

Inch Cape Offshore Wind Farm

New Energy for Scotland

Offshore Environmental Statement:
VOLUME 2E
**Appendix 14A: Marine Mammals
Baseline**



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Glossary

OPSAR Convention	The Convention for the Protection of the marine Environment of the North East Atlantic.
Habitats Directive	Council directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna.
Conservation Regulations 1994	Transpose Council Directive 92/43/EEC (Habitats Directive) into UK national law.
Offshore Marine Regulations 2009	Transpose Council Directive 92/43/EEC (Habitats Directive) into UK national law for offshore waters.
Habitat Regulations Appraisal	Required under the Habitats Directive to assess development plans which may affect Natura sites.
Natura sites	Collective term for protected areas designated under the Habitats Directive and the Birds Directive.

Abbreviations and Acronyms

AIC	Akaike information criterion	OWF	Offshore wind farm
ASCOBANS	Agreement on the conservation of small cetaceans of the Baltic, North East Atlantic, Irish and North Seas	PAM	Passive acoustic monitoring
		PTS	Permanent threshold shift
		R3	Round three zone
BERR	Department for Business, Enterprise and Regulatory Reform	SAC	Special area of conservation
		SCANS	Small cetacean abundance in the North Sea
CV	Coefficient of variation	SCOS	Special Committee on Seals
DECC	Department of Energy and Climate Change	SE	Standard error
EPS	European protected species	SMRU	Sea Mammal Research Unit
ES	Environmental statement	SMRU Ltd	Sea Mammal Research Unit Ltd
FTOWDG	Forth and Tay Offshore Wind Developers Group	SNH	Scottish Natural Heritage
ICOL	Inch Cape Offshore Limited	STW	Scottish territorial waters
IWC	International Whaling Commission	TCE	The Crown Estate
		TTS	Temporary threshold shift
JCP	Joint Cetacean Protocol	UKBAP	United Kingdom Biodiversity Action Plan
JNCC	Joint Nature Conservation Committee		
km	kilometres		
m	meter		
MS	Marine Scotland		
NPC	Natural Power Consultants		
NnG	Neart na Gaoithe		
OSPAR	Convention for the protection of the marine environment of the North East Atlantic		

14A Marine Mammals Baseline

14A.1 Background

14A.1.1 Introduction

Inch Cape Offshore Limited (ICOL) proposes to develop the Inch Cape Offshore Wind Farm in the outer Firth of Tay, Scotland. The Offshore Wind Farm (OWF) is situated approximately 15 km to the east of the Angus coastline in Scottish Territorial Waters (STW). Export cables are to run from the southern end of the Development Area to one of two cable landfall options at either Cockenzie or Seton Sands.

This baseline characterisation provides details of marine mammals that have been observed within the vicinity of the Inch Cape Development Area and associated Offshore Export Cable Corridor.

14A.1.2 Consultations

A number of consultations have been conducted with statutory advisors/regulators to discuss the marine mammal program for the Inch Cape Offshore Wind Farm (Table 14A.1 below). These have resulted in a number of commissioned reports, details of which can be found in *Section 14A.2*.

A summary of further consultation that has informed the methodology of the impact assessment is provided in *Appendix 14B: Marine Mammals Piling Impact Assessment*.

Table 14A.1: Summary of Baseline Consultations

Date	Present	Aims/Outcomes
17 February 2011	Scottish Natural Heritage (SNH), Joint Nature Conservation Committee (JNCC), SMRU Ltd, Natural Research.	To investigate optimisation of surveys to include addition of a marine mammal observer (MMO). Surveys to be spread evenly over year. Forth and Tay Offshore Wind Developers Group (FTOWDG) and Moray Firth developers to share The Crown Estate (TCE) aerial survey data. Harbour seal Special Area of Conservation (SAC) and east coast management unit populations should be investigated.
22 February 2012	SNH, Marine Scotland.	Supportive of proposal to incorporate vessel-based acoustic surveys into marine mammal program. Would like data analysis to be discussed with Neart na Gaoithe developers (NnG) as they have conducted similar surveys.
26 March 2012	SNH and JNCC pre-meeting comments on baseline reports.	<u>Seal baseline reports</u> Note that fewer grey seals have been tagged than harbour seals and that this taken into account when interpreting results.

Date	Present	Aims/Outcomes
		<p><u>Seals reference populations</u></p> <p><u>Harbour Seals</u></p> <p>Confirmed that the Tay and Eden Estuary SAC is the only harbour seal SAC to be considered.</p> <p>Reference population for harbour seals is the east coast management unit but take into account the Firth and Tay and Eden Estuary SAC. Will take the Tay and Eden Estuary SAC population as being equivalent to this.</p> <p><u>Grey Seals</u></p> <p>A wide ranging species therefore they will only be applying the Habitats Regulations Appraisal process to this species as a breeding interest (when the seals are most closely associated with a particular SAC).</p> <p>Grey seal breeding populations of Isle of May SAC and Fast Castle (within Berwickshire and North Northumberland Coast SAC) need to be considered.</p> <p>Population of the east coast management unit can be used as the reference population for the breeding and non-breeding season, with interpretation to consider impacts against each of the SAC populations.</p> <p><u>Cetacean reference populations</u></p> <p><u>Bottlenose Dolphin</u></p> <p>East coast population is to be used as the reference population with the SAC population being equivalent to this.</p> <p><u>Minke Whale</u></p> <p>Uncertain what appropriate reference population is.</p> <p><u>White Beaked Dolphin</u></p> <p>Uncertain what appropriate reference population is.</p> <p><u>Harbour Porpoise</u></p> <p>National population as reference population.</p>

14A.1.3 Species Protection

Marine mammals in UK territorial waters are protected by both European and National Legislation. All cetaceans are listed on *Annex IV* of the *Habitats Directive*, are classed as European Protected Species (EPS) and are fully protected under the *Conservation (Natural Habitats, &c.) Regulations 1994* (as amended in Scotland) and the *Offshore Marine Regulations 2009*.

Harbour seals, grey seals and bottlenose dolphin are species which could be associated with one or more Special Areas of Conservation (SACs). A number of SACs have been designated for marine mammals which are within travelling distance (by the animal) of the

Development Area (Table 14A.2). Movement of animals between the Forth and Tay area and the SACs listed in Table 14A.2 are known to occur, and the potential connectivity of the designated animals with the proposed activities was explored through the HRA screening processes described in detail in Chapter 14.

Table 14A.2: Designated Areas within Travelling Distance of the Development Area Listing Marine Mammals as Notified Features

Special Area of Conservation (SAC)	Distance to site (km)	Area (ha)	Relevant Notified Features
Firth of Tay and Eden Estuary	25	15,413	Common seal ¹ (<i>Phoca vitulina</i>)
Isle of May	32	357	Grey seal (<i>Halichoerus grypus</i>)
Berwickshire and North Northumberland Coast	52	65,046	Grey seal (<i>Halichoerus grypus</i>)
Moray Firth SAC	142	151,347	Bottlenose dolphin (<i>Tursiops truncatus</i>)
Dornoch Firth and Morrich More	246	8,701	Harbour seal (<i>Phoca vitulina</i>); otter (<i>Lutra lutra</i>) ²
Sanday	299	10,972	Common seal (<i>Phoca vitulina</i>)
Faray and Holm of Faray	303	786	Grey seal (<i>Halichoerus grypus</i>)

This HRA screening process identified potential connectivity (and thus Likely Significant Effect) between the Project and:

- The Firth of Tay and Eden Estuary;
- Isle of May;
- Berwickshire and North Northumberland Coast; and
- Moray Firth SAC.

Therefore, the following SACs were not considered further:

- Dornoch Firth and Morrich Moore;
- Sanday; and
- Foray and Holm of Foray.

¹ Note – common and harbour seal are the same species – *Phoca vitulina*. Throughout this document this species has been referred to as “harbour seal”, as commonly used in the scientific community. However this table refers to “common seal” in columns referring to relevant qualifying interests and reason for selection as these are legal documents (as held on JNCC database) and this is how they are referred to in the site designation data forms and Qualifying Interests Lists (QUILs).

² Otters forage in coastal waters, out to approximately 10 m water depth. As such, they are not considered further within this baseline assessment.

14A.2 Baseline

14A.2.1 Introduction

The Firths of Forth and Tay are two estuaries on the east coast of Scotland. The Firth of Forth is the larger of the two, encompassing the coasts of Berwickshire and Lothian and Borders to the south, and Fife to the north. The coastline is generally rocky with some sandy bays. There are a number of islands in the Forth including several which are important for seals (e.g. the Isle of May). The Firth of Tay encompasses the coast of Fife to the south and Tayside to the north. It contains extensive intertidal and sub-tidal sandbanks and a rocky reef, Inch Cape and the Bell Rock, which is occupied by the Bell Rock lighthouse and situated approximately 18 km from Arbroath.

The baseline characterisation has been compiled using existing (published) information and findings of the following studies commissioned by ICOL, the Forth and Tay Offshore Wind Developers Group (FTOWDG) and The Crown Estate (TCE):

- ICOL-commissioned visual boat-based surveys carried out between August 2010 and September 2012. These surveys were conducted by Natural Research Ltd/RPS with reporting and analysis undertaken by Natural Power Consultants (NPC) (Canning, 2012). Sea Mammal Research Unit Ltd (SMRU Ltd) was commissioned to review the original survey protocol and provide recommendations with respect to optimising the design of the survey to collect more robust data on marine mammals, resulting in a dedicated Marine Mammal Observer (MMO) protocol being implemented from December 2010. A second review was conducted by SMRU Ltd at the end of year one, when it was recommended that only data collected by the dedicated MMO be analysed. As a result, even though two years of marine mammal surveys have been conducted, only data collected between December 2010 and September 2012 are presented.
- Analysis of TCE aerial survey data for marine mammals for the FTOWDG (Grellier and Lacey, 2012). The STW and Round 3 (R3) sites within the Firths of Forth and Tay were surveyed during May to August 2009 (summer) and November 2009 to March 2010 (winter). The surveys employed standard visual aerial survey methods to record seabirds and marine mammals. Encounter rates (which can be used as a basic index to make comparisons between the 'relative abundance' of different species) and densities were derived (Grellier and Lacey, 2012).
- Bottlenose dolphin baseline report (Quick and Cheney, 2011).
- Seals baseline report (Sparling *et al.*, 2012).
- An integrated cetacean analysis for the three FTOWDG sites (Mackenzie *et al.*, 2012).
- Boat-based passive acoustic monitoring (PAM) surveys.
- Estimation of detection probability and absolute abundance from joint visual and acoustic surveys for harbour porpoise (Leaper and Gordon, 2012: *Annex 14A.1: Strip Width Acoustic Analysis for Harbour Porpoise*).

- Analysis of acoustic data of white-beaked dolphins during surveys at the Inch Cape Development Area and Neart na Gaoithe (Wittich and Gordon, 2012: *Annex 14A.2: White-beaked Dolphin Acoustic Analysis*).

The following piece of work has been commissioned and is underway:

- Collection of PAMBuoy data through PAMBuoy deployment being undertaken by St Andrews University.

This work stream will report after the submission of this ES, and it is hoped that analysis of the data provides further inform understanding of bottlenose dolphin and porpoise movements within the coastal strip of the Firth of Tay.

14A.2.2 Cetaceans

Two species of cetacean can be observed in the Firths of Forth and Tay throughout the year (harbour porpoise and bottlenose dolphin) and two species occur seasonally (minke whale and white-beaked dolphin). Other species which occur on a more occasional basis include killer whale (e.g. in 2006 and 2007 and during commissioned studies), sperm whale (e.g. in 1997), humpback whale (e.g. in 2003 and 2006), long-finned pilot whale (e.g. during commissioned studies), common dolphin (e.g. during commissioned studies) and white-sided dolphin.

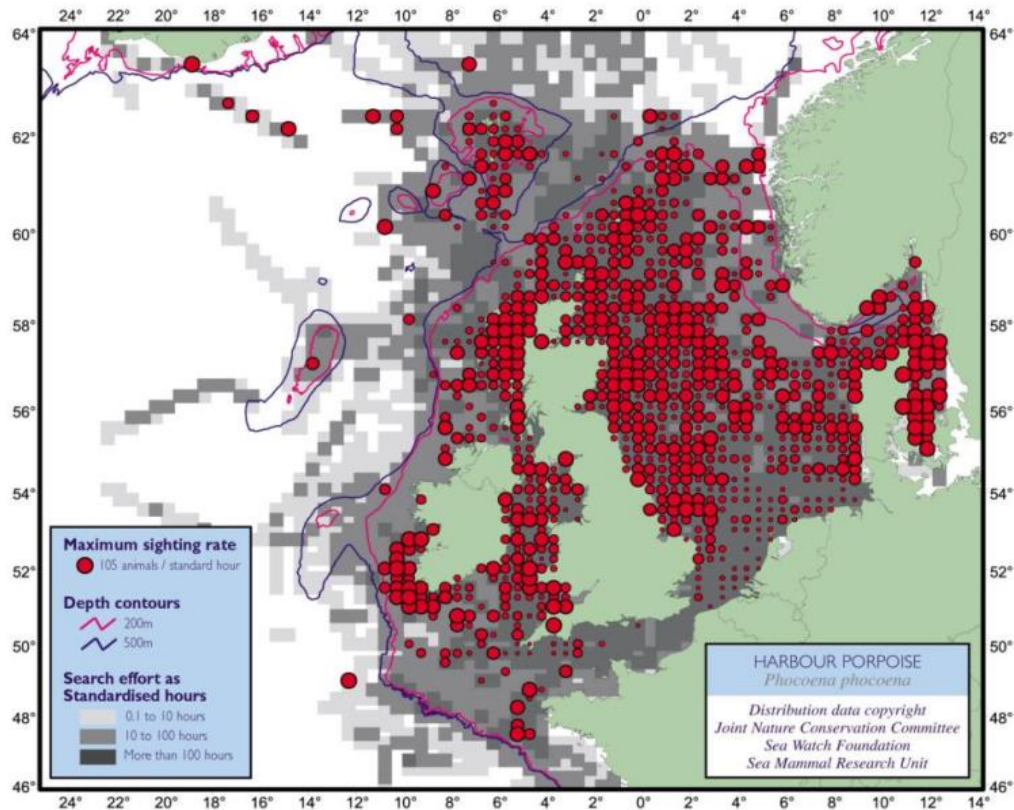
Harbour Porpoise (*Phocoena phocoena*)

Harbour porpoise is the most commonly encountered cetacean in the outer Firths of Forth and Tay (see Figure 14A.1 for UK distribution). It is the most common small cetacean in the eastern North Atlantic and can be seen all round the Scottish coast (Reid *et al.*, 2003). The UK conservation status assessment for harbour porpoises is 'favourable' (JNCC, 2007).

They are typically found in cool, temperate waters of the northern hemisphere (Reid *et al.*, 2003) in water depths of 20-200 m (Evans *et al.*, 2003). Sightings data collected during surveys off the west coast of Scotland indicated a preference for waters within 15 km of the shore and between 50 and 150 m depth (Marubini *et al.*, 2009). There is also a relationship between tidal variables and porpoise distribution with more sightings predicted for high tidal stream speed areas and times of high tide (Marubini *et al.*, 2009).

In UK waters, mating and calving periods are estimated to take place between April and August (Jefferson *et al.*, 2008) with a peak around June and July (Lockyer, 2007). Seabirds at Sea Team (JNCC) data from 1979 to 1991 show the highest rate of porpoise sightings in the northern North Sea in April to June (the calving season), and July to September. These changes may be the result of porpoises moving into the northern North Sea from Norwegian waters (Northridge *et al.*, 1995).

Porpoises occur in small groups or singly and frequently use narrow sounds or bays. They are typically shy of boats and other anthropogenic activities and therefore are likely to be easily disturbed.

Figure 14A.1: Sightings of Harbour Porpoise around the UK (Reid *et al.*, 2003)

Distribution, Seasonal Patterns and Group Size

Harbour porpoises were the most commonly sighted cetacean during both the ICOL commissioned visual boat-based surveys (Canning, 2012) and TCE aerial surveys (Grellier and Lacey, 2012). Porpoises were observed throughout both the boat based and aerial surveys (Figure 14A.2). Sightings were more common during the summer (Figure 14A.4) than in winter (Figure 14A.5) although sightings were made in every month (Figure 14A.6). Porpoises were most often seen singly although group size ranged from one to six individuals (Figure 14A.3). Harbour porpoises were also seen in the Firth of Tay and St Andrews Bay area during the 2009 and 2010 photo-identification surveys (Quick and Cheney, 2011).

Harbour porpoise encounter rates during TCE aerial surveys were generally greater between May and August 2009 than between November 2009 and March 2010 (Figure 14A.7). Because no environmental data were contained within the observation or effort files, there is currently no means of assessing the effect of varying sighting conditions on encounter rates. For example, a consistently higher sea state in winter than summer could result in this pattern, as could greater numbers of animals being present in summer. However, a similar seasonal pattern in sightings was apparent from the visual boat-based survey data (Figure 14A.6).

Harbour porpoise encounter rate during TCE surveys increased with distance from shore (from less than one to between four and five sightings per 100 km; Figure 14A.8). Although the error bars were quite tight for the middle section of transects (22-42), variability was

greater for transects 43-57, meaning that there was greater temporal variation in encounter rate further offshore. Survey track lines for the ICOL commissioned surveys were perpendicular to the coast so direct comparisons between the TCE and boat based surveys, within the Development Area, cannot be made. However, the monthly encounter rates during these surveys ranged between 0.62 porpoise per 100 km (February) to 9.21 per 100 km (August). Overall, the encounter rate for the boat-based surveys was 2.97 porpoise per 100 km.

Figure 14A.2: Distribution of Harbour Porpoise Sightings Recorded within the Inch Cape Development Area and 4 km Buffer Zone during the Visual Boat-based Surveys (Canning, 2012)

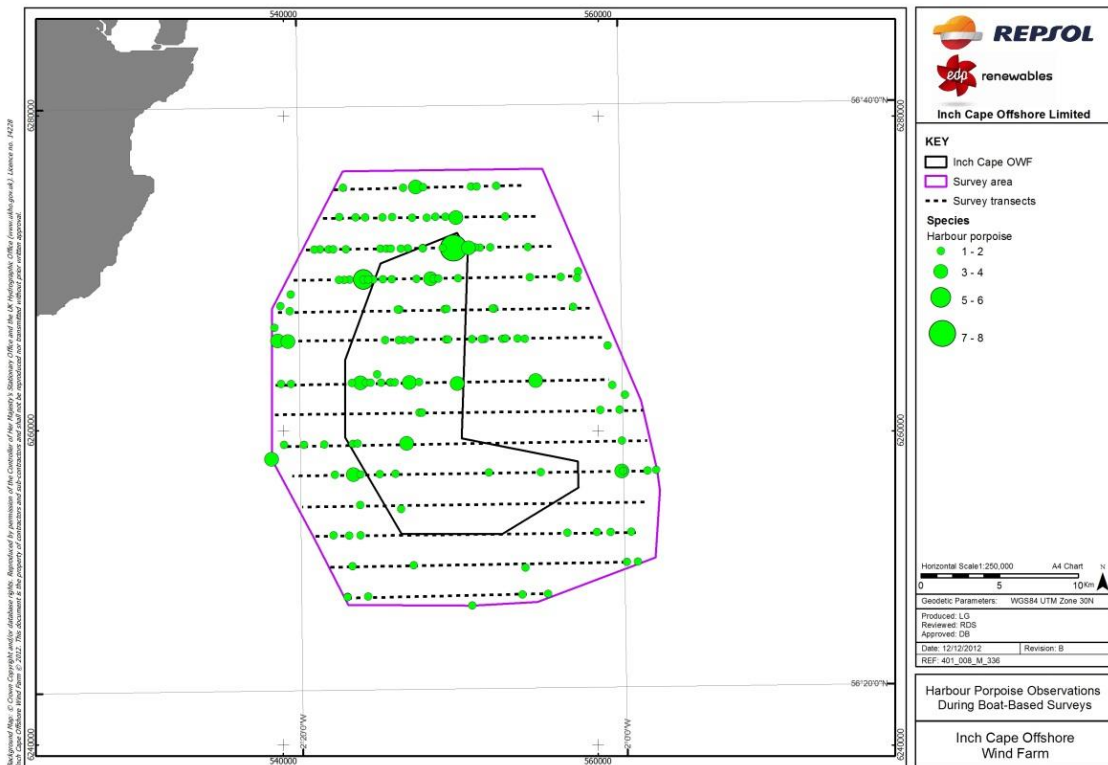


Figure 14A.3: Harbour Porpoise Distribution during TCE Aerial Surveys (Grellier and Lacey, 2012)

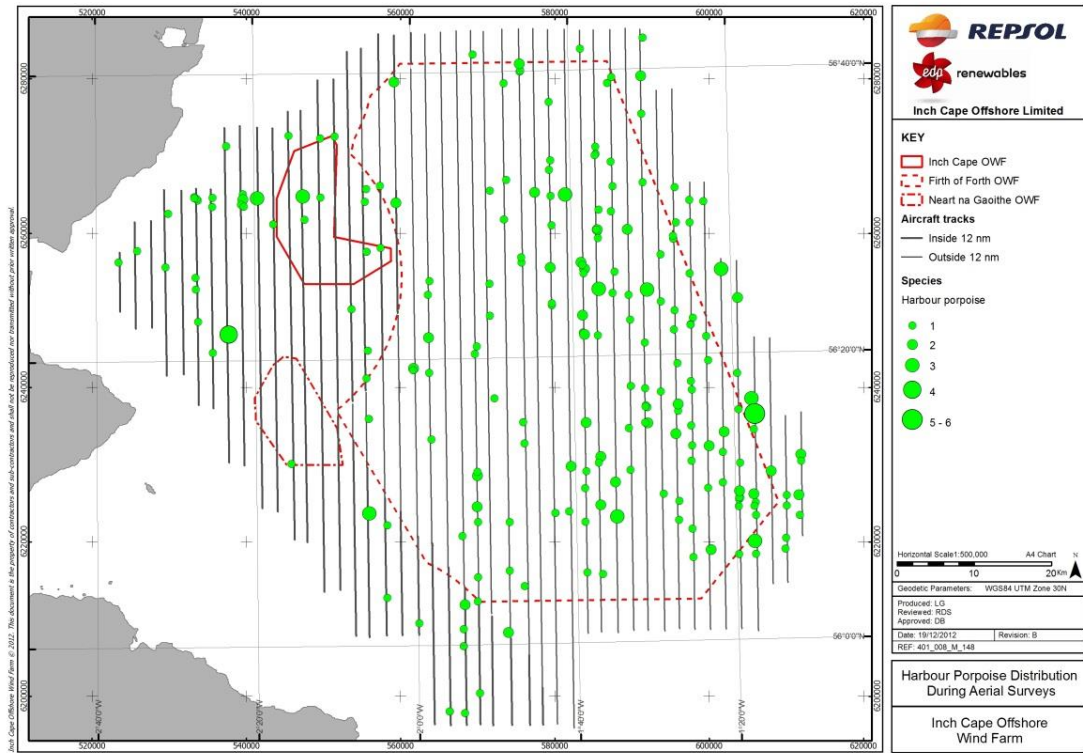


Figure 14A.4: Harbour Porpoise Distribution during Summer TCE Aerial Surveys (Grellier and Lacey, 2012)

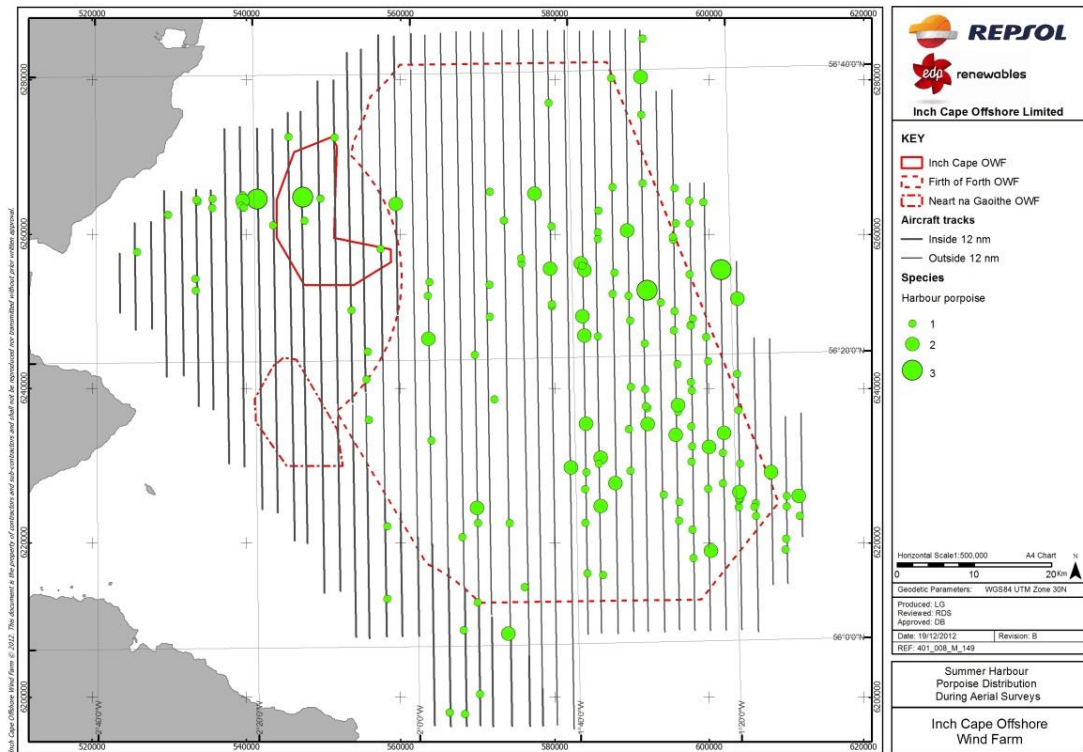


Figure 14A.5: Harbour Porpoise Distribution during Winter TCE Aerial Surveys (Grellier and Lacey, 2012)

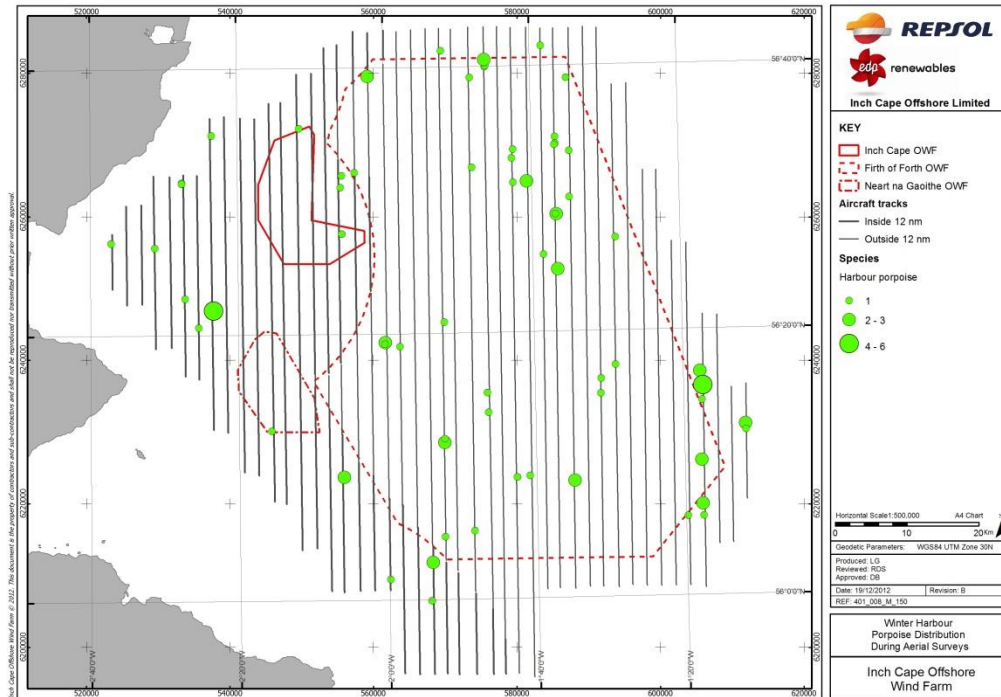


Figure 14A.6: The Number of Harbour Porpoise Observed (green line), the Mean Number of Sightings per km Survey Effort (red line) and the Mean Number of Individual Animals (blue bars) per km of Survey Effort for Each Calendar Month During the Visual Boat-based Surveys December 2010 - September 2012 (Canning, 2012). For distribution map of these sightings, refer to Figure 14A.2

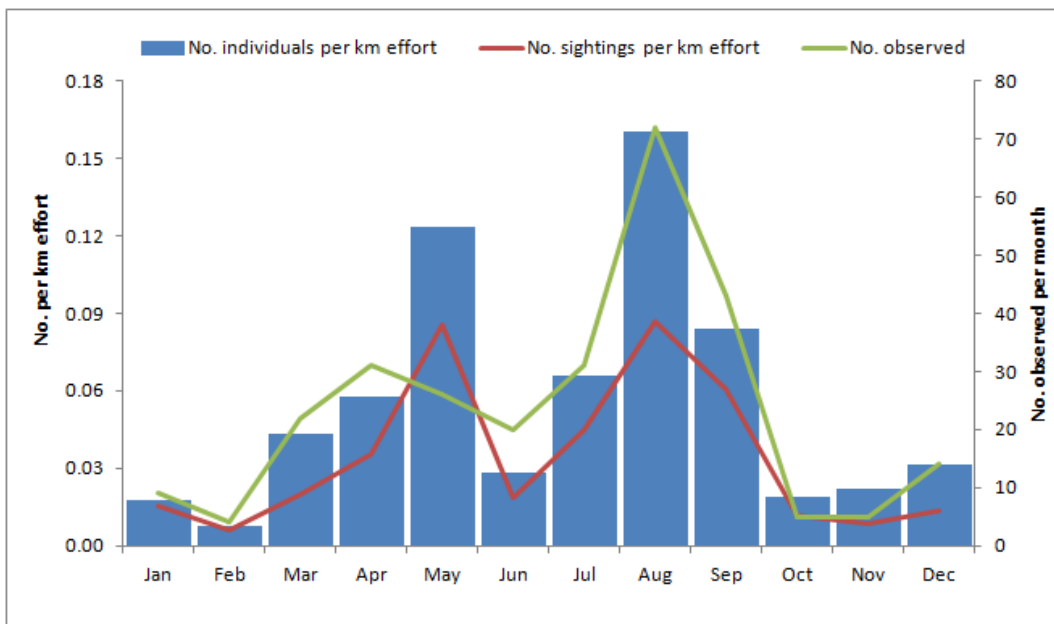


Figure 14A.7: Harbour Porpoise Encounter rate (sightings per 100 km) ± Standard Error by Month during TCE Aerial Surveys (Grellier and Lacey, 2012). No surveys were carried out in September or October

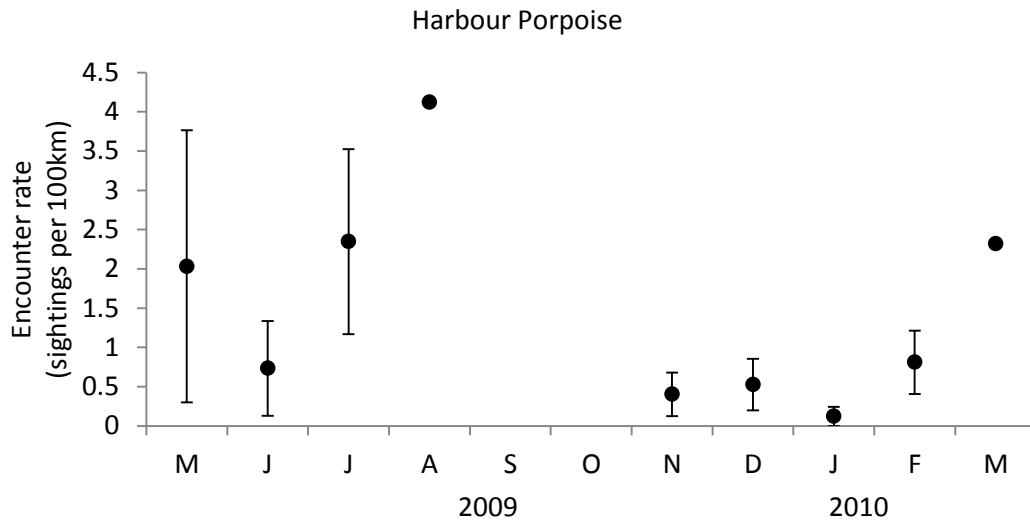
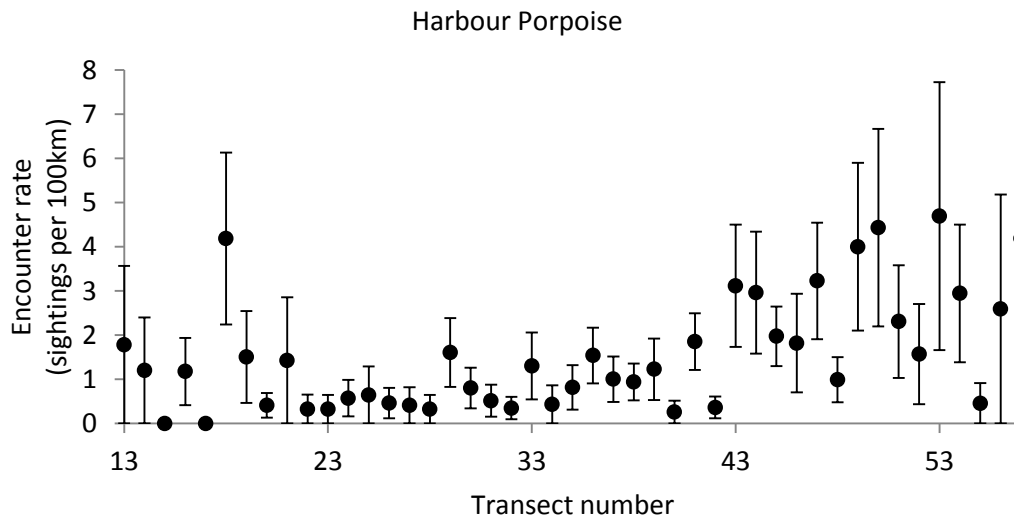


Figure 14A.8: Encounter Rate (sightings per 100 km) ± Standard Error per Transect for Harbour Porpoise during TCE Serial Surveys (Grellier and Lacey, 2012). Transect 13 is the western-most transect, transect 57 is the eastern-most transect. Transects 13-26 were completely inside 12 nm, transects 27-41 crossed the 12 nm contour, and transects 42-57 were completely outside 12 nm



Abundance

The abundance estimate from the 2005 SCANS II survey block incorporating the Inch Cape Offshore Wind Farm Development Area (Block V, which has a surface area of 160,517 km²) is 47,131 (CV = 0.37; SCANS II, 2008). Bjørge and Øien (1995) estimated that there were 82,600 porpoises in the North Sea north of 56°N. This estimate is known to be biased downwards because the probability of detection on the transect line was assumed to be one. There are no other harbour porpoise abundance estimates for the North East Atlantic.

