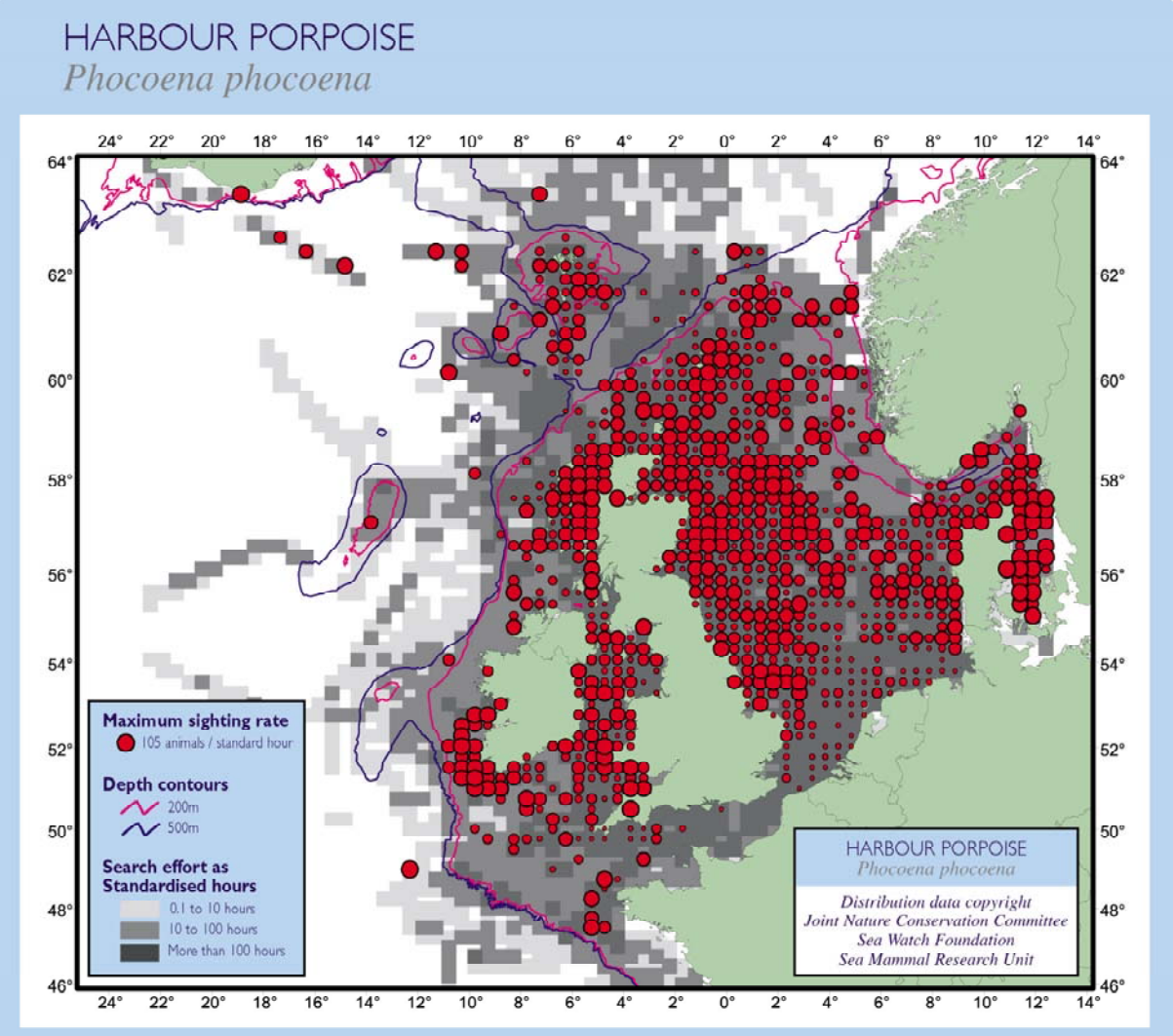

Figure 24. Sightings of harbour porpoises around the UK (1973-1997; taken from Reid et al. 2003).

4.2.1 Distribution

Available data from existing cetacean surveys in the Moray Firth were reviewed by the University of Aberdeen using information from peer-reviewed journals and the grey literature and unpublished data collected by various groups (Thompson et al. 2010a). These data represent observations made over a period of 30 years, from 1980 to 2010 (Table 2), although coverage of the outer Moray Firth is patchy in both space and time. Harbour porpoises were the most commonly encountered species in almost all studies, being seen throughout inshore and offshore waters of the Moray Firth.

Habitat association modelling was based on data from five different surveys (BOWL, MORL, UoA boat, UoA aerial and UoA SAC; Table 2; Thompson and Brookes 2011). Datasets were adjusted to remove data from those cells where no habitat data were available. The results of this model were used to predict spatial variation in the relative abundance of porpoises across the Moray Firth and then scaled to absolute abundance using the density estimates obtained from the aerial line transect survey (Table 6; Figure 25). The predicted number of porpoises in each 4x4km cell (up to around 20 on some cells within the BOWL site) was based upon depth, and proportions of sand and gravelly sand within each cell, standardised for a constant unit of effort.

A second assessment of broad scale spatial variation in the occurrence of harbour porpoises across the Moray Firth was made based on data from arrays of PODs deployed during the University of Aberdeen's DECC funded study in 2009 and 2010 (Thompson et al. 2010a; Figure 26). Harbour porpoises were detected at least once on every POD during their deployments. Detection rates were generally high: porpoises were present at offshore sites on almost all sampling days (Figure 26). The lowest detection rates occurred in those coastal areas where dolphins occurred more commonly (Figure 12).

Finer scale information on variation in the median number of hours that porpoises were detected each day around the BOWL and MORL sites in 2009 and 2010 is shown in Figure 27. Porpoises were present for around a quarter of each day at 14 sites, half the day at 9 sites and three quarters of the day at 3 sites.

The longest time-series of passive acoustic monitoring data was available from the Beatrice Demonstrator site, where devices were deployed by the University of Aberdeen between August 2005 and December 2007. After a break in studies during 2008, devices were again deployed at this site in May 2009 and data collection is anticipated to continue until at least Autumn 2011. There have been some gaps in the time-series due to equipment loss or failure, but these data provide a unique opportunity to explore longer-term temporal change in the occurrence of porpoises at an offshore site (Thompson and Brookes 2011). Overall, porpoises were detected on most (>93%) days that PODs were deployed at this site. On those days that porpoises were detected, they were recorded for a median of 4 hours (IQ range=2-7; Figure 28).

Passive acoustic monitoring data are available from two sites within the BOWL development area for a period of almost two years (2009-2011), and from three additional sites for the final nine months of the study (Thompson and Brookes 2011). Inspection of these data indicates that porpoises were present in the area on an almost daily basis (Figure 17) and were present for many hours each day (Figure 28).

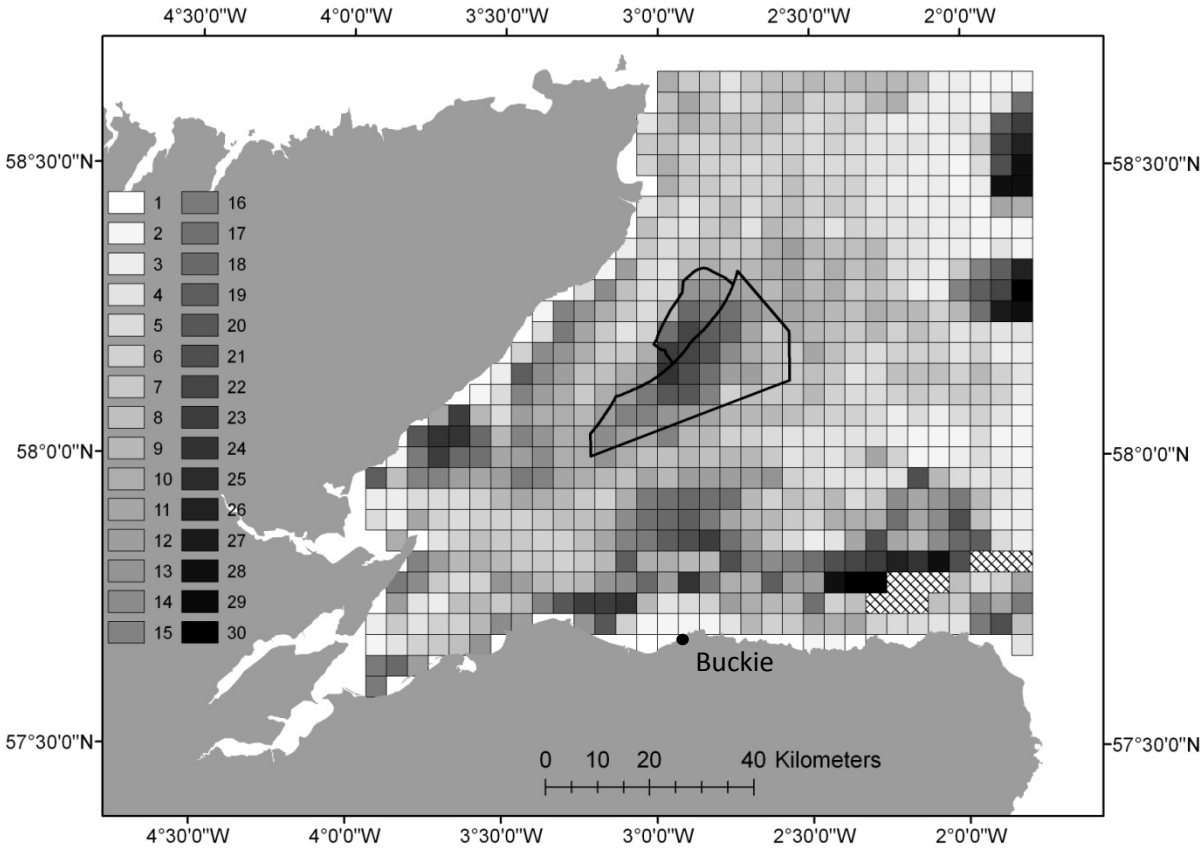

Figure 25. The predicted number of harbour porpoises in each 4x4km cell. Values are based upon measures of relative abundance derived from habitat association modelling, scaled according to estimates of absolute abundance from aerial line transect surveys and extrapolated to other areas according to predicted relative abundance (taken from Thompson and Brookes 2011).

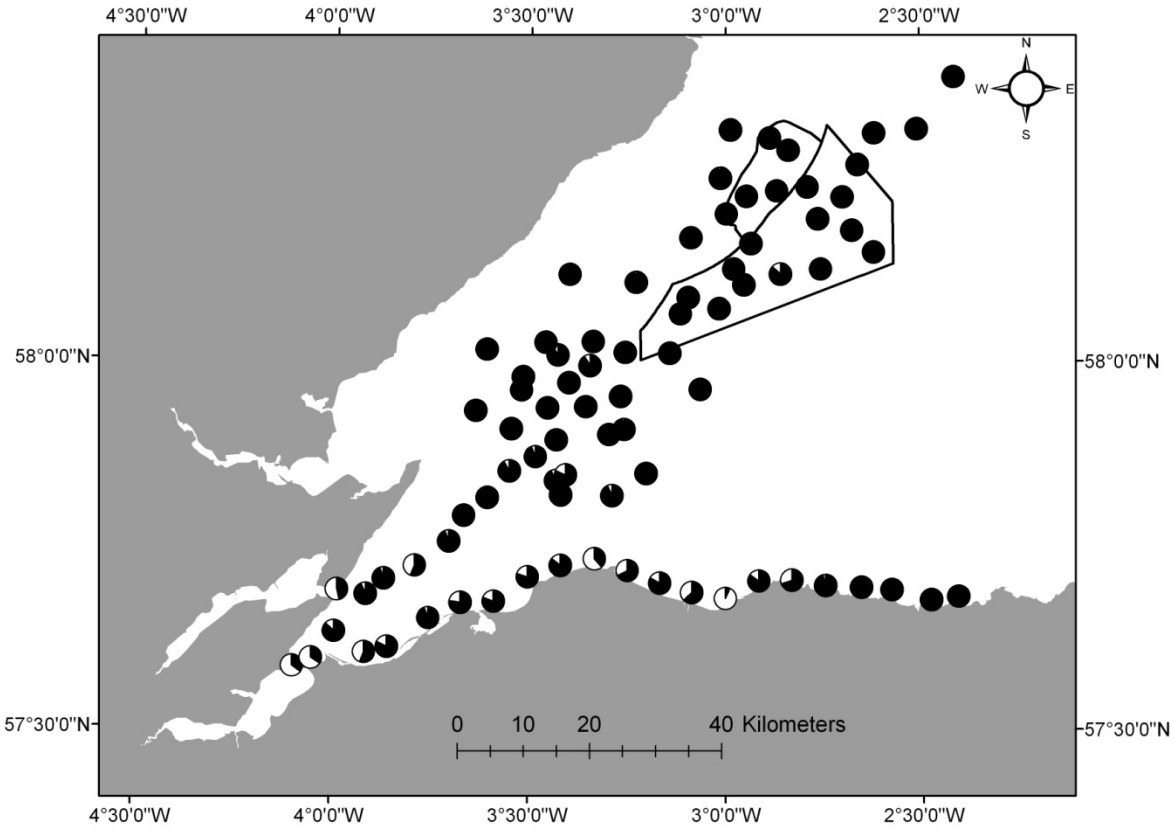

Figure 26. Spatial variation in the occurrence of porpoises in April-October 2009 and 2010. The Figure shows the proportion of days that porpoises were detected on PODs at each sampling location (taken from Thompson and Brookes 2011).

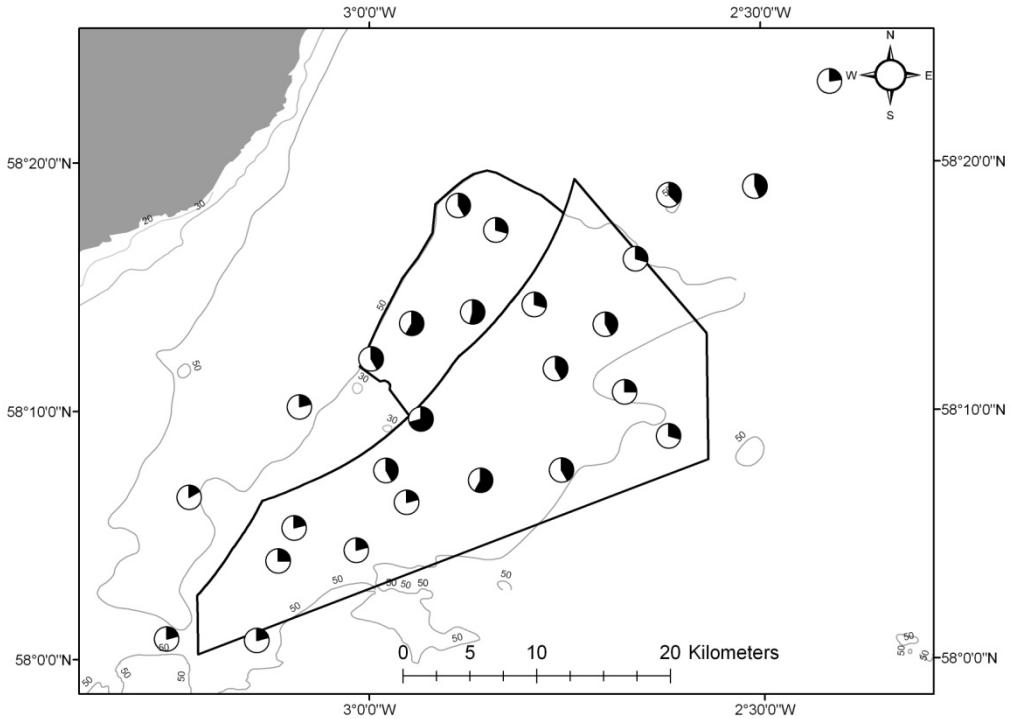

Figure 27. Fine-scale spatial variation in the occurrence of porpoises in and around the BOWL (and MORL) development site. Data are from April-October 2009 and 2010. Pie charts for each sampling

site represent the median proportion of time that porpoises were detected each day (taken from Thompson and Brookes 2011).

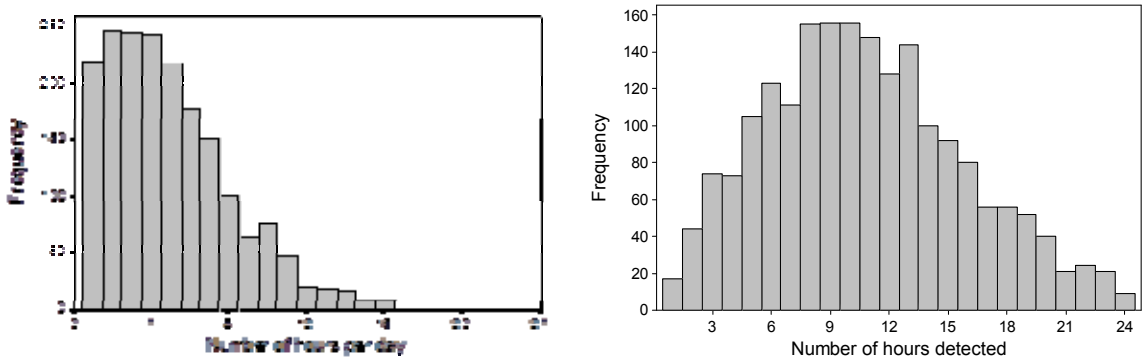

Figure 28. Frequency histogram showing the number of hours per day that porpoises were detected on PODs deployed at the Beatrice Demonstrator site between 2005 and 2010 (left; taken from Thompson and Brookes 2011) and within the BOWL site between 2009 and 2011 (right; taken from Thompson and Brookes 2011). This Figure only includes those days on which there was at least one detection.

4.2.1.1 In the southern Moray Firth (in relation to the cable route)

The University of Aberdeen's POD data show that harbour porpoises are present along the southern Moray Firth coast on a high proportion of days (≥75% of days at 65% of the POD deployment sites), at least between April and October (Figure 26). They are also predicted (using measures of relative abundance derived from habitat association modelling; Thompson and Brookes 2011) to be present in large numbers along this coastline (generally >10 porpoises per 4x4km cell; Figure 25). The exception to this appears to be off Buckie (east Spey Bay), where the predicted number of porpoises per cell was lower (<5 per 4x4km cell).

Additional surveys (to those listed in Table 2) have been carried out between May and October along the southern shore of the outer Moray Firth (between Lossiemouth and Fraserburgh) by the CRRU (Figure 14). Porpoises were the most commonly sighted species on these surveys; sightings made between 2001 and 2008 are shown in Figure 29.

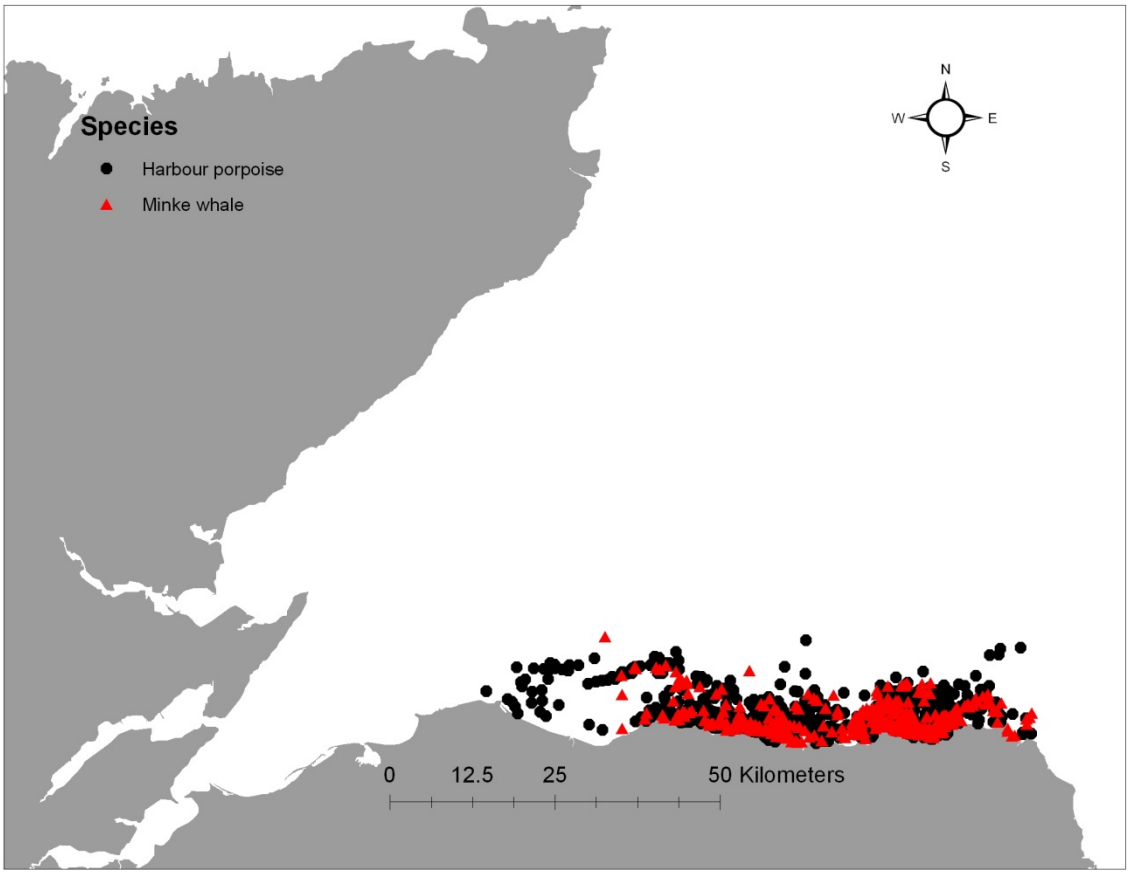

Figure 29. Harbour porpoise (circle) and minke whale (triangle) sightings made by the CRRU between 2001 and 2008 (taken from Thompson et al. 2010a).

