Aberdeen Offshore Wind Farm
Marine Mammals Baseline Addendum

June 2012

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Aberdeen Offshore Wind Farm Marine Mammals Baseline Addendum

Project/Job Title: **Aberdeen Offshore Wind Farm Marine Mammals Baseline Addendum**

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PREFACE

On 1st August 2011 Aberdeen Offshore Wind Farm Limited (AOWFL) applied to the Scottish Ministers under Section 36 of the Electricity Act 1989 (as amended), and applied for a Marine Licence under the Marine (Scotland) Act 2010 to construct, operate and decommission an offshore wind farm and deployment centre off the coast of Aberdeen, Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre (EOWDC).

The application comprised an Environmental Statement (ES), prepared in accordance with the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (as amended) and Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended) and followed current best practice.

The August 2011 submission comprises the following volumes:

- Volume 1 – Non-Technical Summary
- Volume 2 – Environmental Statement
- Volume 3 – Figures
- Volume 4 – Technical Appendices

Project Description / Rochdale Envelope

When the ES was submitted to Marine Scotland in August 2011, it had been agreed that further information would be required in support of the application. This further information was referred to as an 'Addendum' to the ES.

An application for an Offshore Wind Farm requires some flexibility to enable subsequent detailed design. This is particularly important in the context of the scheme to be developed as a demonstrator site. In order to carry out an environmental assessment of the project, parameters require to be defined and sufficient information provided to enable the identification of the significant effects. These parameters form the Rochdale Envelope.

At the time of defining the Rochdale Envelope (as submitted August 2011) the project engineers undertook consultation with the supply chain to understand their ambitions and likely details of their future wind turbines which were at an early stage of development. The results of this initial consultation were inevitably a reflection of the supply chain at the time, and the stated ambitions of manufacturers at the time.

In keeping with the concept of a demonstrator site, over recent months, AOWFL has engaged with global turbine suppliers who wish to demonstrate their next generation turbine technology at the AOWF site. AOWFL has commenced a formal commercial process to identify and refine the turbine supply options for the site. This process is at an early and confidential stage, however revised turbine specifications have been made available to the project by the manufacturers.

The overarching objective of the EU grant associated with AOWF, is to deploy new equipment, systems, processes and initiate R&D to improve the competitiveness of offshore wind energy production, whilst generating environmentally sound marketable electricity and to increase the supply chain capabilities in Scotland, the wider UK and Europe.

The commercial evaluation of prospective turbine suppliers who can meet the EU requirements has revealed that a number of manufacturer's turbines marginally exceed the Rochdale Envelope parameters (as submitted). These turbines would require an adjustment

to the tip height of up to 198.5 m, and rotor radius of up to 86 m as summarised in the table below.

Please note that the maximum dimensions are likely only to be applicable to specific wind turbine locations and are unlikely to be relevant to all 11 turbine locations. Please also note that a minimum clearance of 22 m above Mean High Water Springs (MHWS) will be maintained for marine navigation.

Table 1: As submitted Rochdale Envelope and proposed adjusted Rochdale Envelope

Parameter	Rochdale Envelope as submitted	Rochdale envelope (as requested)	Differential
Tip Ht (aLAT)	Up to 195m	Up to 198.5	3.5m
Hub Ht (aLAT)	Up to 120m	Up to 120m	Nil (likely reduction)
Rotor radius (diameter)	Up to 75m (150m)	Up to 86m (172m)	11m (22m)

Environmental Statement Addendum (June 2012)

Addenda are commonly submitted as a project evolves through time to clarify issues, or to provide additional baseline data and updated environmental assessment information. This report (Aberdeen Offshore Wind Farm Marine Mammal Baseline Addendum) forms part of the ES Addendum.

The June 2012 Addendum contains the following information:

- Additional bird and marine mammal baseline data.
- An additional visualisation from Girdleness lighthouse.
- Results of a geo-locational study into golf courses and Round 1 offshore wind farms.
- Requested minor adjustments to turbine dimensions which form a part of the project description information, known as the 'Rochdale Envelope'.
- Supporting statement and representative viewpoints of landscape and visual effects taking account of the adjustments to the Rochdale Envelope and preliminary design principles.
- Updated ornithological collision risk modelling resulting from the updated Rochdale Envelope, updated ornithological impact assessment, and updated Habitats Regulations Assessment.

Where to View the Consent Application

The ES addendum submission may be viewed at the following locations during normal office hours:

Vattenfall Wind Power Ltd 3rd Floor The Tun Holyrood Edinburgh EH8 8AE	Balmedie Library Eigie Rd Balmedie AB23 8YF
Aberdeen Central Library Rosemount Viaduct Aberdeen AB25 1GW	Peterhead Library 51 St Peter Street Peterhead AB42 1QD
Ellon Library Station Road Ellon AB41 9AE	Bridge Of Don Library Scotstown Road Bridge Of Don Aberdeen AB22 8HH

The ES addendum can also be viewed at the Scottish Government Library at Victoria Quay, Edinburgh, EH6 6QQ.