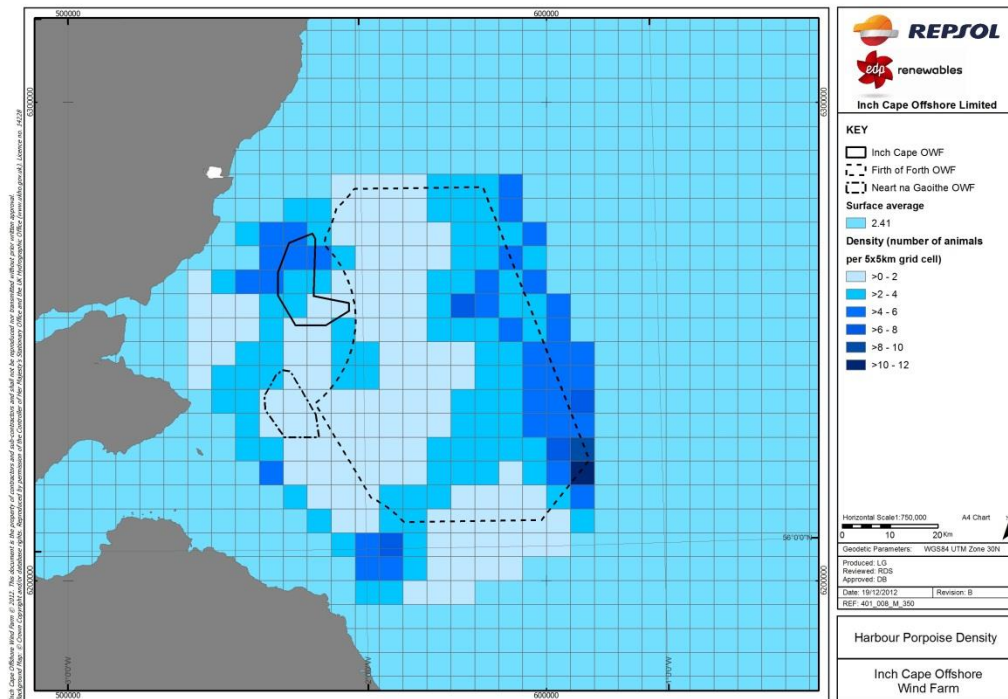
FTOWDG commissioned an integrated analysis of shared cetacean data using individual developer’s boat-based surveys along with TCE aerial survey data (MacKenzie *et al.*, 2012). This analysis addressed availability and potential detectability issues within the data sets, and provides an estimate of abundance for harbour porpoise within the combined survey area (Table 14A.3). Visual representation of the absolute density per km² for the combined survey area can be found in Figure 14A.9.

For the purpose of this assessment, the reference population for harbour porpoise is based on the SCANS II estimate for the North Sea (Blocks T, V and U), estimated at 159,040 animals.

Table 14A.3: Abundance Estimates for Harbour Porpoise from Integrated Cetacean Analysis. Numbers represent estimates for all FTOWDG development sites combined, surveyed between 2009 and 2011 (MacKenzie *et al.*, 2012)

	Estimate	95% Confidence Intervals
Relative abundance ³	252.8	252.27 - 236.02
Absolute abundance ⁴	582.4	581.28 – 1235.07

Figure 14A.9: Estimated Harbour Porpoise Absolute Density per km² Based on Corrected Count Data (MacKenzie *et al.*, 2012)



³ Relative abundance refers to how common a species is within a defined area.

⁴ Data adjusted to take into account sighting availability (i.e. were the animals at the surface and available for counting) using a value of 0.434 based on Westgate *et al.*, 1995 and Thomsen *et al.*, 2006.

Density

Harbour porpoise density estimates are available from TCE aerial, SCANS and ICOL-commissioned visual boat-based surveys (Table 14A.4). The large-scale SCANS estimates were an order of magnitude greater than either TCE aerial or visual boat-based survey estimates. However, the surveys were carried out at different times and extents using different survey design and methodology.

The SCANS estimates were made using a 'line transect' approach (Hammond *et al.*, 2002; SCANS II, 2008).

TCE aerial survey estimates were made using a modified 'strip transect' approach. The assumption that all animals present within the strip are observed was violated because marine mammals spend a proportion of their time underwater. The consequence of this is that density from these surveys will have been underestimated. Given the high degree of uncertainty surrounding the extent to which this has occurred, Grellier and Lacey (2012) did not recommend their use in quantitative impact assessments.

The boat-based survey estimates were made using a hazard rate and a half normal detection function and the best model was chosen based on the lowest Akaike's Information Criterion or AIC (a measure of goodness of fit and model complexity). A hazard rate detection function provided the best model for harbour porpoises and the data were truncated at 400 m. The models were repeated again, with and without sea state. The model with sea state provided the lowest AIC (and therefore the better model) for harbour porpoises.

As well as the single density estimates, density surfaces have been produced using the SCANS and SCANS II data (Figure 14A.10). Accessing these data would be useful (but was not possible) for the impact assessment, but in their absence, the single SCANS II density estimate (0.294 animals per km²; Table 14A.4) has been used as a general density surface for harbour porpoise. It is felt that this estimate is most appropriate because TCE aerial and boat survey estimates are likely to be under-estimates.

An assumption when estimating abundances or densities is that all animals were observed during the survey, although with marine mammals this is rarely the case. MacKenzie *et al* (2012) applied a correction factor to their integrated cetacean analysis to account for this, referred to as the "absolute abundance" in Table 14A.3, based on published data regarding surfacing patterns of cetaceans. The SCANS II ship surveys used two teams of observers following a mark-recapture method to aid in the estimation of animals missed (referred to as $g(0)$) for a number of cetacean species including harbour porpoise, white-beaked dolphin and minke whale (Hammond, 2006). It is interesting to note that if the SCANS II $g(0)$ of 1/0.22 is applied to the TCE aerial survey density estimates (0.08), the resulting density estimate is 0.364 porpoises per km², which is not dissimilar to the SCANS II estimate.

A trial was commissioned by ICOL, to investigate whether a value for $g(0)$ could be calculated for the boat surveys using the visual and PAM data as two platforms (Leaper and Gordon 2012, *Annex 14A.1: Strip Width Acoustic Analysis for Harbour Porpoise*). This produced a

slightly higher value for $g(0)$ than that calculated for the SCANS surveys and when applied to the boat-survey data, produces a density estimate of 0.19 animals/km²) see Table 14A.4).

Table 14A.4: Harbour Porpoise Density Estimates Pertinent to Assessment

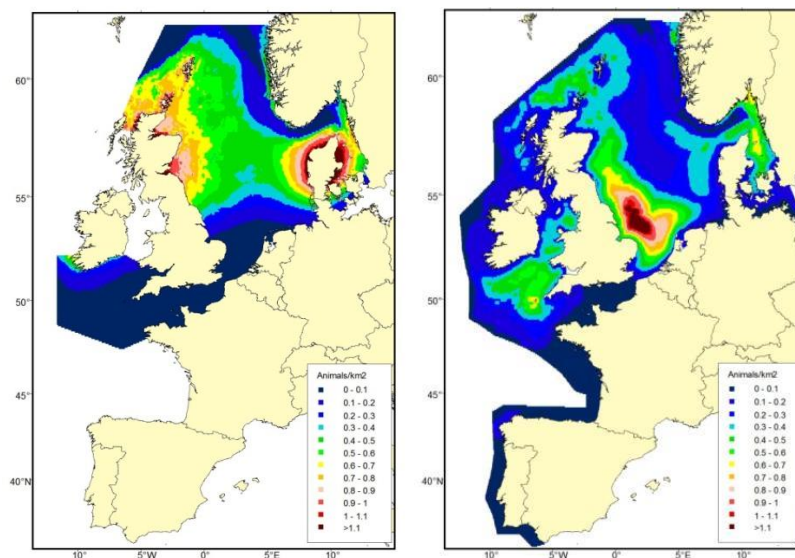
Survey	Time period	Method	Density (animals per km ²)	CV	Other information	Reference
SCANS	July 1994	Line transect	0.387	0.18	This estimate is for Block C. Block size is 43,744 km ² .	Hammond et al., 2002
SCANS II	July 2005	Line transect	0.294	0.37	This estimate is for Block V.	SCANS II, 2008
TCE aerial survey ⁵	May 2009 to March 2010	Strip transect	0.080 Summer = 0.099 Winter = 0.0486	0.11 0.12 0.24	If SCANS II value for $g(0)$ applied, density = 0.36	Grellier and Lacey, 2012
Visual boat-based surveys	December 2010 to September 2012	Line transect	0.058	0.19	If adjusted for $g(0)$, density = 0.19 If SCANS II value for $g(0)$, density = 0.27	Canning, 2012

For the purpose of assessment, the densities presented in Figure 14A.9 were applied as this data is spatially and temporally more relevant for the area. An average density based on this same data has been used for the areas outside of the study area.

⁵ TCE aerial survey density estimate should be considered as a minimum estimate due to the inherent negative bias (Grellier and Lacey, 2012).

⁶ Summer is May to August, winter is November to March.

Figure 14A.10: SCANS (left) and SCANS II (right) Estimated Density Surfaces for Harbour Porpoise (redrawn from SCANS II, 2008)



Diet

The diet of porpoises in Scottish waters has been studied using stomach contents of stranded animals (Santos and Pierce, 2003; Santos *et al.*, 2004). The most important prey types, in terms of contribution by number and weight, were whiting (*Merlangius merlangus*) and sandeels (*Ammodytidae*). Sandeels were more important in the summer months (April-September). The number present and sizes of some prey species found in the stomachs examined were consistent with trends in abundance and size of fish taken during research trawl surveys, suggesting porpoises are opportunistic feeders. There was some evidence that young porpoises (less than one year old) took more gobies (*Gobiidae*) and shrimp than older porpoises. Clupeids (herring *Clupea harengus* and sprat *Sprattus sprattus*) formed a relatively small proportion of the diet, but their importance varied from year to year. Although possible methodological biases prevent firm conclusions, it appears that the importance of clupeids in porpoise diet may have decreased since the 1960s, mirroring the decline in North Sea herring abundance. The recovery of the North Sea herring stock in recent years is not as yet reflected in porpoise diet.

Bottlenose Dolphin (*Tursiops truncatus*)

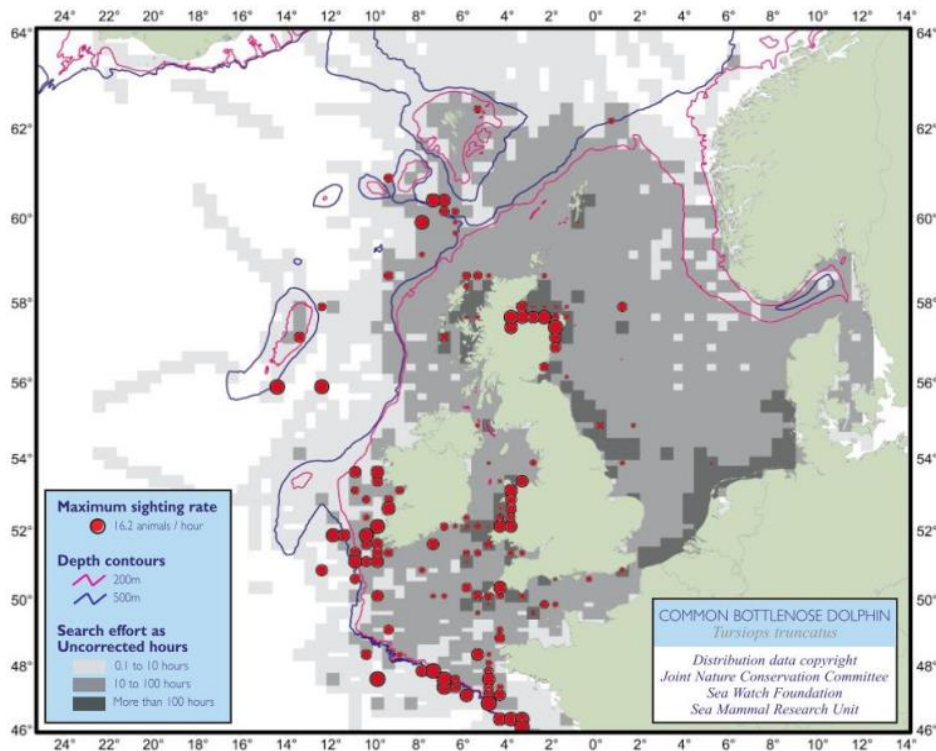
Bottlenose dolphins have a worldwide distribution. In the UK there are two main 'population centres' – one off the Scottish east coast and the other off west Wales (Figure 14A.11). Parts of both areas have been designated as SACs with the species as the primary reason for the designation. The historical distribution of bottlenose dolphins around Scotland was recently reviewed by Thompson *et al.* (2011). Although these animals are often referred to as the 'Moray Firth dolphins', the range of the population expanded in the 1990s with animals routinely using areas adjacent to the SAC in the southern Outer Moray Firth (Culloch and Robinson, 2008), off the Aberdeen coast (Weir *et al.*, 2008) and as far south as St Andrews Bay (Quick, 2006). In recent years, individuals known from the Moray Firth have been sighted

as far south as the Tyne (Thompson *et al.*, 2011). Changes in prey distribution are the most likely reason for this apparent range expansion (Wilson *et al.*, 2004).

The UK conservation status assessment for bottlenose dolphins is ‘favourable’ (JNCC, 2007).

Varying levels of visual survey effort have been undertaken in the Firth of Tay and St Andrews Bay area in the last 14 years (1997-2011). Surveys generally take place during the summer months (May to September) although there has been some winter effort (in 2007/2008; Thompson *et al.*, 2011). In addition to visual survey effort, passive acoustic monitoring has also been undertaken (2006-2009; Thompson *et al.*, 2011). The research has been supported by a variety of organisations, as part of various projects, on the understanding that the data and resulting analytical outputs are made available to support/answer additional research and management questions. Information in this section has mainly been drawn from published sources. The unpublished data reported in Quick and Cheney (2011) are owned by the Sea Mammal Research Unit, University of St Andrews and the University of Aberdeen.

Figure 14A.11: Sightings of Bottlenose Dolphin around the UK (Reid *et al.*, 2003)



Distribution

Scottish bottlenose dolphins range over large distances (Wilson *et al.*, 2004) and exhibit varying levels of residency in the different areas they occur, with many individuals being re-sighted within the same areas (such as St Andrews Bay and the Firth of Tay) both within and between years (Wilson *et al.*, 1997; Quick, 2006; Thompson *et al.*, 2011).

In the summers of 2009 and 2010, dedicated photo-identification surveys took place in the Firth of Tay and St Andrews Bay area (Quick and Cheney, 2011). All trips departed from

Tayport and employed opportunistic search patterns until bottlenose dolphins were encountered. Sixteen trips were carried out and 69 dolphin groups were encountered. Group size ranged from 1-35. In both years the majority of encounters took place within the Tay estuary on the northern side of the large sand bar that marks the south side of the shipping channel (Figures 14A.12 to 14A.16) i.e. within 20 km of the Inch Cape Development Area and Neart na Gaoithe STW site, and within 30 km of the R3 Firth of Forth site (Figure 14A.16).

It should be noted that systematic (line-transect) surveys of the entire area have not been undertaken and therefore the distribution of encounters does not necessarily represent the overall distribution of dolphins in the area.

Although dolphins were not encountered south of the Tay sand bar, delphinid whistles have been detected by a moored acoustic device which was deployed in St Andrews Bay in 2011 (SMRU Ltd, unpublished data). Although species level confirmation has not been possible it is likely that these are from bottlenose dolphins.

Figure 14A.12: Effort from all Eight 2009 Photo-identification Surveys including Encounter Locations (Quick and Cheney, 2011)

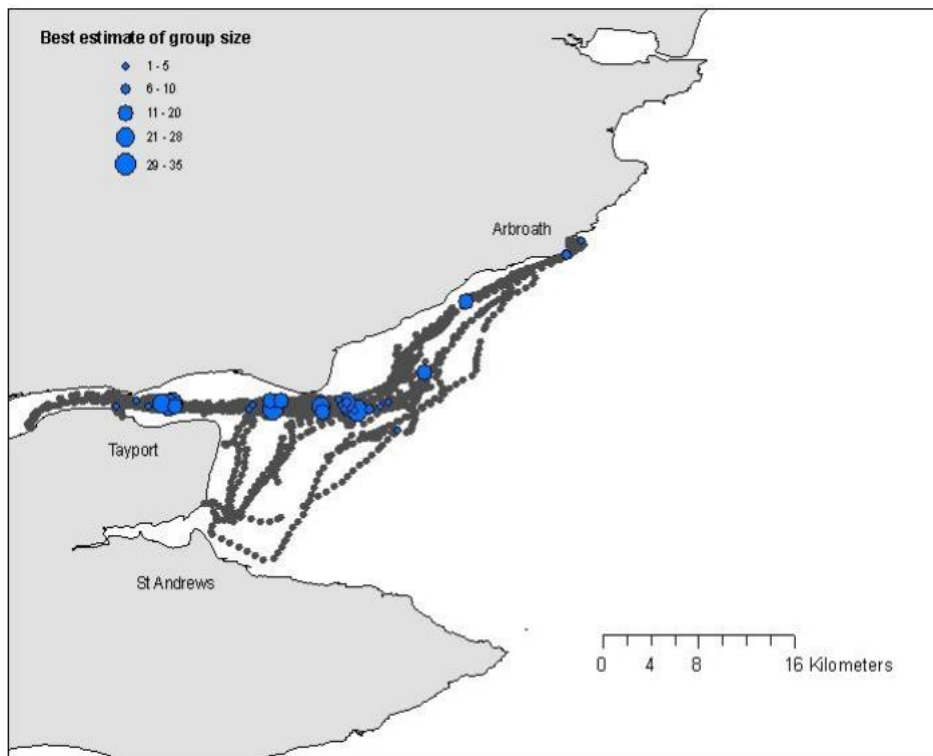


Figure 14A.13: 2009 Encounter Locations, with Size of Circles Indicating Group Sizes (Quick and Cheney, 2011)

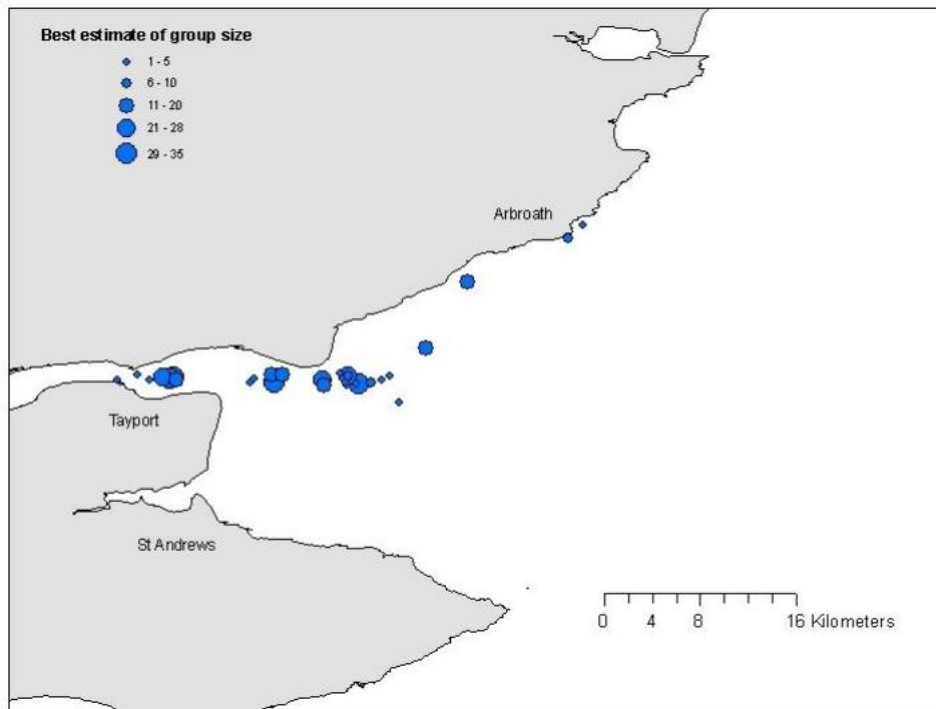


Figure 14A.14: Effort from all Eight 2010 Photo-identification Surveys including Encounter Locations (Quick and Cheney, 2011)

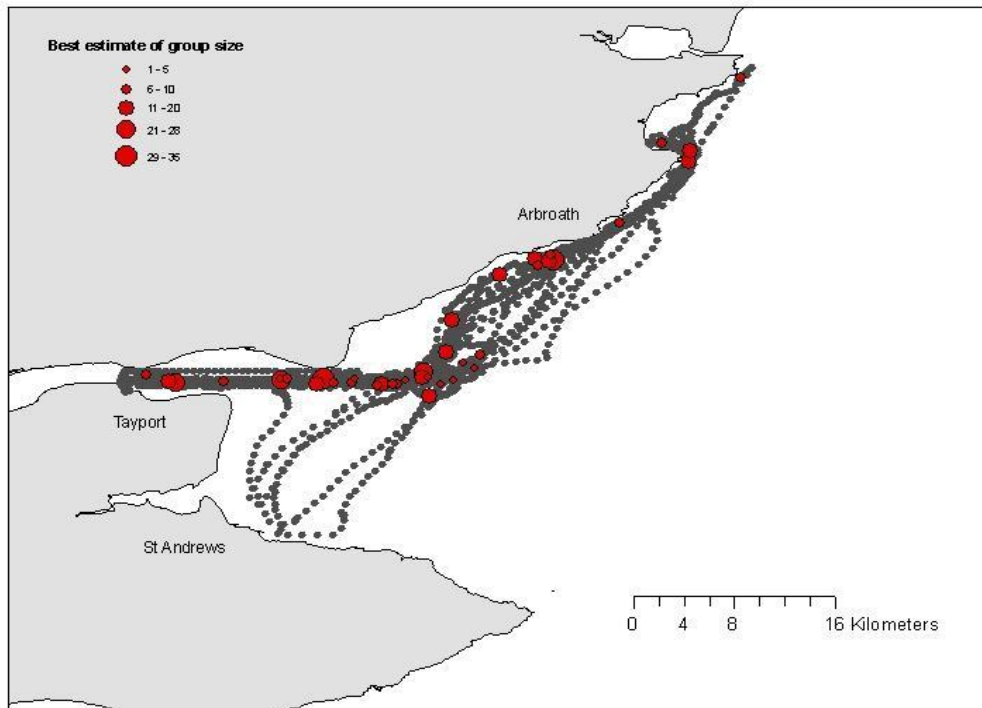


Figure 14A.15: 2010 Encounter Locations, with Size of Circles Indicating Group Sizes (Quick and Cheney, 2011)

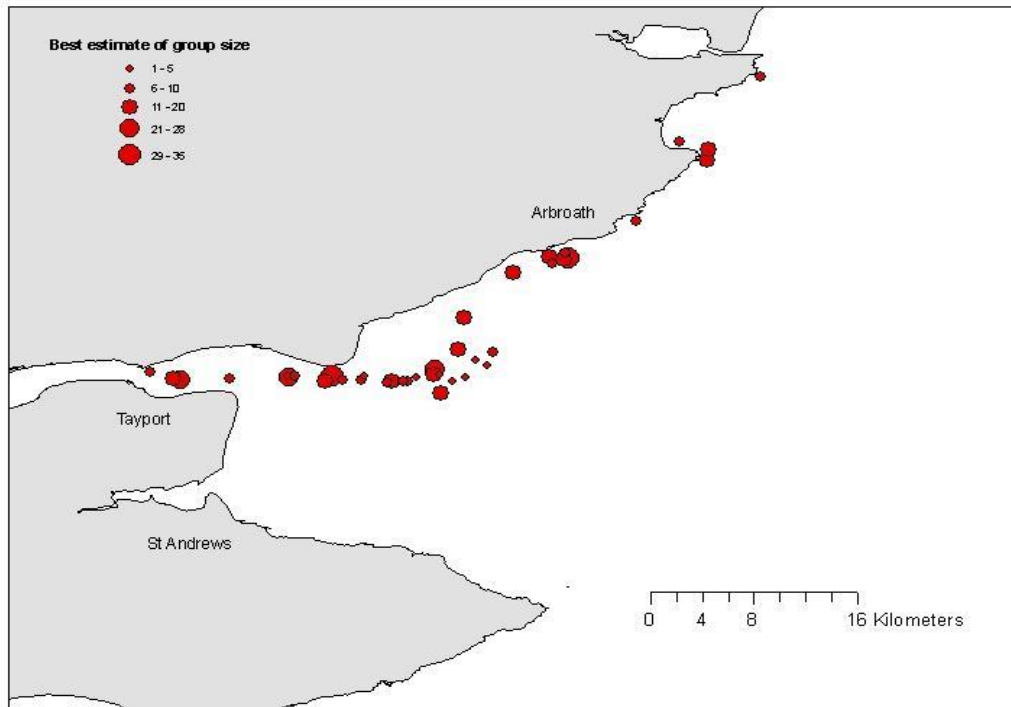
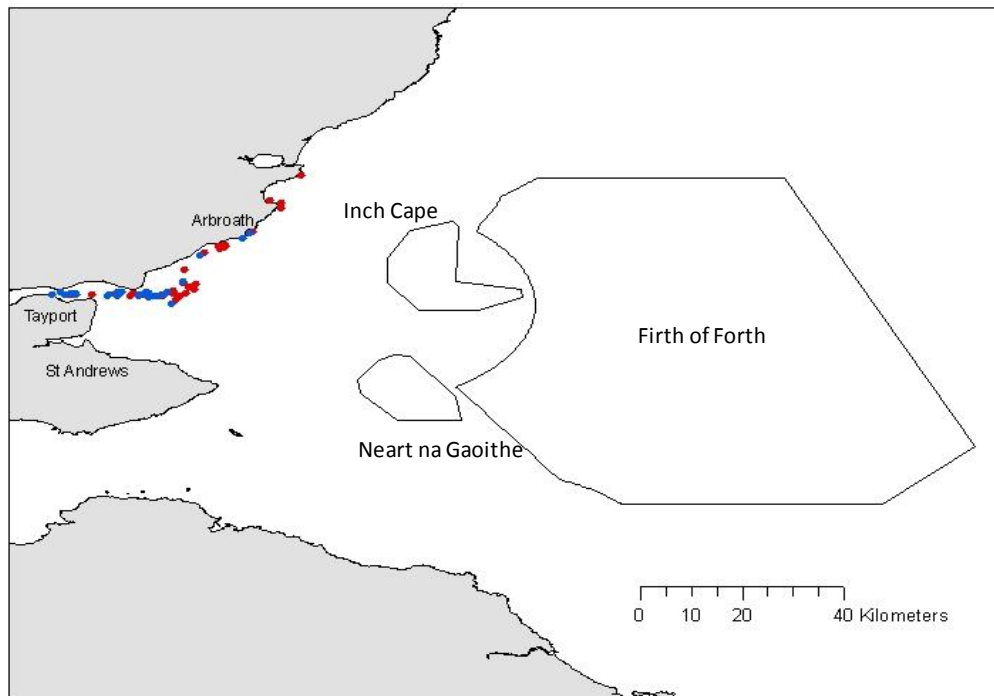


Figure 14A.16: Bottlenose Dolphin Encounter Locations (blue = 2009, red = 2010) with Respect to the Location of the Inch Cape, Neart na Gaoithe and R3 Firth of Forth Wind Farms (Quick and Cheney, 2011)



Abundance

Animal abundance can be estimated using individual identification data and mark-recapture analysis (Buckland *et al.*, 2001). Individual identification data, in this case photo-identification or photo-id data, have been collected in the Firth of Tay and St Andrews Bay area since 1997, and at other locations throughout the range of the Scottish east coast population since 1988. These data have been used to estimate:

- Total population size (Wilson *et al.*, 1999; Durban *et al.*, 2005; Corkrey *et al.*, 2008; Thompson *et al.*, 2011; Cheney *et al.*, 2012b);
- Abundance in the Moray Firth SAC (Thompson *et al.*, 2006; Thompson *et al.*, 2009; Cheney *et al.*, 2012a); and
- Abundance in the Firth of Tay and St Andrews Bay (Quick, 2006; Table 14A.5).

These different abundance estimates have been summarised in Table 14A.5 below. Due to the high level of heterogeneity, Quick (2006) used both conventional and Bayesian methods to provide abundance estimates for the Firth of Tay and St Andrews Bay area (Table 14A.5). It is difficult to know if the conventional method is underestimating abundance, or the Bayesian model overestimating it. However if we take the lowest and highest confidence limits from both methods, between 81 and 142 bottlenose dolphins were using the St Andrews Bay and Forth of Tay area during the summer months of 2003 and 2004. For a population currently estimated at 195 individuals (Cheney *et al.*, 2012b), this is a considerable proportion (between 0.42 and 0.73) of the population. Although the Tay abundance estimate comes from data collected in 2003-2004, and the current total population estimate from data collected in 2006, the values give a relative measure for comparison and indicate a substantial proportion of the Scottish east coast bottlenose dolphin population uses the St Andrews Bay and Firth of Tay area, at least in summer.

These population estimates (Table 14A.5) show an apparent increase in the number of bottlenose dolphins between 1992 and 2006. This is supported by a trend analysis carried out by Cheney *et al.* 2012a using data from 1990 to 2010 which suggests that there is a greater than 80 per cent probability that the Scottish east coast bottlenose dolphin population is either stable or increasing (Cheney *et al.*, 2012a).

Table 14A.5: Bottlenose Dolphin Abundance Estimates. Conventional Estimates were carried out using Chao *et al.*'s (1992) M_{TH} Model Implemented in the Programme CAPTURE

Area	Method	Time period	Abundance estimate	95% C/HPDI	Reference
SCANS II Block V (surface area = 160,517 km ²)	Line transect	2005	123 ⁷	CV = 4.83	SCANS II, 2008

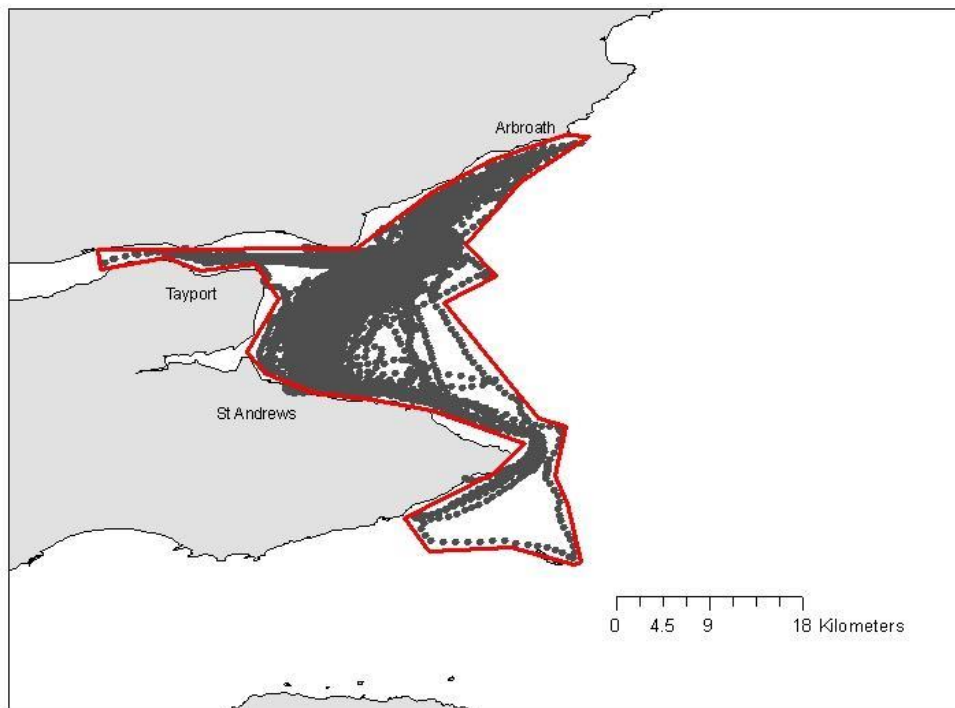
⁷ Note that this estimate is based on a single sighting within the coastal transect of the Firth of Forth and Tay and has been extrapolated up to create an estimate for the whole of Block V.