4.2.2 Seasonal variation

4.2.2.1 In the Moray Firth

A preliminary investigation of changes in the seasonal occurrence of porpoises was carried out by the University of Aberdeen who pooled POD data from (1) the outer Moray Firth (which includes offshore parts of the Moray Firth SAC) (2) the southern Moray Firth coast and (3) coastal sites within the Moray Firth SAC (Figure 30; Thompson et al. 2010a). Porpoises were detected at all sites but were most consistently detected in the outer Moray Firth. Seasonal patterns within the Moray Firth SAC and along the southern Moray Firth coast appeared to be similar with a tendency for porpoise detections to increase through the sampling period (the majority of PODs were deployed in mid-July and recovered in November). The median number of hours per day that porpoises were detected was similar in the two coastal areas (southern Moray Firth coast=2.5; Moray Firth SAC=2). There was no apparent seasonal trend in the outer Moray Firth. Porpoises were consistently detected at all sites in the outer Moray Firth, typically for 5-8 hours per day (Thompson et al. 2010a).

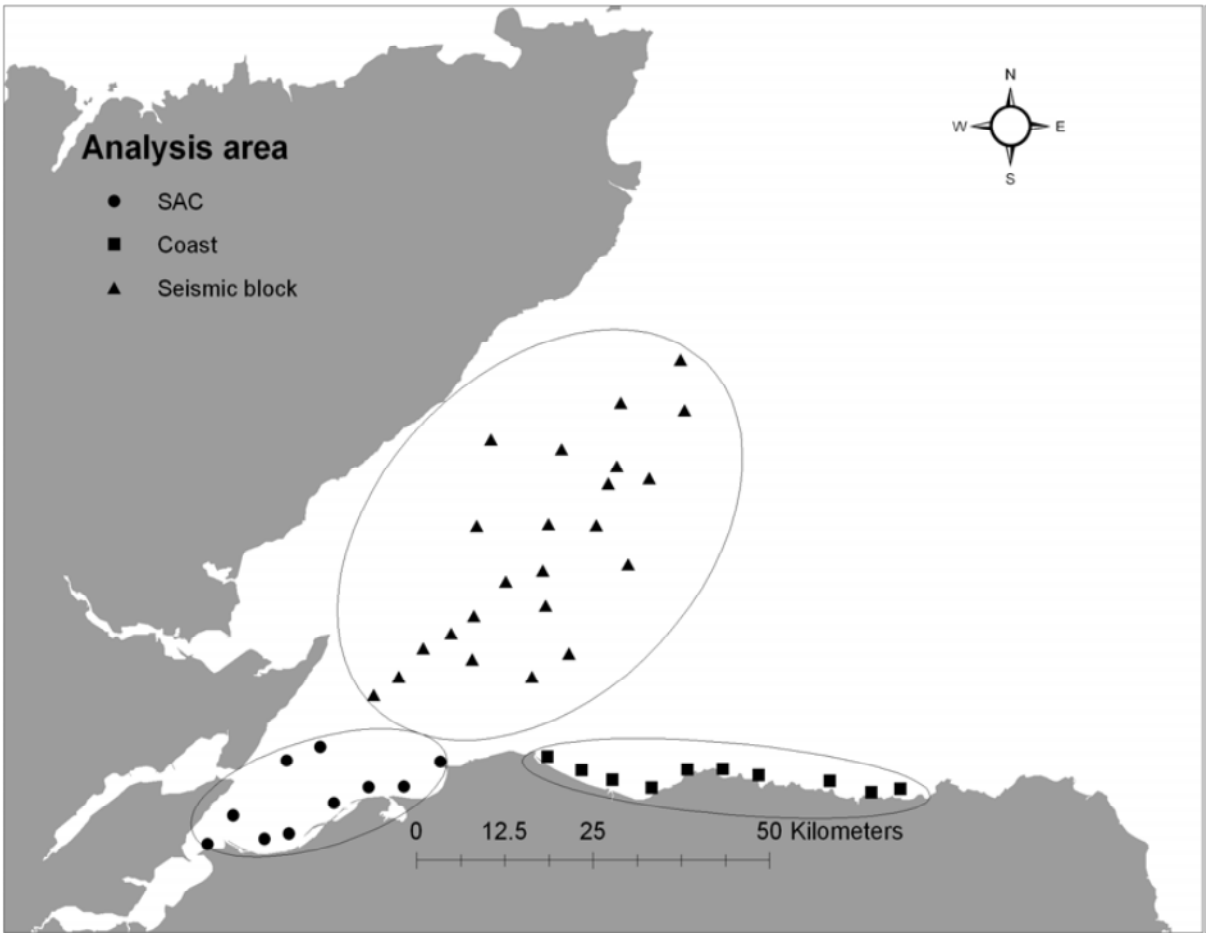

Figure 30. Figure showing which PODs were included in the analysis of seasonal trends in detections of porpoises in the Moray Firth SAC (●), along the southern Moray Firth coast (■) and in the outer Moray Firth (▲; taken from Thompson et al. 2010a).

4.2.2.2 At the BOWL site

Passive acoustic monitoring (POD) data are available from two sites within the BOWL development area for a period of almost two years (2009-2011), and from three additional sites for the final nine months of the study (Thompson and Brookes 2011; see Section 4.2.1). Inspection of these data indicates that porpoises were present in the area on an almost daily basis (Figure 17). However, the median number of hours that porpoises were detected appeared to vary seasonally, with peaks in the Winter and late Summer (Figure 31). Statistical analysis of this pattern has yet to be carried out.

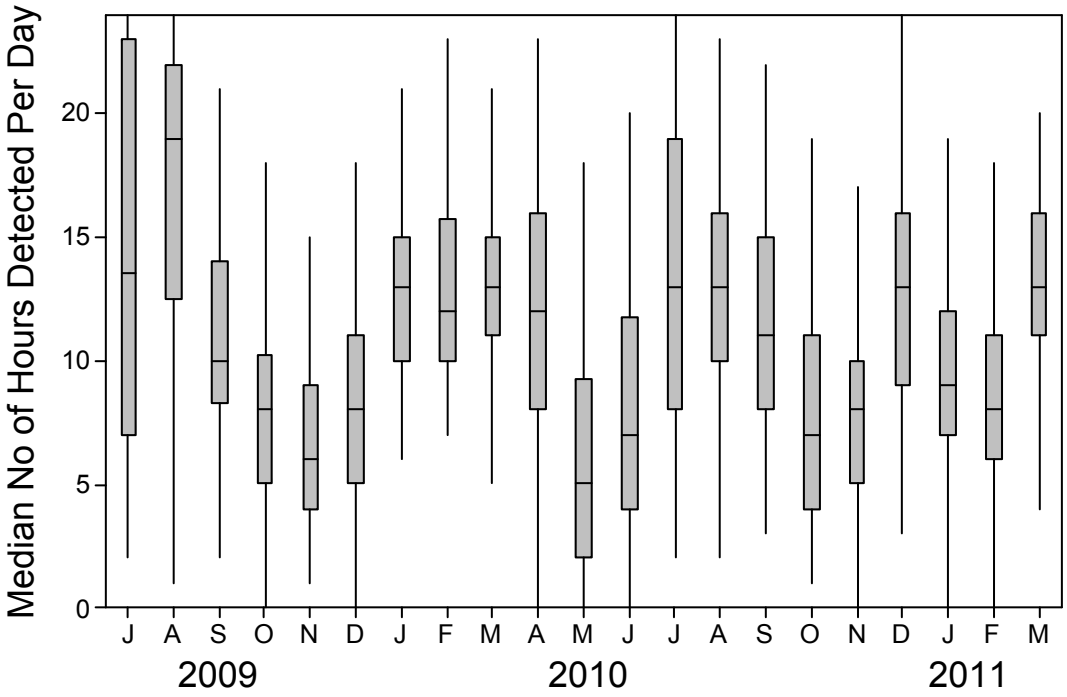

Figure 31. Monthly variation in the median number of hours per day that porpoises were detected on PODs within the BOWL development area (taken from Thompson and Brookes 2011).

4.2.2.3 In the southern Moray Firth (in relation to the cable route)

Harbour porpoises were sighted along the southern Moray Firth coast in all months between May and October (Robinson et al. 2007). However, there is evidence for an increase in visual encounters (from 0.020 per km in May to 0.085 per km in October; Robinson et al. 2007) and acoustic detections (from mid-July to November; Thompson et al. 2010a) through the year. Neonatal calves were typically observed by the CRRU between May and July, consistent with the known calving period for this species in the North Sea (Lockyer 1995). The observed seasonal increase in porpoise encounters may be due to a movement inshore by lactating females and their calves, followed thereafter by males (Robinson et al. 2007).

Year-round POD data were available from two sites along the southern Moray Firth coast from the Summer of 2009 to the Spring (Spey Bay; n=628 days) or Summer (Lossiemouth; n=741 days) of 2011 (Figure 19; Thompson 2011). Porpoises were detected on 52% of days at Spey Bay and 51% of days at Lossiemouth. There appeared to be seasonal patterns in porpoise detections at Spey Bay with a peak in late Summer/Autumn in both years (although it is not possible to tell if this pattern is real without a statistical analysis); this was less evident at Lossiemouth (Figure 32). Median values for the number of hours per day that porpoises were detected were broadly similar at the two sites (Figure 33). Typically, porpoises were detected for fewer hours per day at these coastal sites than at the offshore sites (Figure 28).

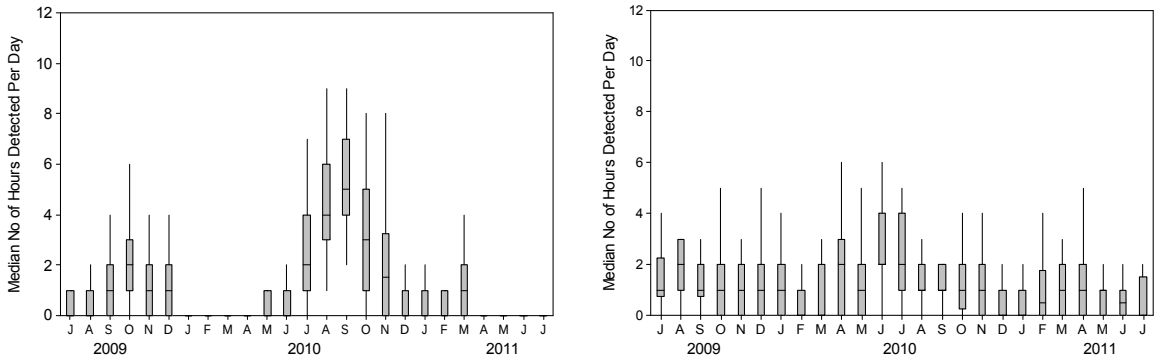

Figure 32. Monthly variation in the median number of hours that porpoises were detected at the Spey Bay (left) and Lossiemouth (right) POD sites (taken from Thompson 2011).

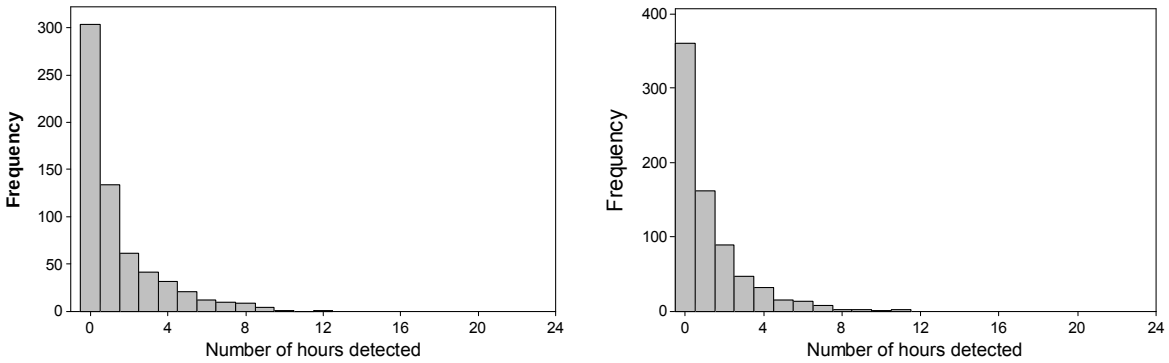

Figure 33. The median number of hours per day that porpoises were detected at the Spey Bay (left) and Lossiemouth (right) POD sites (taken from Thompson 2011).

4.2.3 Abundance/density

Porpoise abundance was estimated for the Moray Firth, Orkney and Shetland (Block J) during both the SCANS (1994) and SCANS II (2005) surveys (Table 6). The SCANS density estimate (of 0.783 porpoises per km^2) is similar to the density estimated by the University of Aberdeen in the furthest offshore of their aerial survey blocks (Block B: 0.812 porpoises per km^2; Figure 4). However, the SCANS II density estimate (0.274 porpoises per km^2) is lower than both the SCANS and University of Aberdeen Block B estimates.

Multiplication of the density estimate from the University of Aberdeen's aerial survey Block B (0.812) by the area of the BOWL site (121km^2) gives an estimate of the number of porpoises present in the BOWL site of 98 individuals (Thompson and Brookes 2011).

Year	Area	Abundance	CV	Density (animals per km^2)	CV	Reference
1994	SCANS Block J (Moray Firth, Orkney and Shetland)	24,335	0.34	0.783	0.34	Hammond et al. 2002
2005	SCANS II Block J (Moray Firth, Orkney and Shetland)	10,254	0.36	0.274	0.36	SCANS-II 2008
2010	UoA aerial – all areas surveyed	NA	NA	0.637	0.18	Thompson and Brookes 2011; see Figure 4 for areas
	UoA aerial – Block A			0.535	0.18	
	UoA aerial – Block B			0.812	0.30	
	UoA aerial – Coast			0.265	0.24	

Table 6. Abundance and density estimates for harbour porpoises in the north-western North Sea and Moray Firth.

4.2.3.1 In the southern Moray Firth (in relation to the cable route)

Porpoise abundance has not been estimated in the southern Moray Firth but there is information on encounter rates (Robinson et al. 2007) that can be used as a proxy for density. Encounter rate was lowest on the inshore survey route (0.077 porpoises per km effort) and higher on the three outer routes (between 0.22 and 0.24 porpoises per km effort).

4.3 Minke whale

Minke whales are extensively distributed in the northern and southern hemispheres in tropical, temperate and polar seas (Reid et al. 2003). They occur along the Atlantic seaboard of Britain and Ireland and also throughout the northern and central North Sea as far south as the Yorkshire coast (Figure 34).

4.3.1 Distribution

Available data from existing cetacean surveys in the Moray Firth were reviewed by the University of Aberdeen using information from peer-reviewed journals and the grey literature and unpublished data collected by various groups (Thompson et al. 2010a). These data represent observations made over a period of 30 years, from 1980 to 2010 (Table 2), although coverage of the outer Moray Firth is patchy in both space and time. Minke whales were the second most commonly sighted species in offshore waters after harbour porpoises, although there was some evidence that this may be a relatively recent situation as there were comparatively few minke whale sightings in earlier datasets (Thompson et al. 2010a). This finding is backed up by sightings made during the University of Aberdeen's boat (Figure 36) and aerial (Figure 37) surveys when the majority of minke whales sightings occurred during the offshore, rather than the coastal, transects.

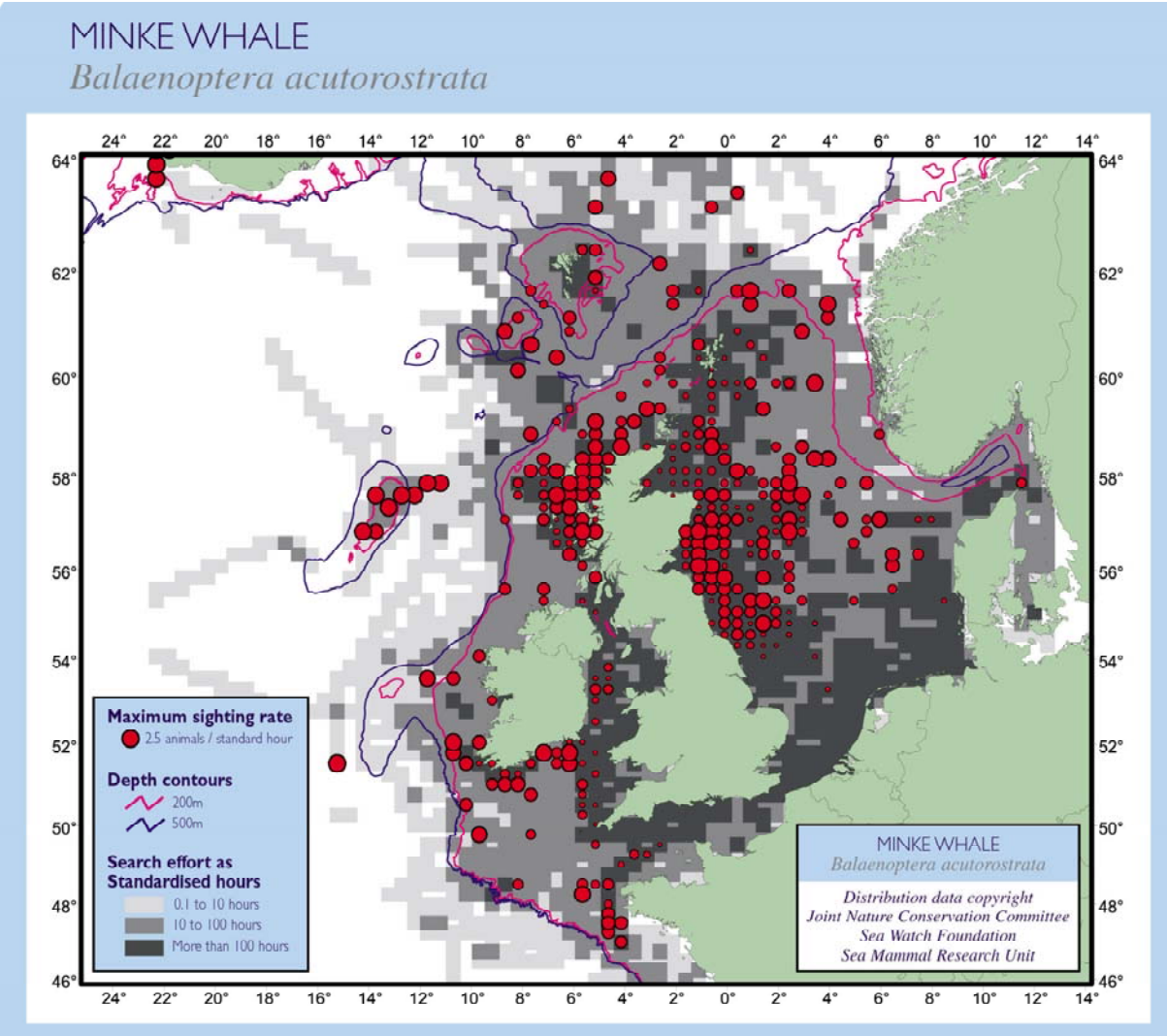

Figure 34. Sightings of minke whales around the UK (1973-1997; taken from Reid et al. 2003).