OBTAINING YOUR OWN COPY OF THE PLANNING APPLICATION ADDENDUM

The ES addendum is available on the Vattenfall website:

http://www.vattenfall.co.uk/en/aberdeen-bay.htm

Contents

NON-TECHNICAL SUMMARY

The marine mammal environmental baseline has incorporated information from research surveys carried out along the north east Grampian coastline and the wider North Sea area, as well as several years of land based and boat surveys covering the wider European Offshore Wind Deployment Centre (EOWDC) area. The marine mammal baseline is updated here to include the results of the additional 8 boat based surveys that have been undertaken since the marine mammal environmental baseline was first produced for the Environmental Statement.

As part of the data gathering process boat based surveys were conducted over two distinct phases, with 14 months of boat based survey data collected in 2007-2008 and 12 months of surveys carried out between 2010-2011. The survey area was expanded in 2007-2008 to cover a greater area offshore and further south. The marine mammal baseline draws upon a total of 26 months of survey data spanning several years. This has enabled the seasonal distribution of marine mammal species to be assessed in Aberdeen Bay and has enabled density and abundance estimates for the most numerous cetacean, the harbour porpoise, to be predicted.

In addition the numbers of harbour porpoise observations during 2010/ 2011 permitted Density Surface Models to be created which enabled a comparison of density estimates generated from previous EOWDC surveys in 2007-2008 to be made.

Aberdeen Bay is an important area for marine mammals, with up to 18 species having been recorded from sighting or stranding records in Aberdeen Bay and the surrounding area; including 12 odontocete species, three mysticete species and three pinniped species. Of these, bottlenose dolphins, harbour porpoises, white-beaked dolphins, minke whales, Risso's dolphins, harbour seals and grey seals occur regularly in the area, with other species only being recorded occasionally or rarely.

Harbour porpoise

Harbour porpoise are the most common species of cetacean in the North Sea and has a wide range and distribution in both coastal and offshore areas. They have been found to regularly occur in the Aberdeen area throughout the year, with peak occurrence during August and September.

Harbour porpoises were the most recorded cetacean species during the EOWDC surveys with 390 observations consisting of 655 individuals recorded. Harbour porpoise sightings were higher to the north of the EOWDC lease area. The harbour porpoise was the only species that was detected in sufficient numbers to allow a detection function to be applied that would allow for abundance and density estimates to be generated. The density estimates produced for harbour porpoise show considerable error margins which is a reflection of the sampling effort. Porpoise detection rates obtained from the acoustic analysis are consistent with those of a high-density porpoise area. Although it should be recognised that considerable differences in estimated density are apparent between the two years of EOWDC boat based survey effort, this is due to the density surface modelling used to compare the survey areas not performing as well as anticipated. There is also likely to be underlying inter-annual variation in harbour porpoise. The harbour porpoise, as expected, was the most frequently detected cetacean species during the acoustic surveys.

Harbour porpoise in Scottish waters feed on a wide variety of fish stocks including whiting, sandeels, haddock/saithe/Pollock and *Trisopterus* spp.

The peak calving period for harbour porpoises in Scottish waters is between April and June. Calves have been observed off Aberdeenshire between May and September, indicating a possible increased sensitivity to any potential disturbance during this time.

Bottlenose dolphin

Bottlenose dolphins are generally found within coastal waters, although they have been observed in offshore areas off north-east Scotland. They have been observed off Aberdeen throughout the year, although there appears to be an increase in occurrence between November and May.

Bottlenose dolphin were the second most frequently sighted cetacean species during the EOWDC surveys, with a total of 25 observations of 117 individuals being detected on effort. The majority of the sightings occurred in the spring and summer months. A higher number of bottlenose dolphins were in the vicinity of the entrance to Aberdeen harbour, which is a known hotspot for dolphin sightings. Bottlenose dolphins were frequently recorded off-effort in close proximity to the harbour entrance, their presence at this location has been linked to salmon migration up the river.

Bottlenose dolphins in the Aberdeen area are part of the resident population from the Moray Firth Special Area of Conservation (SAC), which have a range extending from the Moray Firth to the Firth of Forth. There appears to be sub-groups within the population with one group spending most of their time within the inner Moray Firth (SAC) and the other group having a wider range and spending less time in the inner Moray Firth area.

Young bottlenose dolphin calves have been observed in the Aberdeen area during spring and early summer, indicating a possible increased sensitivity to any potential disturbance during this time.

From the available information it is apparent that the Aberdeen area is important for bottlenose dolphins, however, it is unclear how reliant they are on the area in relation to other areas along the North-east coast of Scotland.

White-beaked dolphins

White-beaked dolphins are present in the central and northern North Sea throughout most of the year. Sightings data suggests their presence in the coastal waters off Aberdeenshire is seasonal, with sightings recorded between June and August. In addition evidence from strandings data indicate they may be present in the area between February and October.

The movement of white-beaked dolphins into coastal waters during summer months is thought to relate to the calving period, with calves also being observed off Aberdeenshire between June and August. It is possible the seasonal movement of white-beaked dolphins is also related to the seasonal abundance or movement of prey species, such as herring or mackerel.