Area	Method	Time period	Abundance estimate	95% C/HPDI	Reference
East coast population	Conventional	1992	129	110-174	Wilson <i>et al.</i> , 1999
	Bayesian	2006	195	162-253	Cheney <i>et al.</i> , 2012b
Moray Firth SAC	Conventional	2007	86	80-107	Thompson <i>et al.</i> , 2009
Firth of Tay and St Andrews Bay (between Arbroath in the north and Fife Ness in the South)	Conventional	2003-2004	89	81-98	Quick, 2006
	Bayesian	2003-2004	112	89-142	Quick, 2006

Density

For the Firth of Tay and St Andrews Bay, there is only one period (2003-2004) for which abundance estimates are available (Quick, 2006; Table 14A.5). Efforts to generate a density surface are therefore limited to these years (and the resulting density estimate will only be applicable over the spatial area and temporal period in which the data were collected). It should be noted that these data were collected as part of a focal follow protocol so effort across the area was not uniform (Figure 14A.12 and Figure 14A.14). The most simplistic application of these data is to estimate the total area over which the data were collected (by drawing a polygon around the area surveyed; Figure 14A.17) and calculate a simple density estimate for the whole region (although this method carries the assumption that animals are distributed equally over the area constrained by the polygon which we know is not the case; Figure 14A.16). The size of the defined polygon was approximately 319 km². Using the (conventional and Bayesian) abundance estimates generated by Quick (2006; Table 14A.5) gives an estimated density of between *0.28 and 0.35 bottlenose dolphins per km²*. These estimates are considerably higher than the SCANS II Block V (which contains the Firth of Tay and St Andrews Bay) estimate which is *0.0008 individuals per km²* (SCANS II, 2008). However, the SCANS II survey was conducted over a much larger area (the size of this Block is 160,517 km²), using different (line transect) methodology, so is not directly comparable to the fine scale data collected and analysed by Quick and Cheney (2011).

Figure 14A.17: Effort from all 42 Trips from 2003 and 2004 shown in Grey. Red Outline Shows the Area of the Defined Polygon used to generate the Area for the Density Estimate (Quick and Cheney, 2011)



Patterns of Occurrence

Timing Porpoise Detectors (T-PODs) can be used to assess patterns of occurrence. T-PODs incorporate a hydrophone, processor and timing systems that automatically log the start and end of each echolocation click; they run successive scans within user-defined frequencies and log detections. Previous studies in the Moray Firth (Bailey *et al.*, 2009) and Ireland (Philpott *et al.*, 2007) have confirmed that T-PODs can successfully detect bottlenose dolphins at distances of 900-1250 m. Combined visual and acoustic studies in the mouth of the Cromarty Firth showed that T-PODs detected all groups of dolphins that spent at least 30 minutes in the area (Bailey *et al.*, 2009) suggesting that PODs can be used for determining presence or absence of dolphins at hourly sampling scales. While PODs cannot discriminate between bottlenose dolphins and other delphinid species, detections at coastal sites in the Firth of Tay and St Andrews Bay are likely to represent bottlenose dolphin occurrence.

T-PODs were deployed off Arbroath (from January 2007 to March 2009) and Fife Ness (from December 2006 to March 2009) by the University of Aberdeen as part of a series of deployments at 18 sites around the east coast of Scotland (Thompson *et al.*, 2011).

Dolphins were detected in all years of deployment. At Fife Ness there were no inter-annual differences in the number of days of detections between 2007 and 2008, the years with most data (Chi-Sq = 0.9791, $p = 0.322$), but at Arbroath there were significantly more days with dolphin detections in 2008 (Chi-Sq = 9.3041, $p = 0.002$; Quick and Cheney, 2011; (14A.18). Overall, dolphins were detected on 24 per cent of days at Arbroath and 18 per cent of days at Fife Ness (Quick and Cheney, 2011). In comparison, dolphins were detected on over 70

per cent of days at a core site in the Moray Firth SAC over the same time period (Thompson *et al.*, 2011).

Although dolphins were detected at Arbroath and Fife Ness between a fifth and a quarter of the time the PODS were deployed, the amount of time dolphins spent in these areas was relatively low (Figure 14A.19). The median number of hours with dolphin detections on dolphin positive days was one hour in the Firth of Tay and St Andrews Bay (range 1-4 hours in 2007 and 1-5 hours in 2008 at Arbroath; range 1-5 hours in both 2007 and 2008 at Fife Ness; Quick and Cheney, 2011). In comparison, at the core site in the Moray Firth SAC, dolphins were recorded for a median of four hours per day (range 1-16 hours) on the days they were detected over the same time period (University of Aberdeen unpublished data). This suggests that although dolphins regularly visit Arbroath and Fife Ness they do not spend long periods there and may simply be travelling through each area.

Winter and summer dolphin detections were similar at Arbroath (Chi-Sq = 0.320, $p = 0.571$; Quick and Cheney, 2011), but fewer dolphin detections were made during the winter at Fife Ness (Chi-Sq = 17.049, $p < 0.0001$; Quick and Cheney, 2011; Figure 14A.20). Despite dolphins being detected on around 25 per cent of days in the summers at both Fife Ness and Arbroath (Quick and Cheney, 2011), these sites showed lower detection rates in comparison with the Moray Firth SAC site where dolphins were detected on 94 per cent of days during the same time period (Thompson *et al.*, 2011). Winter detections were also higher at the Moray Firth SAC site (56 per cent of days; Thompson *et al.*, 2011) compared to 14 per cent and 24 per cent at Fife Ness and Arbroath respectively (Quick and Cheney, 2011). At Fife Ness, dolphins were recorded between one and five hours per day in both summer and winter (Figure 14A.20; Figure 14A.21). In Arbroath, dolphins were recorded between one and three hours in the summer, but this increased to between one and six hours in the winter (Figure 14A.21).

Dolphins were detected in every month of the year at both Arbroath and Fife Ness (Figure 14A.22). The proportion of dolphin positive days increased from May to October (with decreases in July and September) at Fife Ness but at Arbroath the proportion of dolphin positive days was relatively consistent in different months (Figure 14A.22).

For the purpose of the impact assessment, after consultation with scientific experts at the University of Aberdeen and the SMRU Ltd, it has been assumed that at any point in time, half of the bottlenose dolphin population of the Moray Firth SAC (195 individuals) can be found within the Moray Firth and the remainder of the population will be spread out along the east coast in waters from Peterhead to Eyemouth of less than 20 m deep (see Figure 14A.23).

Figure 14A.18: Occurrence of Bottlenose Dolphins around the Firth of Tay in 2007 and 2008 (Quick and Cheney, 2011). Pie Charts Represent the Proportion of Dolphin Positive Days

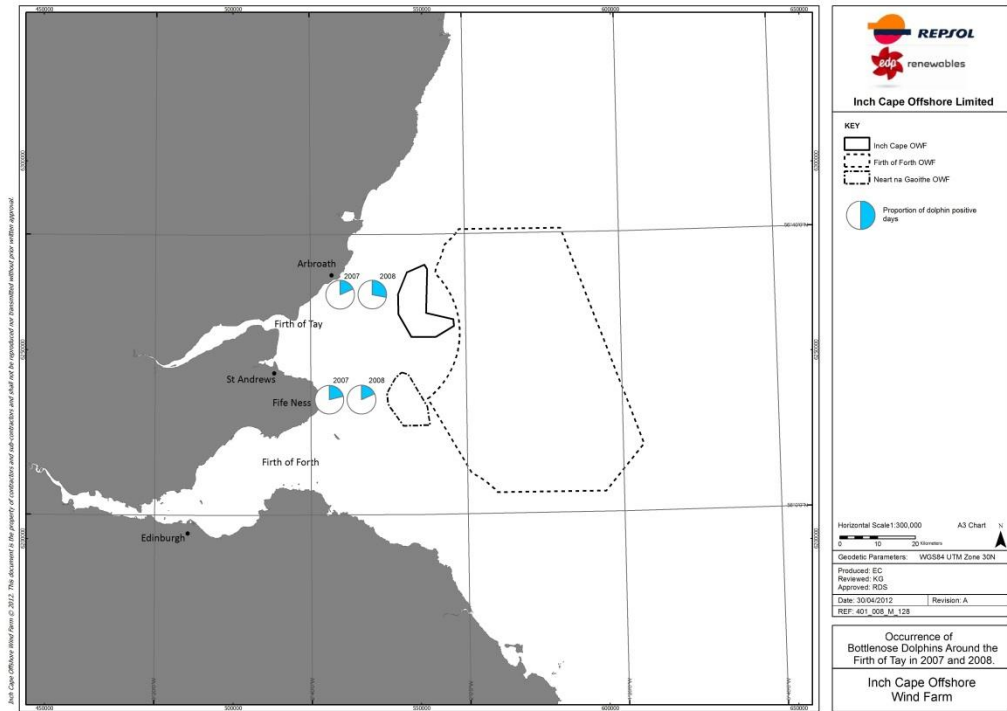


Figure 14A.19: Occurrence of Bottlenose Dolphins around the Firth of Tay in 2007 and 2008 (Quick and Cheney, 2011). Pie Charts Represent the Median Number of Hours with Dolphin Detections on Dolphin Positive Days

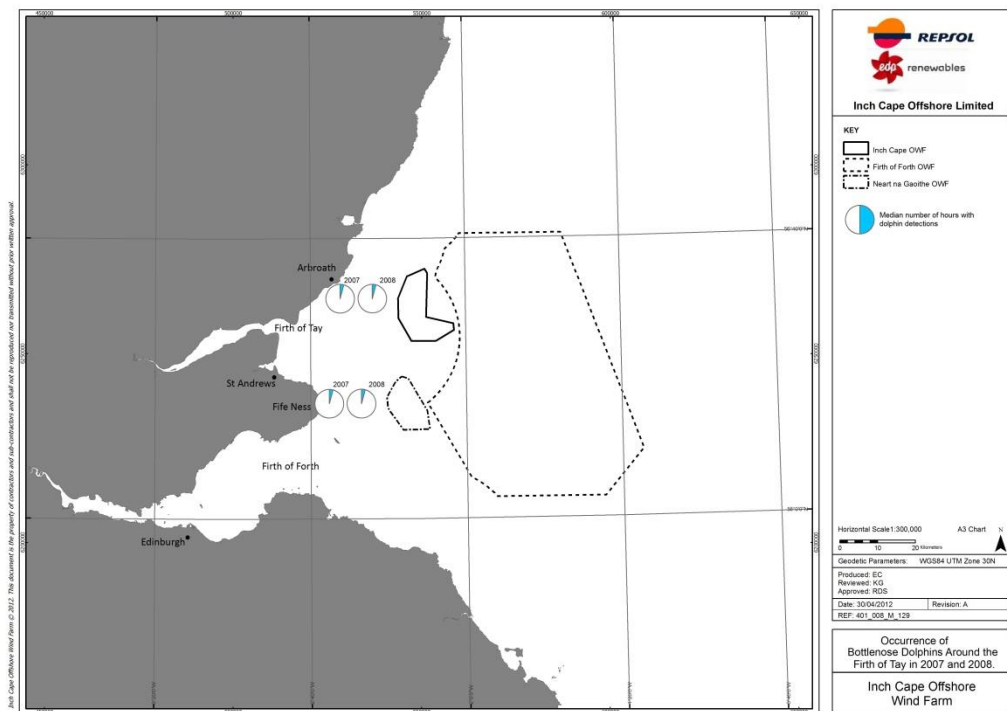


Figure 14A.20: Occurrence of Bottlenose Dolphins around the Firth of Tay in Winter and Summer between 2006 and 2009 (Quick and Cheney, 2011). Pie Charts Represent the Proportion of Dolphin Positive Days

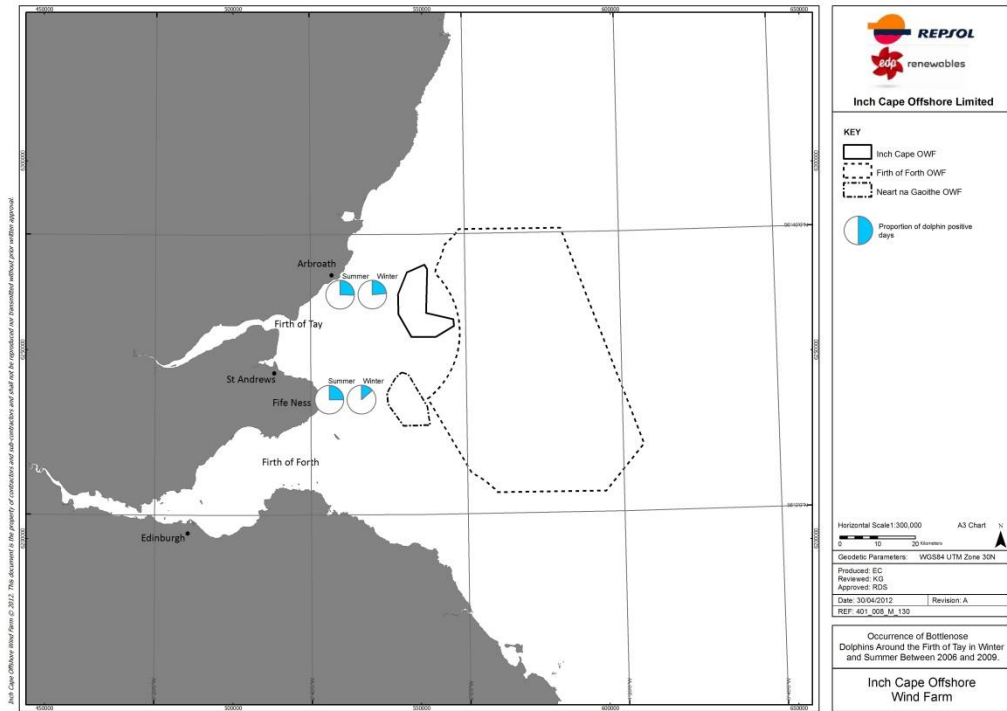


Figure 14A.21: Occurrence of Bottlenose Dolphins around the Firth of Tay in Winter and Summer between 2006 and 2009 (Quick and Cheney, 2011). Pie Charts Represent the Median Number of Hours with Dolphin Detections on Dolphin Positive Days

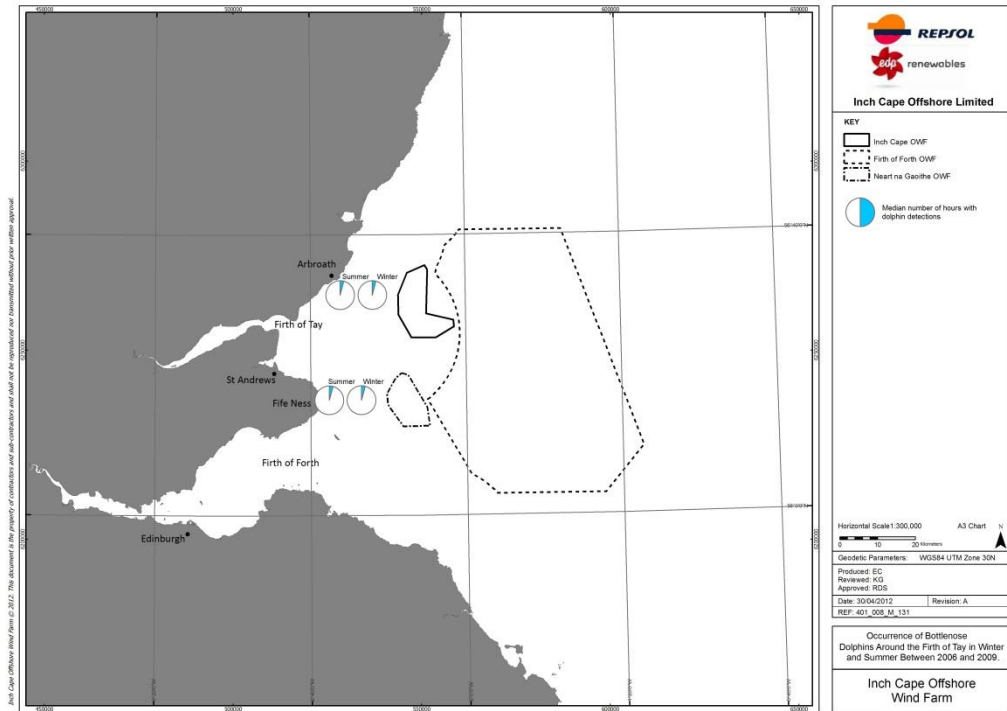


Figure 14A.22: The Average Proportion of Dolphin Positive Days in Each Month (+/- SE) for T-POD sites a) Arbroath and b) Fife Ness for the Entire T-POD Deployment Period (Quick and Cheney, 2011)

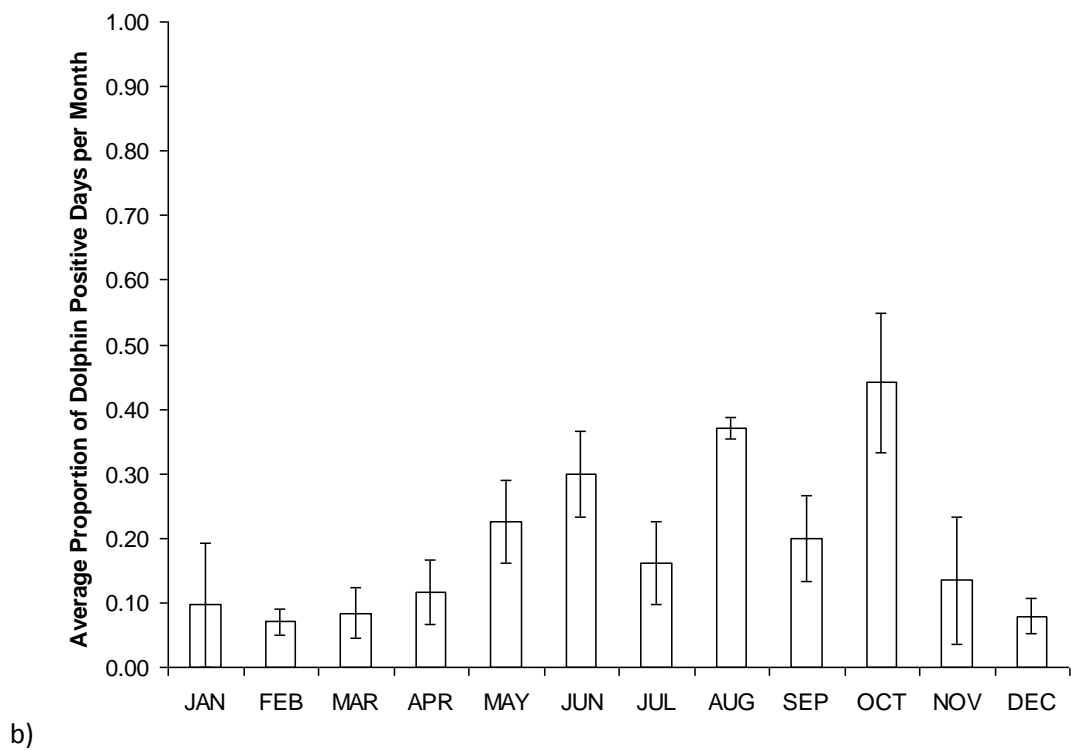
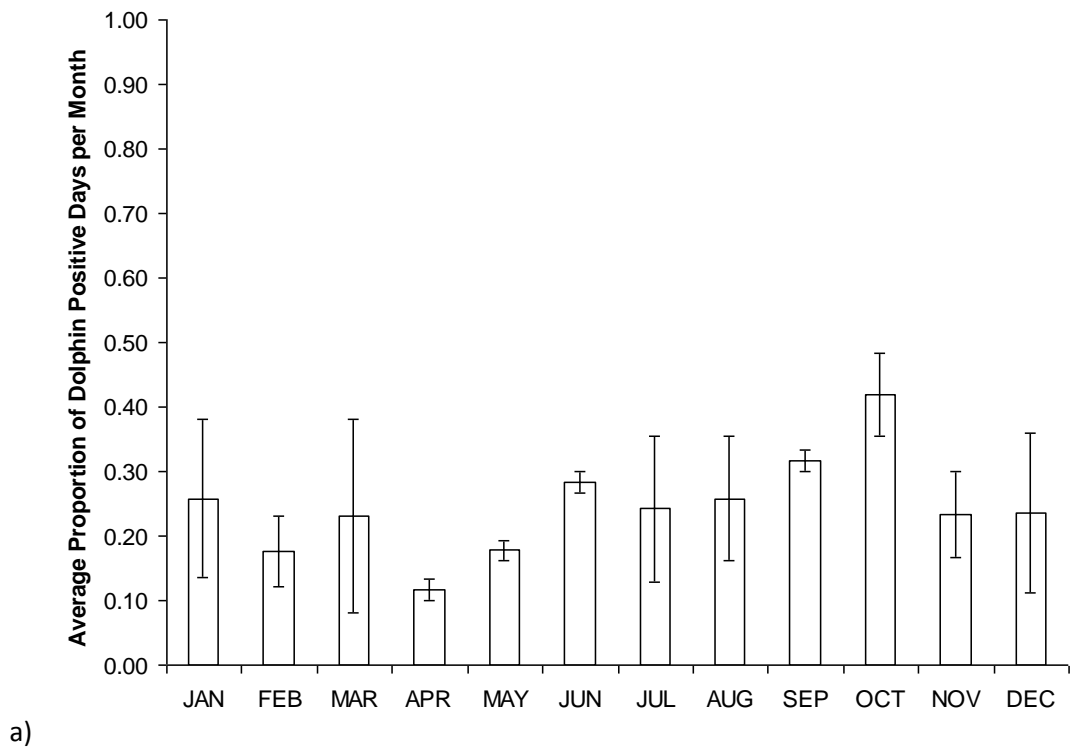
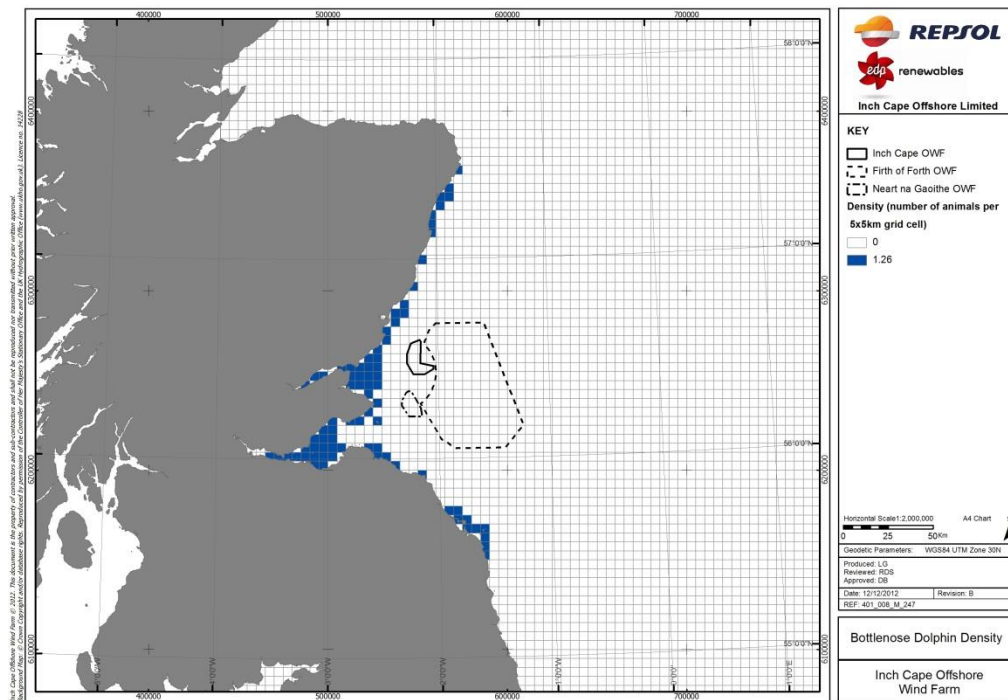


Figure 14A.23: Bottlenose Dolphin Density Inferred by Spreading the Reference Population (50% of East Coast Population) Across the Area Animals are known to Occur (20 m depth contour)



SAC Connectivity

There is a high degree of connectivity between the Firth of Tay and St Andrews Bay area and the Moray Firth SAC although individual movement patterns are variable. What drives these different movement patterns is unknown.

Some individuals are seen in Tayside one year and in the SAC the next, or vice versa. For example, 18 individuals that were only seen in the Tay in 2009 were only seen in the SAC in 2010 (Quick and Cheney, 2011).

Other dolphins move between the SAC and the Tay within a year and, in some cases, even within a month. For example, in 2009 and 2010, seven and ten individuals respectively were either seen in the Tay at the start of the summer and in the SAC by the end of the summer, or vice versa. Eight individuals were seen in both the Tay and the SAC within a month (Quick and Cheney, 2011).

Another behaviour pattern is shown by individuals that appear to make multiple trips between the Tay and the SAC within the year. In 2009, four individuals, and in 2010 two individuals, seen in the SAC at the start of the summer were subsequently seen in the Tay and then back in the SAC by the end of the summer. The shortest trip observed between the Tay and the SAC was in 2009 when three individuals were seen in the Tay on 8 August and then in the SAC on 13 August. It is likely that this movement is representative of other individuals which were either not encountered during surveys in either the Tay or the SAC, or were only seen in poorer quality pictures (Quick and Cheney, 2011).

Behaviour, Group Size and Group Composition

Bottlenose dolphins engage in all types of behaviour in the Tay area, with groups observed travelling through the area, socialising, foraging, engaged in aerial behaviour, bow-riding vessels and logging at the surface (Quick, 2006; Quick and Janik, 2008). It is not possible to make firm conclusions about habitat use or frequency of different behaviours in the Tay area without targeted analysis of behavioural data (Quick and Cheney, 2011).

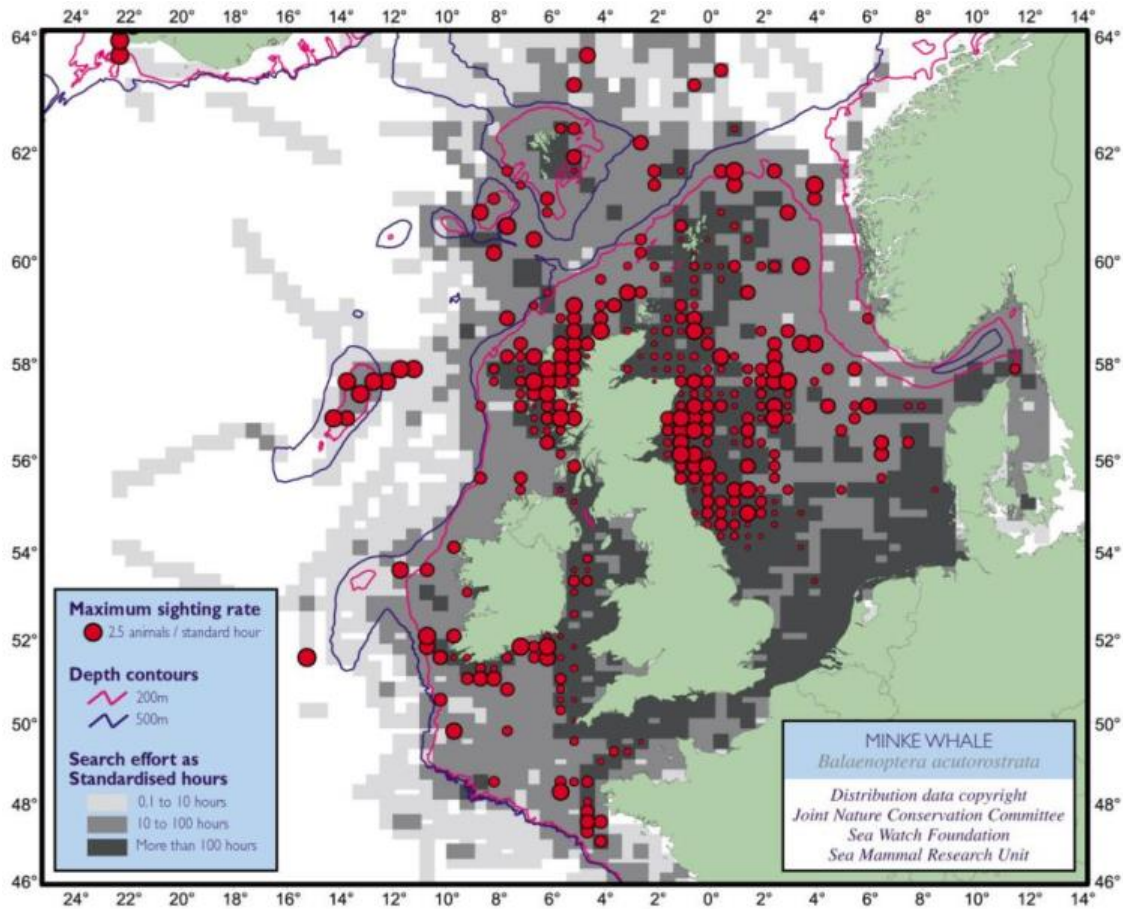
All age classes, both sexes and a variety of group sizes (one to over 30) have been observed throughout the study area (Quick and Cheney, 2011). Although published data on the sex ratio of groups within this area are lacking, the 107 individuals identified in the Tay area in 2009 and 2010 comprised 19 known males, 29 known females and 59 of unknown sex (University of Aberdeen, unpublished data). Groups may be made up of all age classes or may primarily contain only one age class (Quick and Cheney, 2011).

Diet

Bottlenose dolphins have a diverse diet and studies on the Scottish east coast suggest that areas with strong tidal flows are favoured for foraging (Mendes *et al.*, 2002). Santos *et al.* (2001) published dietary information for ten stranded bottlenose dolphins off the east coast of Scotland. The main prey remains recovered were from cod, saithe and whiting.

Minke Whale (*Balaenoptera acutorostrata*)

Within UK waters, minke whales are most frequently sighted in the north-western North Sea (e.g. Robinson *et al.*, 2009; Tetley *et al.*, 2008), the Hebrides (e.g. Macleod *et al.*, 2004) and in the Irish Sea (Northridge *et al.*, 1995; Reid *et al.*, 2003; see Figure 14A.24). They are predominately sighted singly or in pairs, although when feeding they may aggregate in groups as large as 10 to 15 individuals (Reid *et al.*, 2003). There appears to be some seasonality in their occurrence. Regular surveys of the Inner Hebrides have shown that minke whales tend to move northward as the summer season progresses, (Macleod *et al.*, 2004). Northridge *et al.* (1995) found more minke whales in the Hebrides later in the third quarter of the year. There are limited data from the North Sea in terms of seasonality but their distribution is likely to be highly dependent on the location of their prey (Tetley *et al.*, 2008; Macleod *et al.*, 2004). The UK conservation status assessment for minke whales is 'favourable' (JNCC, 2007).

Figure 14A.24: Sightings of Minke Whale around the UK (Reid *et al.*, 2003)

Distribution, Seasonal Patterns and Group Size

Minke whales were the most commonly sighted of the large cetaceans during both the ICOL-commissioned visual boat-based surveys (Canning, 2012) and TCE aerial surveys (Grellier and Lacey, 2012). Although they were observed throughout the Development Area and buffer zone (see Figure 14A.25), they were generally sighted outside 12 nm (Figure 14A.26). There were more aerial survey sightings in summer (Figure 14A.27) than winter (Figure 14A.28); the majority of boat-based survey observations were made between June and August with three observed during April and a single animal observed in November (Figure 14A.29). Minke whales were most often seen singly (Figure 14A.25; Figure 14A.29).