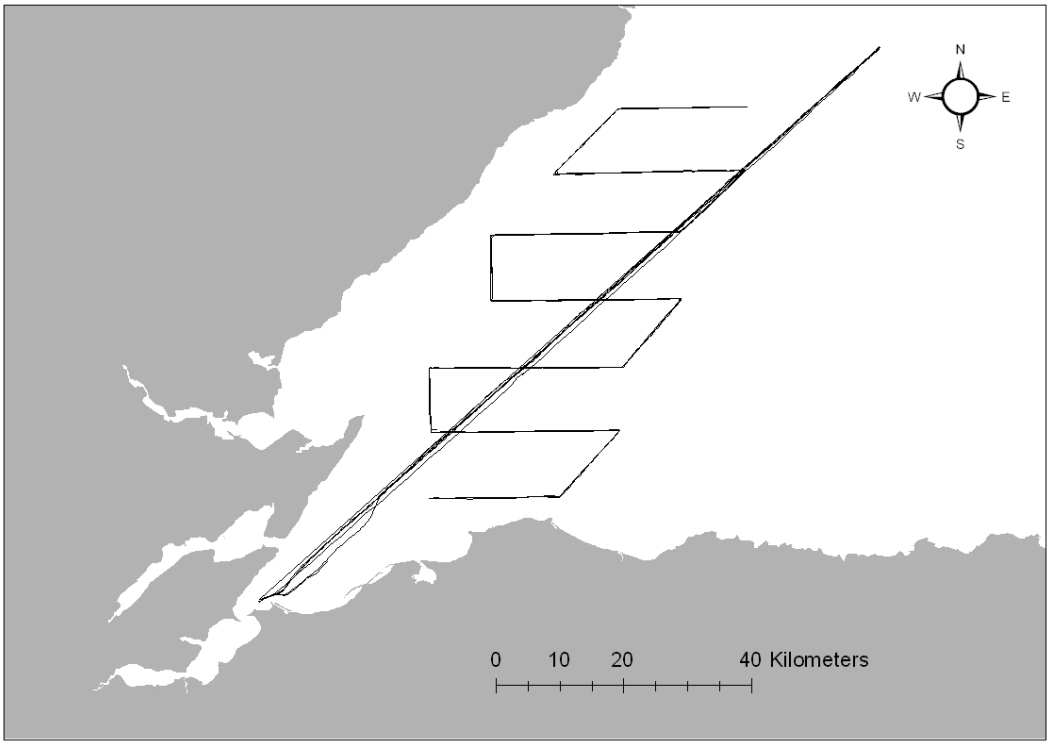

Figure 35. Map of survey tracks from the University of Aberdeen's 2009 boat based surveys (taken from Thompson and Brookes 2011).

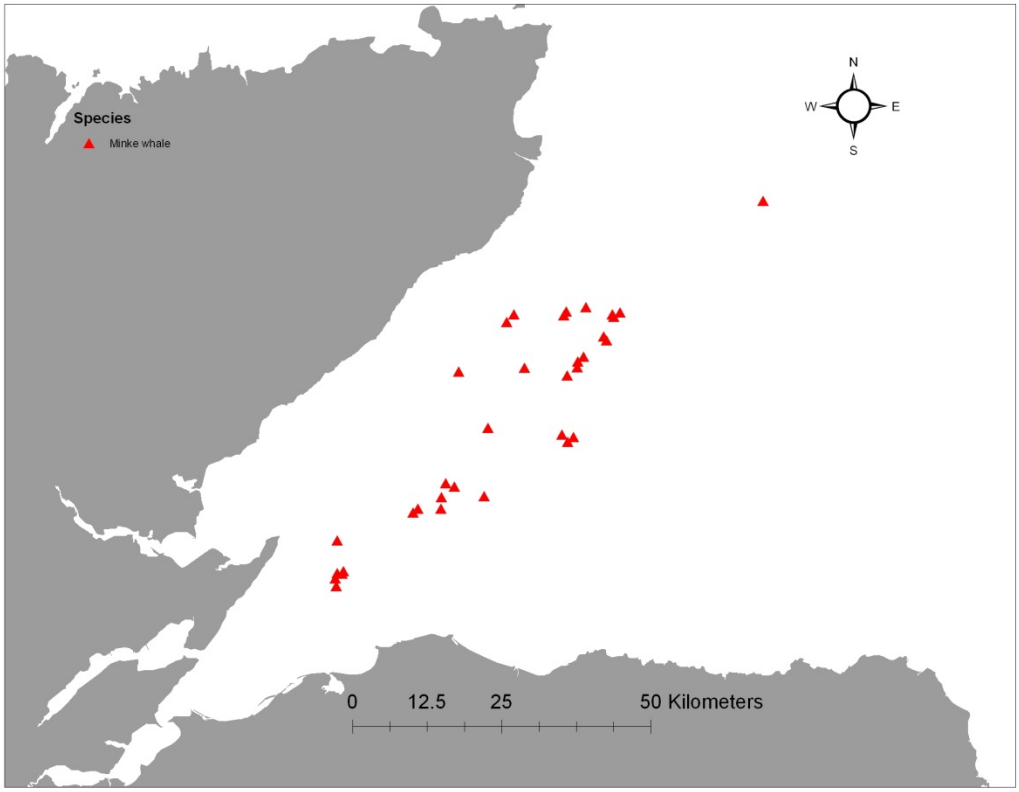

Figure 36. Sightings of minke whales made during the University of Aberdeen's 2009 boat based surveys (track lines are shown in Figure 35; taken from Thompson et al. 2010a).

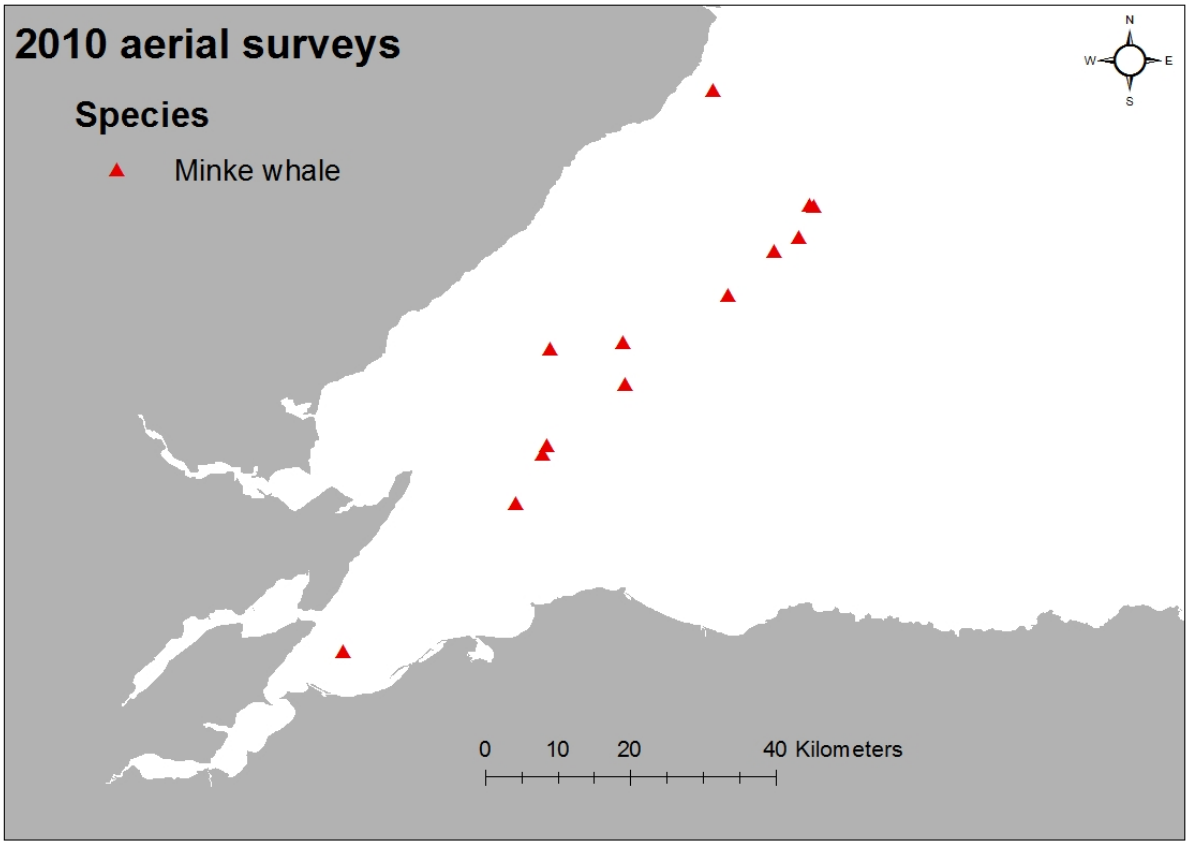

Figure 37. Sightings of minke whales made during the University of Aberdeen's 2010 aerial surveys of the outer Moray Firth (track lines are shown in Figure 4; University of Aberdeen unpublished data).

4.3.1.1 In the southern Moray Firth (in relation to the cable route)

Minke whales are found in coastal as well as offshore waters. Sightings made during surveys (additional to those listed in Table 2) carried out between May and October along the southern shore of the outer Moray Firth (between Lossiemouth and Fraserburgh) by the CRRU (Figure 14) are shown in Figure 29. Minke whales were the second most commonly sighted species on these surveys after harbour porpoises. Minke whales were sighted along the coast from the east side of Spey Bay to Fraserburgh. While they were encountered on all four CRRU survey routes (Figure 14), corrections for effort revealed a considerably higher abundance on the three outer routes (Robinson et al. 2007).

Using southern outer Moray Firth data from May to October 2001 to 2006, Robinson et al. (2009) found a strong spatial preference by minke whales for water depths between 20 and 50m, steep slopes (>60°), a northerly-facing aspect and sandy-gravel sediment type. Lesser sandeels (*Ammodytes marinus*), key minke whale prey in Scottish waters (Pierce et al. 2004), require sediments of coarse sand and fine gravel for burrowing and protection and the arrival of whales in the study area each year appears to be synchronised with the emergence of sandeels into the water column to feed (Robinson et al. 2009).

4.3.2 Seasonal variation

Minke whales are present seasonally in the Moray Firth. Most sightings have been made between May and September, with few records between October and April (Reid et al. 2003). This finding is supported by the BOWL boat survey data which were collected over the BOWL site in 2009-2011: the first minke whale sightings of the year were made in April and the last in October (Figure 38). In 2010 (the only full calendar year of data collection) the number of sightings peaked in July.

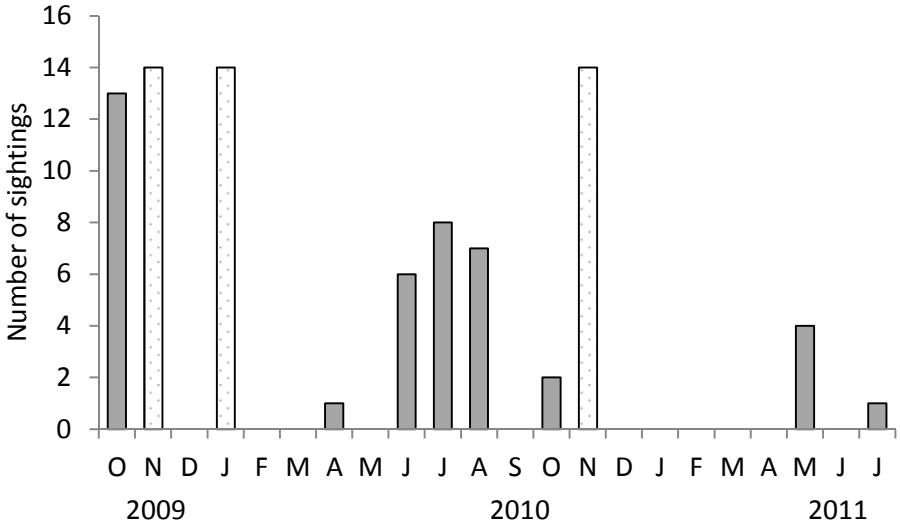

Figure 38. The number of minke whale sightings made each month during the BOWL boat surveys (solid bars; BOWL unpublished data). It should be noted that although the number of sightings has not been effort-corrected, the amount of survey effort in each month is similar. Where two surveys were carried out in a single month (April 2010 and January 2011), as opposed to the usual one, the mean number of sightings was calculated. Months in which no surveys were carried out (November 2009, January 2010 and November 2010) are shown by the patterned bars.

4.3.2.1 In the southern Moray Firth (in relation to the cable route)

Minke whales are typically recorded along the south Moray Firth coast from mid-June onwards with the number of encounters remaining fairly constant from July to October thereafter (Robinson et al. 2007; Robinson et al. 2009; Figure 39). They are absent during the winter/spring months. Minke whale sightings in the southern Moray Firth have been found to be correlated with oceanographic features (Tetley et al. 2008). A cold water current and a warm water plume appear to dominate the Moray Firth region. Encounter rates are significantly higher during warm plume events than when the cold current is dominant (Figure 40). Levels of phytoplankton biomass also appear to be substantially greater during warm water plume events. Tetley et al. (2008) hypothesise that the highest minke whale encounter rates are associated with the presence of targeted prey species that are attracted by high densities of phytoplankton.

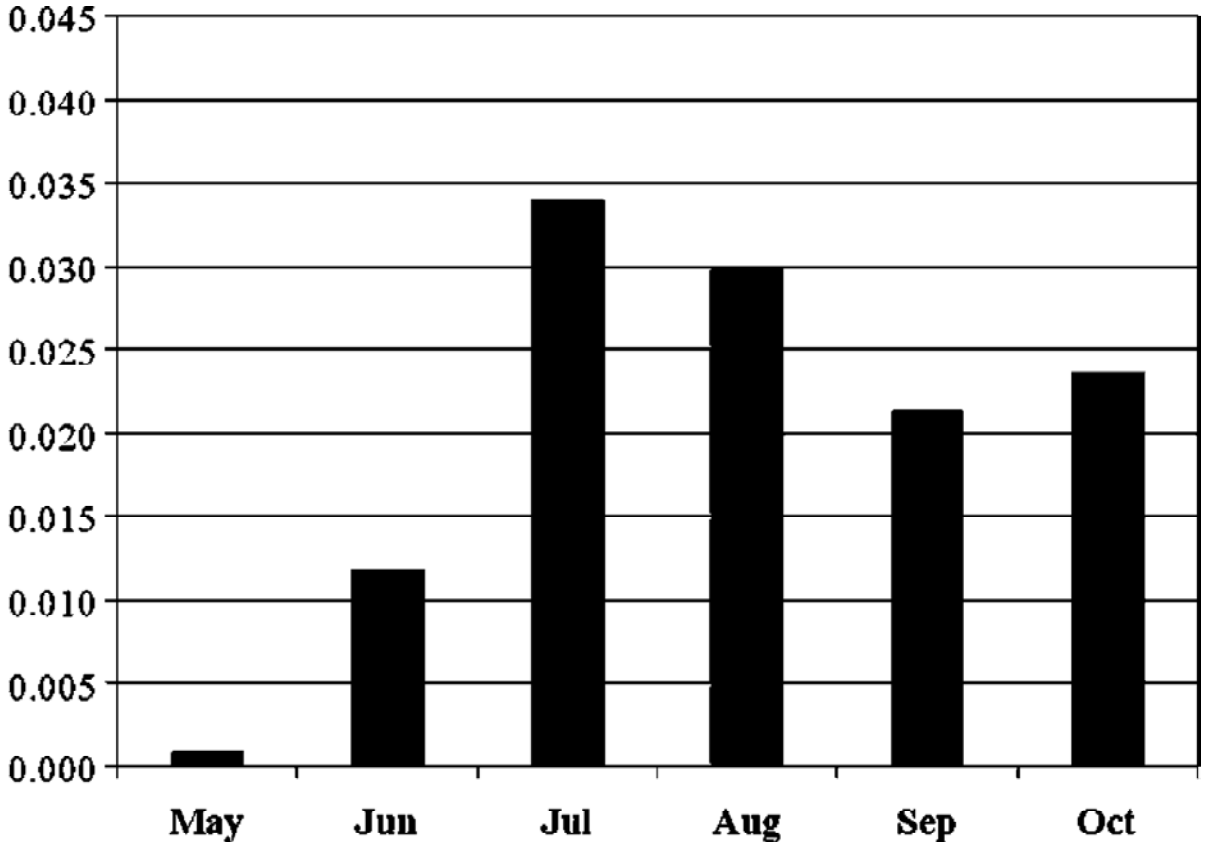

Figure 39. The number of minke whale encounters per km of survey effort between the months of May and October 2001 to 2006 (taken from Robinson et al. 2009).

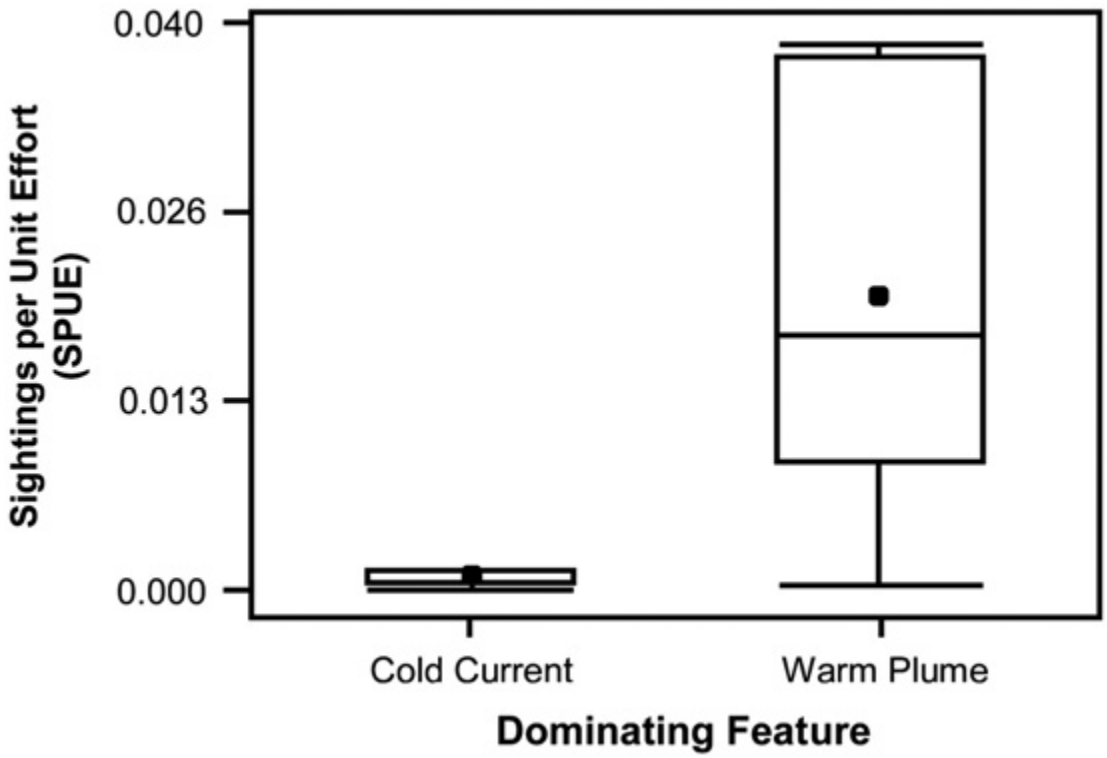

Figure 40. Minke whale sightings per unit effort in months when the cold water current, or the warm water plume, were dominant (taken from Tetley et al. 2008). The mean, interquartile range and range are shown.

4.3.3 Abundance

Minke whale abundance was estimated for the north-western North Sea (Block D) during the SCANS (1994) survey and the Moray Firth, Orkney and Shetland (Block J) during the SCANS II (2005) survey (Table 7). The density estimates from the two surveys are not significantly different.

Year	Area	Estimate	CV	Density (animals per km^2)	CV	Reference
1994	SCANS Block D (north-western North Sea)	2,920	0.40	0.0286	0.40	Hammond et al. 2002
2005	SCANS II Block J (Moray Firth, Orkney and Shetland)	835	1.02	0.0223	1.02	SCANS-II 2008

Table 7. Abundance estimates for minke whales in the north-western North Sea.

4.3.3.1 In the southern Moray Firth (in relation to the cable route)

Minke whale abundance has not been estimated in the southern Moray Firth; however, encounter rates (Robinson et al. 2007) were lower on the inshore survey route (0.011 minke whales per km effort) than on the three outer routes (between 0.036 and 0.044 minke whales per km effort).

4.4 Common dolphin

Common dolphins are among the most abundant cetaceans in the world's warm-temperate and tropical waters (Reid et al. 2003). In the North Atlantic all individuals appear to be *D. delphis*, the short-beaked common dolphin, which is mainly distributed south of around 60°N. They are found in continental shelf waters off western British and Irish coasts although they have been observed occasionally in the North Sea (Figure 41), mainly between June and September (Reid et al. 2003).

4.4.1 Distribution

Common dolphins are more regularly sighted off the UK's west coast (where they occur both around the coast and in offshore waters) than in the North Sea (Figure 41). The few sightings that have been made in the Moray Firth have also been made both around the coast (University of Aberdeen unpublished data) and offshore (Figure 41), predominantly on the north side of the Moray Firth (Figure 3).