Along the Aberdeenshire coast, white-beaked dolphins appear to have a preference for sections of the coast adjacent to deeper waters, with a higher incidence of sightings between Aberdeen and Stonehaven compared to the area between Aberdeen and Collieston.

A total of 29 observations, consisting of a total of 117 individual white-beaked dolphins were recorded during all the EOWDC boat surveys. Twenty eight of the observations, consisting of 114 individuals, were recorded in the surveys occurring between 2010-2011, these surveys also covered a region of deeper water. All the observations of white-beaked dolphins between 2010-2011 were recorded in water depths of 20 m or more.

The EOWDC boat survey data supports the occurrence of white-beaked dolphin as a seasonal summer visitor that possibly moves to coastal waters following prey such as mackerel and for calving purposes. Although white-beaked dolphins are found throughout the central North Sea and generally in more offshore areas, it is apparent that the coastal waters off Aberdeen are important during the summer period.

Minke whales

Minke whales occur throughout the central and northern North Sea, particularly during summer months. They are generally observed in offshore deeper waters, but appear to move into coastal waters along the north-east coast of Scotland from July.

Minke whales have been recorded off the Aberdeenshire coast primarily during summer months (July – August); although observations and strandings indicate they may be present in the area throughout the year. The seasonal movement of minke whales into coastal waters during the summer is thought to be related to prey availability. Minke whales generally feed on a small pelagic fish, such as sandeels, herring and sprat.

There have been a total of 12 observations of minke whales in all the EOWDC boat surveys. One minke whale was recorded during 2007-2008, and 11 observations all being solitary minke whales were recorded in during 2010-2011.

Minke whales are thought to have a preference for water depths of 40 m or more, these depths are generally found further offshore and beyond the EOWDC crown estate lease, although one minke whale was detected within the lease area during the boat based surveys.

Although minke whales occur regularly in the area off Aberdeen, especially during summer, it is unclear how important the area is relative to other areas.

Risso dolphin

In the northern and central North Sea, Risso's dolphins are primarily observed around Shetland and Orkney. However, there has been an increase in reported sightings along the north-east coast in recent years. Risso's dolphins have been recorded off Aberdeenshire since 2005 at various times of the year. As part of the EOWDC surveys Risso's dolphins were detected during vantage point surveys, and in the July 2011 boat survey two observations consisting of 15 individuals were recorded. The increase in sightings of Risso's dolphins may point towards an increase in the use of the Aberdeen area in comparison to historic levels. Possible reasons for the apparent recent increase in observations in the area are unclear, but could be related to prey availability.

Grey and Harbour seals

Grey and harbour seals are frequently sighted throughout the year in Aberdeen Bay, especially at the entrances to the rivers Dee and the Don. Grey seals were frequently observed during the EOWDC boat surveys 2007-2008, surprisingly no harbour seals were recorded during these surveys. Almost equal proportions of grey and harbour seals were recorded during boat surveys carried out during 2010-2011.

Harbour seals increase in numbers at the estuaries of the Rivers Dee and Don in the winter and early spring. They use haul-out sites at the Donmouth, at the mouth of the Ythan estuary and at Catterline. Harbour seals have been observed feeding on salmonids and marine fish at the estuaries of the Dee and Don. The pupping period for harbour seals occurs from June to July and moulting occurs from June to September, during these times they spend a higher proportion of their time ashore and in coastal waters.

Designated coastal SACs for harbour seals along the east coast of mainland Scotland are situated in the Dornoch Firth and Morrich Moore in the Moray Firth and Firth of Tay and Eden estuary.

Grey seals use haul-out sites at the Donmouth, at the mouth of the Ythan River, outside Peterhead harbour, Cruden Bay, Boddom and at Catterline. The most well established grey seal colony in the area is at Catterline, where up to five pups may be born each year. The pupping period for grey seals occurs from October to November and moulting occurs from February to April. During these periods they spend a higher proportion of their time ashore and in coastal waters. Grey seals have been observed feeding on salmonids and marine fish at the estuaries of the Dee and Don. Designated SAC's for grey seals along the east coast of Scotland include the Isle of May at the entrance of the Firth of Forth. It can be expected that individual seals from these colonies may be passing through and the EOWDC development area.

The grey seal was the most frequently recorded seal species, with a total of 21 individuals recorded on effort during the boat based surveys 2007-2008, and a further 41 individuals recorded in EOWDC surveys carried out between 2010-2011. The grey seal was sighted throughout the survey period with no apparent increase in frequency of sightings with any particular season. The majority of grey seal sightings were recorded in the northern half of Aberdeen Bay, a finding consistent with previous surveys.

Other species

For species such as white-sided dolphins, killer whales, common dolphins, striped dolphins, long-finned pilot whales, sperm whales, humpback whales, fin whales, northern bottlenose whales, Sowerby's beaked whales and other pinniped species, the area off north-east Scotland appears to be only a marginal part of their habitat, and is likely to be inhabited only during a restricted part of the year by relatively few individuals.