Figure 14A.25: Distribution of Minke Whale Sightings Recorded within the Inch Cape Development Area and 4 km Buffer Zone (Canning, 2012)

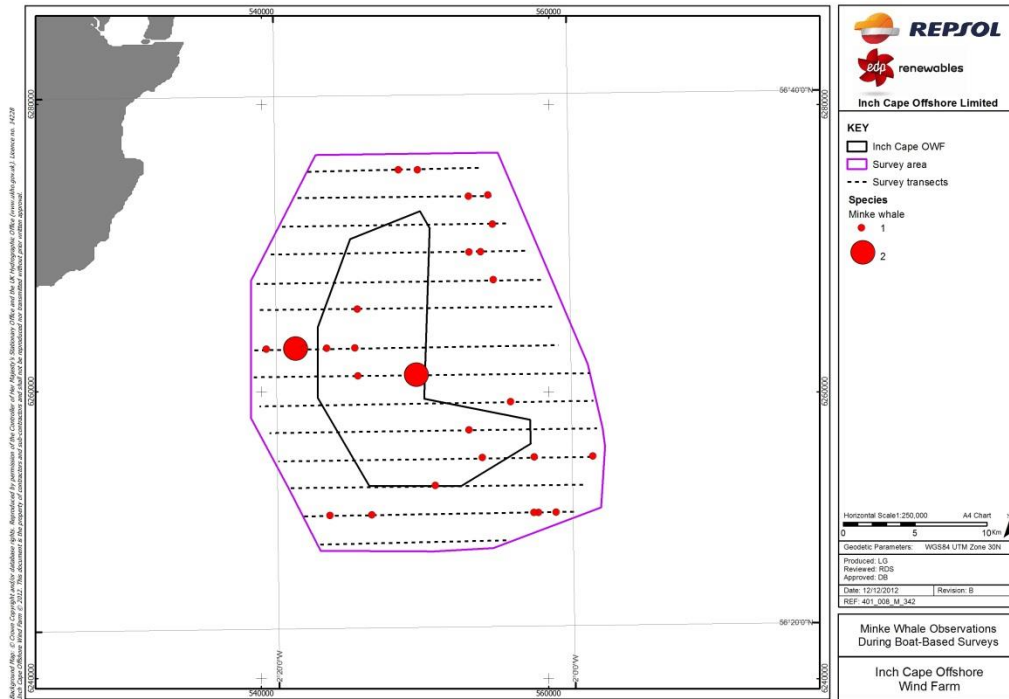


Figure 14A.26: Large Cetacean Distribution during TCE Aerial Surveys – All Seasons (Grellier and Lacey, 2012)

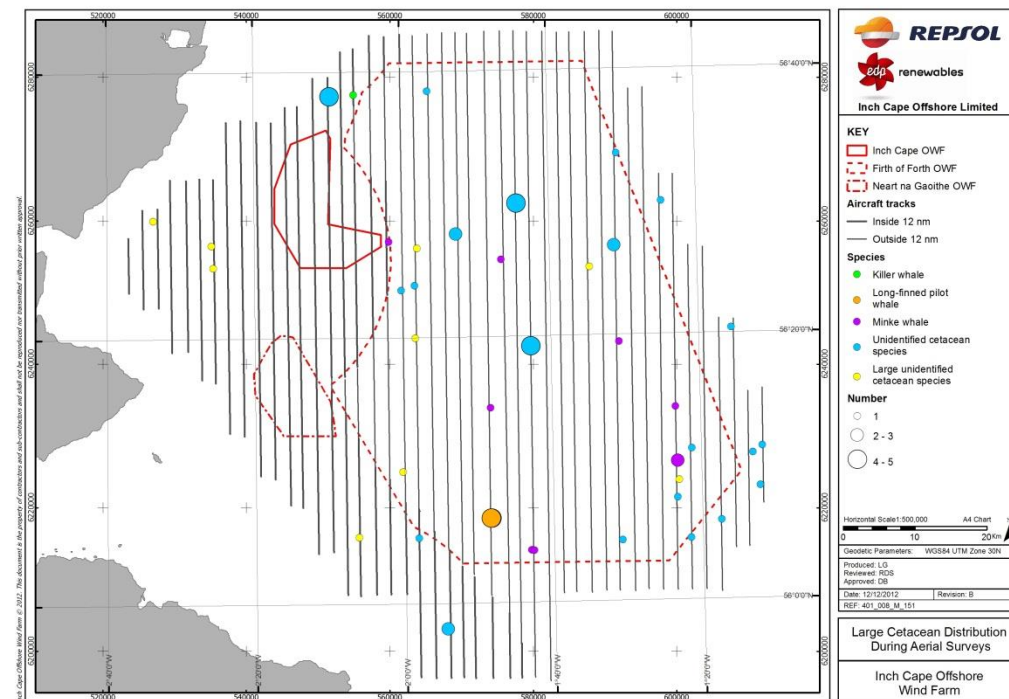


Figure 14A.27: Large Cetacean Distribution during Summer TCE Aerial Surveys (Grellier and Lacey, 2012)

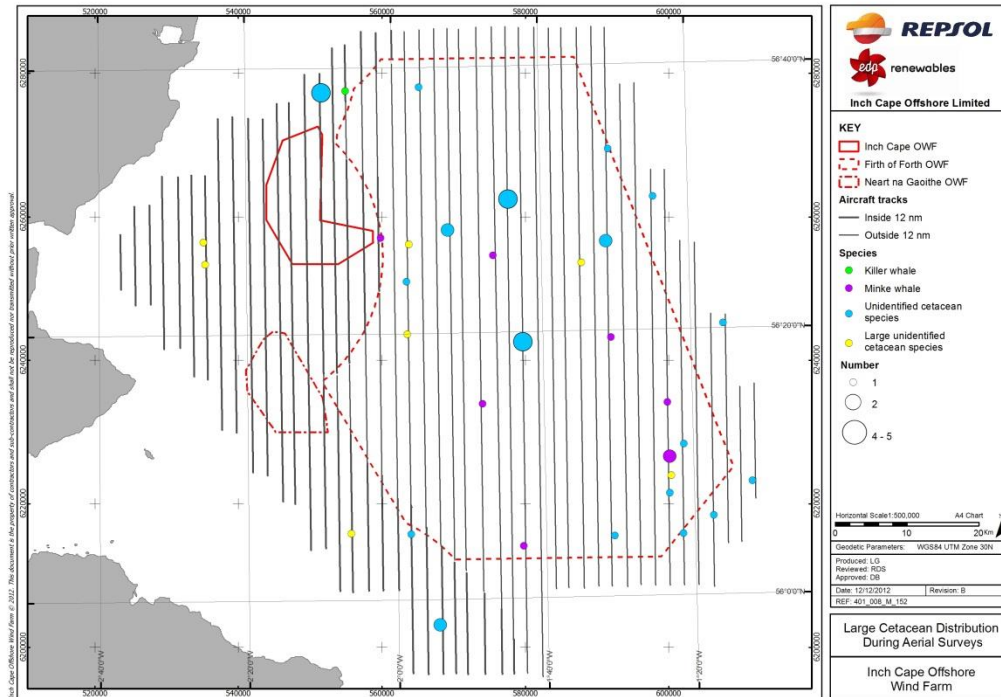


Figure 14A.28: Large Cetacean Distribution during Winter TCE Aerial Surveys (Grellier and Lacey, 2012)

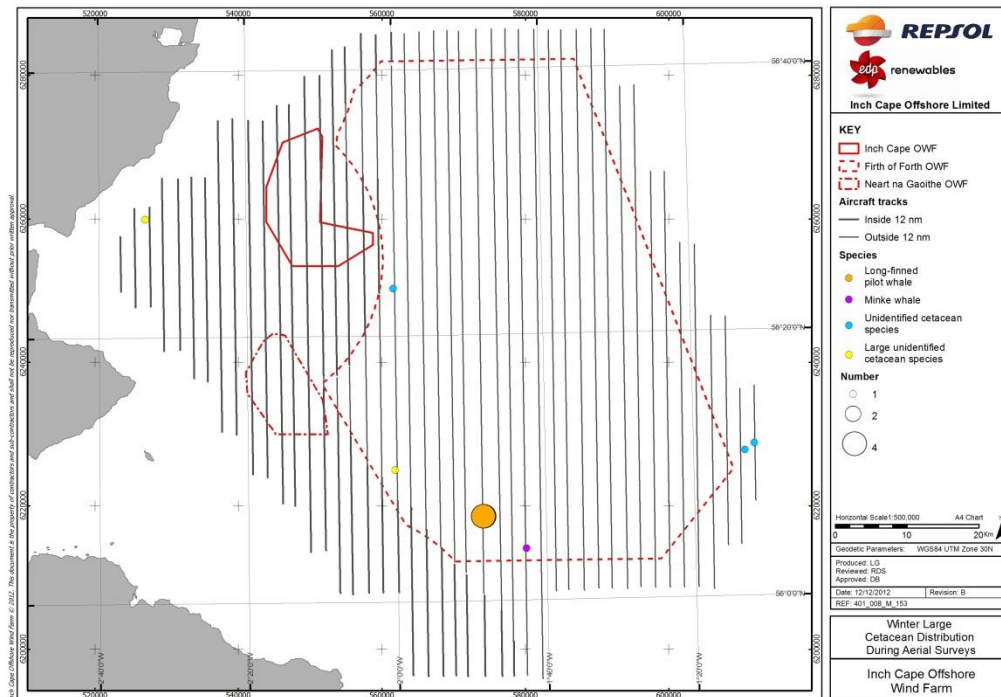
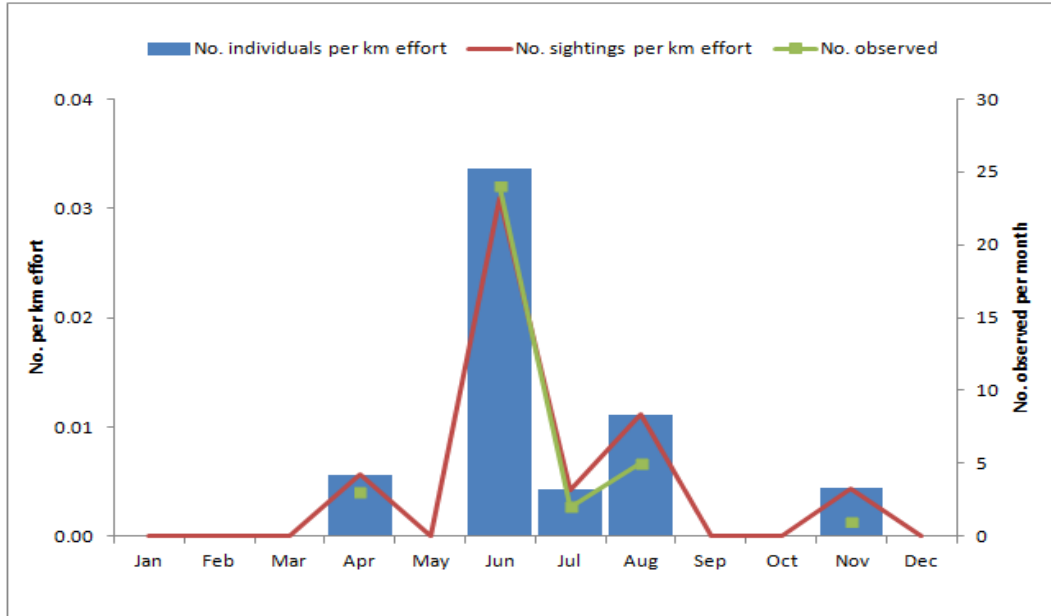


Figure 14A.29: The Number of Minke Whale Observed (green line), the Mean Number of Sightings per km of Survey Effort (red line) and the Number of Individual Animals (blue bars) Recorded per km Survey Effort Each Calendar Month During Boat-based Surveys December 2010 - September 2012 (Canning, 2012). For distribution map of these sightings, refer to Figure 14A.25



Abundance

The following abundance estimates are available for minke whale:

- Schweder *et al.* (1997) generated estimates of the number of minke whales in the North Sea, north of 56°N, of 5,430 (SE=1,870) for 1989 and 20,300 (SE=5,240) for 1995.
- The SCANS II abundance estimate for Block V (north central North Sea) is 4,449 (CV=0.45; SCANS II, 2008).
- The abundance estimate for the North Sea from the most recent Norwegian surveys in July 1998 is 11,700 (SE=3,460) (Skaug *et al.*, 2003).
- International Whaling Commission (IWC) abundance estimates for the central and north-eastern North Atlantic, 1996-2001 is 174,000 (95 per cent CI = 125,000-245,000; International Whaling Commission, 2013).

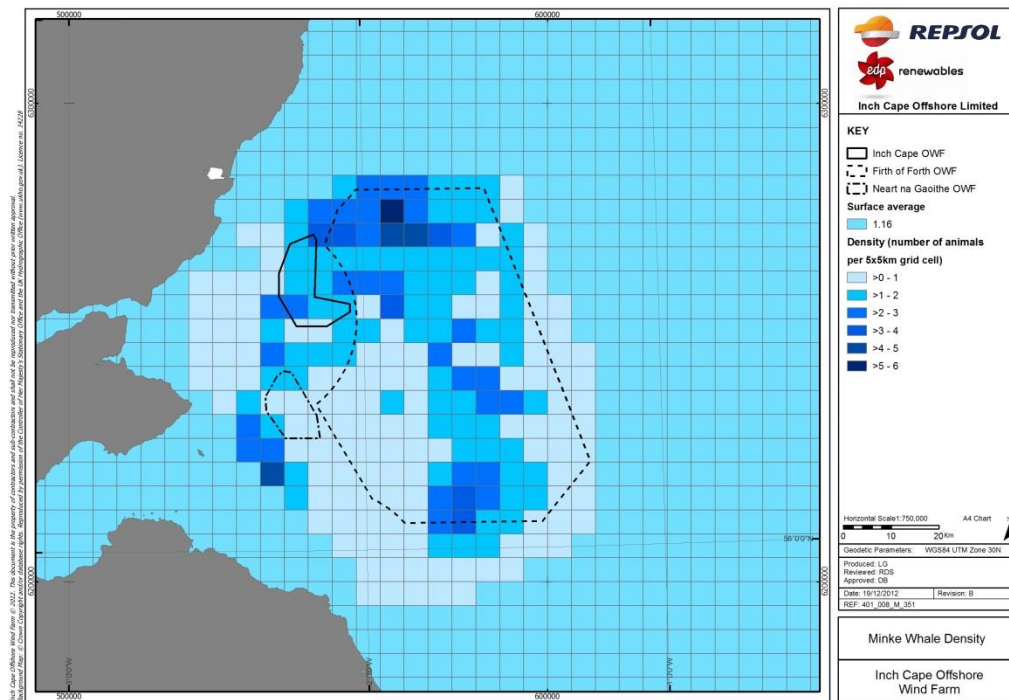
FTOWDG commissioned integrated analysis of shared cetacean data using individual developer's boat-based surveys along with TCE aerial survey data. This analysis addressed availability and potential detectability issues within the data set, and therefore provides a more robust estimate of abundance for minke whale within the combined survey area (see Table 14A.6). Confidence in the absolute abundance estimate is low (based on the 95 per cent CIs) due to the low number of sightings in the original data set. Greater numbers of minke whale were predicted for the northern parts of the survey area (deeper waters) although numbers were still low in absolute terms. Visual representation of the absolute density per km² for the combined survey area can be found in Figure 14A.30.

Recent work (Anderwald et al., 2011) found no geographic structure when comparing genetic samples from the recognised management areas within the North Atlantic, suggesting that minke whales range extensively across the North Atlantic seasonally, and then segregate between multiple breeding grounds. Taking this into account, the abundance estimate for the entire North Atlantic of 181,922 whales (CV = 0.09) has been applied for the purpose of this assessment.

Table 14A.6: Abundance Estimates for Minke Whale Commissioned by FTOWDG Based on Individual Developer Boat-based and TCE Aerial Survey Data. Numbers represent estimates for all FTOWDG development sites combined, surveyed between 2009 and 2011 (MacKenzie et al., 2012)

	Estimate	95% confidence intervals
Relative abundance	23.76	19.31 – 107.79
Absolute abundance ⁸	594.12	482.94 – 2694.87

Figure 14A.30: Estimated Minke Whale Absolute Density per km² Based on Corrected Count Data (MacKenzie et al., 2012)



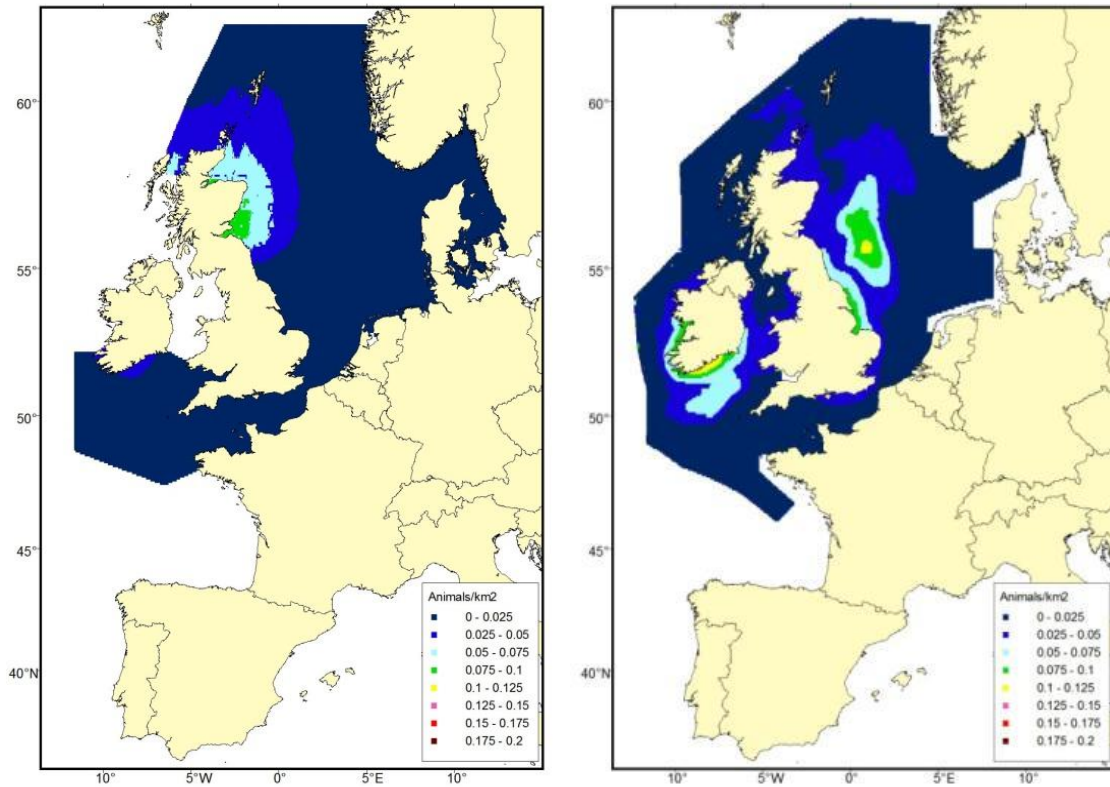
Density

The SCANS II (Block V) density estimate is 0.028 animals per km² (CV=0.45; SCANS II, 2008). As well as the single density estimate, density surfaces have been produced using the SCANS and SCANS II data (Figure 14A.31). For the purpose of assessment, the densities presented in

⁸ Data adjusted based on a sighting availability of 0.0.04 (Joyce et al., 1989).

Figure 14A.30 were applied as this data is spatially and temporally more relevant for the area. An average density based on this same data has been used for the areas outside of the study area.

Figure 14A.31: SCANS (left) and SCANS II (right) Estimated Density Surfaces for Minke Whale (reproduced from SCANS II, 2008)

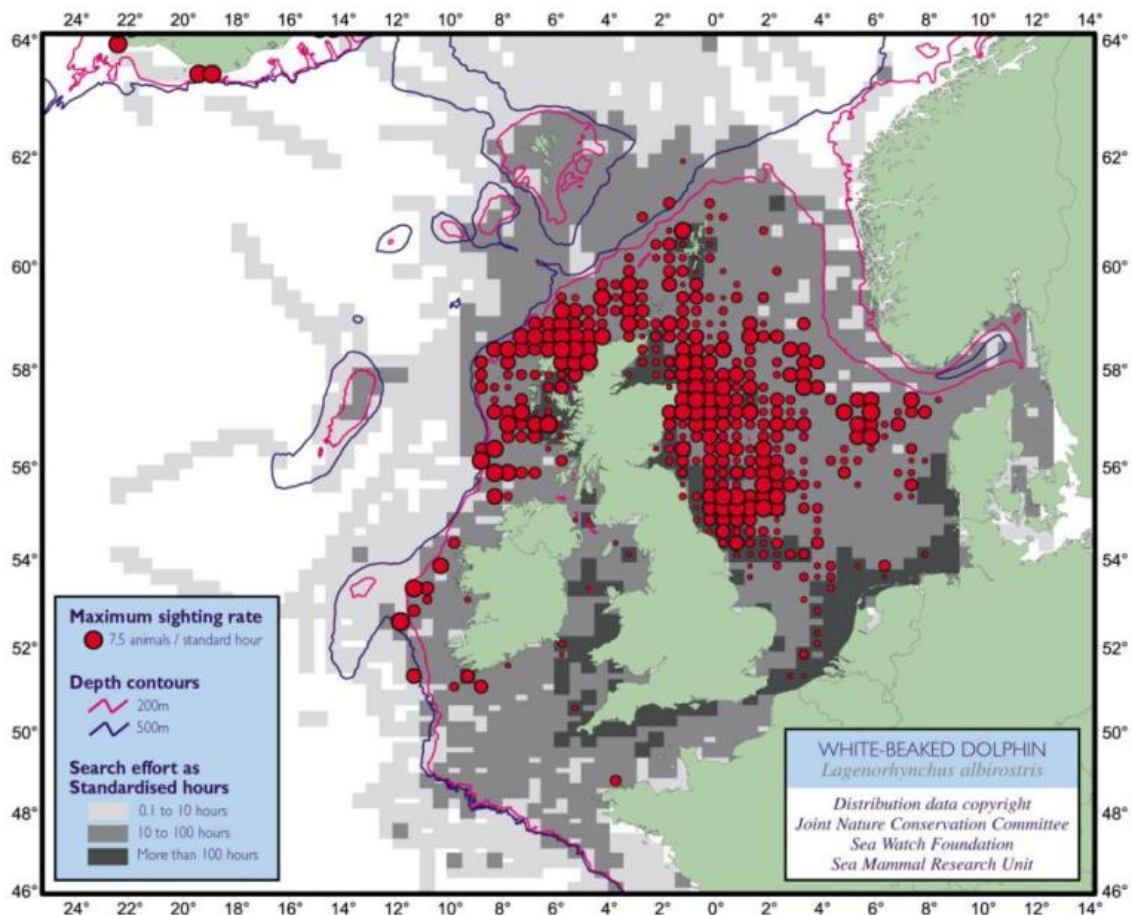


Diet

There is relatively little information on the diet of minke whales in Scotland. Examination of the stomach contents of stranded whales found mainly sandeel and clupeid remains (Pierce *et al.*, 2004).

White-beaked Dolphin (*Lagenorhynchus albirostris*)

Although they have a more limited range than most of the other species present, being found only in the cool temperate and sub-arctic waters of the North Atlantic, white-beaked dolphin is one of the most abundant dolphin species observed in UK shelf waters (Hammond *et al.*, 2002; Reid *et al.*, 2003). They are mainly distributed over the continental shelf and in the northern North Sea (off Scotland and northeast England), generally in waters between 50 and 100 m in depth and rarely out to the 200 m isobath (Northridge *et al.*, 1995; Reid *et al.*, 2003; Figure 14A.32). Sightings of white-beaked dolphins increase in frequency during the summer months, when the animals appear to move inshore (Evans, 1992; Northridge *et al.*, 1995; Weir *et al.*, 2007). The UK conservation status assessment for white-beaked dolphins is 'favourable' (JNCC, 2007).

Figure 14A.32: Sightings of White-beaked Dolphin around the UK (Reid *et al.*, 2003)

Distribution, Seasonal Patterns and Group Size

During both the ICOL-commissioned visual boat-based surveys (Canning, 2012) and TCE aerial surveys (Grellier and Lacey, 2012) white-beaked dolphins were almost always sighted offshore (Figure 14A.33; Figure 14A.34). Sightings were more common in summer (Figure 14A.35) than in winter (Figure 14A.36). The seven sightings made during the monthly visual boat-based surveys shown in Figure 14A.34 were all between the months of June and August (Canning, 2012). White-beaked dolphins were most often seen in groups of two or three although group size ranged from one to six individuals (Figure 14A.37; Figure 14A.33). Analysis of acoustic data of white-beaked dolphin vocalisations collected during the boat-based surveys suggests that a number of unidentified dolphin sightings were white-beaked dolphins (Wittich and Gordon, 2012; *Annex 14A.2: White-beaked Dolphin Acoustic Analysis*).

White-beaked dolphin (Figure 14A.38) encounter rates during TCE aerial surveys were generally greater between May and August 2009 than between November 2009 and March 2010 (Grellier and Lacey, 2012). Because no environmental data were contained within the observation or effort files, there is currently no means of assessing the effect of varying sighting conditions on encounter rates. For example, a consistently higher sea state in winter than summer could result in this pattern, as could greater numbers of animals being present in summer. In the absence of environmental data it is not possible to assess whether these patterns are real or are artefacts of different sighting conditions. Notwithstanding this,

white-beaked dolphins are known to occur seasonally in other areas e.g. in June to August off Aberdeenshire (Weir *et al.*, 2007).

In other areas the distribution of white-beaked dolphins has been linked to sea surface temperature, local primary productivity and prey abundance (MacLeod *et al.*, 2007; Weir *et al.*, 2007; Canning *et al.*, 2008).

Figure 14A.33: Distribution of White-beaked Dolphin Sightings Recorded within the Inch Cape Development Area and 4 km Buffer Zone (Canning, 2012)

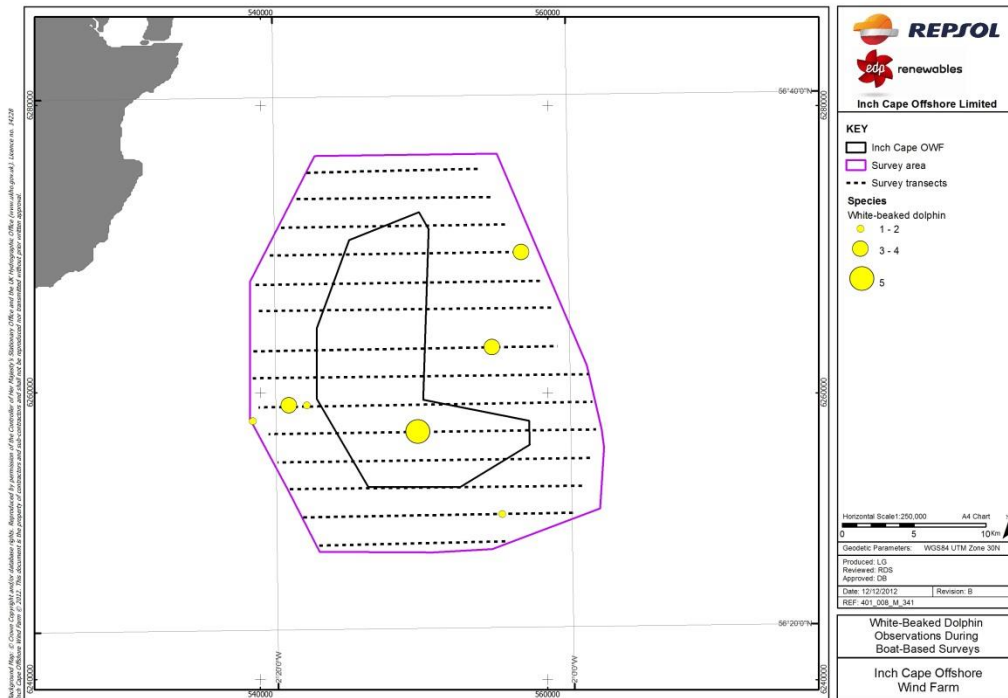


Figure 14A.34: White-beaked Dolphin Distribution during TCE Aerial Surveys Illustrating Group Size – All Seasons

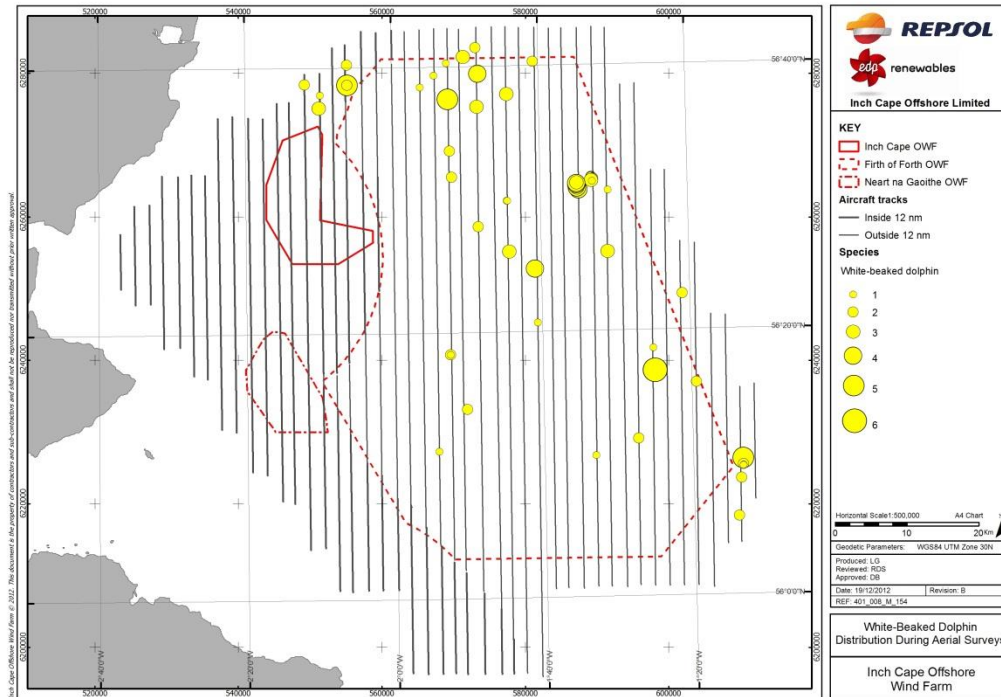


Figure 14A.35: White-beaked Dolphin Distribution during Summer TCE Aerial Surveys

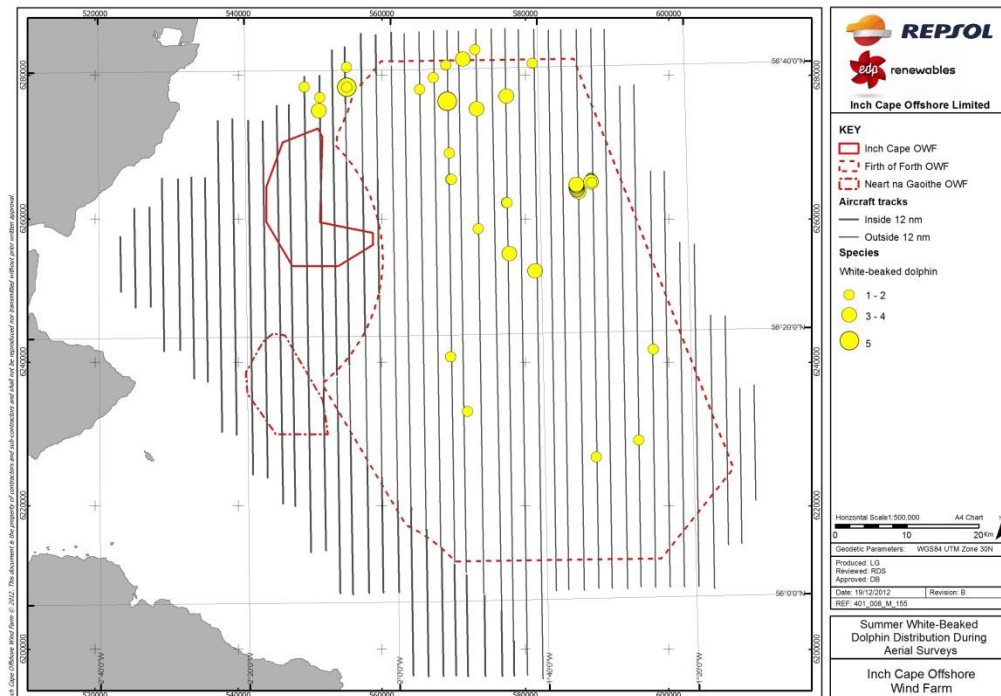


Figure 14A.36: White-beaked Dolphin Distribution during Winter TCE Aerial Surveys

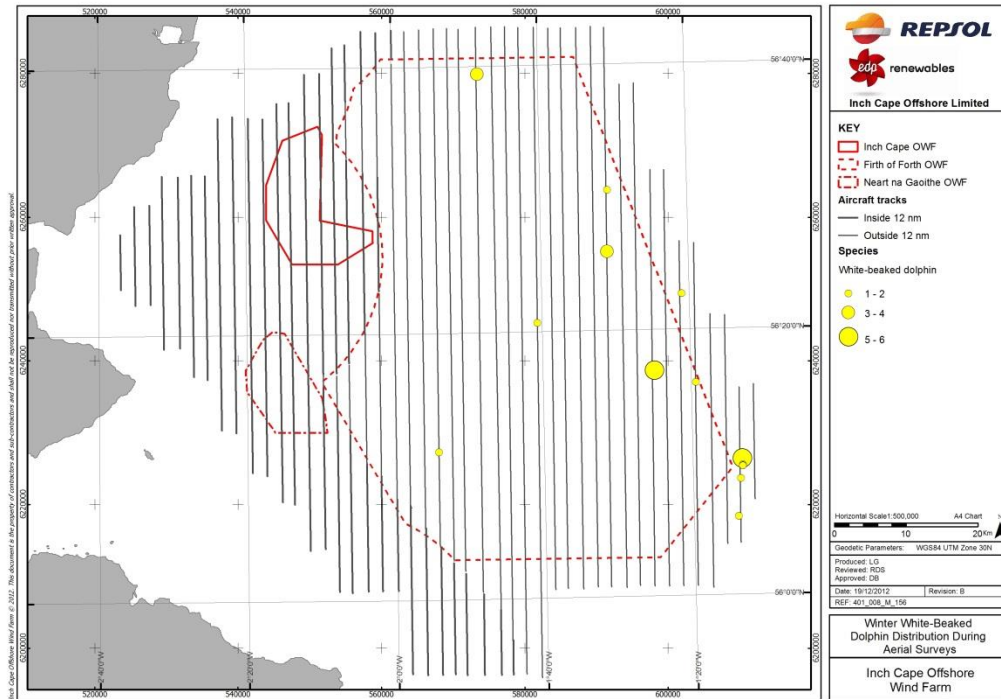


Figure 14A.37: The Number of White-beaked Dolphins Observed, the Mean Number of Sightings per km of Survey Effort (red line) and the Mean Number of Individual Animals (blue bars) Recorded per km Survey Effort Each Survey Month During Boat-based Surveys December 2010 - September 2012 (Canning, 2012). For distribution map of these sightings refer to Figure 14A.33