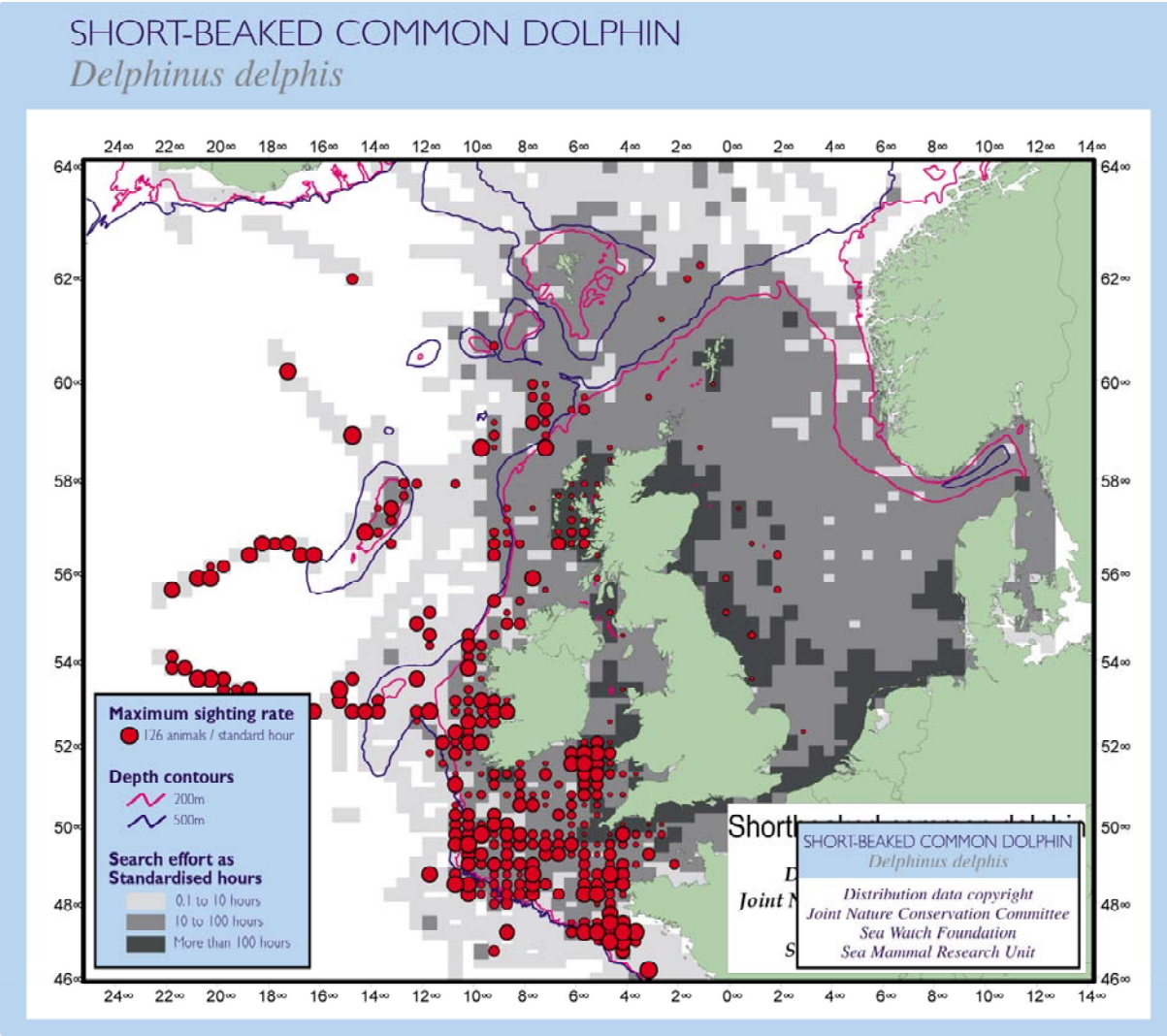

Figure 41. Sightings of common dolphins around the UK (1973-1997; taken from Reid et al. 2003).

4.4.1.1 In the southern Moray Firth (in relation to the cable route)

Common dolphin sightings occur both around the southern Moray Firth coast and offshore (Figure 42) in water depths of 51 to 209m (mean depth 88.6 +/- 42.2m) and at a distance from shore of 5 to 32km (mean distance 16.6 +/- 8.0km; Robinson et al. 2010).

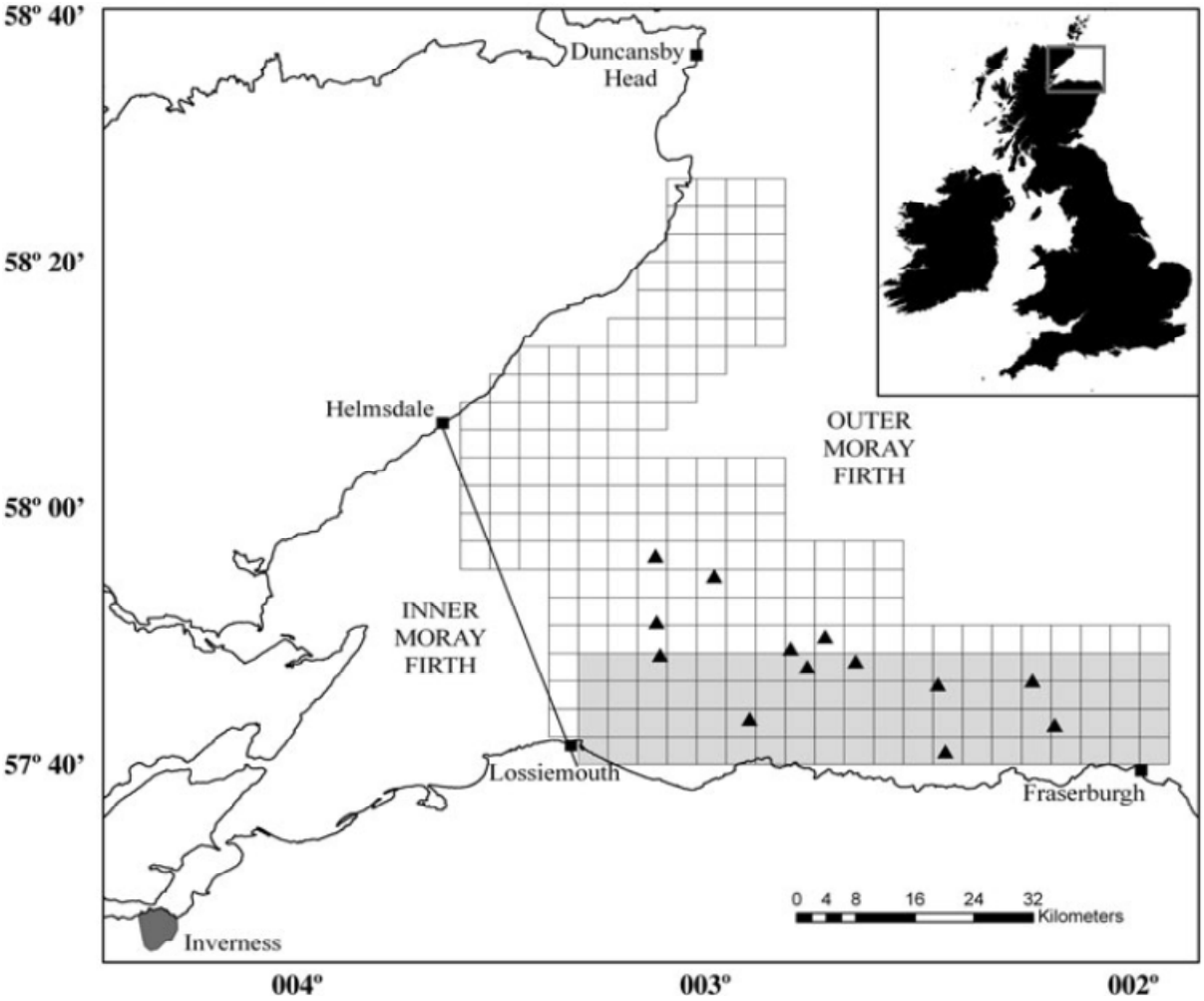

Figure 42. The distribution of common dolphin sightings recorded during surveys carried out between February and November in 2001 to 2009 by the CRRU (area covered shown by the shaded boxes) and WDCS (area covered by all the boxes; taken from Robinson et al. 2010).

4.4.2 Seasonal variation

There have been too few common dolphin sightings in the Moray Firth to be able to assess seasonal variation.

4.4.2.1 In the southern Moray Firth (in relation to the cable route)

Common dolphins were recorded in the southern Moray Firth between May and August in 2006 to 2009, with newborn calves observed in June and July (Robinson et al. 2010). This increase in sightings in recent years (since 2006) may be due to rising sea temperatures: common dolphins are normally found in waters warmer than the northern North Sea, but appear to be able to react rapidly to changes in water temperature and adjust their distribution accordingly (Robinson et al. 2010; MacLeod et al. 2008).

4.4.3 Abundance

Abundance of common dolphins in the Moray Firth is likely to be low; there have been too few sightings to estimate abundance.

4.4.3.1 In the southern Moray Firth (in relation to the cable route)

There are no abundance estimates for common dolphins using the southern Moray Firth. Group sizes recorded during the CRRU/WDCS surveys (see Figure 42) ranged from 2 to over 450 individuals (n=13; Robinson et al. 2010).

4.5 White-beaked dolphin

White-beaked dolphins are restricted to temperate and sub-Arctic seas in the North Atlantic. They occur over a large part of the northern European continental shelf but are recorded most frequently in the western part of the central and northern North Sea and off northern and western Scotland (Reid et al. 2003).

4.5.1 Distribution

Most of the white-beaked dolphin sightings in the Moray Firth have been made offshore (Figure 3; Figure 43). They are the most commonly sighted dolphin species in the outer Moray Firth and there have also been occasional sightings in the inner Moray Firth (Figure 3). This species occurs closer to the coast in other areas e.g. Aberdeenshire (Figure 43; Weir et al. 2007).

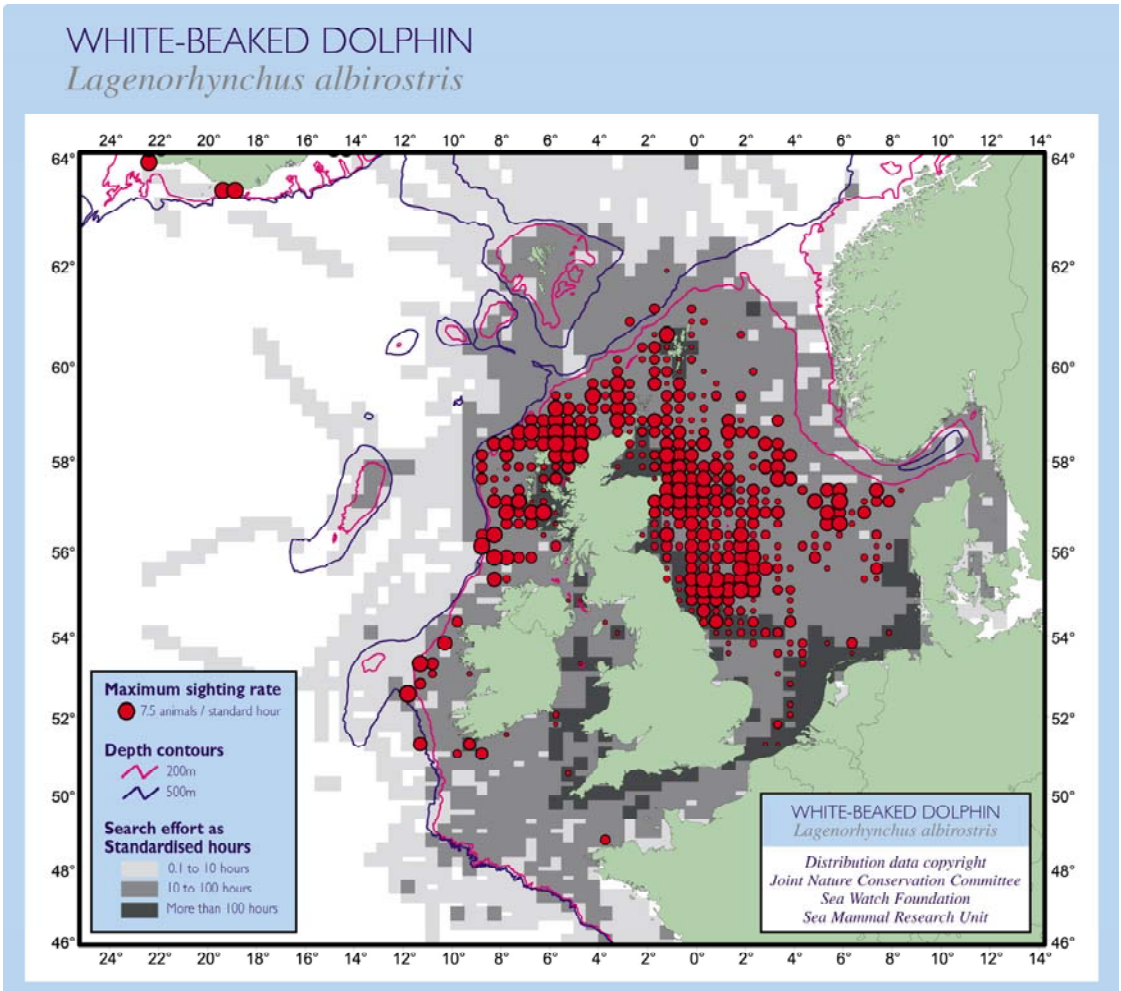

Figure 43. Sightings of white-beaked dolphins around the UK (1973-1997; taken from Reid et al. 2003).

4.5.2 Seasonal variation

There have been too few white-beaked dolphin sightings in the Moray Firth to be able to assess seasonal variation.

4.5.3 Abundance

White-beaked dolphin abundance was estimated for the north-western North Sea (Block D) during the SCANS (1994) survey and the Moray Firth, Orkney and Shetland (Block J) during the SCANS II (2005) survey (Table 8). The density estimates from the two surveys are very similar. Furthermore, the SCANS II density estimate is very similar to the University of Aberdeen 2010 aerial survey density estimate for dolphins obtained for Block B (0.018 individuals per km^2; Table 4).

Year	Area	Estimate	CV	Density (animals per km^2)	CV	Reference
1994	SCANS Block D (north-western North Sea)	1,157	0.56	0.0113	0.56	Hammond et al. 2002
2005	SCANS II Block J (Moray Firth, Orkney and Shetland)	682	0.86	0.0182	0.86	SCANS-II 2008

Table 8. Abundance estimates for white-beaked dolphins in the north-western North Sea.

4.5.4 In the southern Moray Firth (in relation to the cable route)

White beaked dolphin sightings off the southern Moray Firth coast are relatively rare (see Figure 43; no sightings recorded by the CRRU), although there have been several sightings further offshore (Figure 3). It is possible that the species is present during Winter (when fewer bottlenose dolphins are sighted around the coast) but no dedicated visual surveys of the southern Moray Firth coast have been carried out between October and May (Robinson et al. 2007).

4.6 Risso's dolphin

Risso's dolphins occur in virtually all of the world's oceans between 60°S and 60°N although the species does not appear to be common anywhere (Reid et al. 2003). In north-west Europe they appear to be a continental shelf species. Most sightings are from western Scotland, particularly around the Outer Hebrides (Figure 44). Sightings in the northern North Sea were obtained primarily in July and August although some animals were present off north-east Scotland and Shetland in Winter (Reid et al. 2003).

4.6.1 Distribution

Of the few Risso's dolphin sightings in the Moray Firth, most have been made offshore (Figure 3; Figure 44).

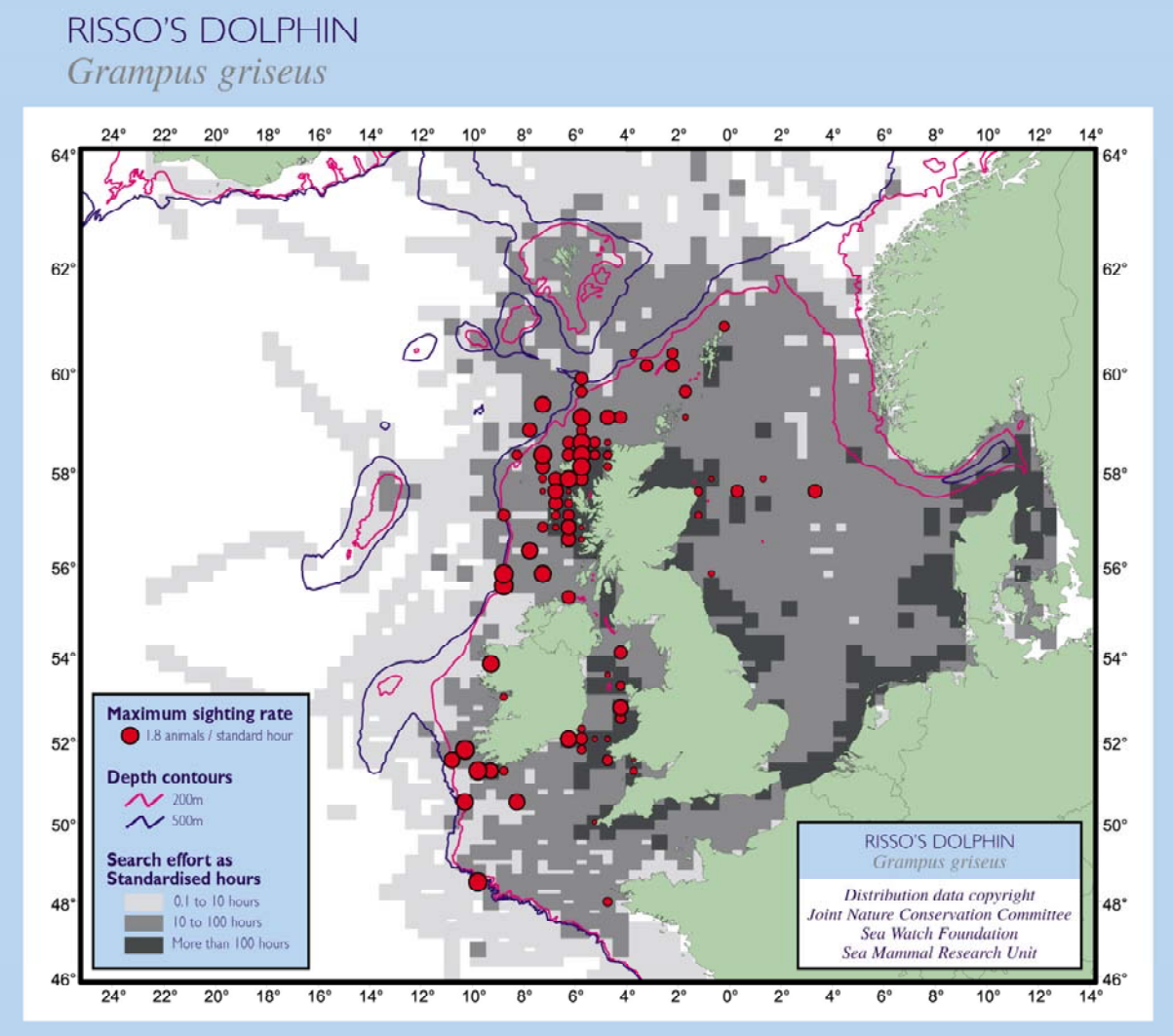

Figure 44. Sightings of Risso's dolphins around the UK (1973-1997; taken from Reid et al. 2003).

4.6.2 Seasonal variation

There have been too few Risso's dolphin sightings in the Moray Firth to be able to assess seasonal variation.

4.6.3 Abundance

Abundance of Risso's dolphins in the Moray Firth is likely to be low; there have been too few sightings to estimate abundance.

4.6.4 In the southern Moray Firth (in relation to the cable route)

Risso's dolphin sightings in the Moray Firth mainly occur offshore (Figure 3; Figure 44). There were five sightings off the southern Moray Firth coast during CRRU surveys carried out between May and October 2001 to 2005. All five sightings were made during the month of September, between the 20 and 50m isobaths (Robinson et al. 2007).

4.7 Other cetacean species

Four other cetacean species (fin, humpback, killer and long-finned pilot whale) have occasionally been sighted in the Moray Firth (Table 1). All four are Annex IV and European Protected species (Table 1) and are widely distributed in the North Atlantic (Roman and Palumbi 2003; Foote et al. 2009; Fullard et al. 2000; see also http://www.iucnredlist.org/). They have been sighted both around the coast and offshore in the Moray Firth (Figure 45; University of Aberdeen unpublished data) but their frequency of occurrence is low (i.e. once every few years) and there have been too few sightings to estimate abundance.