1. INTRODUCTION

Genesis was commissioned by Aberdeen Offshore Wind Farm Limited (AOWFL) to undertake a marine mammal baseline and impact assessment of the proposed European Offshore Wind Deployment Centre (EOWDC). This report follows on from the original baseline assessment provided in the EOWDC Environmental Statement submitted to the Scottish Government in August 2011 and incorporates a further 8 months of boat survey data that has been collected since the initial Environmental Statement submission. The structure of the marine mammal assessment can be summarised as follows:

- **Baseline Report** (this document) – this provides a summary of the existing information relating to the distribution and abundance of marine mammals in Scotland with a focus on Aberdeen Bay. This report draws on the findings of a desk based study and marine mammal research studies and also dedicated marine mammal surveys carried out to supplement the baseline for the EOWDC.
- **EIA Technical Report** – an assessment of the potential impact of the proposed EOWDC on marine mammals in the study area.
- **Non-Technical Summary Chapter for the Environmental Statement** – a summary of findings from the Baseline Report and EIA Technical Report.

In order to assess the importance of the proposed EOWDC and surrounding area for marine mammals and the potential impacts associated with the project, it is necessary to understand the occurrence and distribution of marine mammals in the area and understand why they are there: hence the compilation of the baseline report.

The main aim of the baseline study is to provide detailed information on marine mammals that may be present in the developmental area and also the surrounding area to inform the EIA technical report. The baseline report provides information on the following:

- Marine mammals present in Aberdeen Bay and Scottish coastal waters.
- Abundance and distribution of marine mammals, and seasonal patterns of distribution and migration.
- Usage of the Aberdeen Bay by marine mammals (feeding, passage area, calving).
- Identification of any potential seasonal sensitivities (e.g. calving period).
- Knowledge/data gaps relating to marine mammals in Aberdeen Bay.

2. DATA SOURCES

The following key data sources have been used to inform the baseline assessment:

- Boat based surveys of the EOWDC and wider area carried out by Institute of Estuarine and Coastal Studies (IECS) (2007-2008) and the Sea Mammal Research Unit (SMRU) 2010-2011 (Section 2.1)

- Land based Vantage Point surveys carried out as part of the baseline surveys of EOWDC March 2005-2007 (Section 2.2)

- Joint Nature Conservation Committee (JNCC) aerial survey data of Aberdeen Bay 2005-2006 (Section 2.3)

- Marine mammals present along the Scottish coastline were assessed as part of Strategic Environmental Assessment (SEA) area 5 as part of the oil and gas licensing programme (Section 2.4)

- Northern North Sea Cetacean Ferry Surveys (NORCET) cetacean survey information (Section 2.5)

- Moray Firth cetacean study 2009-2011 into the effects of proposed oil and gas exploration (Section 2.6)

- Cetacean stranding data (Section 2.7)

A full list of documents referenced in the baseline assessment is provided in the reference section.

2.1 BOAT SURVEYS

The aim the EOWDC boat based surveys was to collect seasonal distribution information on the marine mammal species present in the proposed developmental area of the EOWDC and also the wider area of Aberdeen Bay. The passive acoustic monitoring component of the surveys allowed for the acoustic analysis of marine mammal data to generate detection rates for harbour porpoise and delphinids. The analysis of this data has provided information on the abundance and seasonal distribution patterns of marine mammals in the wider EOWDC area. This has been assessed in relation to the existing knowledge of marine mammals in the development area, and the findings were applied within the EIA process.

Marine mammal and seabird surveys were carried out on behalf of AOWFL by the Institute of Estuarine and Coastal Studies (IECS), University of Hull from February 2007 – April 2008, inclusive. SMRU Ltd was contracted to continue the surveys, and a further 12 months of survey data collated between 2010-2011 are included in this report.

For all the marine mammals surveys conducted for the EOWDC baseline marine mammal observers followed standard survey transect procedures to collect data on marine mammals. Data collection was stopped where the sea state exceeded Beaufort Sea state 4 or there was poor visibility.

The vessel used for the IECS surveys and the initial 4 SMRU surveys was an ex-Clyde class lifeboat, the *Gemini Explorer*. It had an observation platform 5.1 m above sea level, cruising

speed of 8-9 knots and a clean electronic footprint which was required for the acoustic survey component. A decision to change vessel in 2011 was made owing to the *Gemini Explorer* having to undergo a refit during the course of 2011. The second vessel used was *Eileen May*; a 17 m long former RNLI vessel, with an observation platform at 4.8 m and a cruising speed of 9-10 knots.

2.1.1 EOWDC boat based surveys 2007-2008 (carried out by IECS)

The survey approach used in the IECS boat based surveys was a Before-After-Control-Impact design (BACI) and was designed for a significantly larger wind farm than the EOWDC. The survey approach was developed in consultation with the Joint Nature Conservation Committee (JNCC) and Scottish Natural Heritage (SNH) in 2006. Two survey areas were defined; the 'wind farm' area and a 'control area', immediately to the north (Figure 2-1). The terminology control area has been used to define one of the survey areas, however, it is accepted that establishing a true control area with equivalent environmental conditions to the wind farm area is difficult, if not impractical, for a coastal environment.