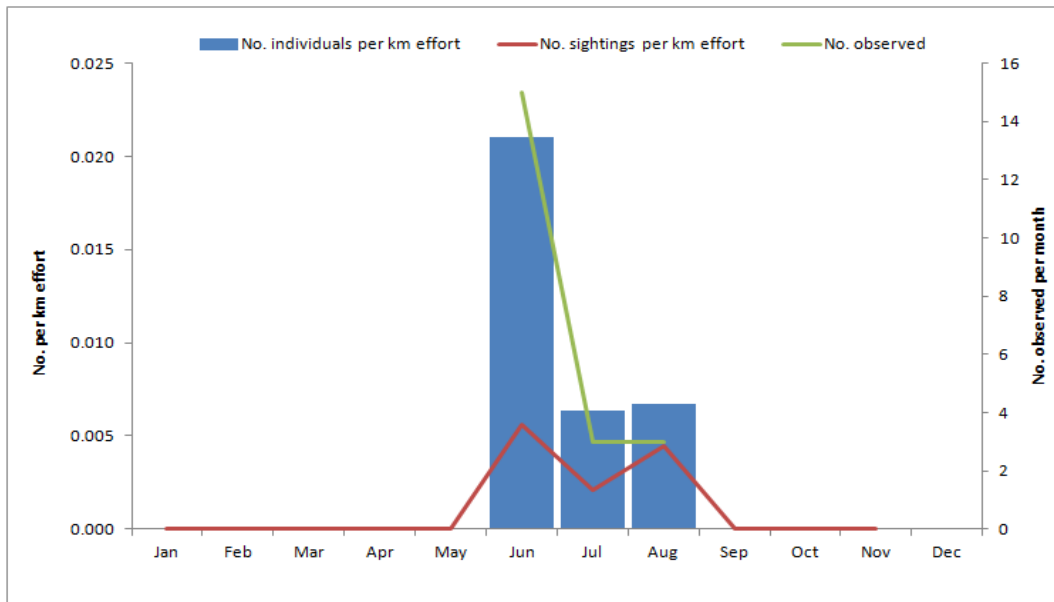
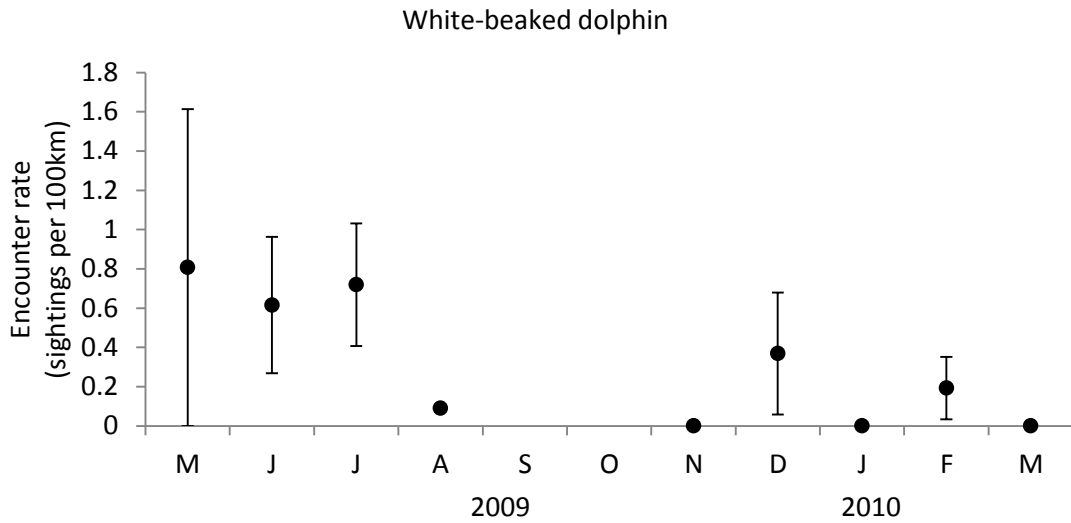


Figure 14A.38: Encounter Rate (sightings per 100 km) \pm Standard Error by Month for White-beaked Dolphin during TCE Aerial Surveys (Grellier and Lacey, 2012). No surveys were carried out in September or October



Abundance

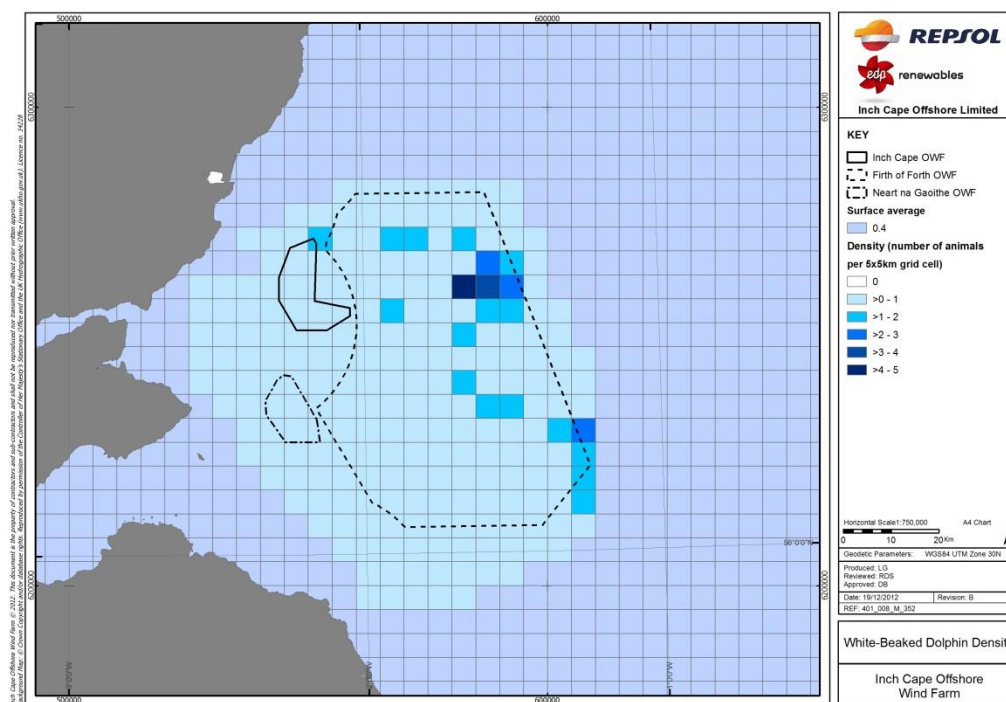
The Block V SCANS II abundance estimate for white-beaked dolphin is 7,862 animals (CV = 0.37; SCANS II, 2008).

FTOWDG commissioned integrated analysis of shared cetacean data using individual developer's boat-based surveys along with TCE aerial survey data. This analysis addressed availability and potential detectability issues within the data set, and therefore provides a robust estimate of abundance for white-beaked dolphin within the combined survey area (see Table 14A.7). Confidence in the absolute abundance estimate is low (based on the 95 per cent CIs) due to the low number of sightings in the original data set. A potential "hotspot" was identified to the north-east of the combined survey area which, even though accompanied with a high level of uncertainty still suggested this area contained relatively higher abundance compared to other parts of the survey area. Visual representation of the absolute density per km² for the combined survey area can be found in Figure 14A.39. For the purpose of the impact assessment, the reference population is taken to be 22,644 dolphins (CV = 0.42, 95 per cent CI = 10,341-49,670) based on estimates produced during the SCANS II surveys for the European Atlantic continental shelf waters.

Table 14A.7: Abundance Estimates for White-beaked Dolphin from the Integrated Cetacean Analysis. Numbers represent estimates for all FTOWDG development sites combined, surveyed between 2009 and 2011 (MacKenzie *et al.*, 2012)

	Estimate	95% Confidence Intervals
Relative abundance	32.25	29.34 – 116.09
Absolute abundance⁹	293.18	266.7 – 1055.37

Figure 14A.39: Estimated White-beaked Dolphin Density per km² Based on Corrected Count Data (MacKenzie *et al.*, 2012)



Encounter Rate

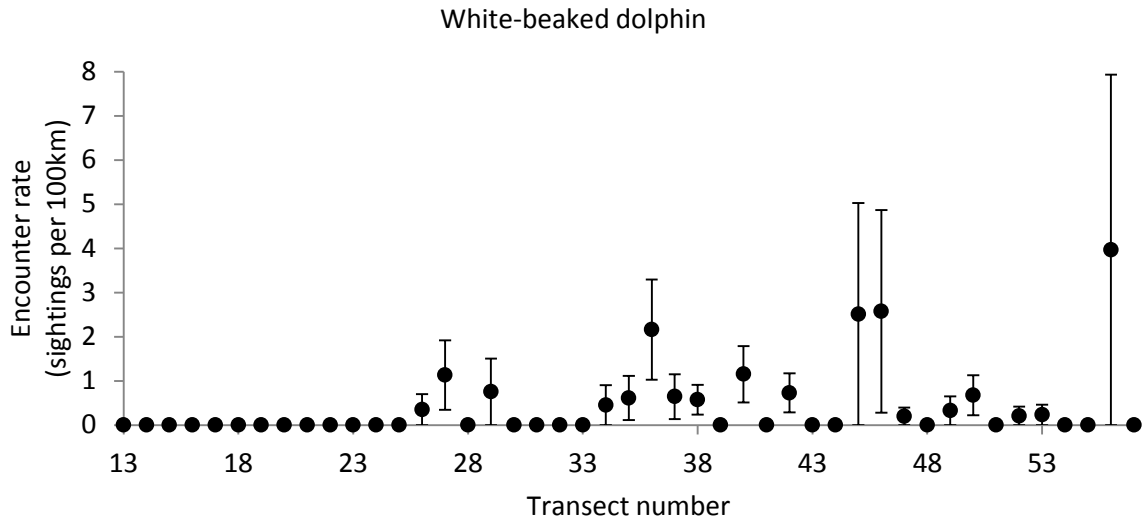
During TCE aerial surveys, white-beaked dolphins were encountered four times more often in summer (0.61 sightings per 100 km) compared to winter (0.15 sightings per 100 km; Grellier and Lacey, 2012). They were encountered more often offshore than inshore in both seasons (Grellier and Lacey, 2012). Encounter rates (individuals per 100 km) were greater than encounter rates (sightings per 100 km) indicating that white-beaked dolphins were almost always sighted in groups (Grellier and Lacey, 2012).

In contrast to harbour porpoise, white-beaked dolphin encounter rates did not consistently increase with distance from shore Figure 14A.37. However, encounter rate was zero for transects 13-25, and roughly equal to one sighting per 100 km thereafter out to the

⁹ No adjustment values available for white-beaked dolphins so data adjusted based on a sighting availability for bottlenose dolphins of 0.11 (Mate *et al.*, 1995).

easternmost extent of the survey area. White-beaked dolphin encounter rate was greatest on transects 45, 46 and 56 (between 2.5 and 4 sightings per 100 km) although variability was too great to be able to draw any robust conclusions.

Figure 14A.40: Encounter Rate (Sightings per 100 km) ± Standard Error per Transect for White-beaked Dolphin during TCE Aerial Surveys (Grellier and Lacey, 2012). Transect 13 is the western-most transect, transect 57 is the eastern-most transect. Transects 13-26 were completely inside 12 nm, transects 27-41 crossed the 12 nm contour, and transects 42-57 were completely outside 12 nm



Density Estimates

White-beaked dolphin density estimates are available from TCE aerial, SCANS and SCANS II surveys (Table 14A.8). Estimates from these surveys are similar. Given the high degree of uncertainty surrounding the extent to which TCE aerial survey estimates are underestimates of density, Grellier and Lacey (2012) did not recommend their use in any quantitative impact assessment. For the purpose of this assessment, densities represented in Figure 14A.39 have been applied as it was felt these data were spatially and temporally the most applicable. An average density based on this same data has been used for the areas outside of the study area for the integrated cetacean analysis described above (MacKenzie *et al.*, 2012) and as shown in Figure 14A.39.

Table 14A.8: White-beaked Dolphin Density Estimates

Survey	Time period	Method	Density (animals per km ²)	CV	Other information	Reference
SCANS	July 1994	Line transect	0.0538	0.52	This estimate is for Block C ¹⁰ . The size of this Block is 43,744 km ² .	Hammond <i>et al.</i> , 2002
SCANS II	July 2005	Line transect	0.049	0.37	This estimate is for Block V ¹¹ . The size of this Block is 160,517 km ² .	SCANS II, 2008
TCE aerial survey ¹²	May 2009 to March 2010	Strip transect	0.042	0.31	Summer density = 0.052 (0.35). Winter density = 0.024 (0.66).	Grellier and Lacey, 2012

Diet

Behavioural observations have shown that white-beaked dolphins forage close to the surface (Weir *et al.*, 2009). In Scottish waters they take a wide variety of prey species with fish representing more than 95 per cent of the diet, the most important prey species being haddock and whiting (Canning *et al.*, 2008).

Other Cetaceans

Other cetacean species which have been sighted in the Firths of Forth and Tay are killer whale (*Orcinus orca*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), sperm whale (*Physeter macrocephalus*), humpback whale (*Megaptera novaeangliae*), long-finned pilot whale (*Globicephala melas*) and common dolphin (*Delphinus delphis*).

Killer whale movements in the North Atlantic and into the North Sea appear to be driven by prey abundance, and animals have been sighted throughout the year in UK waters. They are commonly sighted around the north and west of Scotland with inshore sightings mostly between April and October (Figure 14A.41). No killer whales were sighted during the ICOL-commissioned visual boat-based surveys, but one sighting of one individual was made during TCE aerial surveys (Figure 14A.27). The UK conservation status assessment for killer whales is 'unknown' (JNCC, 2007).

Atlantic white-sided dolphins are more common off north-west Scotland than off the east coast (Figure 14A.42). They have been recorded within the Firths of Forth and Tay, but infrequently. No sightings were made on either the visual boat-based (Canning, 2012) or TCE

¹⁰ Area covered the east UK coastal waters from Aberdeenshire to Norfolk.

¹¹ Area covered is the northern third of the North sea, not including the Moray Firth.

¹² TCE aerial survey density estimate should be considered as a minimum estimate due to the inherent negative bias (Grellier and Lacey, 2012). Summer is May to August, winter is November to March.

aerial (Grellier and Lacey, 2012) surveys. The UK conservation status assessment for white-sided dolphins is 'unknown' (JNCC, 2007).

Sperm whales off the UK occur mainly beyond the shelf break north and west of Scotland (Figure 14A.43). There are occasional records of animals in the Forth, but none were sighted on either the visual boat-based (Canning, 2012) or TCE aerial (Grellier and Lacey, 2012) surveys. The UK conservation status assessment for sperm whales is 'unknown' (JNCC, 2007).

Humpback whale sightings in Scottish waters are rare (Figure 14A.44). Small numbers have been seen off the continental shelf west and north of Scotland between May and September (Reid *et al.*, 2003). No sightings were made on either the visual boat-based (Canning, 2012) or TCE aerial (Grellier and Lacey, 2012) surveys. No UK conservation status assessment for humpback whales has been made.

The distribution map of long-finned pilot whales around the UK highlights its deep water habitat. They occur mainly to the north of Scotland, as well as along the shelf edge from southern Ireland to the Bay of Biscay (Figure 14A.45). There are relatively few sightings in coastal waters although two groups of four individuals were seen at the same time (in different distance bands) by the starboard observer on one of the November TCE aerial surveys (Grellier and Lacey, 2012; Figure 14A.28). None were sighted on the visual boat-based surveys (Canning, 2012). The UK conservation status assessment for pilot whales is 'unknown' (JNCC, 2007).

In the UK, common dolphins are most commonly sighted off the south-west. In Scotland they are mainly seen off the west coast, but they have occasionally been sighted in the North Sea (Figure 14A.46). No common dolphins were sighted during the ICOL-commissioned visual boat-based surveys (Canning, 2012), but one sighting of one individual was made during TCE aerial surveys (Grellier and Lacey, 2012). The UK conservation status assessment for common dolphins is 'unknown' (JNCC, 2007).

Figure 14A.41: Sightings of Killer Whale around the UK (Reid *et al.*, 2003)

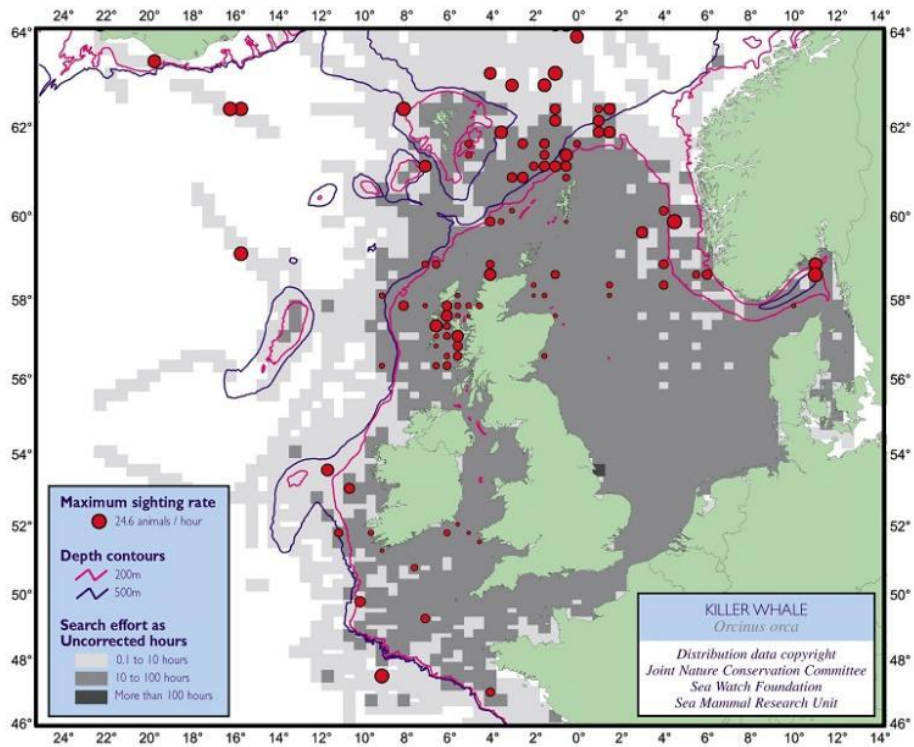


Figure 14A.42: Sightings of White-sided Dolphin around the UK (Reid *et al.*, 2003)

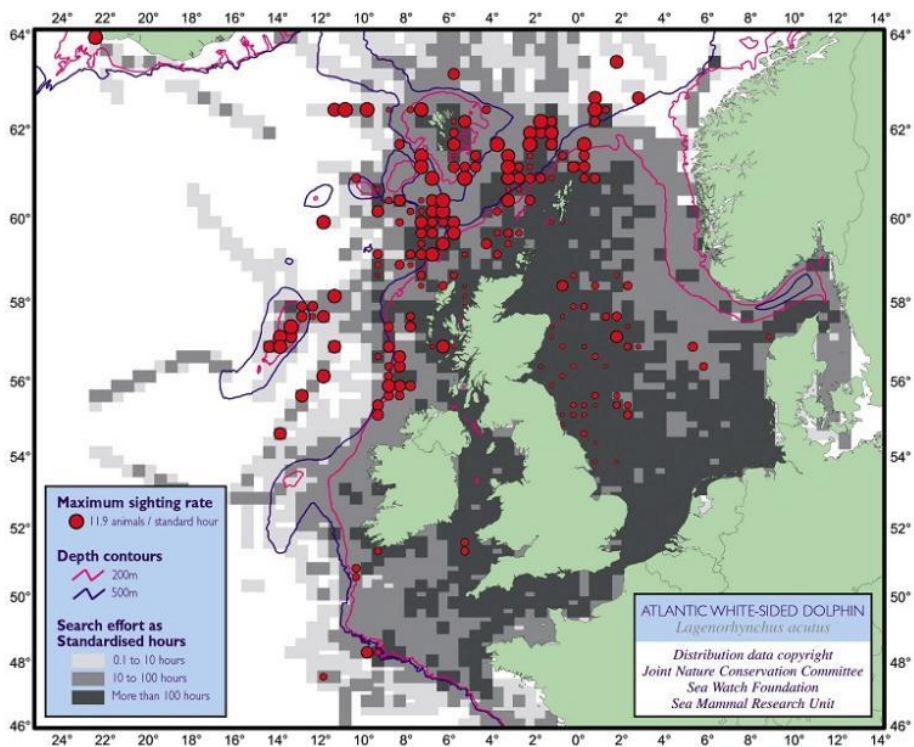


Figure 14A.43: Sightings of Sperm Whale around the UK (Reid *et al.*, 2003)

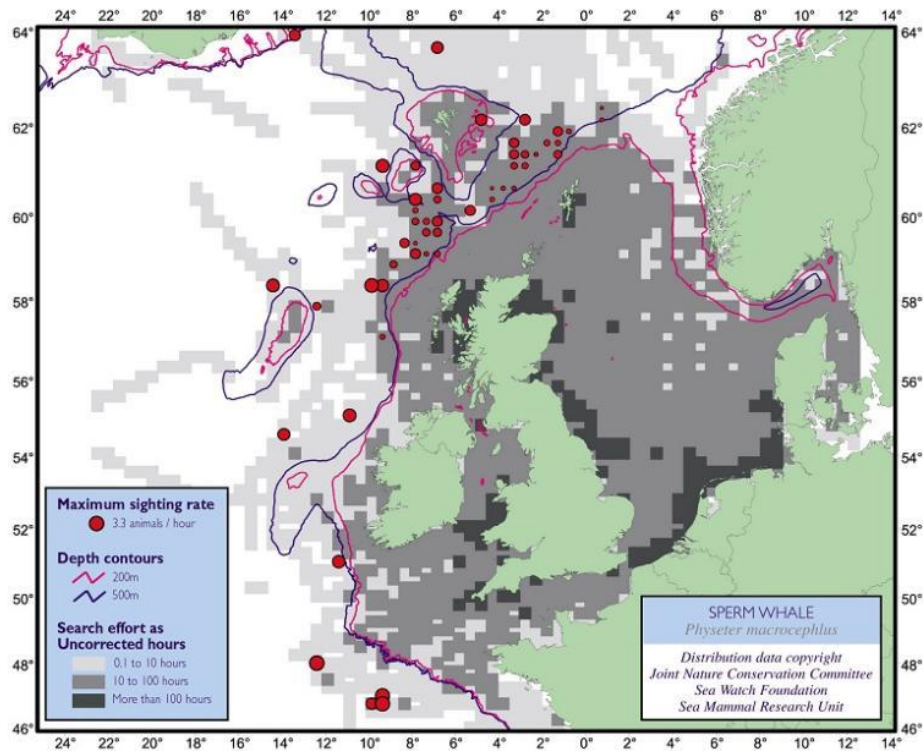


Figure 14A.44: Sightings of Humpback Whale around the UK (Reid *et al.*, 2003)

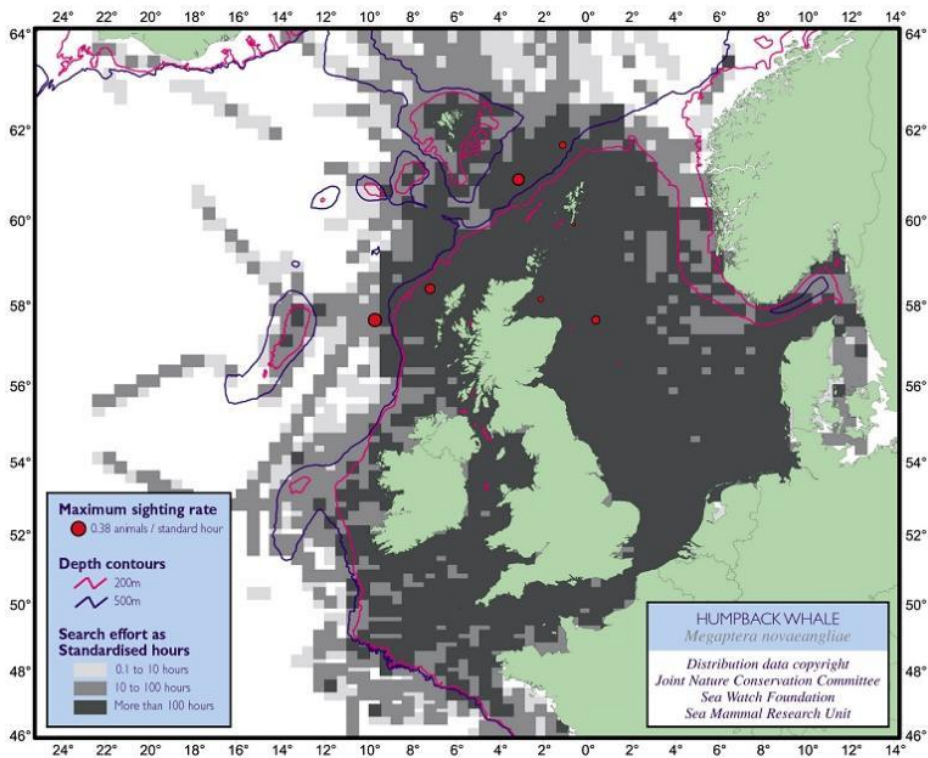


Figure 14A.45: Sightings of Long-finned Pilot Whale around the UK (Reid *et al.*, 2003)

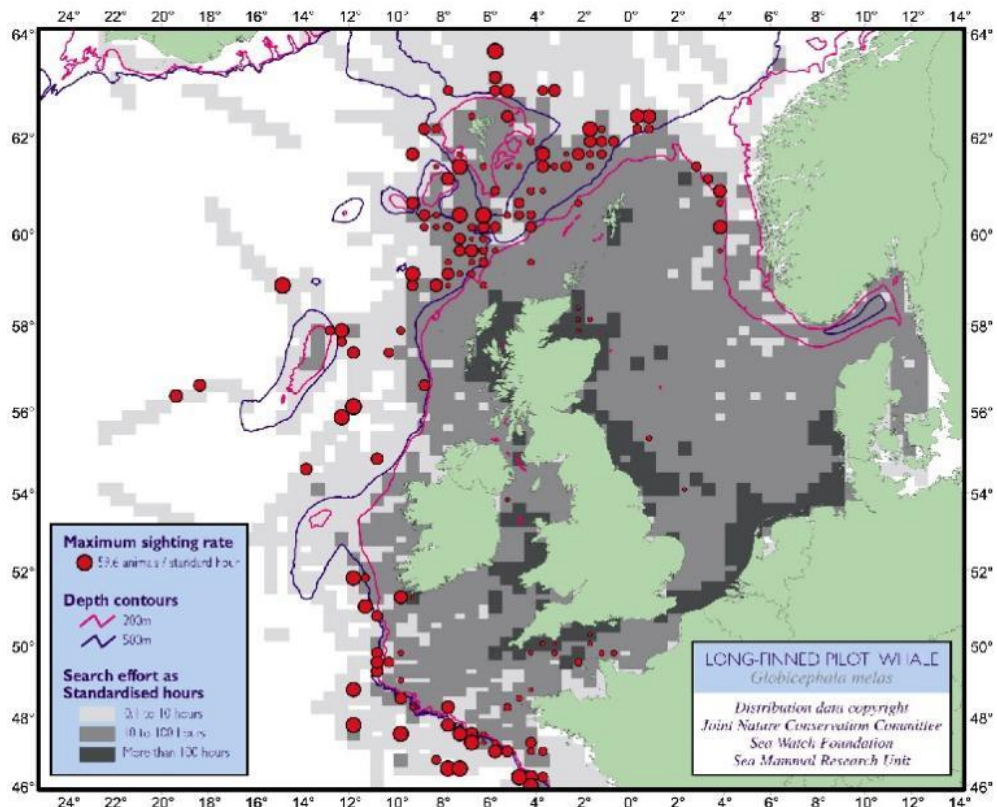
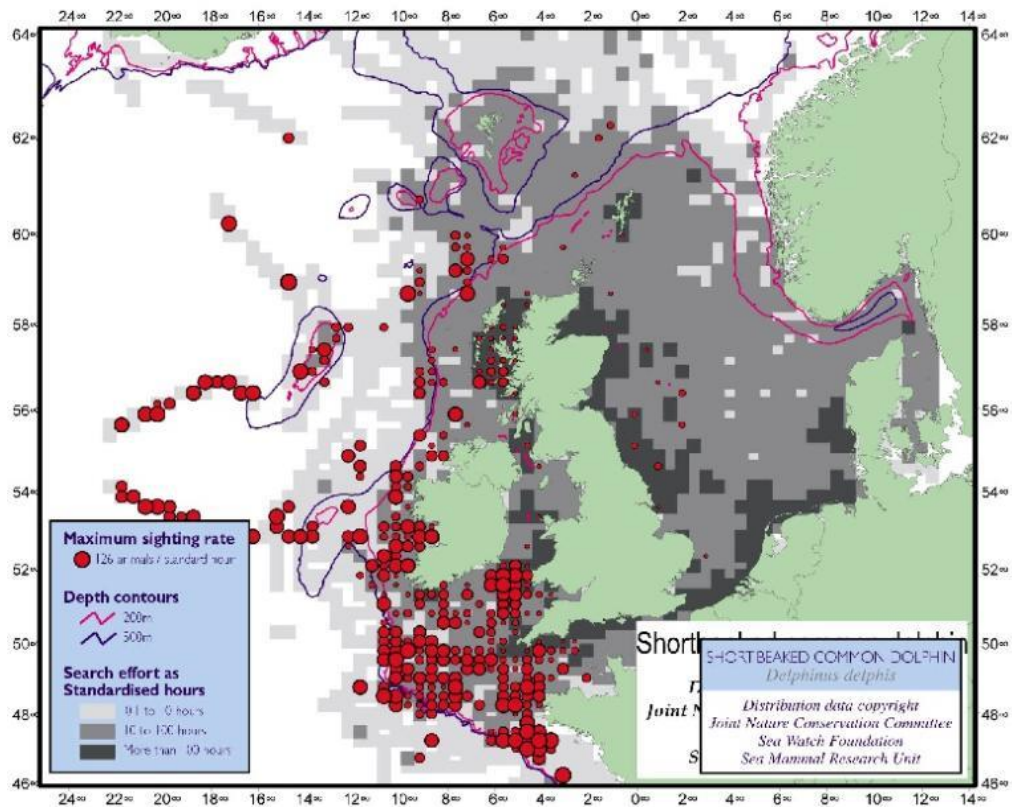


Figure 14A.46: Sightings of Common Dolphin around the UK (Reid *et al.*, 2009)



14A.2.3 Pinnipeds

Two pinniped species are found in the Firths of Forth and Tay, grey (*Halichoerus grypus*) and harbour (*Phoca vitulina*) seals. Much of the information below has been provided by SMRU Ltd through a joint FTOWDG commission (Sparling *et al.*, 2012) to establish usage of the Forth and Tay Area by seals and connectivity of the seals with local SACs.

Harbour Seal (*Phoca vitulina*)

Approximately 30 per cent of European harbour seals are found around the UK coast. Scotland holds about 82 per cent of the UK population with the remainder being found mainly in the Thames and Wash Estuaries in England (13 per cent) and around the coast of Northern Ireland (5 per cent). Harbour seals in Scotland are widely distributed around the west coast and throughout the Hebrides, Orkney and Shetland; on the east coast they are concentrated in the Moray Firth and Firth of Tay.

Harbour seals haul out on land in relation to the tidal pattern. On the east coast this is typically on sand banks and in estuaries, although they also use rocky areas. The breeding season is in June and July and the moult occurs in August. It is during the moult, when the greatest numbers of animals are likely to be ashore, that population counts generally take place.

Major declines have been documented in harbour seal populations around Scotland in the last decade with declines since 2000 of 66 per cent in Orkney, 50 per cent in Shetland, 36 per cent in the Outer Hebrides, 46 per cent in the Moray Firth and 84 per cent in the Firth of Tay (SCOS, 2011). Populations on the west coast have remained stable. The UK conservation status assessment for harbour seals with regard to population is 'inadequate' (JNCC, 2007).

Distribution on Land

Surveys of harbour seals are carried out by the Sea Mammal Research Unit (SMRU) during the summer months. Breeding seals are surveyed in June and July. As described above, the main population surveys are carried out during the moult in August. In Scotland, moult surveys are carried out annually in the Firth of Tay and Moray Firth, but less frequently elsewhere.

Most of the harbour seals in south east Scotland haul out along the Angus, Fife and Lothian coasts (Figure 14A.47). Counts in this area have declined dramatically since the early 2000s (Table 14A.9). The decline seen in the Tay and Eden Estuaries is similar to declines seen in other parts of the species' range, particularly in the Northern Isles. In other parts of the range, particularly the west of Scotland, harbour seal numbers are stable. In contrast to Scotland, numbers in south east England have increased dramatically, with counts in The Wash and North Norfolk population increasing 20 per cent between 2008 and 2009 (SCOS, 2010). The cause of these local declines is not yet known. A number of factors have been proposed as the cause of the decline: disease, killer whale predation, competition with grey seals, declines in important prey species and anthropogenic mortality. Investigations into some of these are continuing (SCOS, 2010) but it is likely that the declines are multi-factorial and that the factors responsible might be different in different areas.