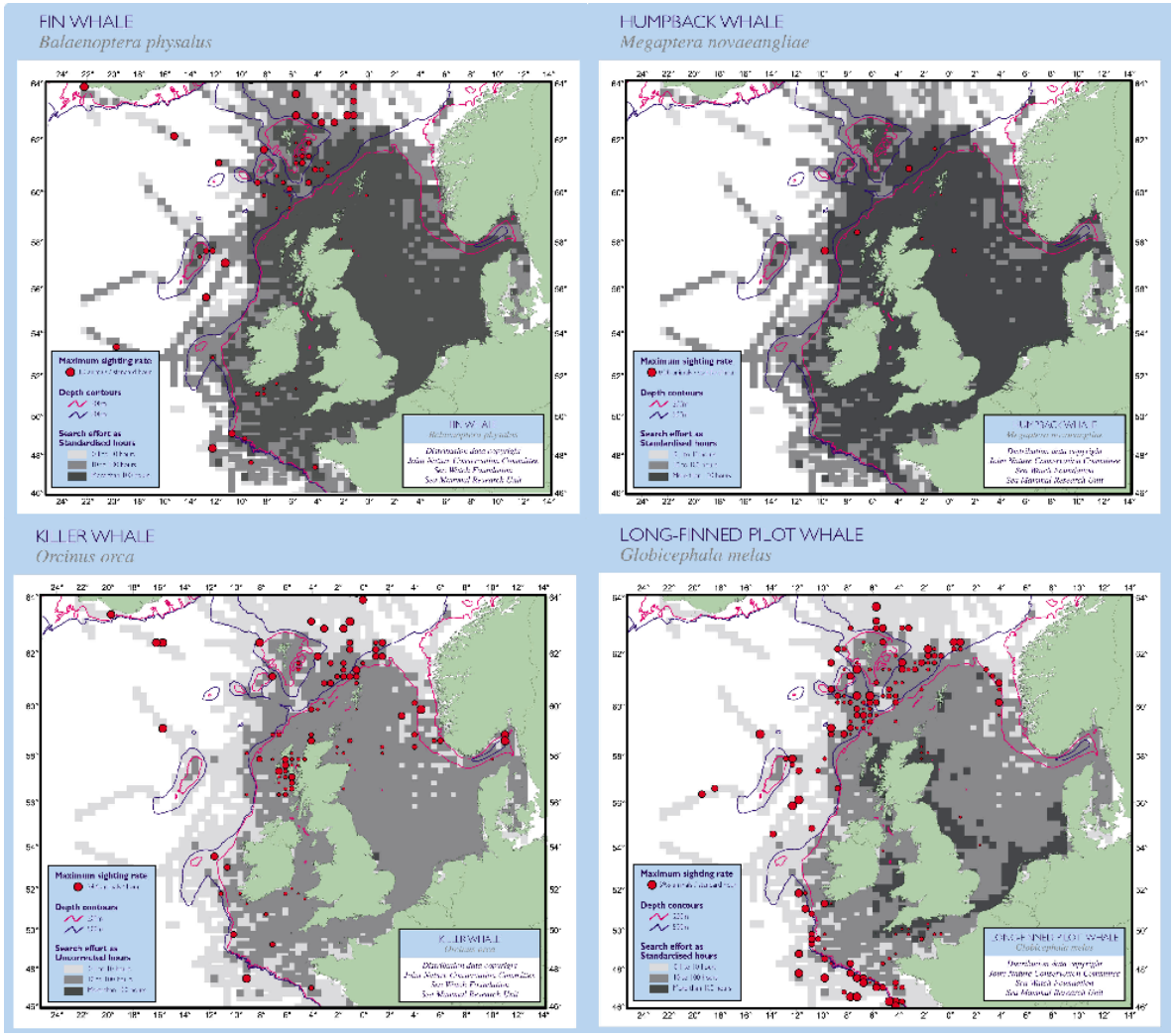

Figure 45. Sightings of fin, humpback, killer and long-finned pilot whales around the UK (1973-1997; taken from Reid et al. 2003).

4.7.1 In the southern Moray Firth (in relation to the cable route)

Killer whales (6 sightings), pilot whales (3 sightings), humpback whales (1 sighting) and white-sided dolphins (*Lagenorhynchus acutus*; 1 sighting) have all been encountered intermittently off the southern Moray Firth coast during the Summer months (Robinson et al. 2007; see Figure 14 for survey route).

4.8 Harbour seal

Britain is home to 30% of the population of the European harbour seal *P. v. vitulina*, and Scotland holds 84% of the British population. Harbour seals are present in the Moray Firth all year round and use intertidal haulout sites to rest between foraging trips, to breed (June/July) and to moult (August/September). They are an Annex II species for which part of the Dornoch Firth has been designated as an SAC (Figure 46; see Section 4.8.4). Compared with the 1990s, major declines have been observed in Shetland (50%), Orkney (67%), the Outer Hebrides (35%), the Moray Firth (40%) and the Firth of Tay (85%; SCOS Main Advice 2010). Other populations appear to be stable (Strathclyde and the west coast of the Highland region) or increasing (English East Coast).

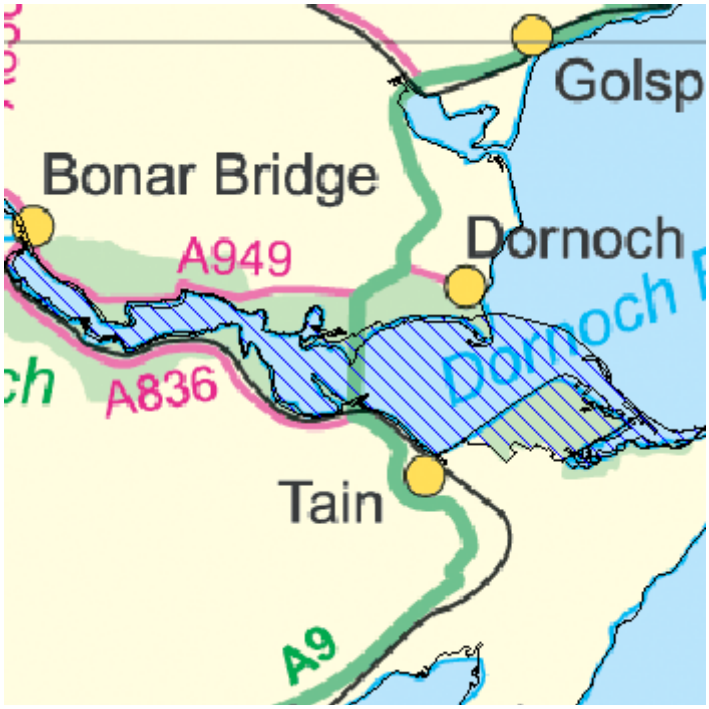

Figure 46. The extent of the Dornoch Firth and Morrich More harbour seal SAC shown by the hashed area (information accessible via the NBN Gateway[19]).

4.8.1 Distribution

4.8.1.1 On land during the moult (August)

Figure 47 shows the distribution of seals counted during the latest SMRU moult surveys in the Moray Firth and adjacent areas. The largest numbers of animals were hauled out at Findhorn, Ardersier, in the Beauly, Cromarty and Dornoch Firths, and at Loch Fleet.

19 http://data.nbn.org.uk/siteInfo/siteSpeciesGroups.jsp?useIntersects=1&allDs=1&engOrd=1&srcKey=UK0019806&srcDsKey=GA000327

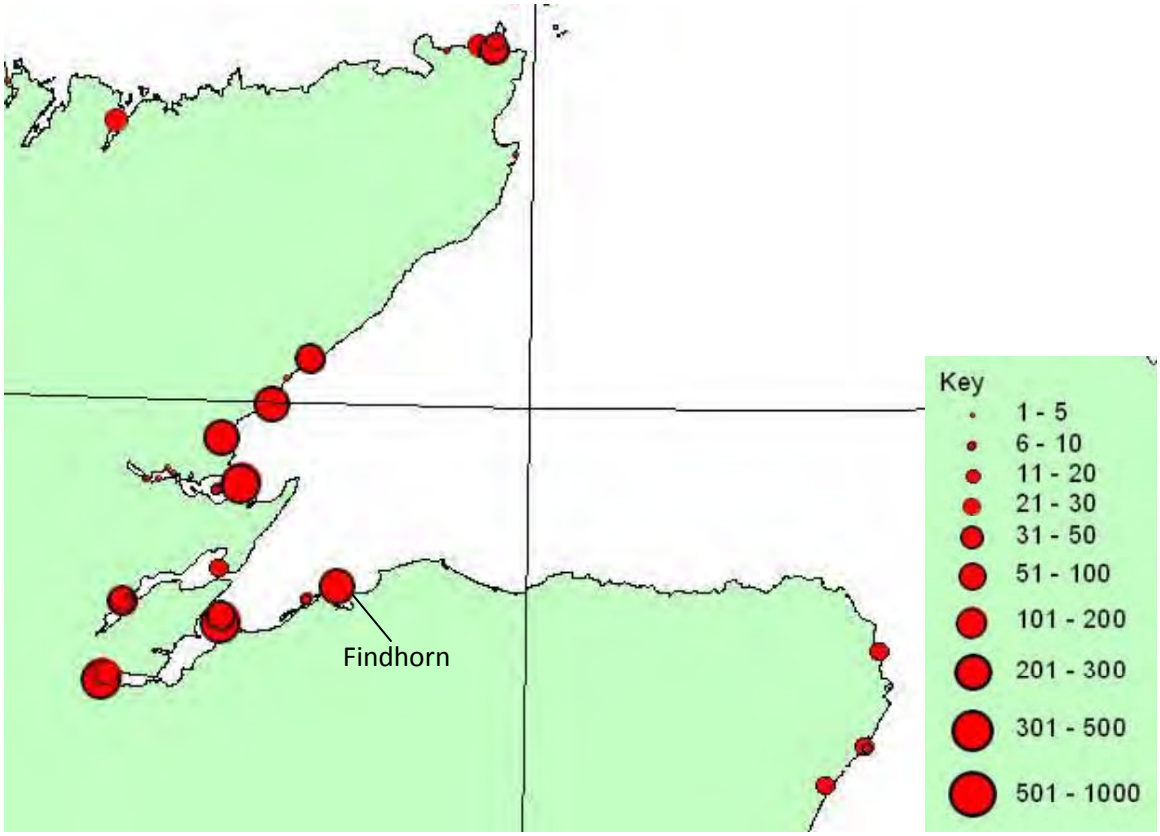

Figure 47. The number and distribution of harbour seals counted during SMRU thermal imaging surveys between August 2007 and 2009 (taken from Duck and Thompson 2009).

4.8.1.2 At sea

Telemetry data provide the best estimate of year-round distribution. The distribution of harbour seals when they are at sea in the Moray Firth has been examined in a number of studies using VHF radio, SRDL and GPS phone telemetry.

In the late 1980s/early 1990s Thompson et al. (1996) caught 21 harbour seals and fitted them with VHF radio tags. All 21 seals foraged within 60km of their haulout sites. They showed seasonal variation in their foraging areas (Figure 48) which was related to changes in their terrestrial distribution. When compared to tracks from five grey seals, which were tagged as part of the same study, there was overlap in the foraging areas used by both species in more inshore areas (Thompson et al. 1996).

In 2004-2005, ten harbour seals were captured in the Dornoch Firth and Loch Fleet and fitted with SRDL tags (Sharples et al. 2008). The majority of foraging occurred to the east and north-east of the haulout sites (Figure 49). The densest areas of foraging were between 30 and 70km from haulout sites. Only two animals switched haulout site, one travelled approximately 50km to haul out in the Beauly Firth while the other travelled more than 190km to haul out on Stronsay in Orkney (Figure 49), just south of the harbour seal SAC on Sanday.

Cordes et al. (2011) compared foraging areas of breeding females caught in the Dornoch Firth and at Loch Fleet in 1989 and 2009 using a combination of VHF radio (1989) and GPS phone (2009) telemetry. They found that females foraged in broadly similar areas during both time periods (Figure 50).

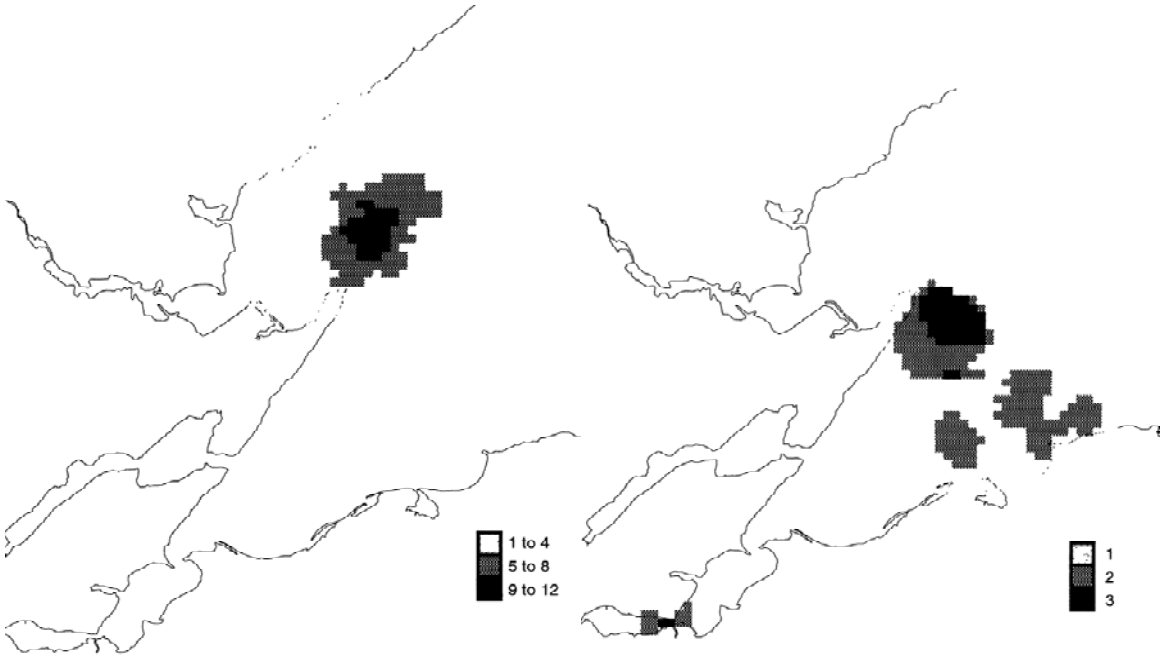

Figure 48. Foraging areas used by radio-tagged harbour seals from the Dornoch Firth in Summer (left) and Winter (right). The shading is related to the number of different individuals whose foraging areas overlapped each 1km square (taken from Thompson et al. 1996).

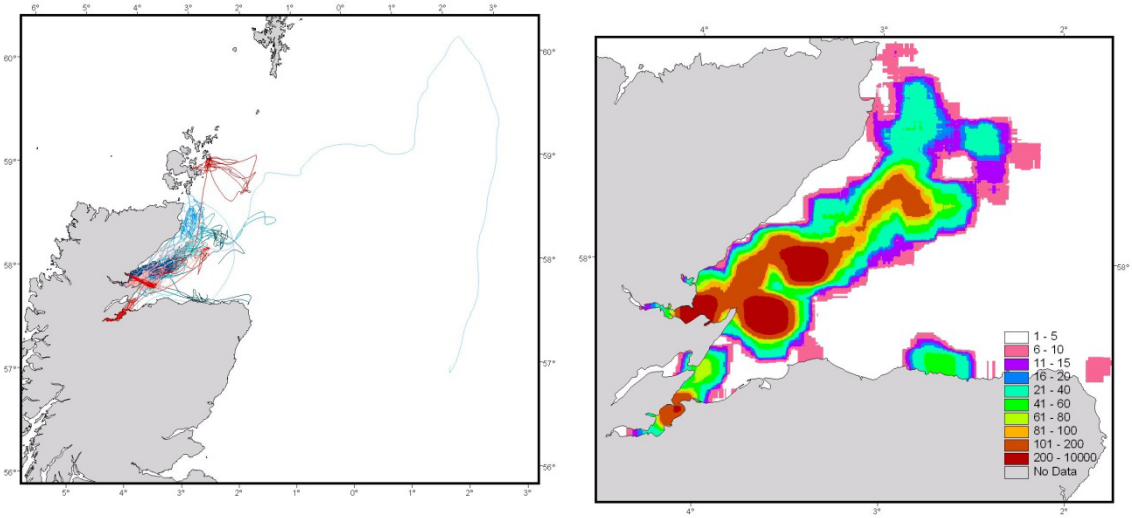

Figure 49. Tracks of individual harbour seals captured in the Dornoch Firth and Loch Fleet in 2004 and 2005 (left) and density of foraging locations at sea (right) (taken from Sharples et al. 2008).

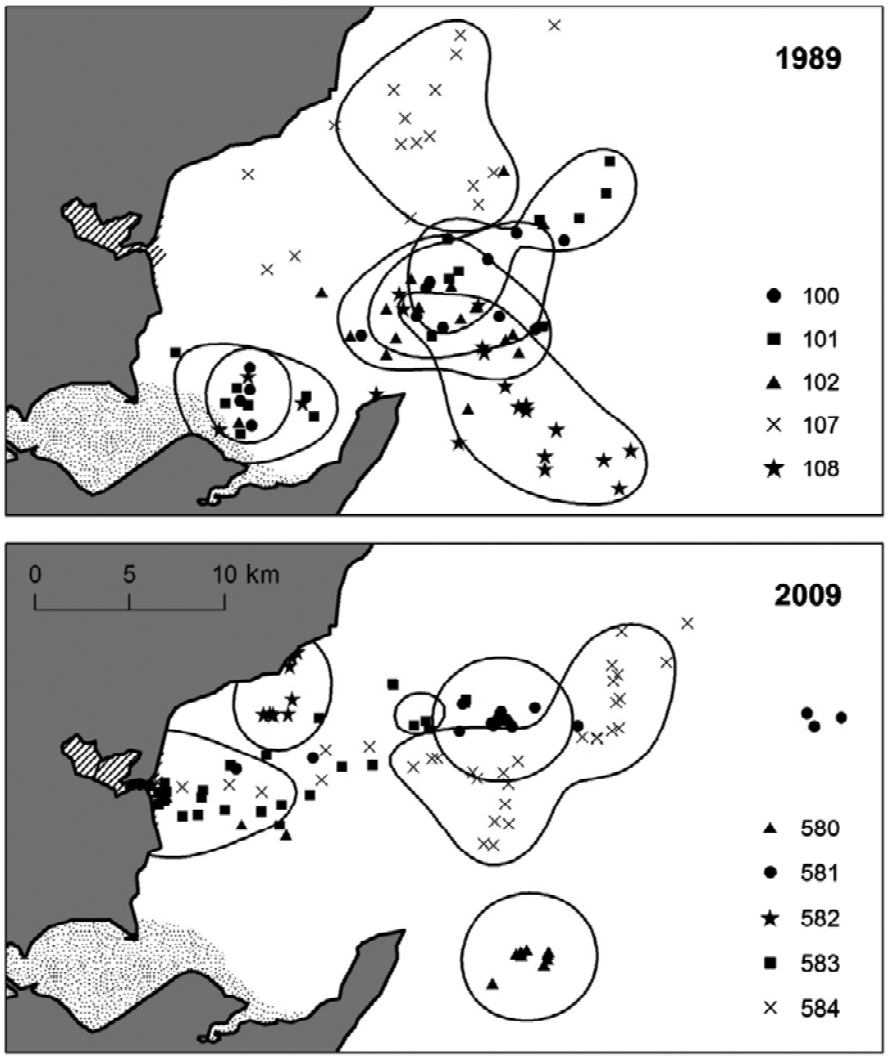

Figure 50. Comparison of adult female foraging locations in 1989 (n=5) and 2009 (n=5; taken from Cordes et al. 2011). The foraging locations of each individual are represented by a different symbol (key relating symbols to individuals is shown at the bottom right of each map). The solid lines show the 50% contours for individual foraging areas as calculated by Kernel analysis. The Dornoch Firth and Morrich More SAC is shown by the shaded area. The Loch Fleet NNR is shown by the hashed area.

4.8.2 Seasonal variation on land

Harbour seals are present at haulout sites in the inner Moray Firth throughout the year although the number of animals at these sites peaks during June, July and August (the breeding and moulting seasons; Thompson et al. 1996). Their distribution within this area is known to vary seasonally and between years and is likely influenced by proximity to foraging area (outside the breeding season) and site characteristics (during the breeding season; Thompson et al. 1996).

4.8.3 Abundance

Numbers of harbour seals in many areas around the UK have declined since the 1990s. Numbers in Shetland have declined by 50%, Orkney by 67%, the Outer Hebrides by 35%, the Moray Firth by 40% and the Firth of Tay by 85%. Numbers in other areas (Strathclyde, the west coast of the Highland region and the English East Coast) do no show consistent declines (SCOS Main Advice 2010).

Nearly 25,000 harbour seals were counted in the whole of Britain during the most recent available SMRU moult counts of which 84% were in Scotland and approximately 4% (<1,000) in the Moray Firth (SCOS Main Advice 2010). Moult surveys provide the best estimates of population size.