In each area (50.8 km^2), parallel line transect surveys were completed across two survey strata (Wind farm and Control). During each survey month, ten transects of 6.5 km length were surveyed in each of the two areas giving a total survey effort of 130 km per survey month. Surveys were undertaken during a total of 15 months between February 2007 and April 2008 (Table 2-1), giving 1,950 km of survey effort during this phase of data collection (Travers *et al*., 2008).

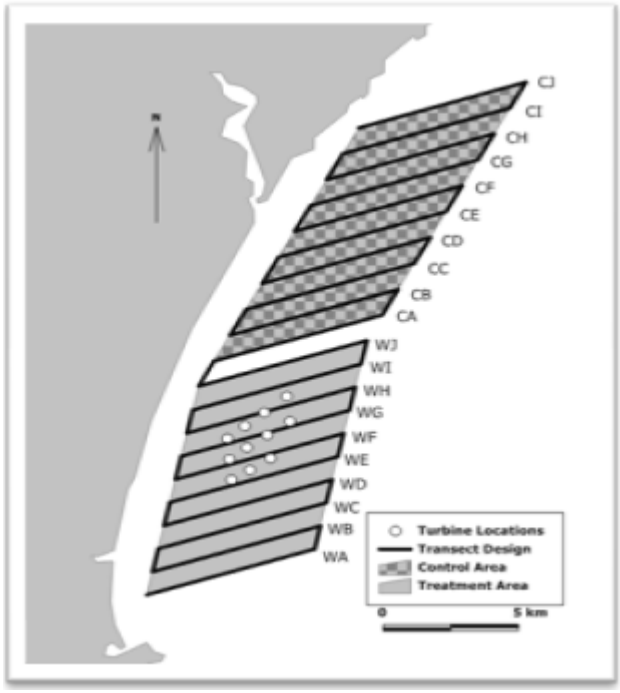


Figure 2-1 Boat based survey transects 2007-2008 (IECS), the grey area with the turbine locations is the wind farm area and the cross-hatched area is the control area (Travers, *et al*., 2008).

2.1.2 EOWDC boat based surveys 2010-2011 (carried out by SMRU Ltd)

SMRU Ltd carried out 12 boat based surveys for birds and marine mammals between August 2010- August 2011, the following sections describe the survey design and effort. The survey design differed to that used by IECS and is based on zigzag line transects with the survey

area extended into the South, North and Offshore, which were 82.8 km^2, 150.8 km^2 and 105.2 km^2 in area respectively (Figure 2-2) (SMRU Ltd, 2011a).

The North survey area encompassed the Wind farm and 'Control' areas surveyed in the EOWDC between February 2007 and April 2008.

During each EOWDC carried out during 2011-2011 it was the intention to survey all 36 transects during one day if daylight hours permitted. There are a total of 9 transects in the South, 9 Offshore and 15 in the North survey areas. Giving a total survey effort per survey block of approximately 40 km (South), 60 km (Offshore) and 75 km (North). An entire survey of all three survey blocks would cover a distance of approximately 175 km. The landward edge of the north strata approximates the 5 m depth contour.

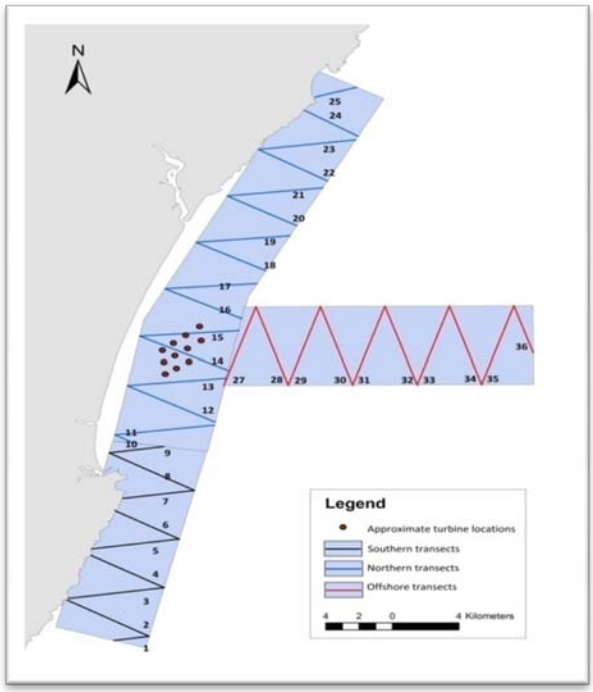


Figure 2-2 Boat based survey areas covered during 2010-2011; the southern area, (survey transects shown in black), the northern area, (survey transects shown in blue), and the offshore area, (survey transects shown in red). The survey transects are also labelled 1-36 (SMRU Ltd, 2011a).

The survey is based on a gradient design and the shortfalls of the BACI approach used in the first phase of data collection are avoided. The data collected using this gradient approach is compatible, and can be analysed in conjunction with the first phase of boat based surveys. Where sufficient observations of marine mammals have been collected this has allowed pooled density estimates and abundances of marine mammals to be generated. The survey design will enable a repeatable baseline to be monitored throughout the development of the proposed EOWDC.