Figure 14A.47: The Number and Distribution of Harbour Seals around the Coast of Scotland from Surveys Carried Out Between August 2007 and 2009 (SCOS, 2011). All areas were surveyed by helicopter using a thermal imaging camera

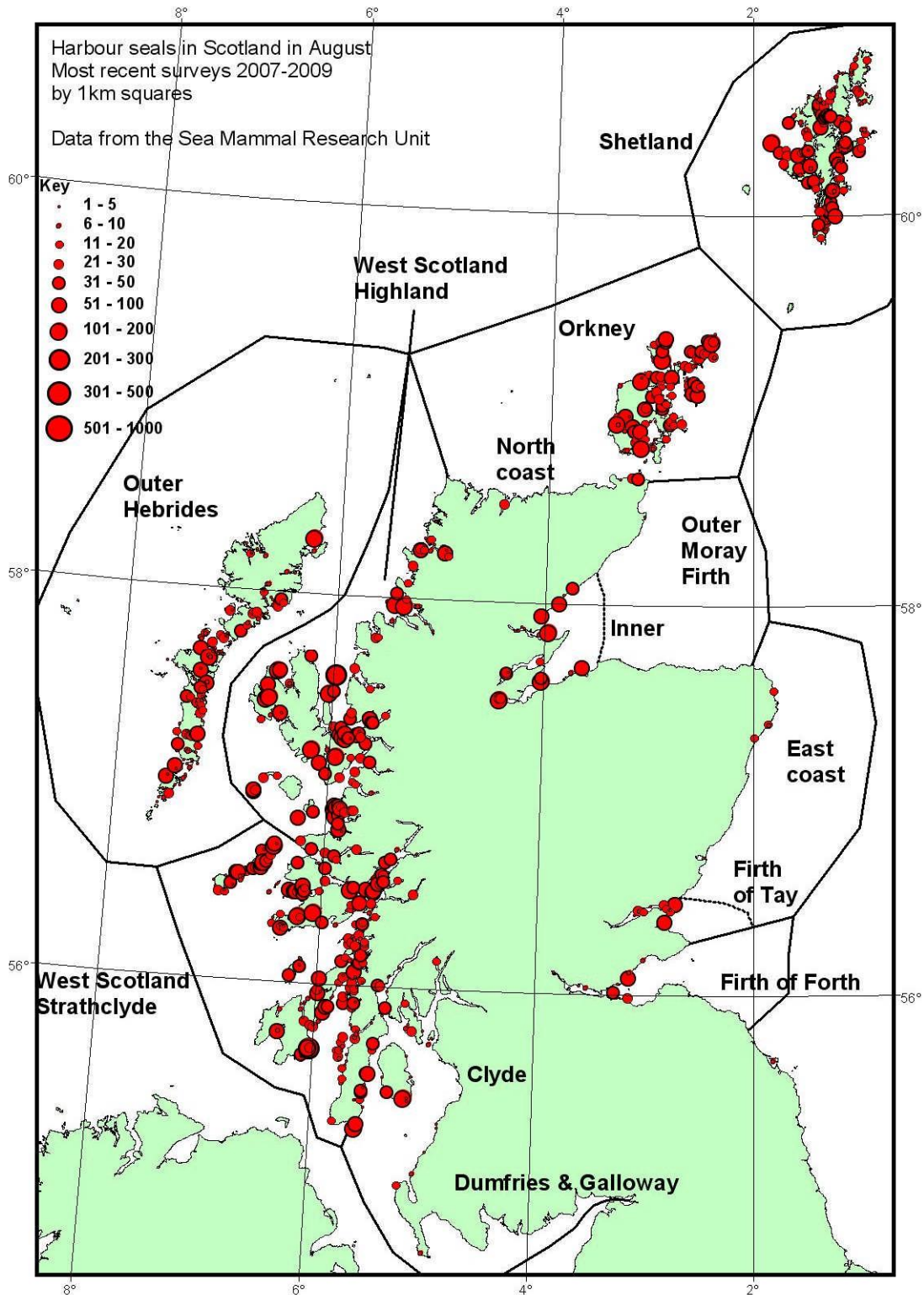


Table 14A.9: The Number of Harbour Seals Counted Within the Firth of Tay and Eden Estuary SAC, during Surveys Carried Out Over the Last Decade by Light Aircraft Using Vertical or Conventional, Oblique Photography (Sparling *et al.*, 2012; Duck and Morris, 2012). Single counts were made in each year apart from 2005, when two counts were made and for which the mean has been presented. Counts were made at locations within the SAC – a total count is provided in column 6

Year	Eden Estuary	Abertay and Tentsmuir Point	Upper Tay	Broughty Ferry and Buddon Ness	Firth of Tay and Eden Estuary SAC total
1990	31	409	27	*	467
1991	0	428	73	169	670
1992	0	456	148	169	773
1994	80	289	89	117	575
1997	223	262	113	35	633
2000	267	153	115	165	700
2002	341	167	51	109	668
2003	93	53	83	232	461
2004	78	126	134	121	459
2005	105	63	91	76	335
2006	90	34	91	127	342
2007	89	31	63	91	274
2008	83	50	49	40	222
2009	22	8	45	36	111
2010	36	9	41	38	124
2011	32	0	16	29	77

*(Survey at this specific site did not begin until 1991)

At-Sea Distribution and Behaviour

SMRU has collected information on harbour seal distribution and movements using telemetry since 2001. Data from 36 tagged harbour seals which had locations inside a 100 km buffer zone drawn around the Forth and Tay OWFs were selected. While Figure 14A.48 shows these movements, features of individual tracks are obscured and it is difficult to visually separate areas which are important for transit. Patterns are easier to discern within

Figure 14A.49 (2011 data only) because data from fewer animals are shown. Nevertheless, movements of harbour seals from haul out sites in St Andrews Bay to the east and north-east are extensive, with many tracks crossing the Inch Cape Development Area and northern half of the Firth of Forth site. When locations are split using a threshold of 0.5 m per second into fast (transiting) and slow (potentially foraging) locations, the patterns become easier to discern and six or seven foraging areas are apparent (Figure 14A.50 and Figure 14A.51).

Highlighting just how useful the telemetry data are for collecting information on animals which spend much of their time underwater, just 40 harbour seal observations were recorded during the ICOL-commissioned boat-based surveys (Figure 14A.52). All observations were made between February and August apart from a single sighting in December and were of single animals except for a single sighting of two animals together. An additional 43 seals not identified to species were also recorded. Harbour seals were recorded throughout the Development Area and buffer zone (see Figure 14A.52).

Very few confirmed species-specific seal sightings were made during TCE aerial surveys, therefore all seal sightings (species-specific and unidentified seal species) were combined (Grellier and Lacey, 2012). These data have been presented in Figure 14A.65 because the majority of animals are likely to have been grey seals (given the difference in numbers of each species ashore).

Figure 14A.48: Tracks of Adult Harbour Seals Tagged in 2001 - 2008 which have Entered a 100 km Buffer Zone Drawn Out from the Boundaries of the OWFs (Sparling *et al.*, 2012). Each colour represents a different animal

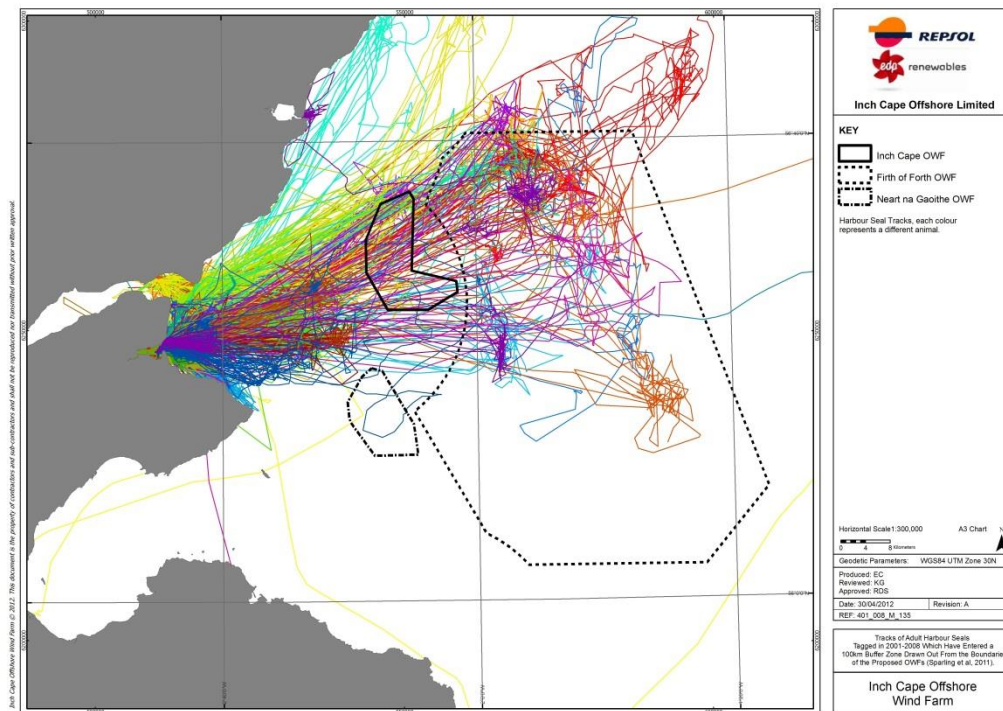


Figure 14A.49: Tracks of Adult Harbour Seals Tagged in 2011 which have Entered a 100 km Buffer Zone Drawn out from the Boundaries of the OWFs (Sparling *et al.*, 2012). Each colour represents a different animal

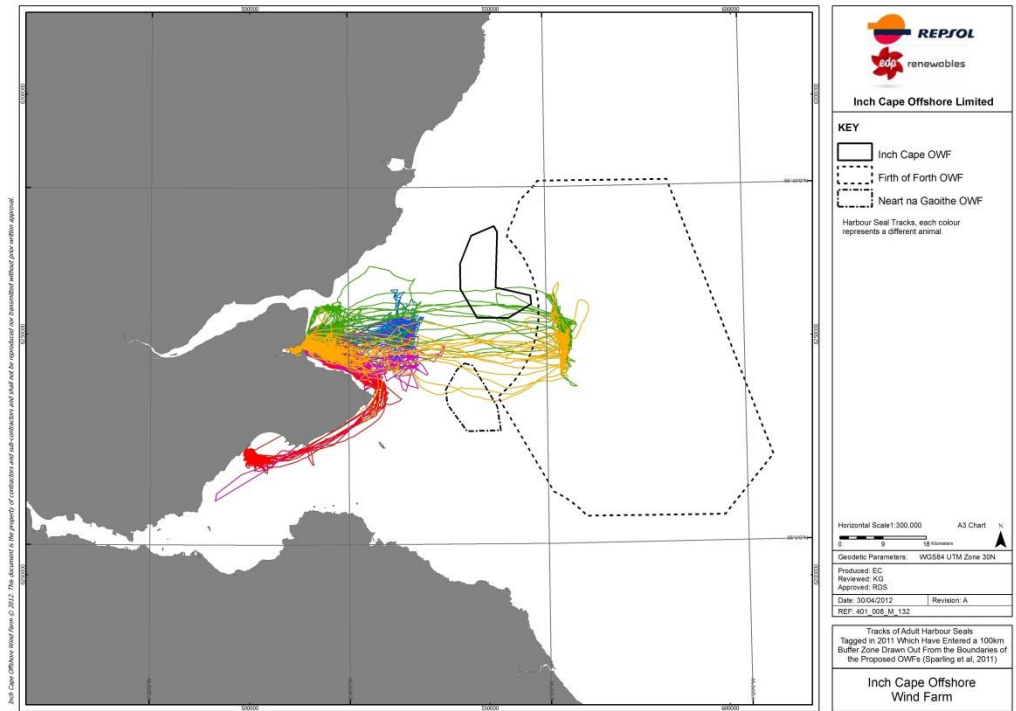


Figure 14A.50: The Locations of Adult Harbour Seals Tagged in 2001-2008 with Locations Classified by Speed (Sparling *et al.*, 2012). Slow speed may indicate foraging locations, fast speed may indicate transiting

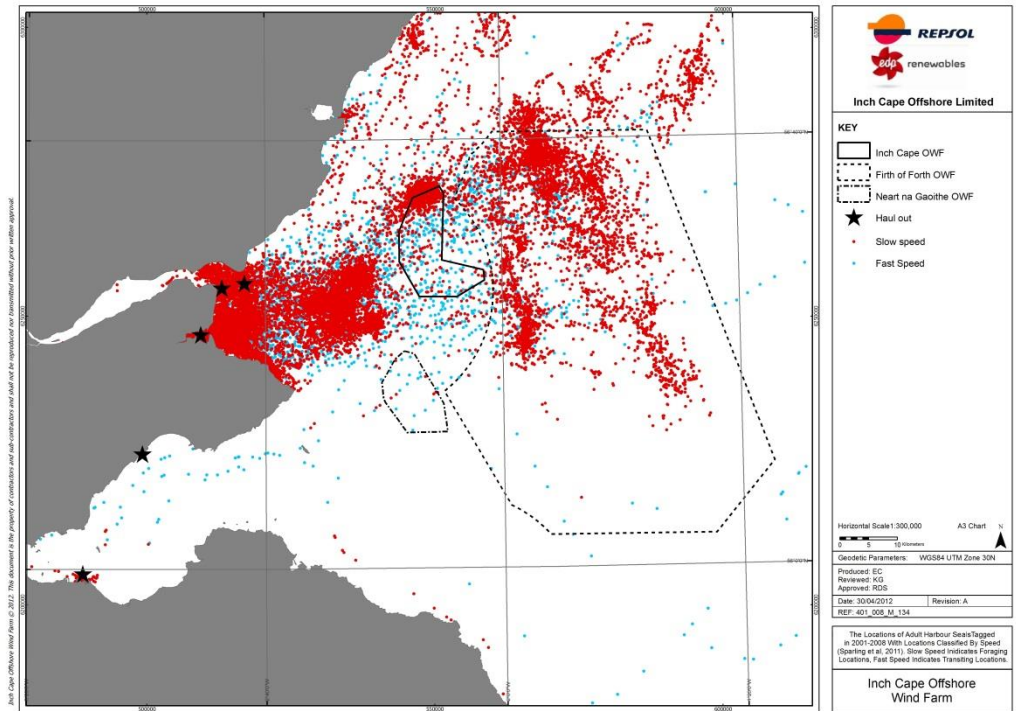


Figure 14A.51: The Locations of Adult Harbour Seals Tagged in 2011 with Locations Classified by Speed (Sparling *et al.*, 2012). Slow speed may indicate foraging locations, fast speed may indicate transiting

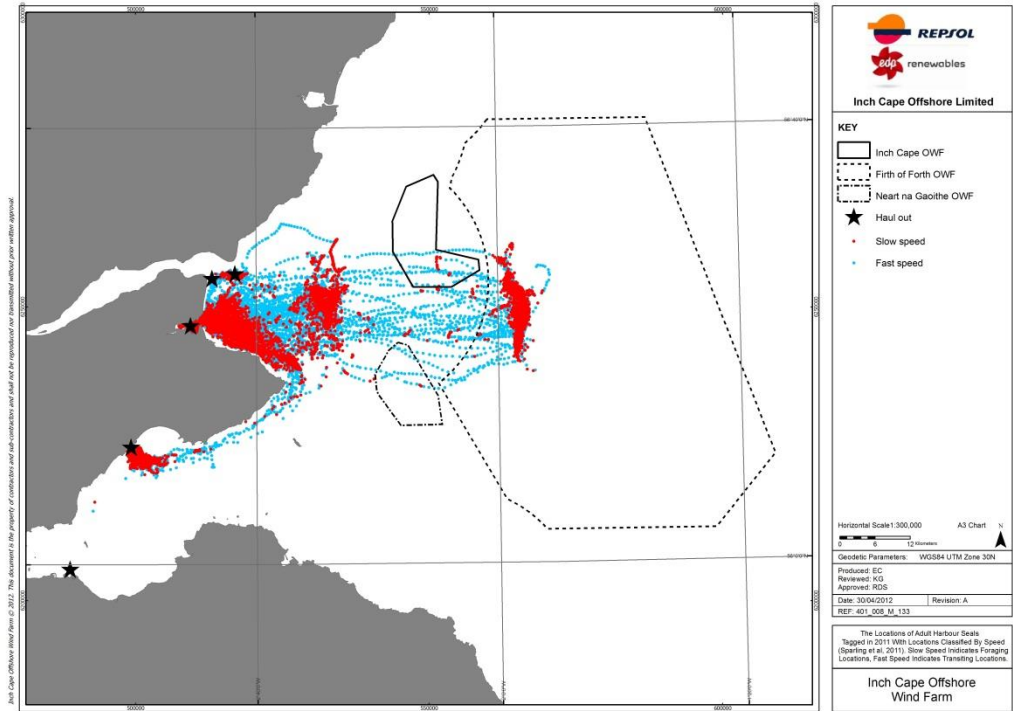
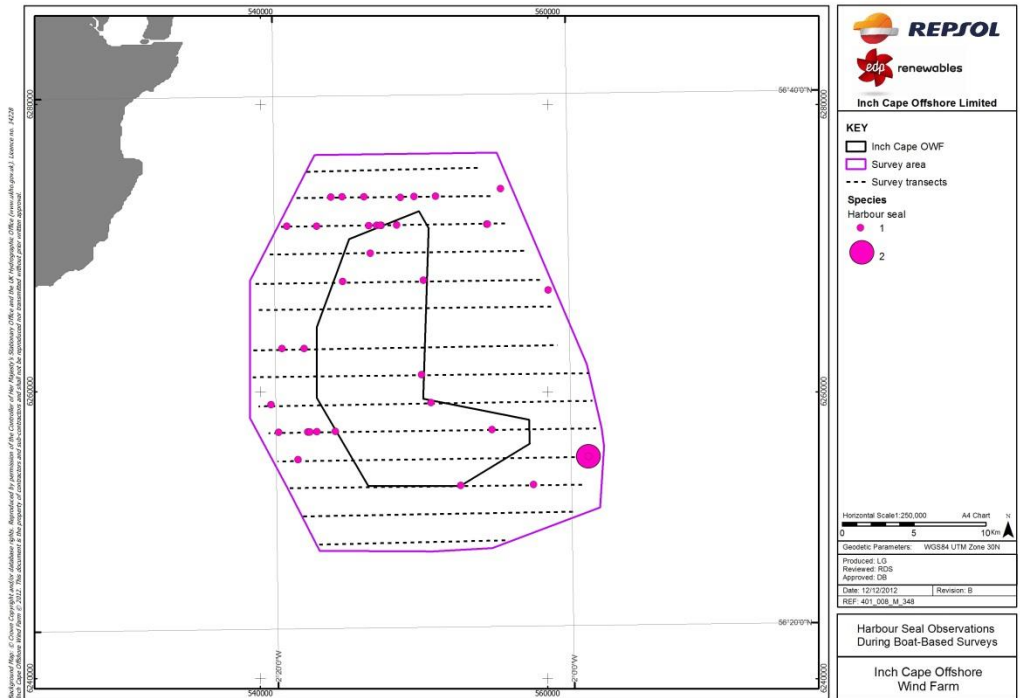


Figure 14A.52: Distribution of Harbour Seals observed within the Inch Cape Development Area and 4 km Buffer Zone (Canning, 2012)

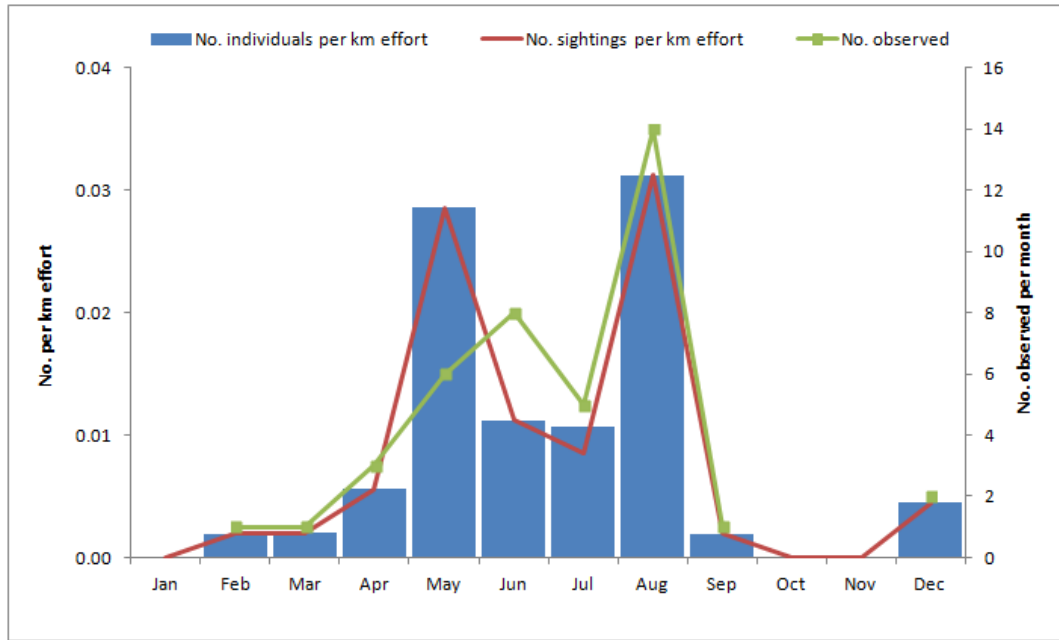


Seasonal Patterns

Harbour seals are present all year round in the Tay and Eden estuaries. Numbers ashore are generally lowest in winter and higher in summer during the moult and breeding seasons (Sharples *et al.*, 2009). Sharples *et al.*, (2009) demonstrated that changes in the number of seals hauled out results from seasonal variation in the proportion of animals at sea rather than seasonal movements of animals in and out of the area.

Counter-intuitive to this finding, harbour seals seen during the ICOL-commissioned boat-based surveys were mainly recorded during the breeding season and moult (Figure 14A.53). However, such a small number of sightings were made in total that it is not possible to draw any conclusions from this.

Figure 14A.53: The Number of Harbour Seal Observed (green line), the Mean Number of Sightings per km Effort (red line) and the Mean Number of Individual Animals (blue bars) Recorded per km Survey Effort Each Calendar Month During Boat-based Surveys December 2010 - September 2012 (Canning, 2012). For distribution map of these sightings refer to Figure 14A.52



Abundance

The numbers presented in Table 14A.9 (above) represent minimum population estimates, since a proportion of the population will always be at sea when aerial counts are made. A study by Lonergan *et al.* (in SCOS, 2011) demonstrated that flipper tagged harbour seals hauled out on average 72 per cent of their time during the annual moult (95 per cent confidence interval 54-88 per cent). Scaling up the most recent count of the east coast harbour seal population (not including the Moray Firth) of 389 seals (SCOS, 2011) gives a local population estimate of 540 (442-720) seals. Scaling up the 2010 count for the Firth of Tay and Eden Estuary SAC of 124 (Table 14A.9) gives an SAC estimate of 172 (141-230; Sparling *et al.*, 2012). For the purpose of this assessment, the reference population is assumed to be 638 seals based on SMRU survey data during 2007 for the east coast management area count corrected for animals at sea.

At-Sea Movements: Density and Foraging Areas

Telemetry data gives information on where the tagged animals go, and the areas of land and sea they use (e.g. Figure 14A.48). If the sample of tagged animals is assumed to be representative of the population, the telemetry data can be combined with estimates of total population size to provide estimates of total population usage of, or estimated density in, an area. The method used here for seals is based on that used by Matthiopoulos *et al.* (2004).

Harbour seal usage extends out from haul out sites located at the mouth of the Firth of Tay to areas of concentrated usage which are likely to be offshore foraging areas (Figure 14A.54). These foraging areas are located between the haul out sites and the Inch Cape Development Area, on the north tip of the Inch Cape Development Area and in the northern part of the Firth of Forth site (over Scalp Bank). There is also a patch of increased use on Marr Bank in the south eastern part of the Firth of Forth site (Figure 14A.54).

These spatially explicit density estimates will be used when examining harbour seal exposure to construction noise, whenever possible. Density surfaces represent the number of animals likely to be found in an area better than multiplying a single density estimate by the size of the area (because density is assumed to be uniform across the area).

Figure 14A.54: Estimated Harbour Seal At-Sea Usage around the FTOWDG Development Sites (Sparling *et al.*, 2012). White contours show standard deviation from mean usage as a measure of uncertainty

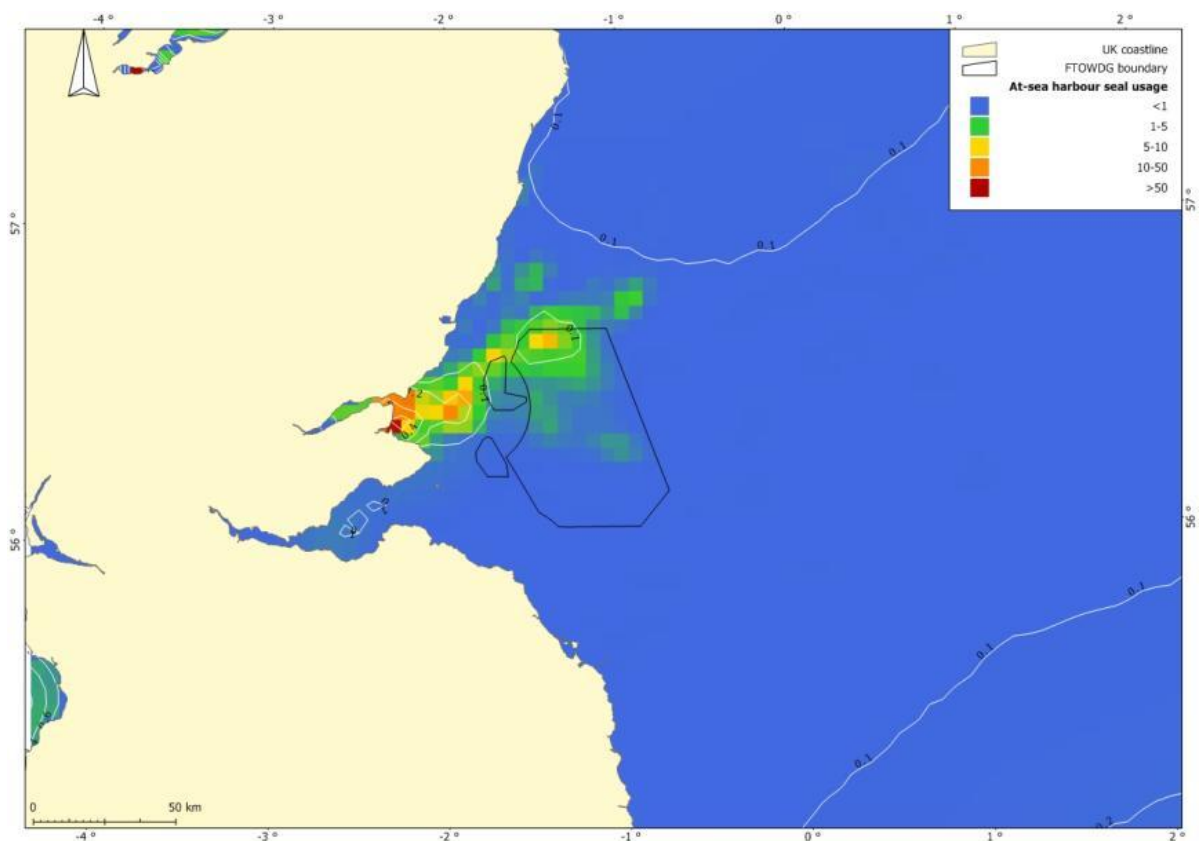
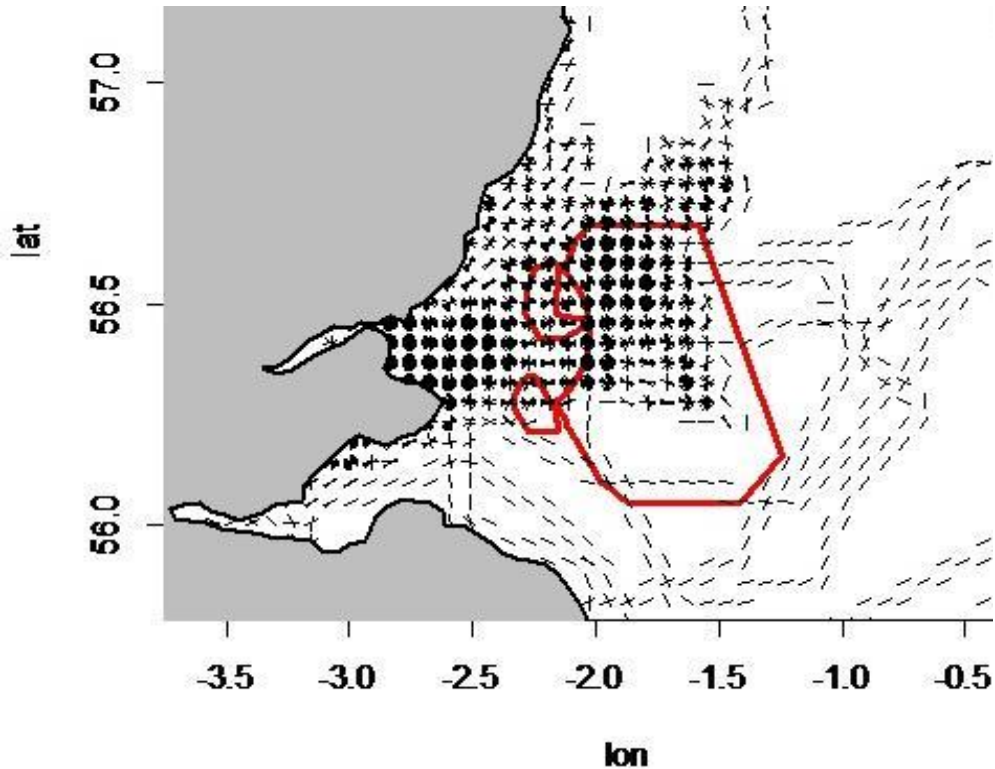


Figure 14A.55: Plot of Harbour Seal Track Orientation – the Direction of Each Seal Transit across Each 5 km Grid Cell is Shown (Sparling *et al.*, 2012). Cells containing circular shapes represent areas where tracks crossed the cell in different directions, suggesting random movement. Cells containing parallel lines represent areas where tracks are more indicative of directional travel



SAC Connectivity

Individual harbour seals show a very high degree of site fidelity, with all seals tagged at the Firth of Tay and Eden Estuary SAC travelling relatively locally to forage and returning to the SAC to haul out. Harbour seals tagged at the Firth of Tay and Eden Estuary SAC did not visit any other harbour seal SACs during the tag deployment period (Sparling *et al.*, 2012).

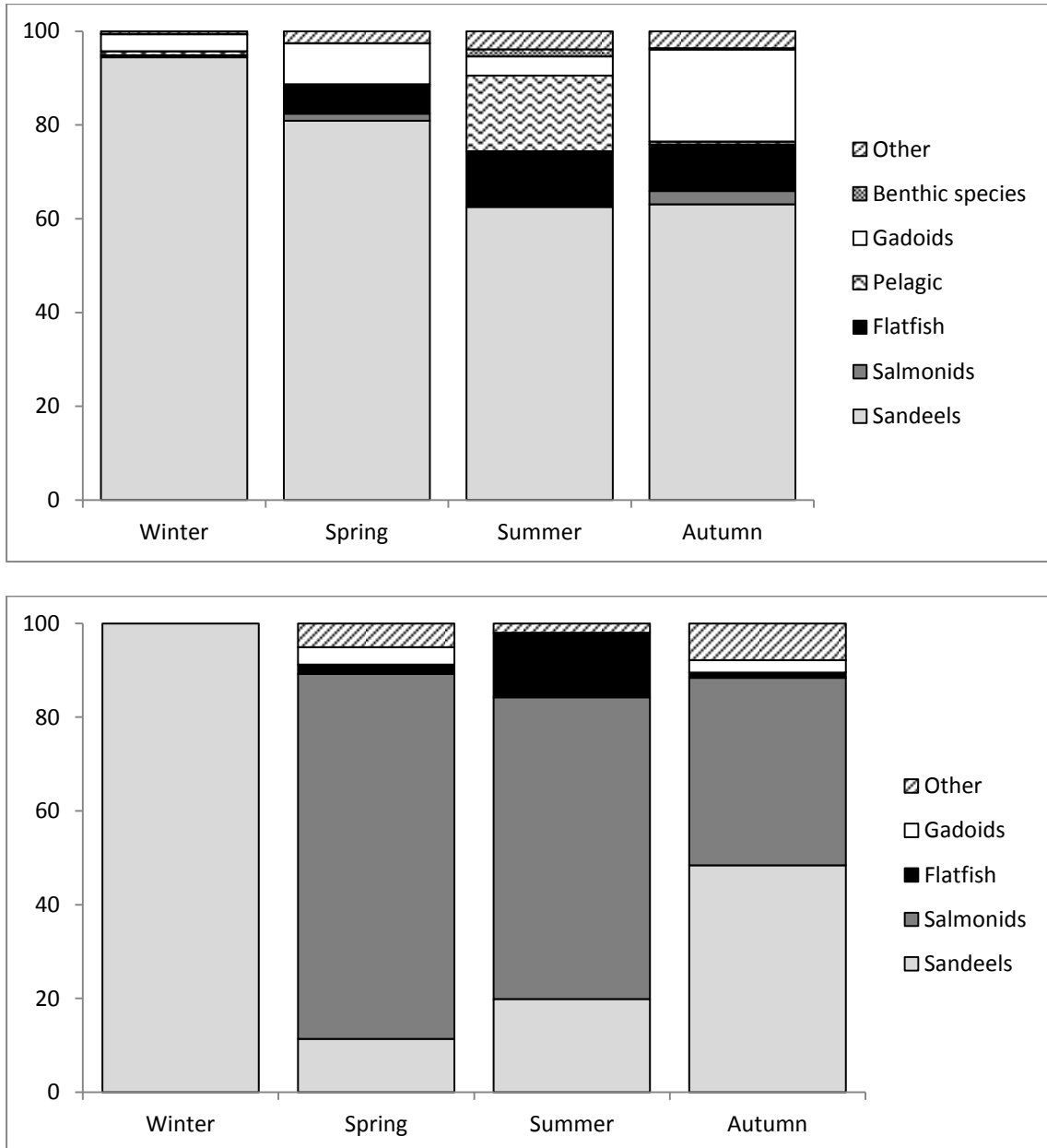
Diet

Scat analysis is a suitable technique for assessing harbour seal diet in areas such as the Firth of Tay, where animals forage close enough to shore that passage rates are greater than the time it takes to return from foraging trips. Fish ear bones (otoliths) and cephalopod (squid and octopus) beaks recovered from scats collected at haul out sites can be used to identify the species, and size, of prey consumed by the seal.