4.8.3.1 On land during the breeding season (June/July)

Breeding season counts in the inner Moray Firth have been carried out since the late 1980s by the University of Aberdeen and SMRU (Duck at al. 2010). Counts of 700-800 were usual in the inner Moray Firth in the late 1980s (after the phocine distemper virus outbreak in 1988) and these increased to around 1000 animals in 1993. Since then breeding season numbers have decreased steadily: by 2007-2008 only around 500 animals were counted in the inner Moray Firth. Numbers increased by 27% in 2009 to 671 animals (Duck at al. 2010).

4.8.3.2 On land during the moult (August)

Figure 51 shows trends in the number of harbour seals counted at the different haulout sites in the Moray Firth during annual moult (August) surveys carried out over the last 15 years by the University of Aberdeen and SMRU. Numbers in the Dornoch Firth have decreased over this period. Cordes et al. (2011) showed that there has been a shift in distribution between the Dornoch Firth and Loch Fleet. In 1988, all mother-pup pairs counted in the two estuaries were located at haulout sites within the Dornoch Firth but by 2008 the newly developed site at Loch Fleet accounted for 37% of mother-pup pairs.

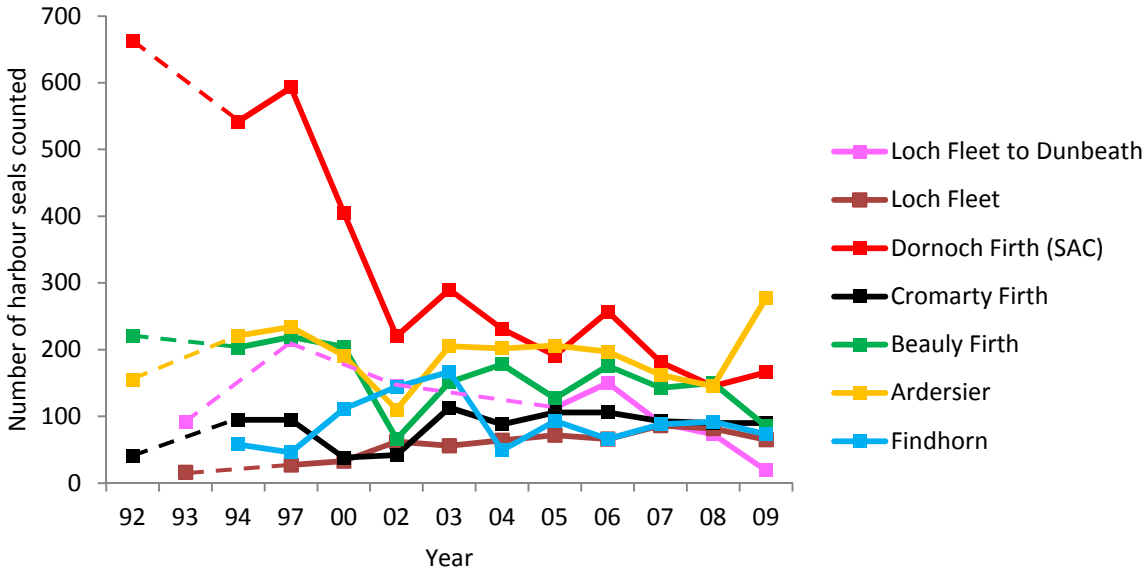

Figure 51. Number of harbour seals at different haulout sites in the Moray Firth during moult (August) surveys (produced using data from Table 2 in Duck et al. 2010). When multiple surveys of haulout sites were carried out in one year (2004, 2005, 2006, 2007, 2008) the mean count for the site is presented. Dashed lines indicate a hypothetical trend between counts (due to a lack of data for the intervening years).

4.8.4 The Dornoch Firth and Morrich More SAC

Selection of SACs for harbour seals was primarily based on numbers counted during their annual moult, in August. Additional surveys confirmed that the candidate SACs were also used for breeding. There are eight harbour seal SACs designated in Scotland: Yell Sound Coast and Mousa (Shetland), Sanday (Orkney), Ascrib, Isay and Dunvegan (Skye), Eileanan agus Sgeiran Lios mor (Isles and Skerries of Lismore) and South-East Islay Skerries (Strathclyde), Dornoch Firth and Morrich More (Moray Firth), and the Firth of Tay and Eden Estuary (Tayside and Fife).

The marine component of the Dornoch Firth and Morrich More SAC extends from Bonar Bridge to the mouth of the estuary between Dornoch Point on the north shore and to the west of Portmahomack on the south shore (Figure 46; SNH 2006). As well as harbour seals, the estuary supports a second qualifying Annex II species, the otter (*Lutra lutra*).

Trends in abundance of harbour seals within the Dornoch Firth (and at the nearby Loch Fleet National Nature Reserve/NNR) are shown in Figure 52. Numbers in the Dornoch Firth are now around one third of what they were 20 years ago, while numbers at sites in Loch Fleet, which was not used by harbour seals 20 years ago, have increased (though not by an equivalent number). The condition of the Dornoch Firth and Morrich More SAC has been assessed three times during the last reporting cycle. There were 405 seals in 2000, 220 seals in 2002 (although this is considered an undercount because the survey was undertaken more than two hours after low tide), and 290 seals in 2003 (SNH 2005). These data, along with previous counts made in 1992 (662), 1994 (542) and 1997 (593), indicate that the number of harbour seals within the SAC during the moulting season has decreased over the reporting cycle. The SAC is considered to be "Unfavourable (recovering)" (SNH 2005) and a management plan[20] is now in place which is addressing the main reason believed to be behind the decline (shooting of seals mainly to protect salmon and sea trout fisheries).

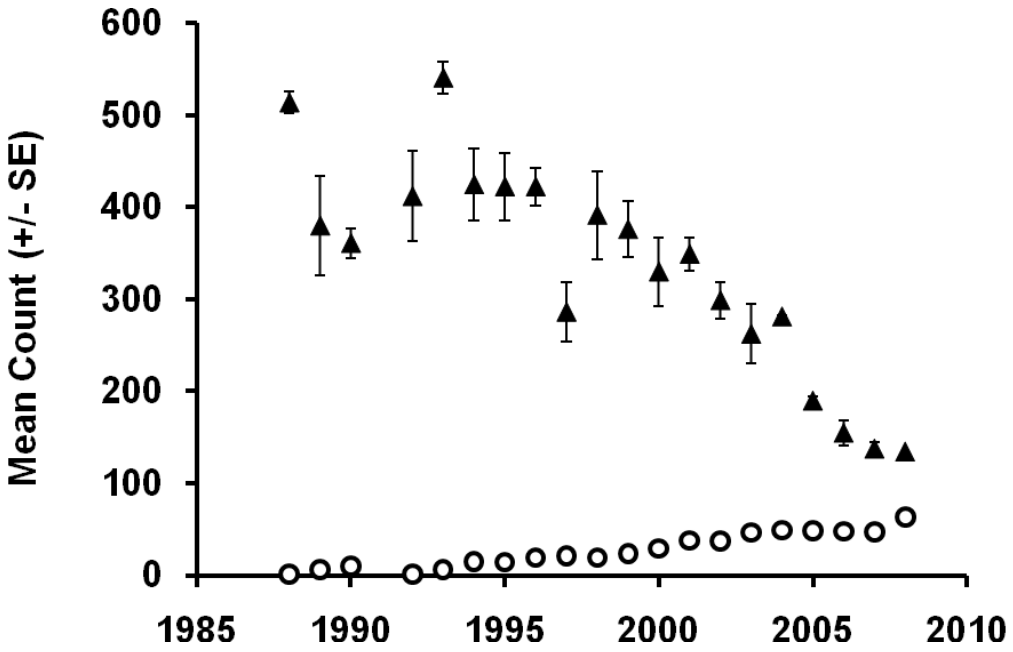

Figure 52. Trends in abundance of harbour seals within the Dornoch Firth (filled triangles) and at the nearby Loch Fleet NNR (open circles; taken from Cordes et al. 2011).

[20] http://www.speyfisheryboard.com/images/stories/sfb/docs/seal_plan.pdf

4.8.5 Links between the Dornoch Firth and Morrich More SAC and the BOWL site

Over the last two decades, 37 individual harbour seals from the Dornoch Firth and Morrich More SAC and the nearby Loch Fleet NNR have been tracked using a variety of techniques (VHF radio, SRDL and GPS phone telemetry) (Thompson et al. 1994; Sharples et al. 2008; Cordes et al. 2011; see Section 4.8.1.2; Table 9). These data were used to underpin predictions of use of the BOWL (and MORL) sites by harbour seals using habitat association modelling (Bailey and Thompson 2011). Habitat characteristics used included depth, slope, distance to nearest haulout and sediment type. Different error structures for each of these technologies (VHF radio, SRDL and GPS phone telemetry) required the development of a novel Bayesian state-space approach to integrate these data into a single modelling framework (Bailey and Thompson 2011). Existing procedures were then used to predict habitat usage (Aarts et al. 2008) and estimate how many harbour seals from the Dornoch Firth and Morrich More SAC were likely to use habitats within the development areas (Matthiopoulos et al. 2004). Analysis of the combined VHF radio, SRDL and GPS phone telemetry dataset demonstrated that harbour seals from the Dornoch Firth and Morrich More SAC were dispersed widely across the Moray Firth, particularly over offshore sandbanks, and are likely to spend time foraging within the BOWL (and MORL) sites (Bailey and Thompson 2011). Although there is variability in the importance of different parts of the BOWL and MORL sites, some 4x4km grid squares in this region might be expected to hold up to eight seals (based on the highest levels of abundance seen over the last two decades), representing a density approaching 0.5 individuals per km^2 (Figure 53).

As well as the link with the Dornoch Firth and Morrich More SAC, animals from other harbour seal SACs, e.g. that in Orkney (see Section 4.8.4), may also use the BOWL site. Figure 54 shows tracks of harbour seals tagged with SRDL tags, mostly in Orkney. Although this Figure shows only tracks of seals which entered the Pentland Firth and Orkney Strategic Area at least once (SMRU Ltd 2011), it gives an idea of how widely harbour seals range and highlights the possibility that animals from other SACs may also use the Moray Firth.

Tag type	Deployment years	Number of tags
VHF radio	1989-1991	21
SRDL	2004-2007	11
GPS phone	2009	5

Table 9. Summary of telemetry data for harbour seals tagged in the Dornoch Firth and Morrich More SAC and Loch Fleet NNR (Thompson et al. 1994; Sharples et al. 2008; Cordes et al. 2011).

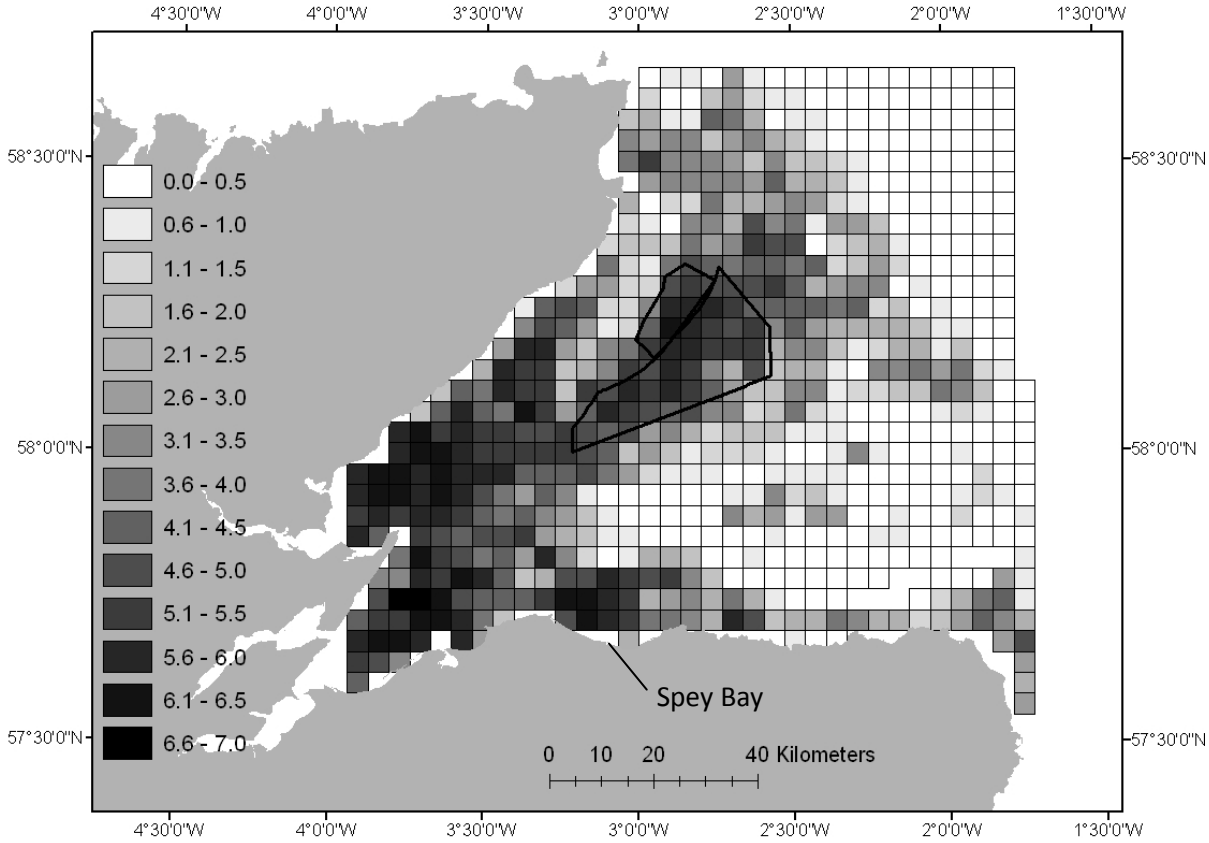

Figure 53. Predicted numbers of harbour seals from the Dornoch Firth SAC and Loch Fleet NNR in different 4x4km grid cells across the Moray Firth (taken from Bailey and Thompson 2011).

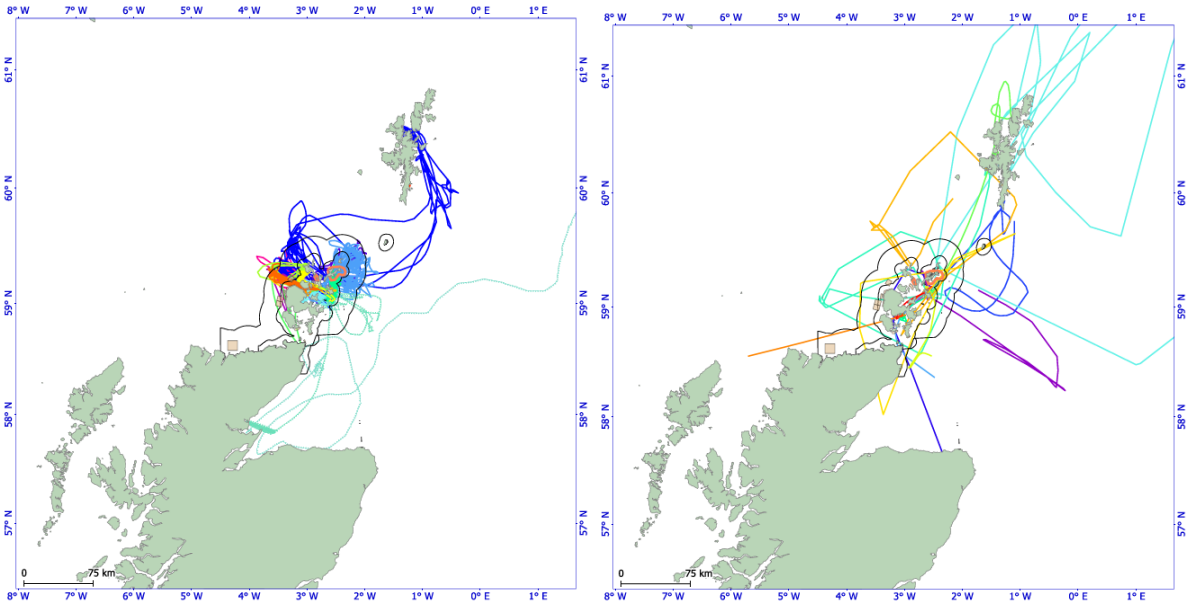

Figure 54. Tracks of 17 harbour seals (2 of which were tagged at the Dornoch Firth and Morrich More SAC and Loch Fleet NNR, the other 15 were tagged in the northern half of Orkney, including the Sanday SAC; left) and 15 female harbour seal pups (tagged on Sanday in Orkney; right) fitted with SRDL tags (taken from SMRU Ltd 2011). Only tracks (colour coded by individual seal) of seals which entered the Pentland Firth and Orkney Strategic Area at least once are shown, but they give an idea of how widely both young and adult harbour seals range.

4.8.6 Loch Fleet National Nature Reserve (NNR)

Photo-ID studies of harbour seals using the Loch Fleet NNR offer the opportunity to assess individual measures of fitness such as reproduction rates, survival and phenology (biological cycles and events) by observing the behaviour of individuals through time (Thompson and Wheeler 2008). Loch Fleet is the closest harbour seal breeding site to the BOWL site, and has become increasingly important relative to the Dornoch Firth SAC over the last 20 years (Figure 52; Cordes at el. 2011). Photo-ID has been carried out at this site during the breeding season for the last six years (University of Aberdeen unpublished data).

4.8.7 In the southern Moray Firth (in relation to the cable route)

Findhorn is the main harbour seal haulout on the southern Moray Firth coast (Figure 47). Numbers have varied over the years and the site is currently used by around 100 animals during the August moult (Figure 51). The site is also used for pupping. The area around Spey Bay appears to be used by at least some of the animals tagged in the Dornoch Firth and Loch Fleet for foraging (Figure 53). It should also be noted that there is evidence of movement of harbour seals between the Sanday (Orkney) and the Dornoch Firth and Morrich More SACs and the southern Moray Firth coast (Figure 54; Section 4.8.5).

4.8.8 Mortality from corkscrew injuries

In 2009 a previously unidentified source of anthropogenic mortality was identified in harbour and grey seals in Scotland (Thompson et al. 2010b). In 2010, severely damaged seal carcasses were found on beaches in eastern Scotland (St Andrews Bay, Tay and Eden Estuaries and Firth of Forth), along the North Norfolk coast in England (centred on the Blakeney Point Nature Reserve) and within and around Strangford Lough in Northern Ireland (Thompson et al. 2010b). All the seals had a characteristic wound consisting of a single smooth edged cut that started at the head and spiralled around the body. In most cases the resulting spiral strip of skin and blubber was detached from the underlying tissue. In each case the wound would have been fatal (Thompson et al. 2010b). The extremely neat edge to the wound strongly suggested the effects of a blade with a smooth edge applied with considerable force, while the spiral shape was consistent with rotation about the longitudinal axis of the animal. The injuries were consistent with the seals being drawn through a ducted propeller such as a Kort nozzle or some types of Azimuth thruster (Thompson et al. 2010b). Such systems are common to a wide range of ships including tugs, self-propelled barges and rigs, various types of offshore support vessels and research boats. All other proposed explanations of the injuries, including Greenland shark predation, are difficult to reconcile with the observations and, based on the evidence to date, seem very unlikely to have been the cause of these mortalities (Thompson et al. 2010b). At present the population consequences of these mortalities is unknown (SCOS Main Advice 2010).

4.9 Grey seal

About 45% of the world population of grey seals is found in Britain and over 90% of British grey seals breed in Scotland (SCOS Main Advice 2008). Although grey seal pup production has increased steadily since the 1960s, when dedicated surveys began, and continues to increase rapidly in the North Sea, there is clear evidence that growth is now levelling off in Orkney and the Hebrides. Grey seals are present in the Moray Firth year-round, hauling out at intertidal sites between foraging trips and breeding on beaches (or in caves) above the high water mark along the Helmsdale coastline in Autumn. They are an Annex II species and are protected by means of a network of SACs (see Section 4.9.4).

4.9.1 Distribution

4.9.1.1 On land

Figure 55 gives an idea of the distribution of grey seals on land around the Moray Firth in Summer and shows that the greatest numbers of grey seals haul out in the Dornoch Firth at this time of year. In Winter the majority of grey seals hauling out in the Moray Firth can be found along the Helmsdale coast where they breed.