The current design will allow potential impacts on marine mammals, such as displacement caused by noise, to be assessed during construction, as it allows for a greater distance from the turbine locations to be covered within a similar survey timeframe. The increased offshore coverage, as well as the increased coverage to the North and South of the development area could also increase the potential for detection of any displacement of marine mammals should they occur.

All observers operated from the bridge roof (approximately 5 m above sea level) and followed standard line transect procedures for marine mammals and modified European

Seabird At Sea (ESAS) methods for seabirds. There were two seabird and four marine mammal observers, one of whom was also an experienced Passive Acoustic Monitoring (PAM) operator. Surveys were carried out in Beaufort Sea state 4 or below with good visibility.

2.1.3 Survey Effort during EOWDC boat based surveys: IECS (2007-2008) and SMRU (2010-2011)

The amount of survey effort completed on each transect varied slightly between surveys due to navigational issues (i.e. shipping traffic). The GPS logger data from each survey were therefore used to provide an accurate measure of survey effort for each transect, and these effort values were used for analysis.

The IECS boat based surveys were carried out from February 2007 – April 2008. In order to concentrate on the breeding months for season for seabirds, April was surveyed three times, to concentrate more survey effort during the breeding season. February was surveyed twice, all other months were only surveyed once. The seasonal survey effort was highest in the winter and spring months with 520 km and 650 km, respectively (Table 2-3).

SMRU surveys were undertaken during August, September and November 2010, and January to August 2011, with two surveys occurring in June and July (Table 2-2). Surveys were not possible during October 2010, due to ongoing geophysical surveys, which may have biased marine mammal distributions, and then a long period of poor weather. Surveys were also not possible in December 2010 due to access restrictions to the site that Marine Scotland were made aware of, and in May 2011, due to a prolonged period of bad weather. The survey effort completed for each survey stratum (north, south and offshore) are provided in Table 2-3.

The seasonal survey effort was broadly comparable with the exception being the summer months that had the highest effort (1,328 km), the lowest survey effort occurred in the autumn months (721 km) (Table 2-4).

Table 2-1 Total number of EOWDC boat based surveys and survey effort between February 2007 and April 2008 (IECS).

Season	Month	Number of surveys	Year	Total Effort (km)*	Seasonal effort (km)
Winter	December	1	2007	130	520
	January	1	2008	130	
	February	2	2007, 2008	260	
Spring	March	1	2007	130	650
	April	3	2007, 2008, 2008	390	
	May	1	2007	130	
Summer	June	1	2007	130	390
	July	1	2007	130	
	August	1	2007	130	
Autumn	September	1	2007	130	390
	October	1	2007	130	
	November	1	2007	130	
***Vessel used was the Gemini Explorer**					

Table 2-2 Total number of EOWDC boat based surveys carried out 2010-2011 (SMRU).

Month	Year	Dates	Vessel
August	2010	03/08/10 – 04/08/10	Gemini Explorer
September	2010	02/09/10 – 03/09/10	Gemini Explorer
November	2010	05/11/10 – 06/11/10	Gemini Explorer
January	2011	20/01/11 – 21/01/11	Gemini Explorer
February	2011	28/02/11 – 01/03/11	Eileen May
March	2011	24/03/11 – 25/03/11	Eileen May
April	2011	18/04/11 – 19/04/11	Eileen May
June (1)	2011	06/06/11 (1 day only)	Eileen May
June (2)	2011	24/06/11 (1 day only)	Eileen May
July (1)	2011	13/07/11 (1 day only)	Eileen May
July (2)	2011	27/07/11 (1 day only)	Eileen May
August	2011	22/08/11 – 23/08/11	Eileen May

Table 2-3 SMRU Survey effort (km) completed during each survey for each stratum (south, north and offshore).

Month	Survey Number	South stratum	North Stratum	Offshore Stratum	Total
August 2010	1	32.9	70.3	60.2	163.4
September 2010	2	35.7	76.6	55.6	167.9
November 2010	3	32.5	76.2	56.6	165.3
January 2011	4	30.9	73.7	55.4	160.0
February 2011	5	39.8	74.2	59.0	173.0
March 11	6	39.5	75.2	59.7	174.4
April 2011	7	40.1	63.3	0.0	103.4
June (1) 2011	8	38.6	74.4	59.9	172.9
June (2) 2011	9	39.9	74.3	42.5	156.7
July (1) 2011	10	38.2	72.5	58.1	168.8
July (2) 2011	11	38.0	71.9	56.9	166.8
August 2011	12	37.2	69.5	57.2	163.9
-	Total	443.3	872.1	621.1	1936.5

Table 2-4 Total number of EOWDC surveys and survey effort completed per season between February 2007 and April 2008 (IECS) and August 2010 August 2011 (SMRU).

Season	Number of Surveys			Effort (km)		
	Total	IECS	SMRU	Total	IECS	SMRU
Winter	6	4	2	852	520	332
Spring	7	5	2	927	650	277
Summer	9	3	6	1382	390	992
Autumn	5	3	2	721	390	331

2.1.4 Passive Acoustic Monitoring

Passive Acoustic Monitoring was used during the surveys carried out by IECS in 2007-2008 and the SMRU surveys carried out in 2010-2011. The total number of surveys and associated effort is shown in Table 2-5.