Scats were collected from harbour seal haul out sites in St Andrews Bay and the Firth of Tay between February 1998 and July 2003 (Sharples *et al.* 2009). Sandeels were the dominant prey species found in the diet of harbour seals in the region. Pelagic species such as herring were relatively unimportant. Seasonal variation in species composition was evident as was within-region spatial variation; salmonids were the dominant prey type in the Firth of Tay in spring and summer while diet in St Andrews Bay was dominated by sandeels in all seasons (Sharples *et al.* 2009; Figure 14A.56). The mean length of sandeel recovered increased from

12.6 cm before 2000 (the year of the sandeel fishery closure) to 13.3 cm after 2000. This difference was highly significant (Kolmogorov-Smirnov, $D = 0.104$, $p < 0.001$; Sharples *et al.* 2009).

Figure 14A.56: Average Seasonal Percentage by Weight of Each Prey Type in the Diet of Harbour Seals in St Andrews Bay (top) and the Firth of Tay (bottom) (Sharples *et al.*, 2005)



Grey Seal (*Halichoerus grypus*)

Grey seals are only found in the North Atlantic and have three population centres: the north-west Atlantic, the north-east Atlantic and the Baltic. Approximately 37 per cent of the world population is found in the UK, with approximately 90 per cent of these breeding in Scotland (mainly in the Hebrides and Orkney; SCOS, 2009). The UK conservation status assessment for grey seals is ‘favourable’ (JNCC, 2007).

In Scotland, adult female grey seals aggregate between September and early December to breed at traditional colonies on remote, uninhabited islands and coasts where they give birth to a single white-coated pup. Breeding colonies in the vicinity of the Inch Cape Development Area are the Isle of May and other islands in the Firth of Forth, Fast Castle and the Farne Islands. After weaning their pups after three weeks, females mate and depart to sea. Pups remain on the breeding colony for a further two weeks before departing to sea themselves. Breeding colonies vary greatly in size from only a few to several thousand pups. Mature seals of both sexes are usually faithful to particular breeding colonies and may return to within metres of previous breeding locations in successive years (Pomeroy *et al.*, 2000). Grey seals also come ashore in large numbers to moult, between December and April (SCOS, 2011).

Pup production of UK grey seals has increased since monitoring began in the 1960s. In both the Inner and Outer Hebrides, the rate of increase declined in the early 1990s and production has been relatively constant since then. The rate of increase in Orkney has declined since 2000 and pup production has been relatively constant since 2004. Overall pup production at North Sea colonies continues to increase exponentially although it appears that this is due to the expansion of newer colonies on the mainland coast in Berwickshire and East Anglia.

Grey seals spend approximately 40 per cent of their time at or near terrestrial haul out sites, 12 per cent of their time foraging and the remainder travelling between foraging areas and haul out sites (McConnell *et al.*, 1992; McConnell *et al.*, 1999). Foraging trips usually last between two and five days but may be as long as 30. Most grey seals feed within 40 km of their haul out site (McConnell *et al.*, 1999).

Distribution on Land

Grey seals in Scotland are currently monitored at two different times of year: aerial surveys in August (which are primarily for moulting harbour seals) provide information on non-breeding season distribution and annual surveys during the September to early December breeding season determine the numbers of pups born at the main breeding colonies.

The largest concentrations of grey seals counted during the August surveys are in Orkney followed by the Western Isles and then the east coast sites (Figure 14A.57). Most of the east coast grey seals were counted around Peterhead and in the Firths of Forth and Tay, and also to the south at the Farne Islands.

The closest grey seal breeding colony to the Inch Cape Development Area is the Isle of May, an SAC for grey seals, where around two thousand pups are born every year (Figure 14A.58). A small number of pups are born at other islands in the Firth of Forth, and there is also a fast-growing colony at Fast Castle in the outer reaches of the Forth on the Berwickshire coast (Figure 14A.58). The Farne Islands to the south also support a large colony.

Figure 14A.57: The Number and Distribution of Grey Seals around the Coast of Scotland from Surveys Carried Out Between August 2007 and 2009 (SCOS, 2011). All areas were surveyed by helicopter using a thermal imaging camera

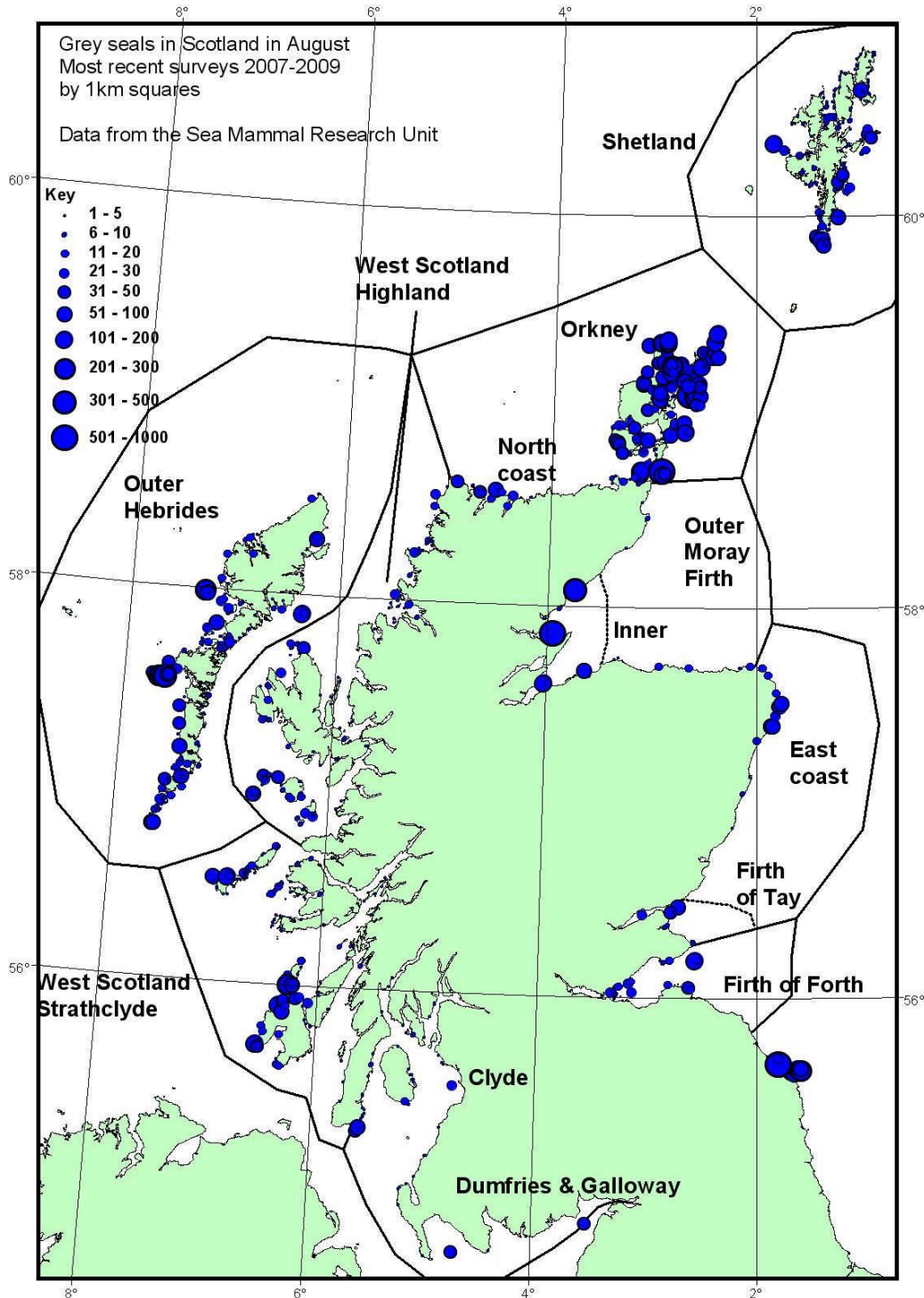
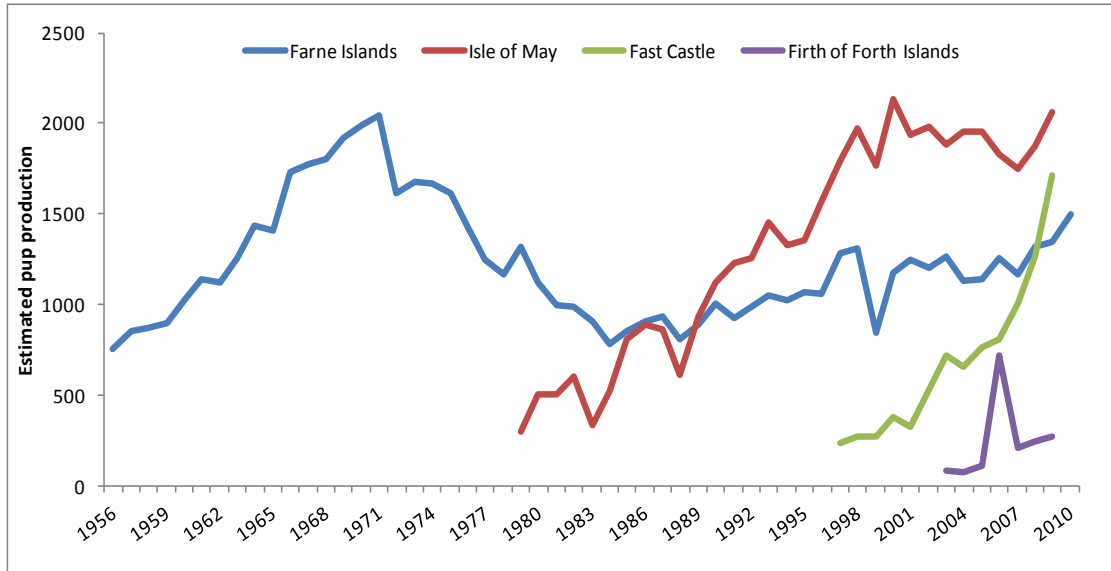


Figure 14A.58: Grey Seal Pup Production Estimates for Breeding Colonies on the North East Coast of England and South East Coast of Scotland for the Last Decade (SCOS). Data derived from aerial and ground counts carried out during the grey seal breeding season (September to December) by SMRU (Isle of May, Fast Castle, Firth of Forth islands), the Forth Seabird Group (Firth of Forth islands) and the National Trust (Farne Islands)



At-Sea Distribution and Behaviour

SMRU has collected information on grey seal distribution and movements using telemetry since 1988. Data from 122 tagged grey seals which had locations inside a 100 km buffer zone drawn around the Forth and Tay OWFs were selected. While Figure 14A.59 and Figure 14A.60 show these movements, features of individual tracks are obscured and it is difficult to visually separate areas which are important for transit or foraging. Nevertheless, movements of grey seals from haul out sites in St Andrews Bay to the east and north-east are extensive, with many tracks crossing the Inch Cape Development Area, Firth of Forth and NnG sites. When locations are split using a threshold of 0.5 m per second into fast (transiting) and slow (potentially foraging) locations, the patterns become easier to discern and six potential foraging areas are apparent (Figure 14A.61; Figure 14A.62).

Grey seal observations were recorded throughout the Development Area and buffer zone during the ICOL-commissioned boat-based surveys (see Figure 14A.63). In total, 155 observations were recorded totalling 159 individuals.

Very few confirmed species-specific seal sightings were made during TCE aerial surveys therefore all seal sightings (species-specific and unidentified seal species) were combined (Grellier and Lacey, 2012). These data have been summarised in the grey seal sections because the majority of the seals are likely to have been greys given the difference in numbers of each species ashore.

Figure 14A.59: Tracks of Grey Seal Adults Which have Entered a 100 km Buffer Zone Drawn out from the Boundaries of the OWFs (Sparling *et al.*, 2012). Each colour represents a different animal

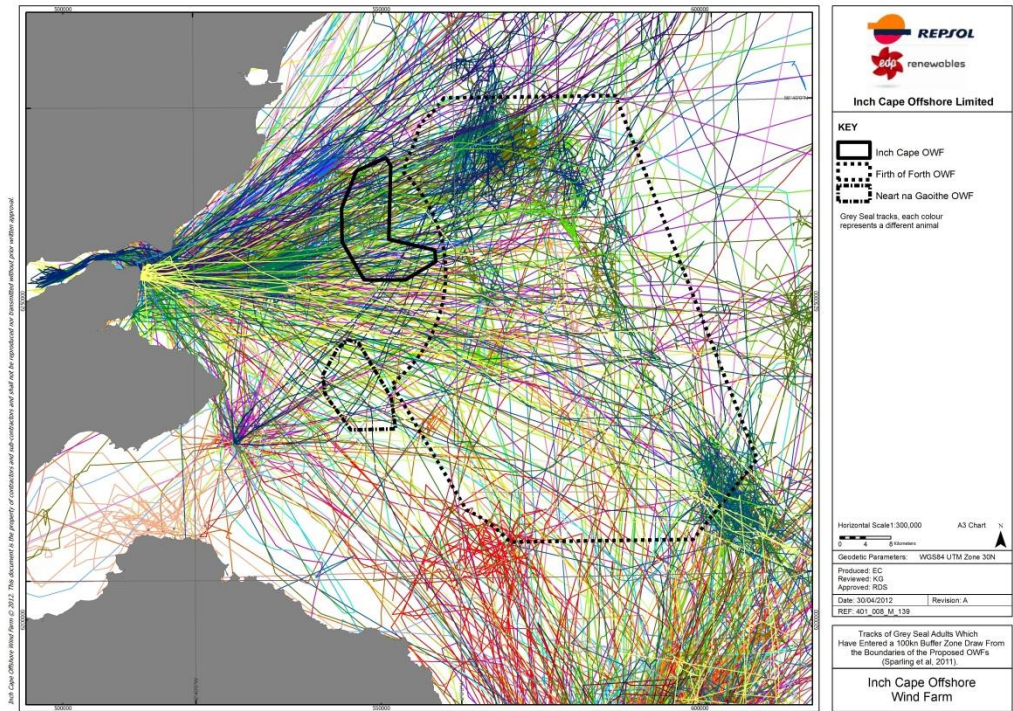


Figure 14A.60: Tracks of Grey Seal Pups Which have Entered a 100 km Buffer Zone Drawn Out from the Boundaries of the OWFs (Sparling *et al.*, 2012). Each colour represents a different animal

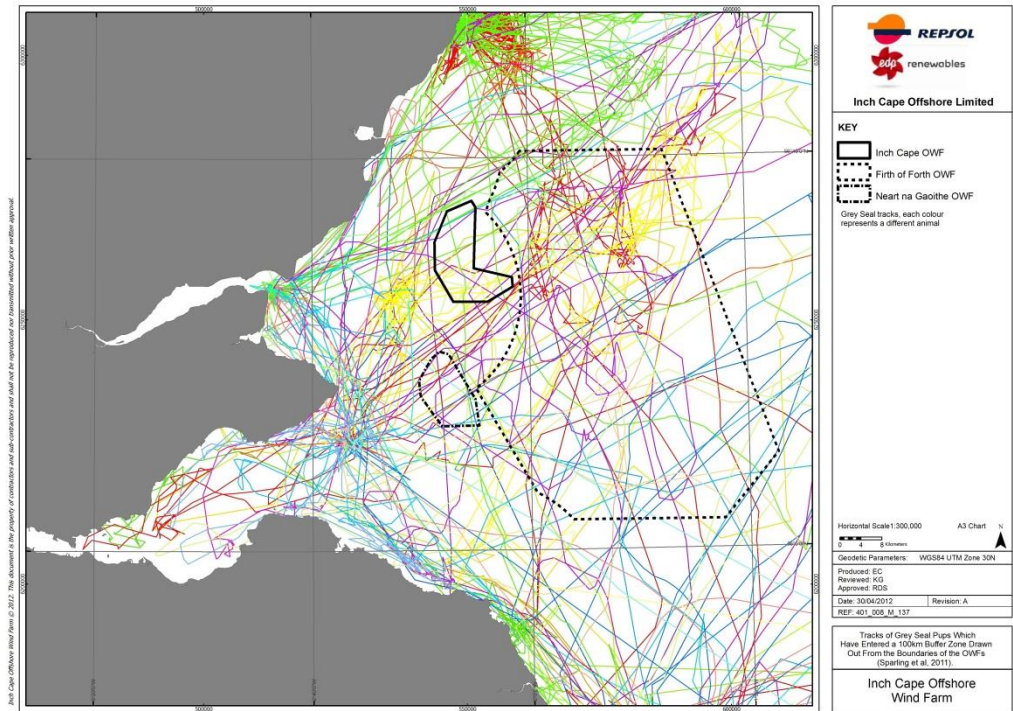


Figure 14A.61: The locations of Grey Seal Adults with Locations Classified by Speed (Sparling *et al.*, 2012). Slow Speed Suggests Foraging Locations, Fast Speed Suggests Transiting

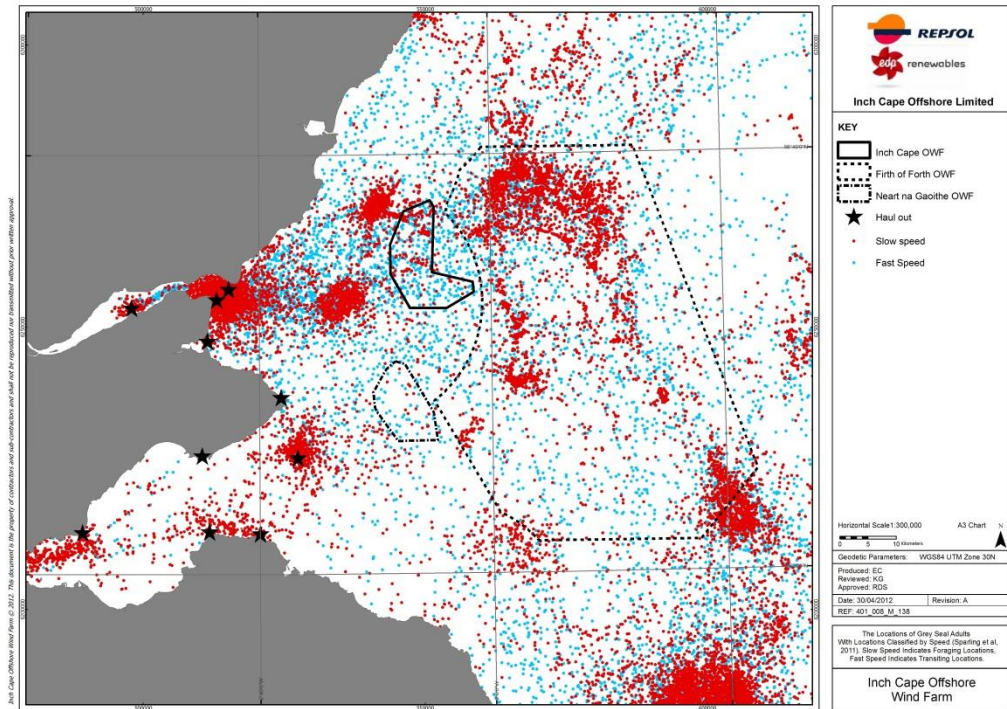


Figure 14A.62: The Locations of Grey Seal Pups with Locations Classified by Speed (Sparling *et al.*, 2012). Slow speed suggests foraging locations, fast speed suggests transiting

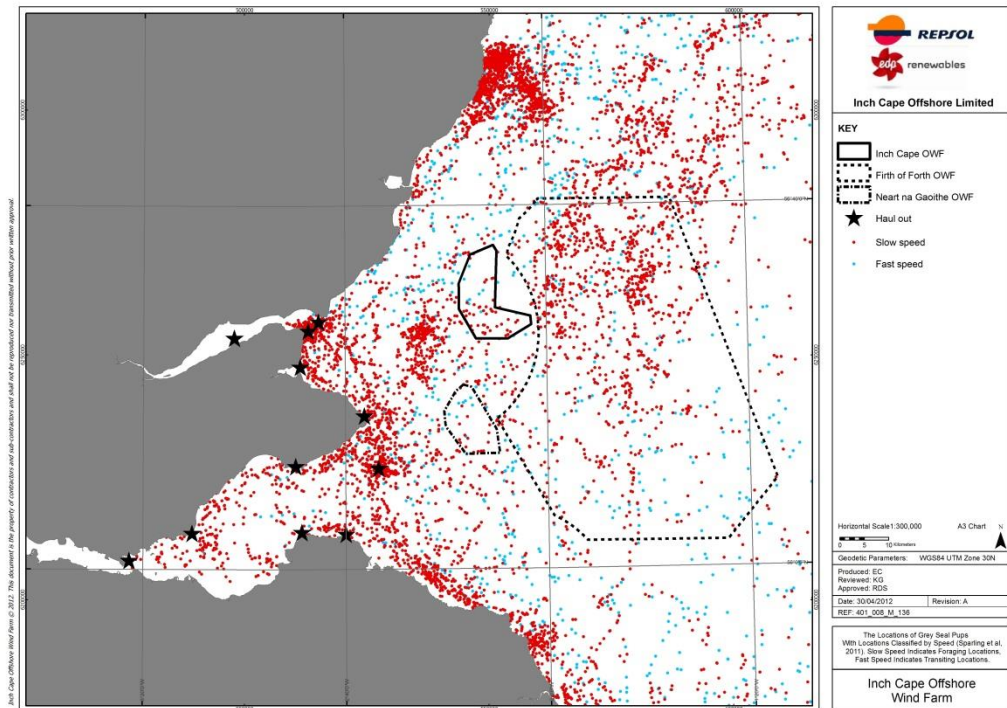
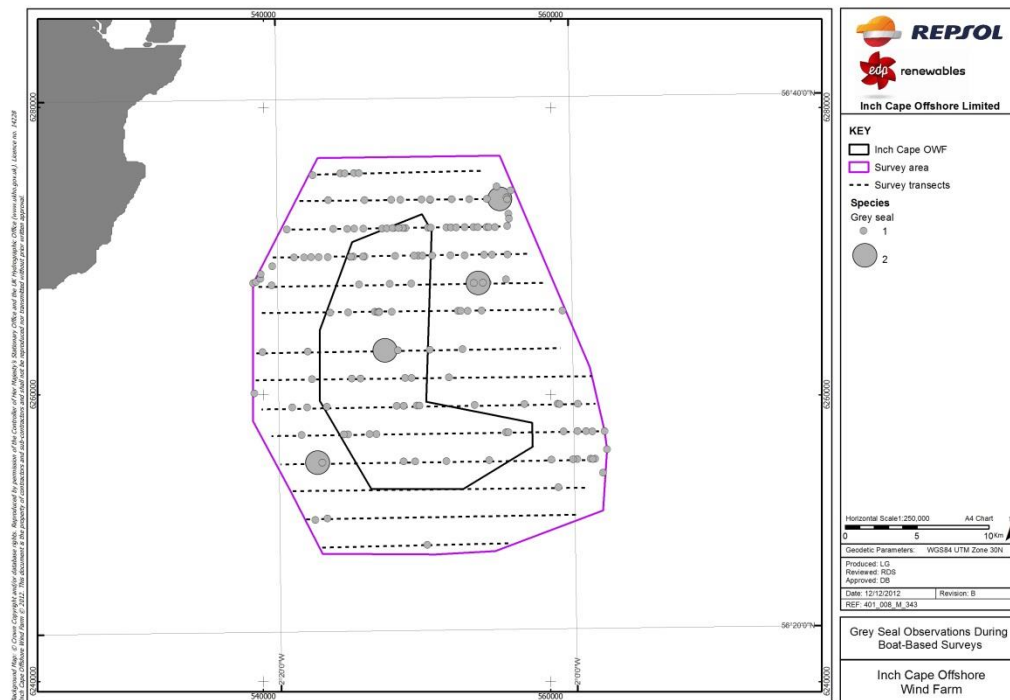


Figure 14A.63: Distribution of Grey Seals Observed within the Inch Cape Development Area and 4 km Buffer Zone (Canning, 2012)



Seasonal Patterns: At-Sea

'Seals' were distributed across the survey area during TCE aerial surveys (Figure 14A.64) although they appeared to be more common offshore, than inshore, in summer (Figure 14A.65; Grellier and Lacey, 2012). Sightings were more common in summer than in winter (Figure 14A.66) in general. Seals were most often sighted singly although a group of 30 individuals was sighted on Transect 20 near the Bell Rock, an area where seals are known to 'congregate' (Grellier and Lacey, 2012).

Encounter rates during TCE aerial surveys were generally greater between May and August 2009 than between November 2009 and March 2010 for 'all seals' (Grellier and Lacey, 2012). In the first period (May to August), mean encounter rates were greatest in May (~4 sightings per 100 km), lower in June and July (~2.5 sightings per 100 km), and lower still in August (< 2 sightings per 100 km). These lower encounter rates coincide with harbour seals coming ashore to give birth to their pups in June and July, and to moult in August (when the greatest and most consistent numbers of seals are found ashore; SCOS, 2011).

In the second period (November to March), mean encounter rate varied from 0.35 in November 2009 to 1.9 sightings per 100 km in December. These months coincide with months when grey seals are breeding and moulting. There are likely to be more grey seals in the 'all seals' category than harbour seals due to the difference in local population size; a total of 124 harbour seals counted in the Firth of Tay and Eden Estuary SAC during the August 2010 moult compared to an estimated pup production of 4047 for the Firth of Forth in 2009. Therefore we would expect encounter rates to be lowest when grey seals are ashore breeding and moulting.

Grey seals were observed in all months boat-based surveys were carried out except December (see Figure 14A.67) – the end of the breeding, and the start of the moulting, season. Encounter rates during July (peak observations) equated to about nine grey seals per 100 km (Figure 14A.67).

Figure 14A.64: Seals Distribution during Aerial Surveys – All Seasons (Grellier and Lacey, 2012)

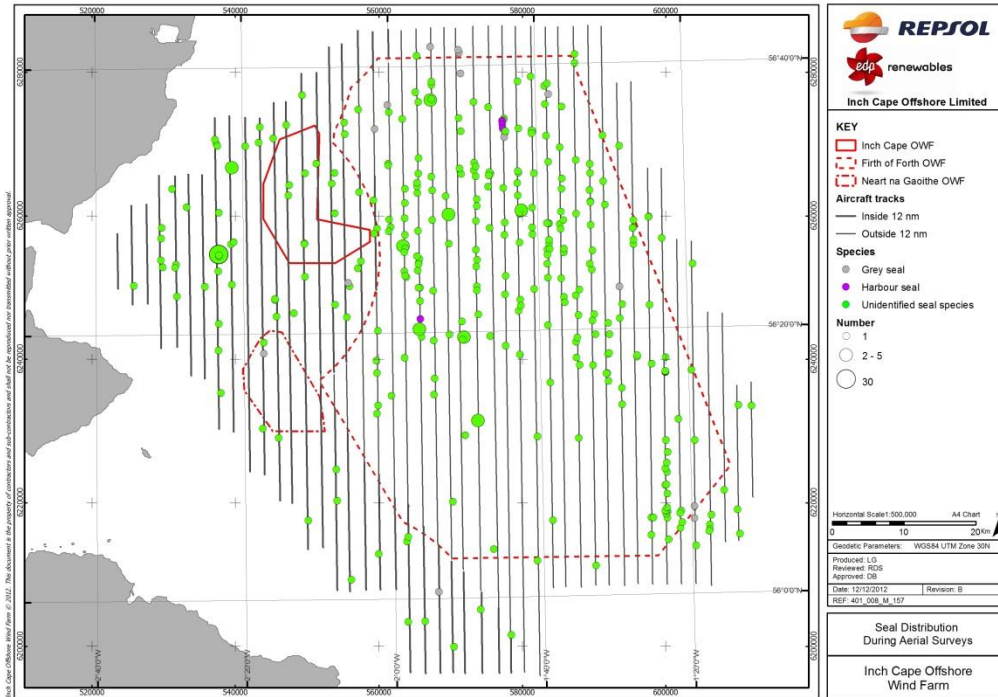


Figure 14A.65: Seals Distribution during Summer Aerial Surveys (Grellier and Lacey, 2012)

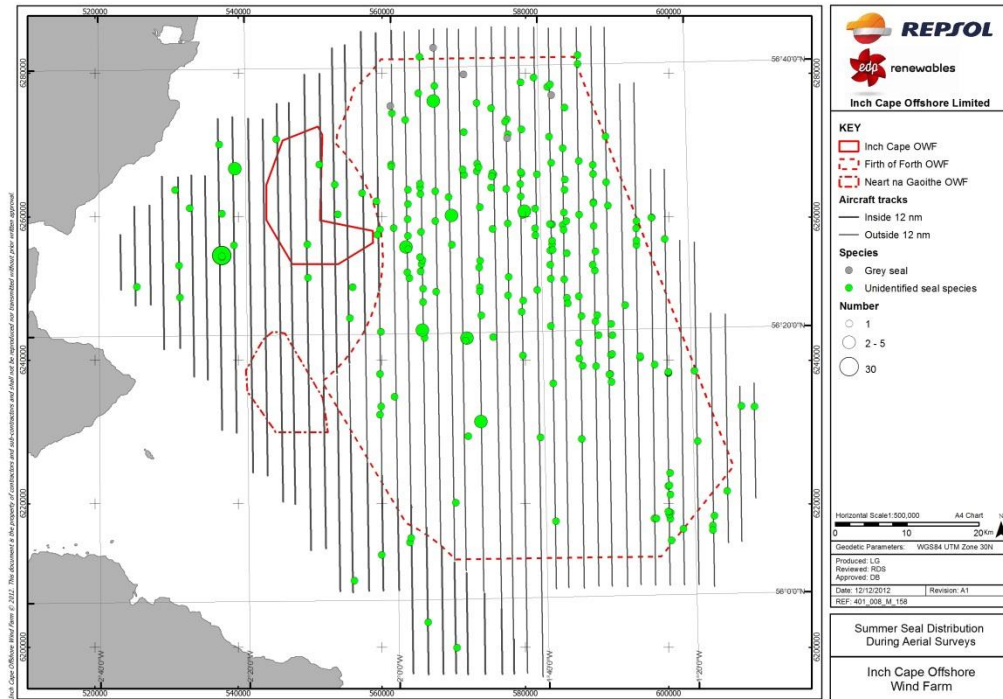


Figure 14A.66: Seals Distribution during Winter Aerial Surveys (Grellier and Lacey, 2012)

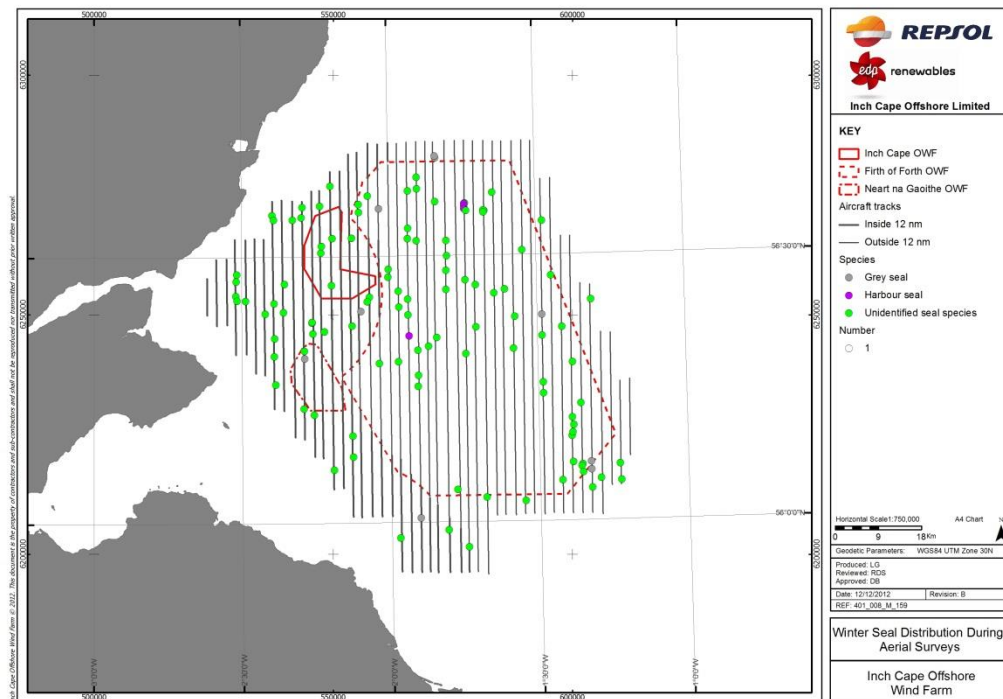
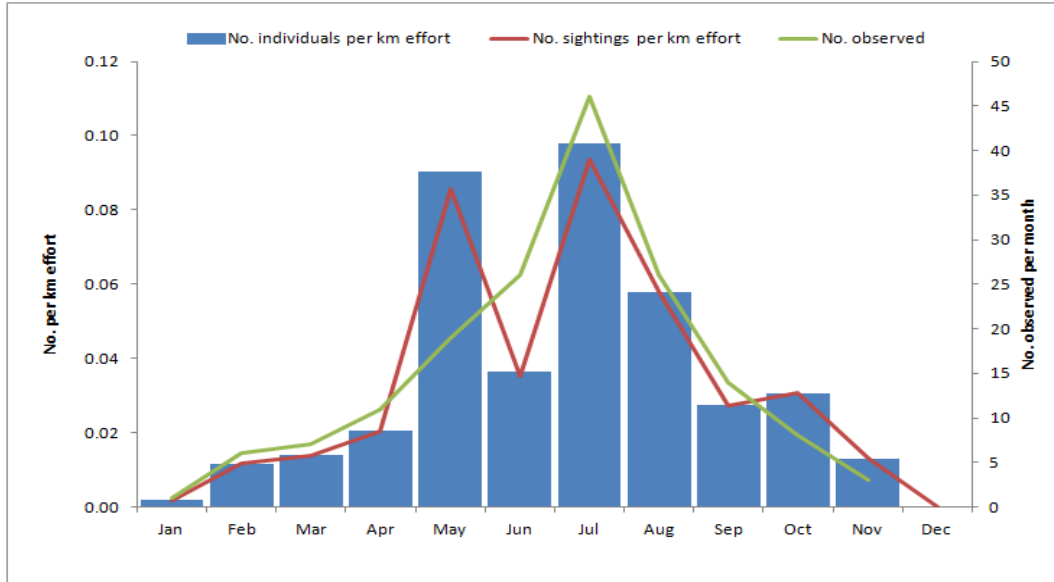