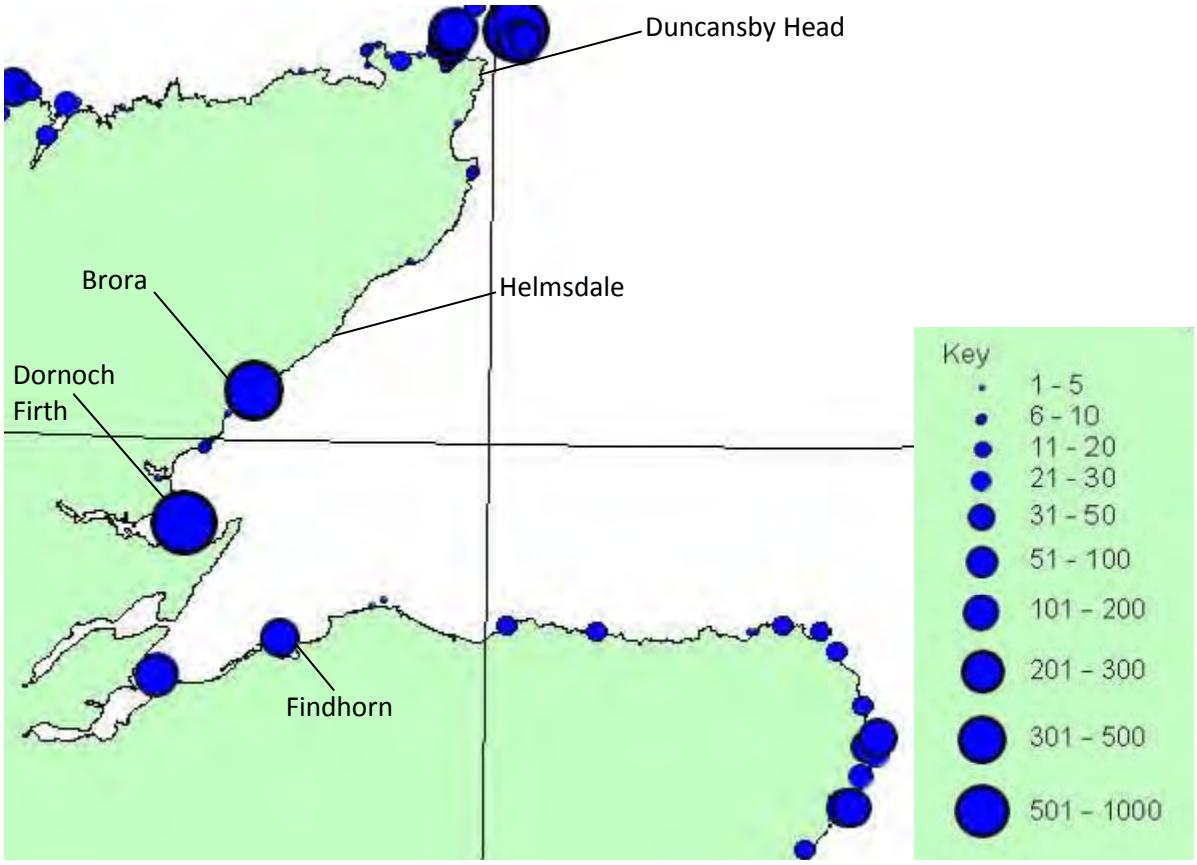

Figure 55. The number and distribution of grey seals counted during SMRU thermal imaging surveys of the Moray Firth in August 2007 and 2009 (taken from Duck and Thompson 2009).

4.9.1.2 At sea

4.9.1.2.1 In UK waters

One of the best ways to estimate how grey seals use the marine environment is to use telemetry data (e.g. Matthiopoulos et al. 2004). As a result of modelling and interpolating satellite telemetry (from 110 tagged individuals captured at major haulout sites during 1991-1999 and observed from May to September i.e. outside the breeding and moulting seasons) and haulout survey data around Britain, we can see that grey seal usage is primarily concentrated:

(i) off the northern coasts of the British Isles;

(ii) closer to the coast than might be expected purely on the basis of accessibility from the haulout sites; and

(iii) in a limited number of marine hot-spots e.g. the Pentland Firth and, to a lesser extent, the Moray Firth (Figure 56).

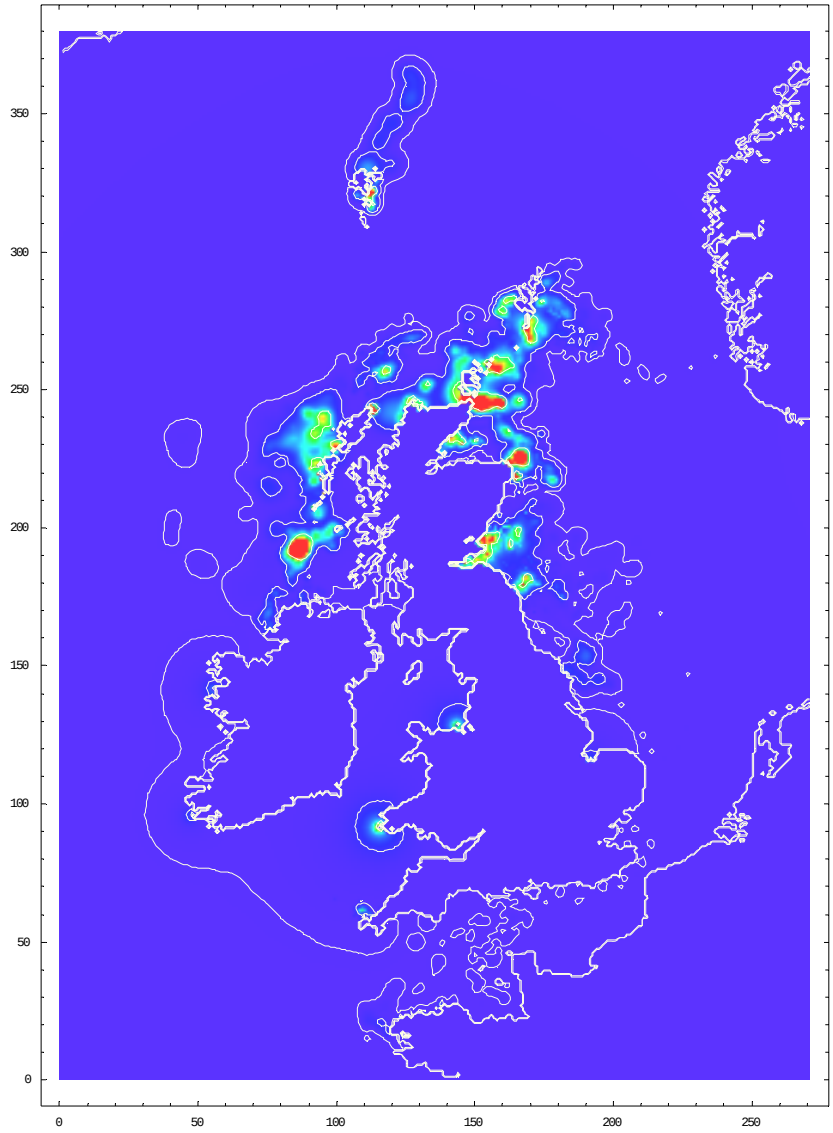

Figure 56. The estimated usage of the British marine environment by grey seals (taken from Matthiopoulos et al. 2004).

4.9.1.2.2 In the Moray Firth

The density of grey seals in the Moray Firth was estimated by Jones and Matthiopoulos (2011 – see Appendix 3) using telemetry and count data. As for the other species for which density has been estimated (bottlenose dolphin, harbour porpoise and harbour seal), a 4x4km^2 grid was used. Maps of estimated total, at-sea, and hauled-out usage in a study area surrounding the proposed MORL and BOWL wind farm developments are presented (although it is anticipated that use of the at-sea densities will be most appropriate when assessing the potential impact of construction).

Figure 57 shows the spatial usage of grey seals around the proposed MORL/BOWL proposed development sites with white contour lines denoting standard deviation as a measure of uncertainty around estimated usage. Highest usage is located in the Dornoch Firth (and also in the Pentland Firth and around the Orkney Islands). Possible offshore foraging patches can also be seen (denoted in orange and yellow).

Figure 58 shows estimated at-sea usage. Total and at-sea usage display similar characteristics although at-sea usage is 28% lower than total usage due to the removal of hauled-out usage.

Figure 59 shows estimated grey seal hauled-out usage. The highest hauled-out usage occurs in the Dornoch Firth (and at some of the islands in the Pentland Firth, e.g. Stroma, and around Orkney, e.g. Stronsay).

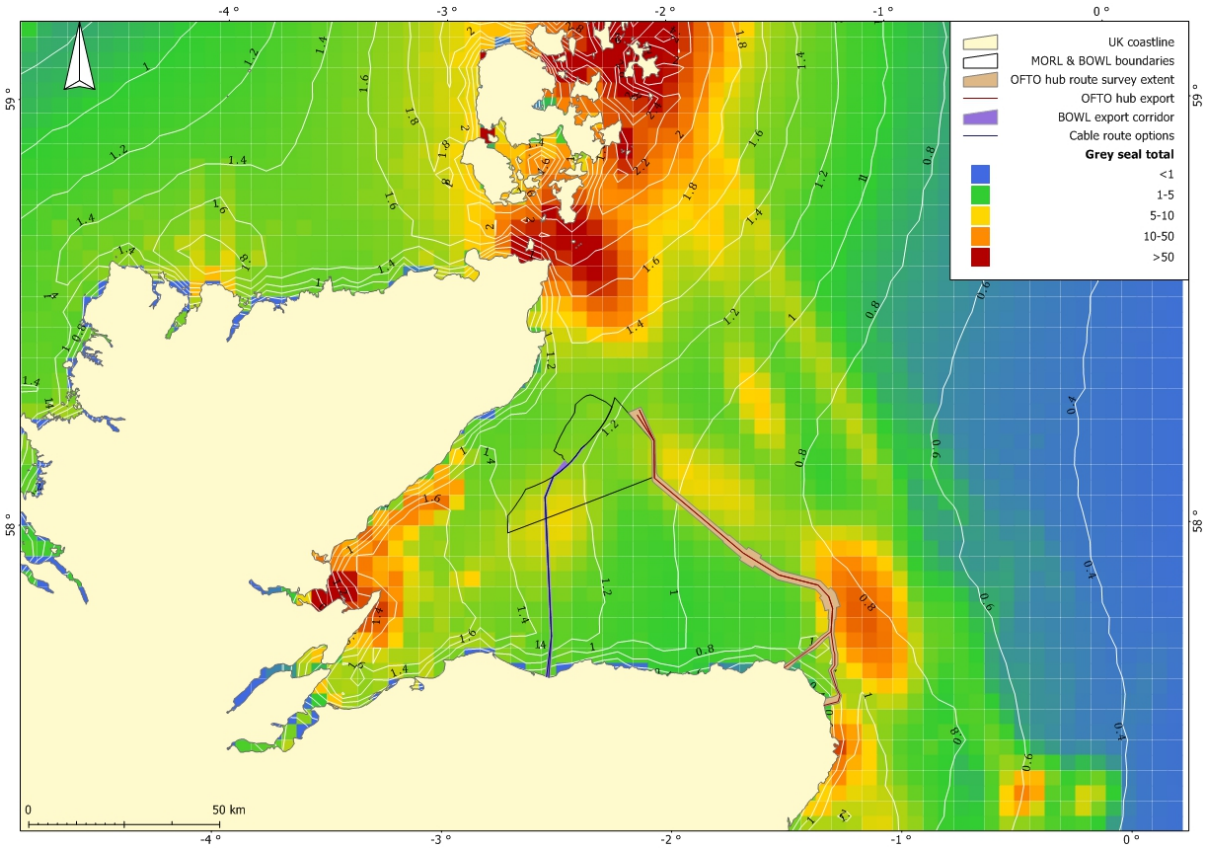

Figure 57. Estimated grey seal total (at-sea and hauled-out) usage around the proposed MORL/BOWL development sites. White contours show standard deviation from mean usage as a measure of uncertainty.

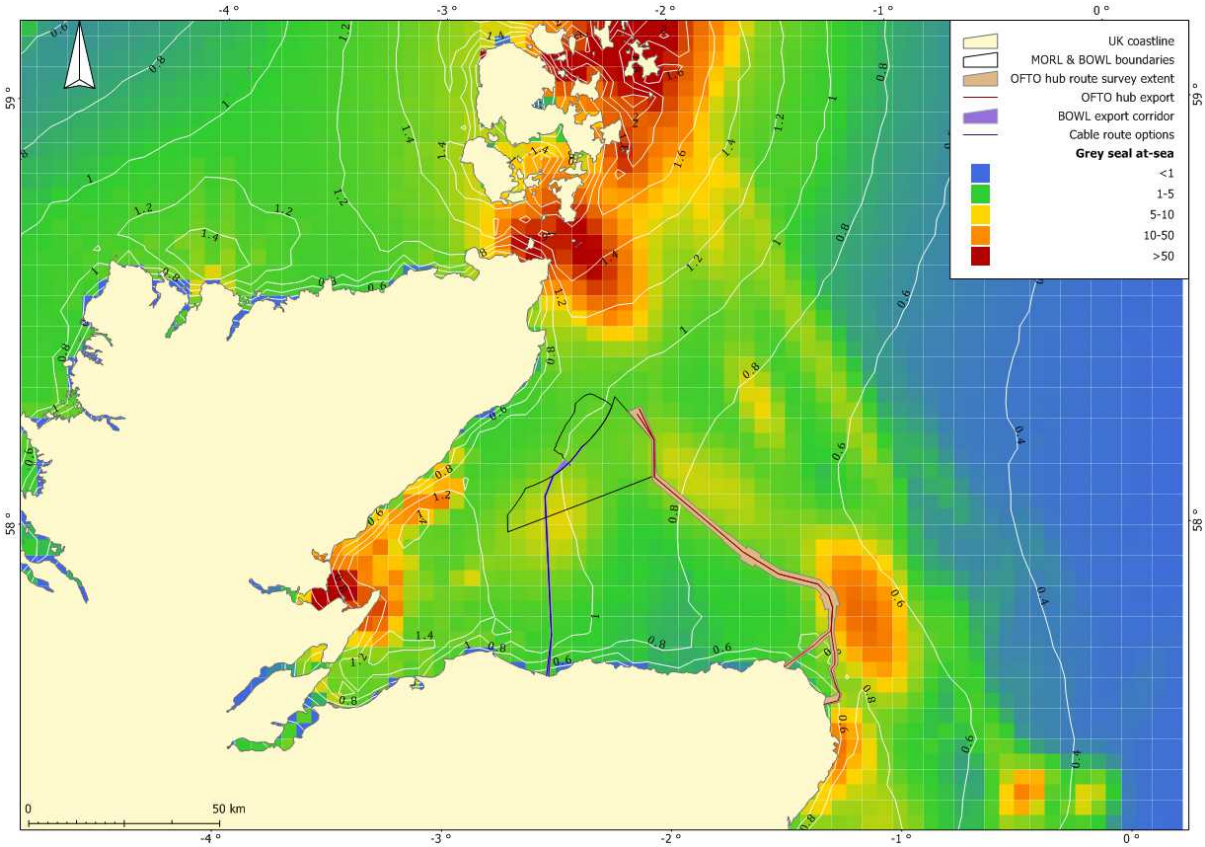

Figure 58. Estimated grey seal at-sea usage around the proposed MORL/BOWL development sites. White contours show standard deviation from mean usage as a measure of uncertainty.

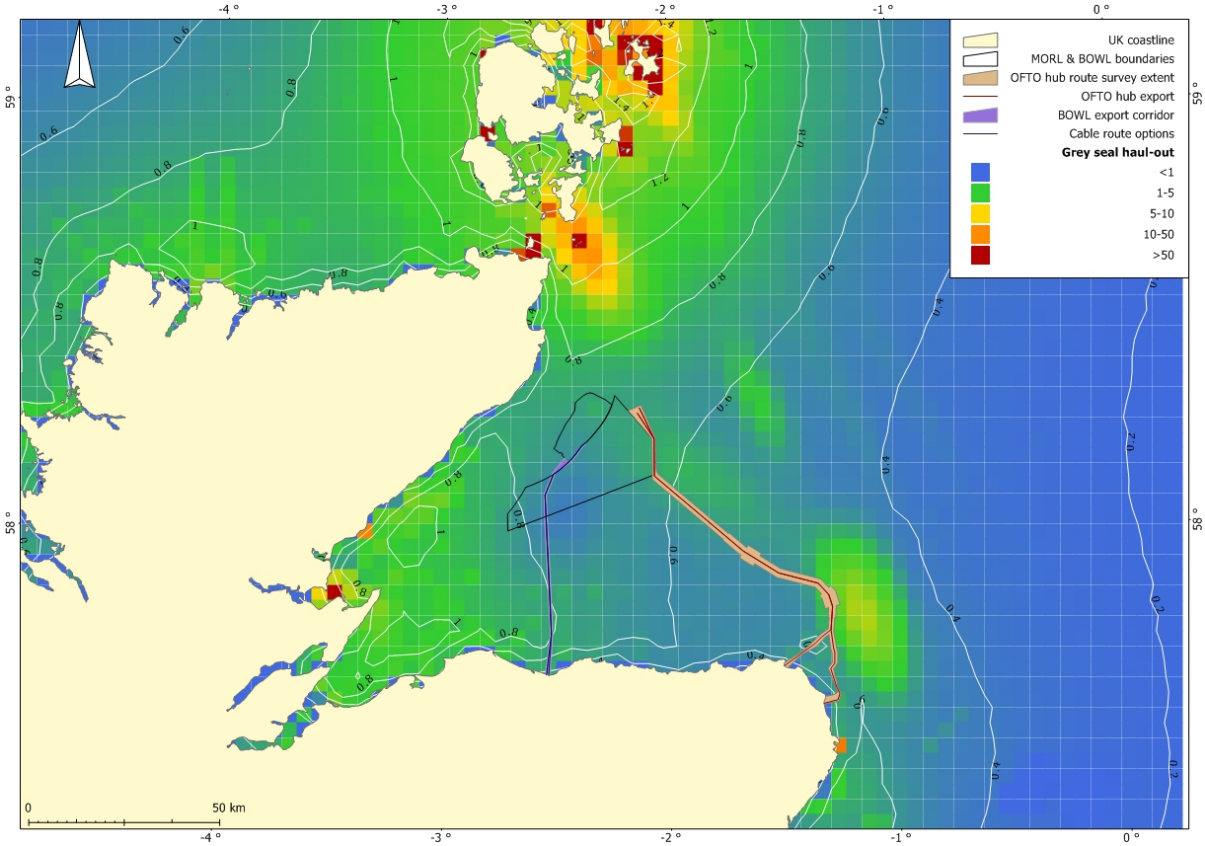

Figure 59. Estimated grey seal hauled-out usage around the proposed MORL/BOWL development sites. White contours show standard deviation from mean usage as a measure of uncertainty.

4.9.2 Seasonal variation on land

The number of grey seals counted at inter-tidal haulout sites within the inner Moray Firth appears to be highest during the Summer, at least historically (Figure 60). Only a few grey seals (tens) use these sites during the Winter.

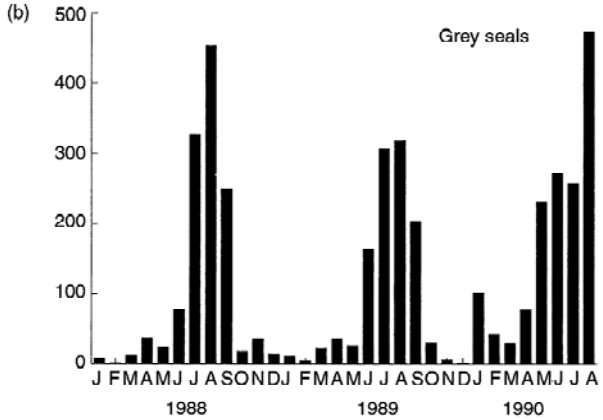

Figure 60. Maximum monthly counts of grey seals at inner Moray Firth haulout sites from January 1988 to August 1990 (taken from Thompson et al. 1996).

4.9.3 Abundance

Each year, SMRU conducts aerial surveys of the major grey seal breeding colonies in Britain to determine the number of pups born (pup production). Pup production surveys have been carried out by SMRU in the North Sea since the 1960s (SCOS Main Advice 2008). The total number of seals associated with surveyed sites can then be estimated by applying a population model to the estimates of pup production (SCOS Main Advice 2008). The latest SMRU survey data available for the Moray Firth were collected in 2009 when pup production was estimated for the coastline between Duncansby Head and Helmsdale (Figure 55; SCOS Main Advice 2010). Figure 61 shows the trend in pup production which has been occurring at the regularly surveyed North Sea colonies (Isle of May, Fast Castle, Farne Islands, Donna Nook, Blakeney Point and Horsey in east Norfolk) since the 1980s. Pup production at Helmsdale (surveyed less regularly than other North Sea sites) has remained constant over this period and now accounts for less than 15% of grey seal pup production in the North Sea (Figure 61).

The typical abundance of grey seals on land during August (i.e. outwith the breeding season) is shown in Figure 55. The greatest numbers of animals (low hundreds) haul out in the Dornoch Firth and to the north of Brora.