In the IECS survey a hydrophone array was towed behind the survey vessel during the line transects across both the wind farm and control area. Acoustic effort was calculated by examining the time that PAM was deployed against the distance travelled from the GPS data.

In the IECS surveys if acoustic data was being recorded and the vessel was shown to be on a long transect line, the effort status was classed as being “on effort”. If acoustic data was being recorded but the vessel was not sailing a transect line, or was sailing a short transect line, the effort status was classed as “opportunistic”.

During the SMRU surveys acoustic effort was recorded in the field, and was defined as periods when the hydrophone and associated recording equipment were operational and the survey vessel was adhering to one of the pre-designed survey transects. If the hydrophone and associated recording equipment were operational but the vessel was not sailing a transect line, the effort status was classed as “opportunistic”. Acoustic data was collected using a 75 m towed array. The hydrophone was deployed from the stern of the vessel.

During the August 2010 survey poor visibility in the northern area of the survey resulted in the repetition of some of the southern transects for the visual observers and these extra transects have been included in the August acoustic analysis.

Table 2-5 PAM survey effort during IECS and SMRU surveys between October 2007 and August 2011.

Month	Surveys	Effort (km)
October 2007	1	111
November 2007	1	102
December 2007	1	127
January 2008	1	88
February 2008	1	127
April 2008	2	227
August 2010	1	207
September 2010	1	169
November 2010	1	167
January 2011	1	164
February 2011	1	173
March 11	1	174
April 2011	1	103
June 2011	2	330
July 2011	2	338
August 2011	1	164
Total	19	2771

Continuous acoustic recordings were made via a National Instruments soundcard at a sample rate of 500 Hz, and stored on portable hard discs. Hydrophone data were run through a harbour porpoise detection algorithm in real time in the field using the Rainbow Click software (freely available from www.ifaw.org). Rainbow click highlights porpoise-type clicks within the acoustic data, and these detections were validated manually to ascertain the number of harbour porpoise detections. Detection rates are expressed as events per kilometre.

The acoustic data were also processed to detect tonal vocalisations, termed 'whistles', made by dolphin species. In addition to the Rainbow Click files created during the line transect surveys; recordings were also made at a sample rate of 96 kHz. The combined data set was run through the PAMguard "whistle and moan" detector module (PAMguard software freely available from www.pamguard.org) by SMRU Ltd to identify any dolphin whistles that may have been recorded. Detections were validated manually to ascertain the number of dolphin events. Detection rates are expressed as events per kilometre.

2.2 VANTAGE POINT SURVEYS

Shore-based vantage point bird surveys were conducted for two hours weekly at Blackdog and Donmouth and fortnightly at Drums and Balmedie covering a distance of up to 2 km from shore. These surveys were designed primarily for bird observations, but also collected information on marine mammals observed. Vantage point surveys were conducted from August 2005 until March 2008 (Alba Ecology and Envirocentre, 2008).

Bottlenose dolphins were recorded at all four sites (Donmouth, Blackdog, Balmedie and Drums), with the distance from shore ranging from less than 0.5 km to greater than 3 km and

the direction of travel being up and down the coast. They were observed throughout the year (except in June) and at various times of the day.

Harbour porpoises have been recorded at all four sites (Donmouth, Blackdog, Balmedie and Drums), with the distance from shore ranging from 0.5 km to 2 km. The direction of travel has been observed to be up and down the coast, although the majority appeared to be heading north. Harbour porpoises have been observed in January, February, May, June, July, August, September and December and at various times of the day.

The majority of seal sightings were of individual animals, probably grey seals, although harbour seals were recorded at Blackdog in June 2007 and at the Donmouth in July 2007. Seals have been recorded at all four sites Donmouth, Blackdog, Balmedie and Drums, although there is only one recorded sighting at Drums, with the distance from shore ranging from the surf zone to 1.5 km. Seals have been observed in January, February, March, August and December, at various times of the day.

Other species recorded were Risso's dolphins in April 2006 and April 2007. Single minke whales were recorded at both Donmouth and Blackdog on 13th July 2007, although this may have been the same individual moving along the coast and a large unidentified cetacean more than 5 km from the coast was observed in December 2006.

2.3 JNCC MARINE MAMMAL OBSERVATIONS DURING WINTER AERIAL SURVEYS OF ABERDEEN BAY

The Joint Nature Conservation Committee (JNCC) conducted aerial surveys of wintering aggregations of birds within Aberdeen Bay in December 2004, February 2005, December 2005, January 2006, May 2006 and April 2007. Surveys were conducted from light aircraft, following a line-transect method (details of the survey methods are provided in Söhle *et al*. (2006) and Wilson *et al*. (2006). During these surveys observations of bottlenose dolphins and harbour porpoises were recorded incidentally (Table 2-6).