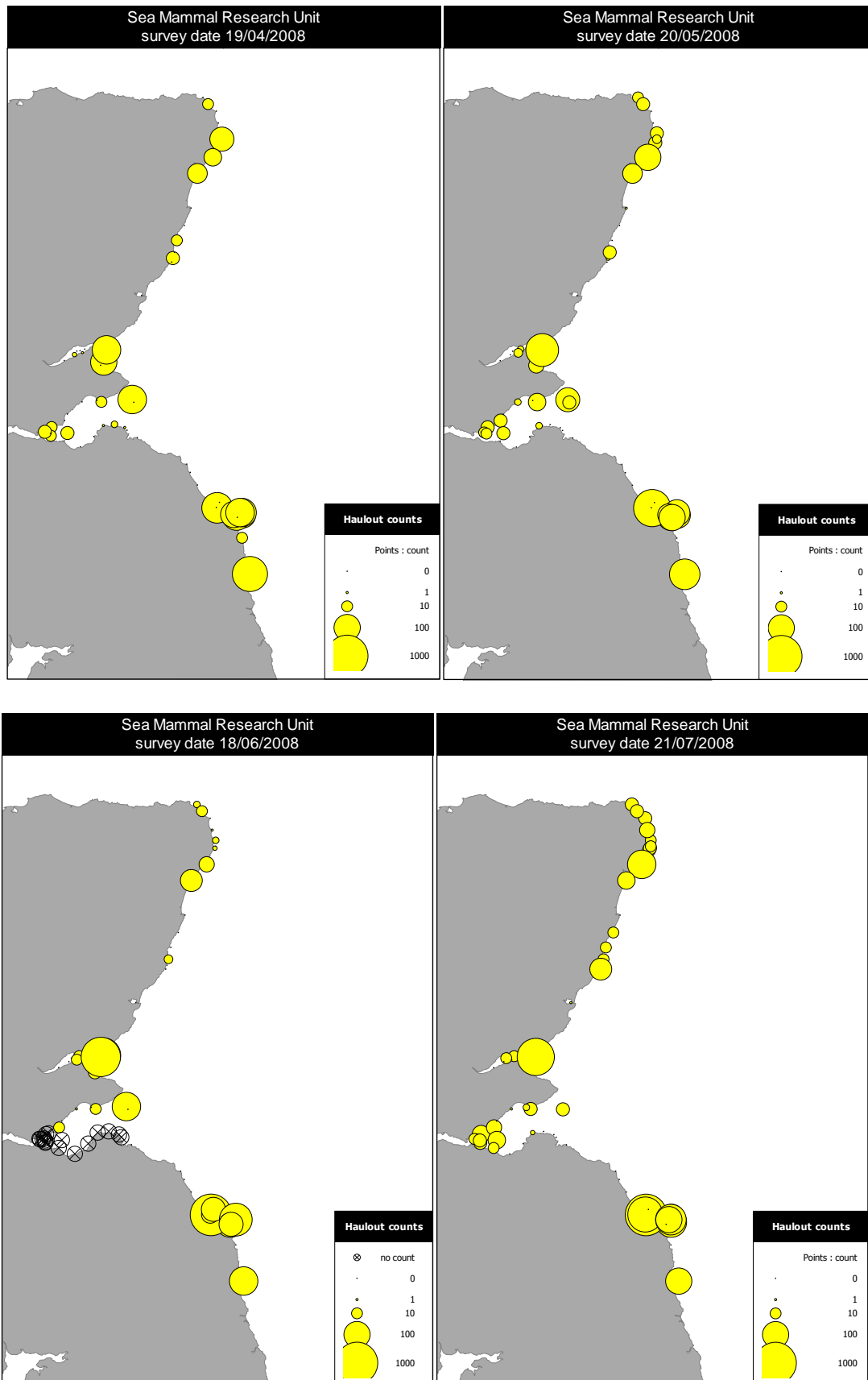
Figure 14A.67: The Number of Grey Seal Observed (green line), the Mean Number Sightings per km Effort (red line) and the Mean Number of Individual Animals (blue bars) Recorded per km Survey Effort Each Calendar Month During Boat-based Surveys December 2010 - September 2012 (Canning, 2012). For distribution map of these sightings refer to Figure 14A.63

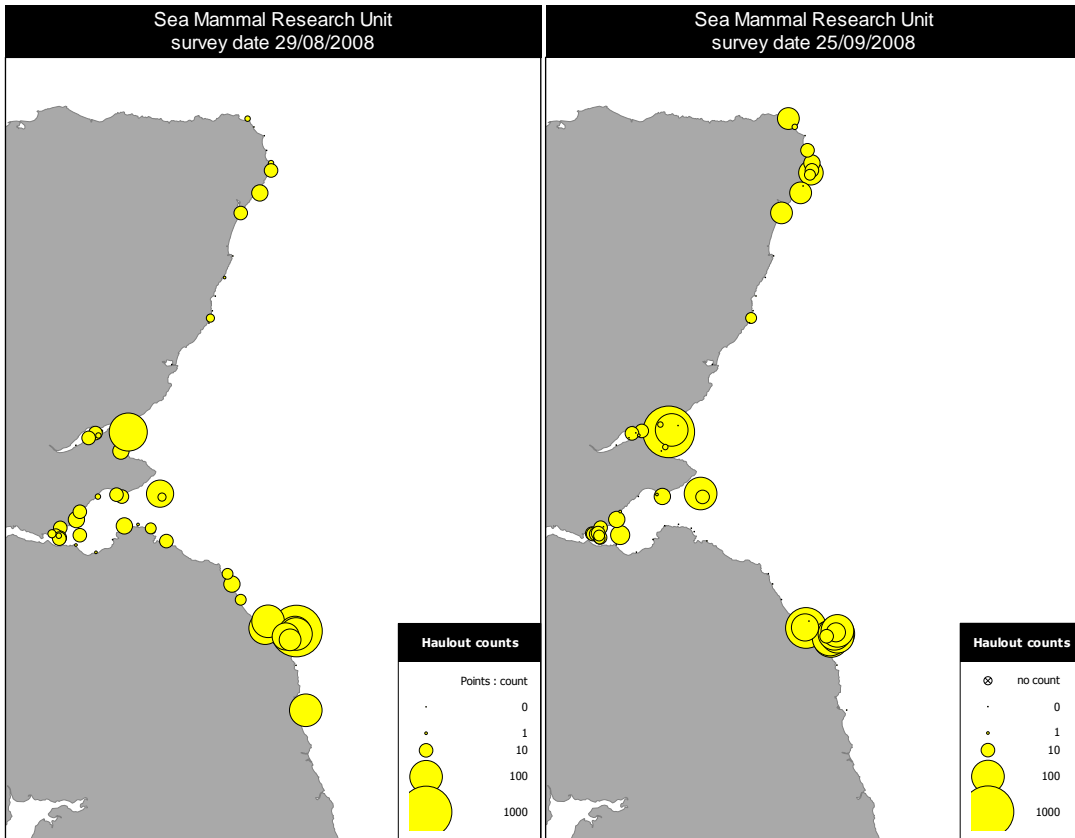


Seasonal Patterns: On Land

A series of monthly counts of grey seals were carried out on the east coast of Scotland and north-east coast of England as part of a Department for Business, Enterprise and Regulatory Reform (BERR) (now Department of Energy and Climate Change (DECC)) funded project in 2008 (McConnell *et al.*, 2009). The maximum monthly count was of 6,498 animals made in July 2008. The July count was similar to the June count, and approximately double the other monthly counts. Much of this was due to a very high number of seals (2,756) counted at Lindisfarne (10 km north of the Farnes; Sparling *et al.*, 2012). The distribution of seals by month is shown in Figure 14A.68. The number of seals hauled out at the various sites varied between months, with the maximum count at Abertay occurring in June.

Figure 14A.68: The Number and Distribution of Grey Seals on the East Coast of Scotland and NE Coast of England from DECC-funded Surveys carried out Between April and September 2008 (McConnell *et al.*, 2009)





Abundance

Given their wide-ranging nature, defining an appropriate reference population of grey seals for this area (against which to assess the magnitude of any impacts) is problematic (Sparling *et al.*, 2012). The issue is complicated further by having two methods for estimating the population – pup production estimates and numbers of animals hauled out in August.

Total pup production for the breeding colonies closest to the Inch Cape Development Area was 5,393 pups in 2009 (Figure 14A.58). Using a ratio of adults to pups of 2.60 (95 per cent CI 1.74-3.69) calculated from the 2009 estimates for the total North Sea population of 19,900 adults (95 per cent CI 13,300-28,200):7,640 pups, the local breeding population is estimated at 14,047 (9,388-19,906) grey seals (Sparling *et al.*, 2012).

August grey seal counts can also be used to give an indication of the population size using a given area if telemetry data exist, so that the proportion of time seals spend at sea at the time the counts are made can be calculated (Lonergan *et al.*, 2010, presented in SCOS, 2011). Because the August surveys do not cover the entire range of haul out sites relevant to grey seals which use the Firth of Forth and Tay area, the August 2008 count of 3,331 seals from the DECC surveys (McConnell *et al.*, 2009) was examined (Sparling *et al.*, 2012). Correcting for the proportion of seals hauled out (0.34; 95 per cent confidence interval 0.30-0.37), a population of 9,797 (9,003-11,103) seals was estimated for the region.

These analyses suggest that the number of grey seals using this area ranges from 9,003 to 19,906 depending on the time of year, and whether estimates are based on numbers hauled out in August or breeding in winter (Sparling *et al.*, 2012). For the purpose of this

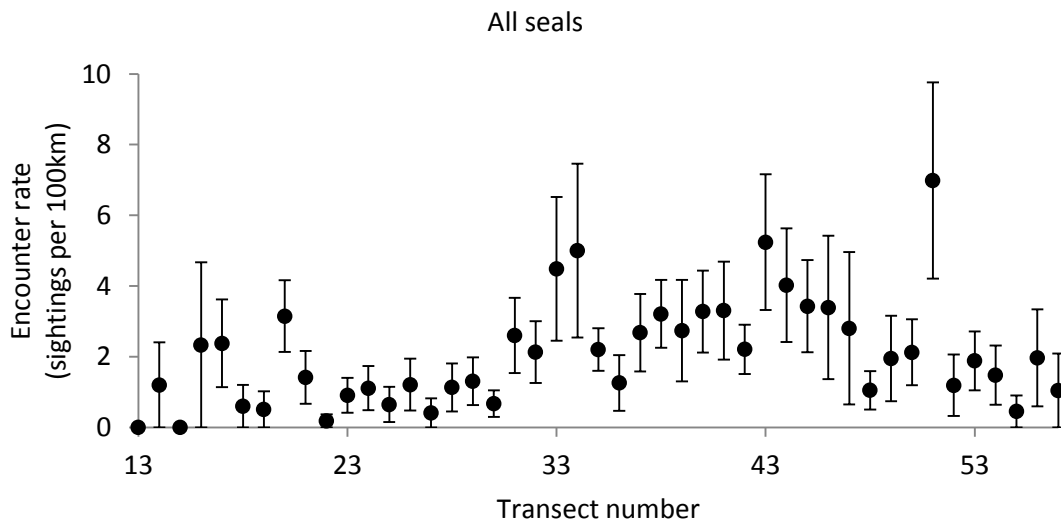
assessment, the reference population is given to be 7112 seals based on SMRU survey data (2007) of the east coast management area corrected for animals at sea.

Encounter Rate

During TCE aerial surveys, ‘all seals’ were encountered more than twice as often in summer (2.85 sightings per 100 km) compared to winter (1.22 sightings per 100 km; Grellier and Lacey, 2012). In summer, sightings were made three times more often in offshore waters (3.72 sightings per 100 km) compared to inshore waters (1.09 sightings per 100 km; Grellier and Lacey, 2012). Encounter rates (individuals per 100 km) were greater than sightings rates (sightings per 100 km) indicating that seals are sighted in groups as well as singly (Grellier and Lacey, 2012).

Seal encounter rate was generally less than two sightings per 100 km out to transect 30 (Figure 14A.69). Encounter rate then increased consistently with distance from shore, peaking at more than five seals per 100 km on transect 43. Encounter rate then decreased and by transects 52-57, was back at 1-2 sightings per 100 km. Variability was greatest for the most inshore (14, 16 and 17) and sections of the offshore (e.g. 43-47) transects, meaning that there was greater temporal variation in encounter rate close inshore and in patches further offshore.

Figure 14A.69: Encounter Rate (sightings per 100 km) ± Standard Error per Transect for all Seals during TCE Aerial Surveys (Grellier and Lacey, 2012). Transect 13 is the western-most transect, transect 57 is the eastern-most transect. Transects 13-26 were completely inside 12 nm, transects 27-41 crossed the 12 nm contour, and transects 42-57 were completely outside 12 nm



At-sea movements: Density and foraging areas

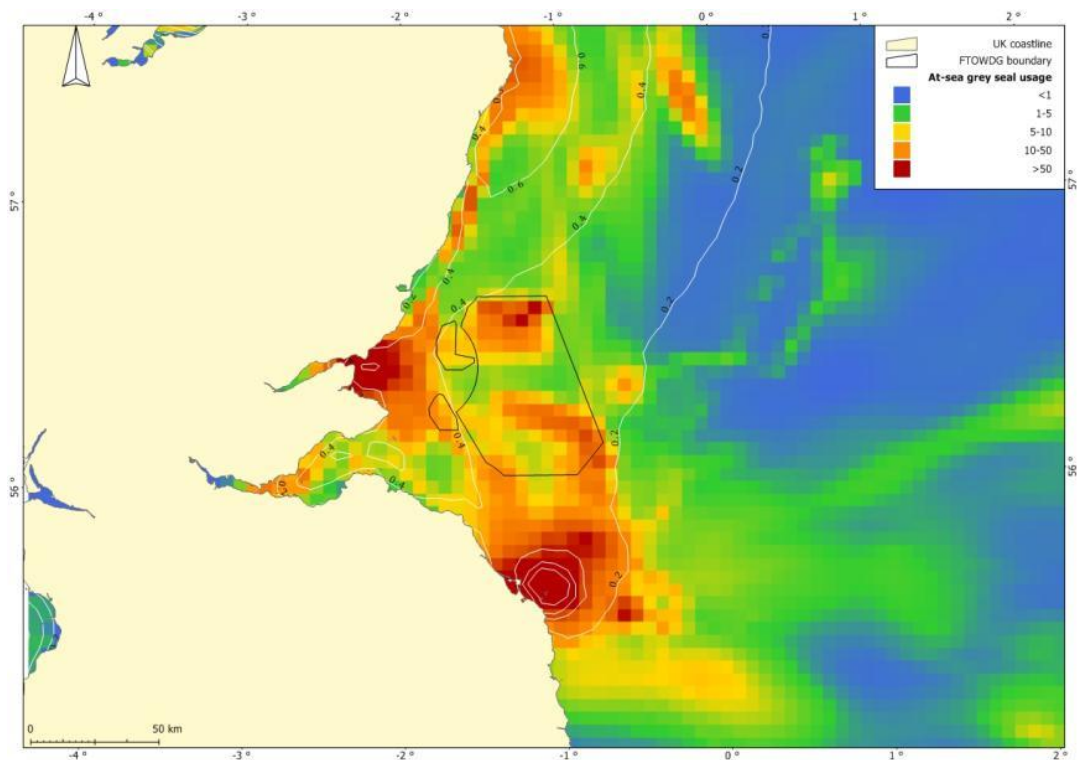
The estimated density of ‘all seals’ from TCE aerial surveys is 0.106 individuals per km² (Grellier and Lacey, 2012). Density was greater in summer (0.137 individuals per km²) compared to winter (0.051 individuals per km²). Given the high degree of uncertainty surrounding the extent to which TCE aerial survey estimates are underestimates of density,

Grellier and Lacey (2012) did not recommend their use in any quantitative impact assessment. In addition, the proportion of grey to harbour seals in this 'all seals' estimate is unclear – although given the sizes of the associated populations, it is likely to predominantly be made up of grey seals.

Seals were not recorded during SCANS surveys.

Figure 14A.70 shows the SMRU Ltd estimated at-sea spatial usage of grey seals around the FTOWDG development sites. The map can be interpreted as the average number of seals in each 5 km² grid square at any point in time. For example, a green square denotes that, on average, between one and five grey seals will be within that grid square at any point in time. A red square denotes that over 50 animals will be in that grid square at any point in time. The largest aggregations of high usage are located at the mouth of the Firth of Tay and near Berwick-upon-Tweed. Possible offshore foraging patches can also be seen, with an aggregation of high usage on the northern boundary of the Firth of Forth Round 3 site (at Scalp Bank). There is also an area of high usage at Marr Bank, covering an area from north-west to south-east towards the south eastern corner of the Firth of Forth site. These areas of high usage generally correspond to the areas of slow at-sea locations predicted to be indicative of foraging effort (Figure 14A.61).

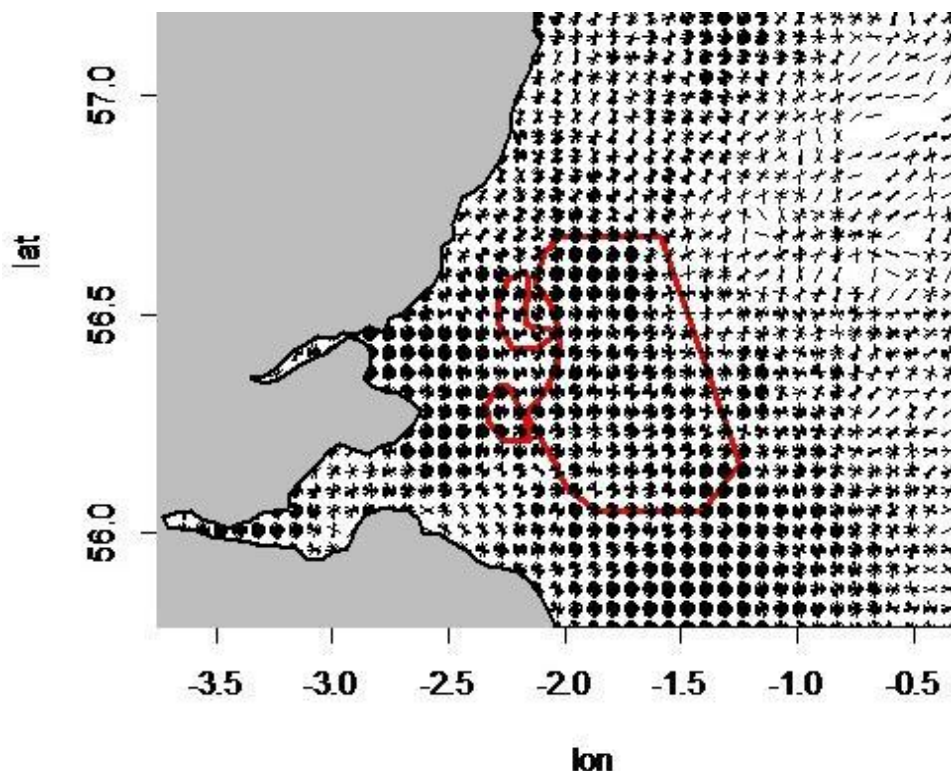
Figure 14A.70: Estimated Grey Seal At-Sea Usage Around the FTOWDG Development Sites (Sparling *et al.*, 2012). White contours show standard deviation from mean usage as a measure of uncertainty



At-Sea Movements: Transit routes

The routes that seals take between haul out sites and foraging areas are important although, in relative terms, less time is spent there. Understanding such movements is important in understanding the potential implications of activities which may displace animals from preferred transit routes (Sparling *et al.*, 2012). As with harbour seals above, in order to examine transit routes a 5 km grid was used and seal tracks were divided into segments with each segment starting when the animal entered a grid cell and ending when it left it (Sparling *et al.*, 2012). Each segment was represented by a line of standard length, centred on the middle of the appropriate grid cell. All transits across each cell, and the distribution of the orientations of these crossings, are shown in Figure 14A.71. There is a very large amount of data for grey seals, resulting in many tracks, which makes discerning patterns difficult. However, there appear to be few areas of purely directional movement. There is some indication of an area (which encompasses the Inch Cape Development Area) between offshore foraging hotspots and areas close to shore. There is also a region south and south-west of the NnG site (Figure 14A.71).

Figure 14A.71: Plot of Grey Seal Track Orientation – The Direction of each Seal Transit Across each 5 km Grid Cell is Shown (Sparling *et al.*, 2012). Cells containing circular shapes represent areas where tracks crossed the cell in different directions, suggesting random movement. Cells containing parallel lines represent areas where tracks are more indicative of directional travel



SAC Connectivity

The closest SACs to the Inch Cape Development Area are the Isle of May, Berwickshire and North Northumberland Coast, and Faray and Holm of Faray. Grey seals which occurred within the 100 km buffer zone drawn around the FTOWDG OWFs travelled within the vicinity

of several SACs throughout the duration of the tag deployment period: Isle of May – 31 seals; Berwickshire and North Northumberland Coast - 56 seals; Faray and Holm of Faray, Orkney – four seals; North Rona – one seal (Sparling *et al.*, 2012). Seal tracks were visually examined using GIS and included in these totals if the interpolated track passed within 1 km of the designated site.

Diet

Scat analysis is a suitable technique for assessing grey seal diet in the central North Sea, where animals forage close enough to shore that passage rates are greater than the time it takes to return from foraging trips. Otoliths (fish ear bones) and cephalopod (squid and octopus) beaks recovered from scats collected at haul out sites can be used to identify the species, and size, of prey consumed by the seal.

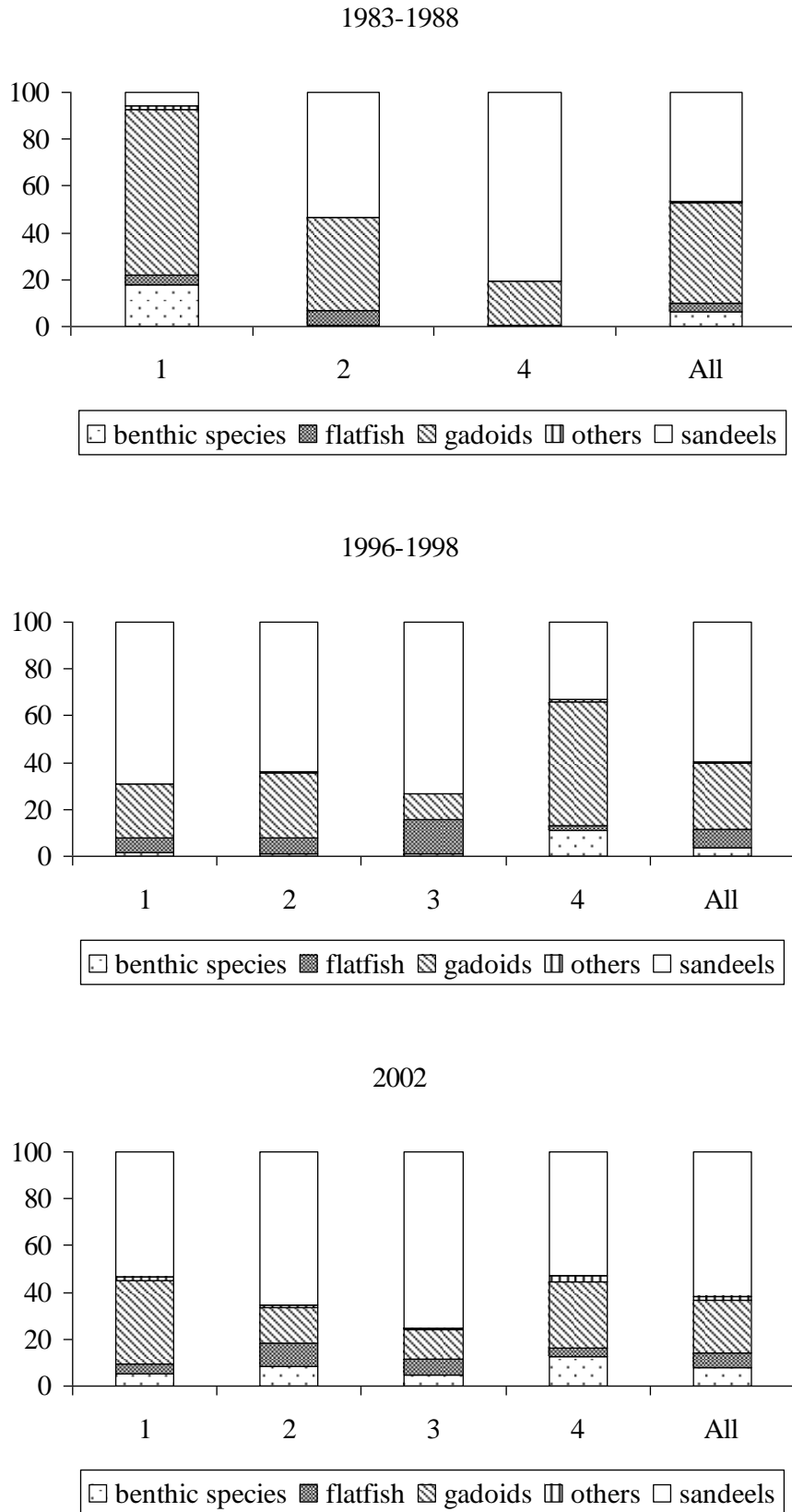
Grey seal diet composition data are available for the 1980s (Hammond and Prime, 1990), 1990s (Hall *et al.*, 2000) and 2002 (Hammond and Grellier, 2005).

Grey seal diet in the 1980s was dominated by cod and sandeel (Figure 14A.72). Gadoids (mostly cod but also some whiting) dominated in the first quarter of the year with benthic prey (dragonet and unidentified *Cottidae*) being the next most important contributor. Sandeel dominated in both quarter two and quarter four (no data were collected in quarter three) with cod being the next most important contributor in both quarters (Sparling *et al.*, 2012).

Grey seal diet in the 1990s was also dominated by sandeel and cod (Figure 14A.72). Together these two prey species made up 75 per cent or more of the diet in all four quarters. Sandeel dominated in the first three quarters of the year while cod dominated in quarter four. Cod did not really feature in the diet in quarter three, but the proportion of haddock (and flatfish) increased. The proportion that benthic species made up was only notable in quarter four (Sparling *et al.*, 2012).

Sandeel dominated the diet in all seasons in 2002, contributing between 53 and 76 per cent to the diet, by weight, in each quarter (Figure 14A.72). Gadoids were the second biggest contributor in each season; 35 per cent of the diet was made up by gadoids (mostly haddock and cod) in quarter one. In quarter two gadoids (mainly haddock and whiting) contributed 15 per cent while flatfish (mainly plaice) and benthic species (mainly dragonet) contributed 10 per cent and 9 per cent, respectively. In quarter three, gadoids (mainly haddock) contributed 12 per cent while in quarter four gadoids (28 per cent; mainly haddock and cod) and benthic species (13 per cent; mainly short-spined seascorpion) were the next most important contributors after sandeel (Sparling *et al.*, 2012).

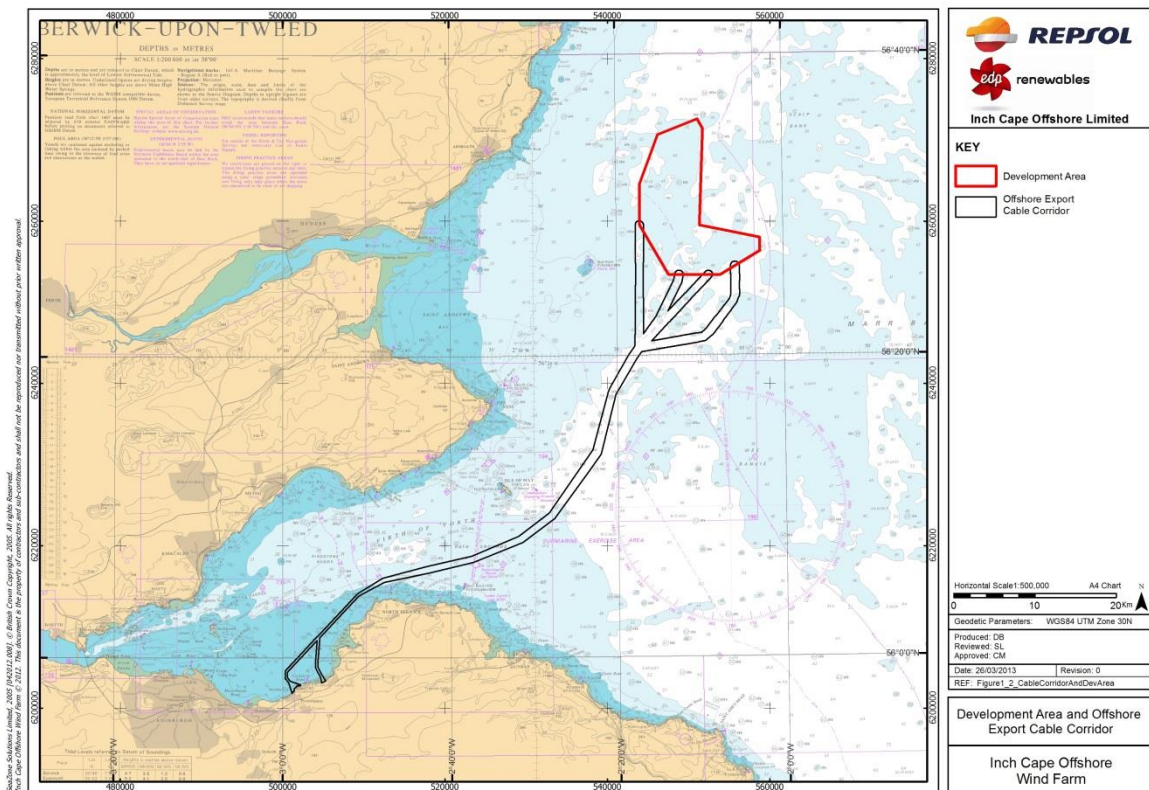
Figure 14A.72: Between and Within Year Variation In Grey Seal Diet Composition (shown as % by Weight and Expressed by Prey Type) in the Central North Sea (Sparling *et al.*, 2012)



14A.2.4 Offshore Export Cable Corridor

The Offshore Export Cable Corridor for the Offshore Transmission Works (OfTW) exits the south side of the Development Area, passing to the south side of the Isle of May, coming ashore at either Seton Sands or Cockenzie, on the southern side of the Firth of Forth (see Figure 14A.73). Of the marine mammal species discussed in the previous section, grey seal and bottlenose dolphin are of particular relevance with regard to the Offshore Export Cable Corridor.

Figure 14A.73: Development Area and Offshore Export Cable Corridor



The Offshore Export Cable Corridor passes relatively close to the Isle of May (approximately 5.5 km at nearest point), an area designated as an SAC for grey seal. Around 2000 pups are born each year on the island, with smaller numbers recorded on smaller islands in the southern half of the Firth of Forth. A fast-growing colony can also be found at Fast Castle, on the outer southern reaches of the Forth.

Bottlenose dolphins in Scottish waters are primarily coastal in nature, generally observed in waters of less than 25 m deep (Hastie *et al* 2003; Robinson *et al.*, 2007). Survey effort in the Forth and Tay area has primarily covered the Firth of Tay and St Andrews Bay area. An acoustic study on the northern side of the Forth (Fife Ness) recorded dolphins in every month between 2006 and 2009. The length of time dolphins appeared to stay in the area was low compared to the Moray Firth, suggesting that the dolphins may have been travelling through the area. While there appears to be no reports of bottlenose dolphins near to

Seaton Sands or Cockenzie, they have been recorded to the south of the Firth of Forth along the Northumberland coast suggesting they cross the area to be traversed by the Offshore Export Cable Corridor (Brereton *et al.*, 2010).

14A.2.5 Baseline Summary

Two species of cetacean can be observed in the Firths of Forth and Tay throughout the year (harbour porpoise and bottlenose dolphin) and two species occur seasonally (minke whale and white-beaked dolphin). Other species which occur on a more occasional basis include killer whale (e.g. in 2006 and 2007 and during commissioned studies), sperm whale (e.g. in 1997), humpback whale (e.g. in 2003 and 2006), long-finned pilot whale (e.g. during commissioned studies), common dolphin (e.g. during commissioned studies) and white-sided dolphin. Two pinniped species are found in the Firths of Forth and Tay, grey (*Halichoerus grypus*) and harbour (*Phoca vitulina*) seals.

The ranging behaviour and population structure of the harbour porpoise, minke whale and white-beaked dolphins in the North Sea remains unclear, making predictions of future trends difficult. The UK conservation status assessment for all three species is, however, considered “favourable” (JNCC, 2007). The conservation status of the bottlenose dolphin in UK waters is also considered to be “favourable”, with abundance estimates remaining relatively stable during the years studied to date.

Grey seal pup production has been increasing during recent years in many areas including the North Sea and their conservation status is considered “favourable”. Harbour seal numbers for a number of populations including that found in the Firths of Forth and Tay, however, have been decreasing since the mid 1990’s. The future of their conservation status (referred to as “future prospects” in the assessment) is stated as being “unknown” in the last (2007) UK assessment.

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