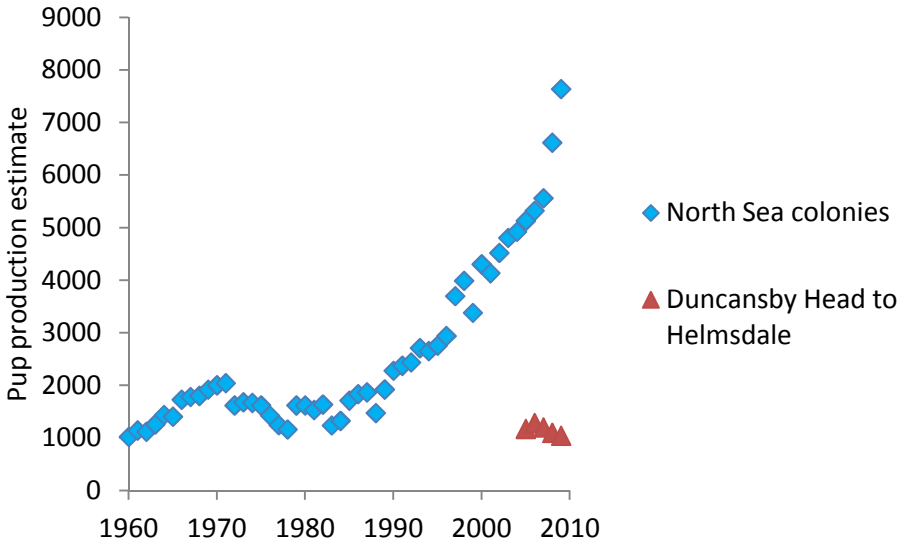

Figure 61. Grey seal pup production estimates for North Sea colonies from 1960 to 2009 (produced using data from Duck and Morris 2010) and for the Duncansby Head to Helmsdale area from 2005 to 2009 (produced using data from Duck and Mackey 2006; Duck and Mackey 2007; Duck and Mackey 2008; Duck 2009; Duck and Morris 2010). The Duncansby Head to Helmsdale colony was counted by boat prior to 2005, but only single counts were made and therefore no pup production estimates are available. Note that the surveys described here do not account for the small groups of seals breeding in caves along the Sutherland and Caithness coasts.

4.9.4 Grey seal SACs

Grey seal SAC designation was based on the numbers of pups born at individual breeding colonies. Candidate SACs had to contribute a reasonable proportion of pups to the total and had to be evenly distributed across the geographic range of grey seal breeding colonies. The largest grey seal breeding colonies were selected as SACs using the most up to date pup production data (SMRU Ltd 2011). There are six grey seal SACs in Scotland: the Treshnish Isles (Strathclyde), the Monach Isles (Outer Hebrides), North Rona (Outer Hebrides), Faray and Holm of Faray (Orkney), the Isle of May (Firth of Forth) and the Berwickshire and North Northumberland Coast (which crosses the border between Scotland and England on the east coast).

4.9.5 Links between grey seal SACs and the BOWL site

Published studies relating to grey seal movements at sea show that, while grey seals often forage close to shore in areas local to the sites they are using to haul out, they also make long distance movements (e.g. McConnell et al. 1999). For example, Figure 62 shows the mean daily locations of five grey seals satellite tagged in the Moray Firth illustrating the long-range movements (from the Moray Firth to haulout sites 125-365km away in Orkney, the Firth of Forth and at the Farne Islands) made by four of the five tagged seals (Thompson et al. 1996). This highlights the interchange that occurs between areas for grey seals. Even the three grey seals which foraged within the Moray Firth travelled up to 145km from haulout sites to do so (Figure 63).

SMRU has been deploying telemetry tags on grey seals since 1988 (see Section 3.2.2). BOWL- and MORL-commissioned work examined these data to determine the extent of movement of (1) pups from breeding sites and (2) animals aged one year and above (Russell 2011). All telemetry locations were cleaned according to SMRU protocol (Russell et al. 2011) and, where appropriate, corrected for

positional error using a linear Gaussian state space Kalman filter (Royer and Lutcavage 2008; Jones et al. 2011).

Grey seal pups showed considerable inter-individual variation in the extent of movements they made upon departing from breeding colonies (Figure 64). For example, pups tagged at the Isle of May made movements out into the North Sea both close to and far from shore; some travelled great distances, moving as far afield as Norway and The Netherlands (Figure 64). Although there have not been any telemetry deployments on pups at the Helmsdale breeding colony, it is likely that their movements will be consistent with those of pups which were tagged at the breeding colonies shown in Figure 64.

For grey seals aged one year and above, a buffer zone was generated which extended 100km from the boundary of the potential BOWL and MORL wind farm development sites (Russell 2011). Data were presented if a location was recorded inside the buffer zone (Figure 65; Figure 66). Grey seals aged one year and above ranged widely e.g. the individual which travelled to the Faroe Islands. There is a high probability that grey seals using the Moray Firth and/or the BOWL site have hauled out, or will haul out, at some point at one or more of the six Scottish grey seal SACs (Figure 65; Figure 66; see Section 4.9.4).

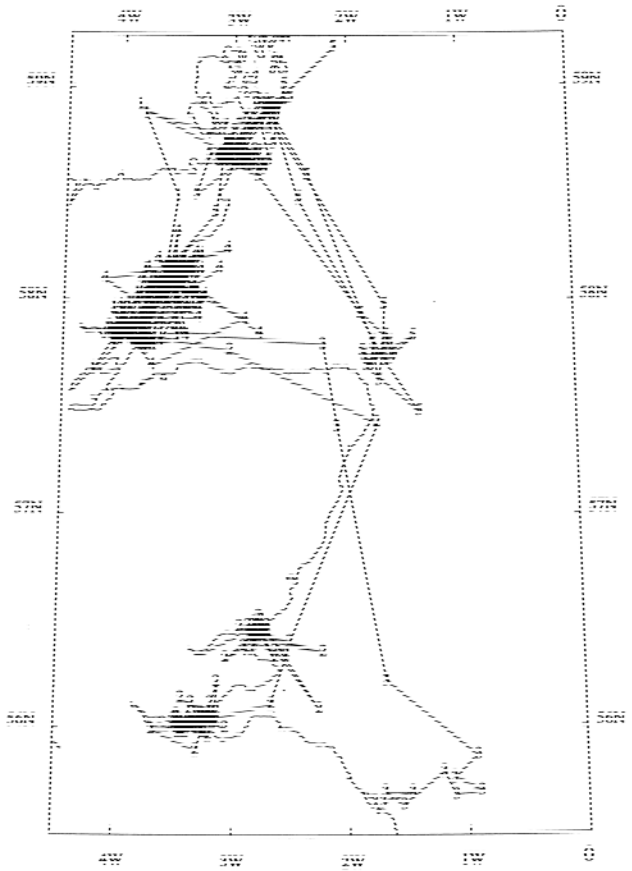

Figure 62. Mean daily locations of five grey seals satellite tagged in the Moray Firth illustrating the long-range movements made by four of the five individuals (taken from Thompson et al. 1996).

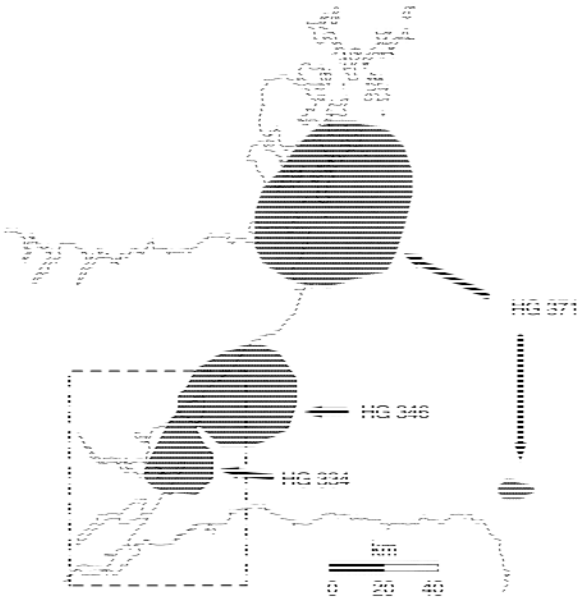

Figure 63. Foraging areas of three satellite tagged grey seals (taken from Thompson et al. 1996).

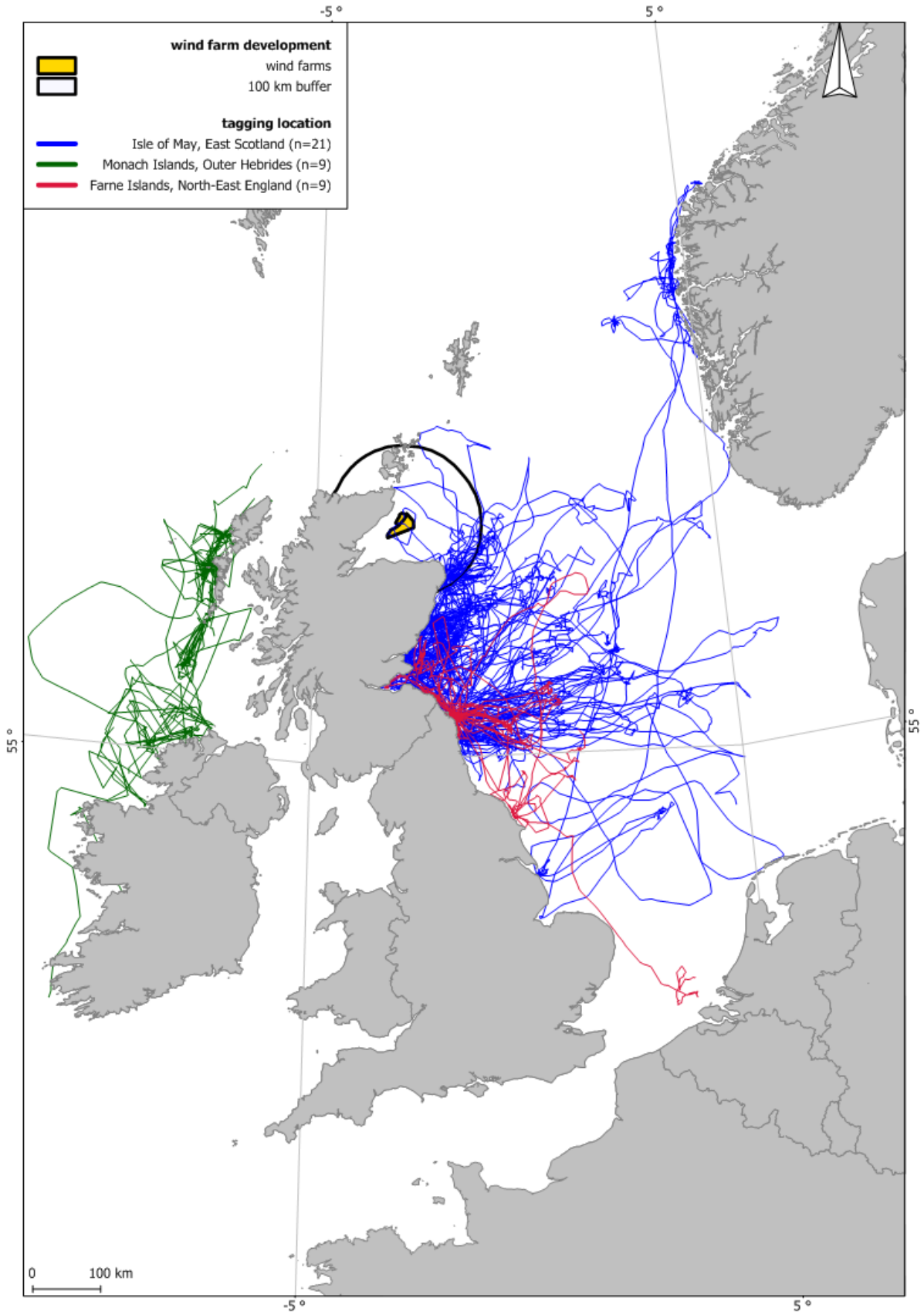

Figure 64. The extent of grey seal pup (n=39) movements from the breeding sites where they were tagged (taken from Russell 2011). The tracks are colour coded by tagging location (see legend). The solid black line shows a 100km buffer zone around the BOWL and MORL wind farm sites.

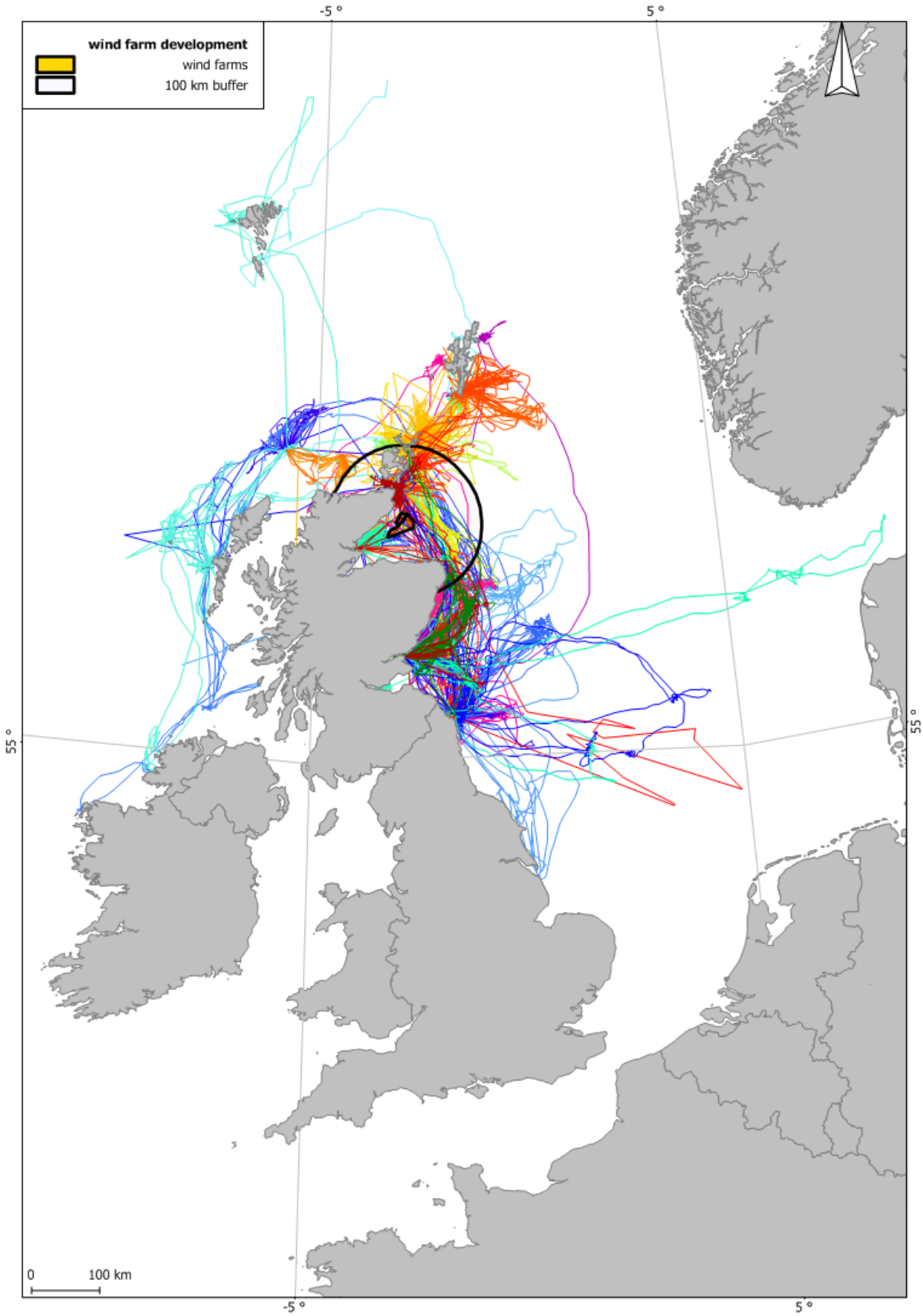

Figure 65. Tracks of grey seals (aged one year and above; n=65) which, at least once while they were tagged, entered a 100km buffer zone around the proposed BOWL and MORL wind farm sites. Each colour represents a different individual (taken from Russell 2011).

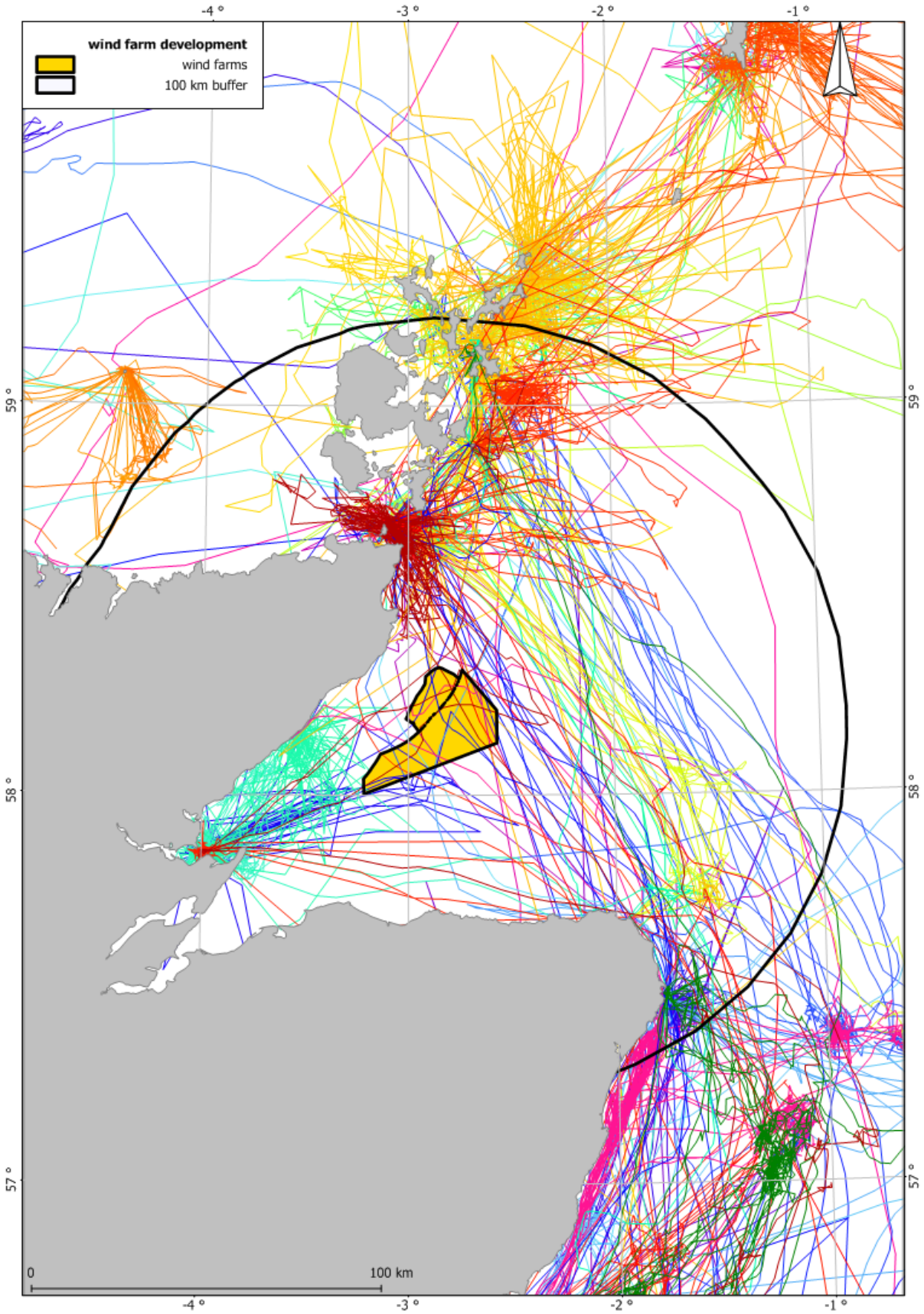

Figure 66. Tracks of grey seals (aged one year and above; n=65) which, at least once while they were tagged, entered a 100km buffer zone around the proposed BOWL and MORL wind farm sites. Each colour represents a different individual. This Figure shows the same information as Figure 65 but is magnified to show the Moray Firth in more detail (taken from Russell 2011).

4.9.6 In the southern Moray Firth (in relation to the cable route)

There are several grey seal haulouts on the southern Moray Firth coast, the largest of which (at least in August) is at Findhorn (Figure 55), but there are no grey seal breeding colonies. The outer Moray Firth appears to be used primarily by grey seals transiting between sites to the south of the Moray Firth and sites in Orkney (Figure 66).

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6 Appendices

Appendix 1: Thompson, P. and Brookes, K. 2011. Technical report on pre-consent marine mammal data gathering at the MORL and BOWL wind farm sites. University of Aberdeen report to MORL and BOWL.

Appendix 2: Thompson, P. 2011a. Bottlenose dolphin densities across the Moray Firth. Unpublished University of Aberdeen report to BOWL.

Appendix 3: Jones, E. and Matthiopoulos, J. 2011. Grey seal usage maps for MORL/BOWL developments. SMRU Ltd report to MORL and BOWL.