Table 2-6 Marine mammal observations during JNCC aerial surveys of Aberdeen Bay (2004-2007) (Söhle *et al*., 2006; Wilson *et al*., 2006).

Date	Bottlenose dolphin	Harbour porpoise
11th December 2004	4	0
17th February 2005	1	0
8th December 2005	4	6
24th January 2006	0	5
10th May 2006	0	0
26th April 2007	1	0

2.4 DISTRIBUTION AND ABUNDANCE OF CETACEANS TO THE NORTH AND EAST OF SCOTLAND (SEA5)

Hammond *et al*. (2004) examined the distribution and abundance of cetaceans occurring to the north and east of Scotland during the Strategic Environmental Assessment (SEA) 5 (Figure 2-3). Species that are known to occur regularly in this area are the harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin, killer whale, bottlenose dolphin and minke whale. In addition there are occasional at-sea records in the area of at least eight further cetacean species: humpback whale, fin whale, sperm whale, northern bottlenose whale, long-finned pilot whale, Risso's dolphin, short-beaked common dolphin and striped dolphin.

Hammond *et al*. (2004) reviewed quantitative information for this area from a variety of sightings surveys including the Small Cetacean Abundance in the North Sea (SCANS)

survey in July 1994 (Hammond *et al.,* 1995; 2002), the North Atlantic Sightings Surveys (NASS) in July 1989 (Bjørge and Øien, 1995), and the Norwegian Independent Line transect Surveys (NILS) in July 1995 and 1998 (Schweder *et al.,* 1997; Skaug *et al.,* 2003). There are also published cetacean observations made during seismic surveys in 1996 to 1999 (Stone, 1997; 1998; 2000; 2001; 2003a). Acoustic recordings have also been used to determine the general distribution and seasonal patterns of movement of some cetacean species by Cornell University, Aberdeen University and the Joint Nature Conservation Committee using the US Navy's SOSUS hydrophone array and low frequency sonor buoys (Swift *et al.,* 2002).

Information from Hammond *et al*. (2004) has been included in this review, with particular reference to the north-east coast of Scotland.

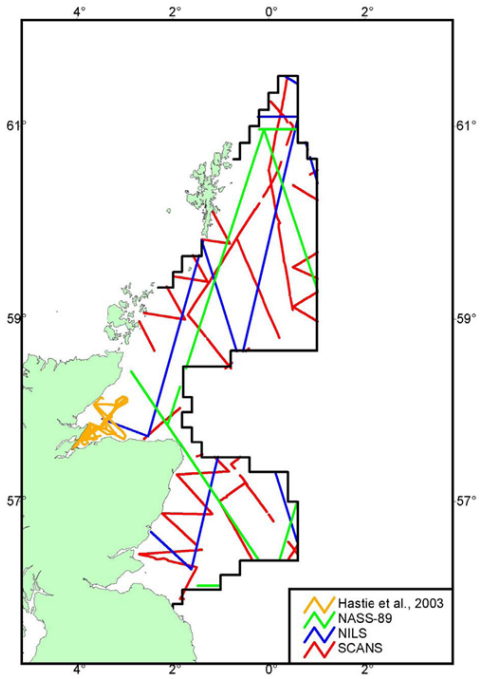


Figure 2-3 SEA5 Area: north and east Scotland, including cruise tracks from various surveys conducted in the SEA5 area and SCANS (Hammond *et al*., 1995; 2002: black line outlines SEA5 area).

2.5 NORTHERN NORTH SEA CETACEAN FERRY SURVEYS (NORCET)

As part of the NORCET cetacean surveys were conducted from the bridge of the *MV Hascosay* ferry between Aberdeen, Orkney and Shetland during daylight hours in the summer months April to September from 2002 to 2006 (MacLeod *et al*., 2007). Data from these surveys provided important additional information on the occurrence and distribution of cetaceans in areas away from the coast that are not regularly covered by other surveys. Although the surveys continued after 2006, no analysed sightings data was available.

In the first five years, surveys were conducted on over 100 days and 383 sightings of 1,148 individual cetaceans were recorded. These sightings represent 10 different species. The most commonly sighted species was the harbour porpoise (164 sightings) which were recorded throughout the region. Minke whales were the second most commonly recorded species (55 sightings) and were most commonly sighted in deeper waters of the outer Moray Firth in early summer and in more coastal waters in later summer. The third most commonly seen species was the white-beaked dolphin (53 sightings). Again this species was recorded through out the study area, but was most commonly sighted in July and August in coastal

waters. Thirty nine observations of bottlenose dolphins were sighted, but this species was almost exclusively sighted close to shore as the ferry passed along the coast of mainland Scotland. Only harbour porpoises, minke whales and bottlenose dolphins were recorded in all summer months. The remaining species sighted were the Atlantic white-sided dolphin (10 observations), the common dolphin (9 observations), the Risso's dolphin (6 observations), the killer whale (3 observations), the fin whale (3 observations) and the humpback whale (1 observations).

The data collected from the NORCET ferry surveys 2002-2006 is summarised in Figure 2-4. The proportion of cetacean species detected during each month and year of survey effort is illustrated in Figure 2-5 and Figure 2-6.

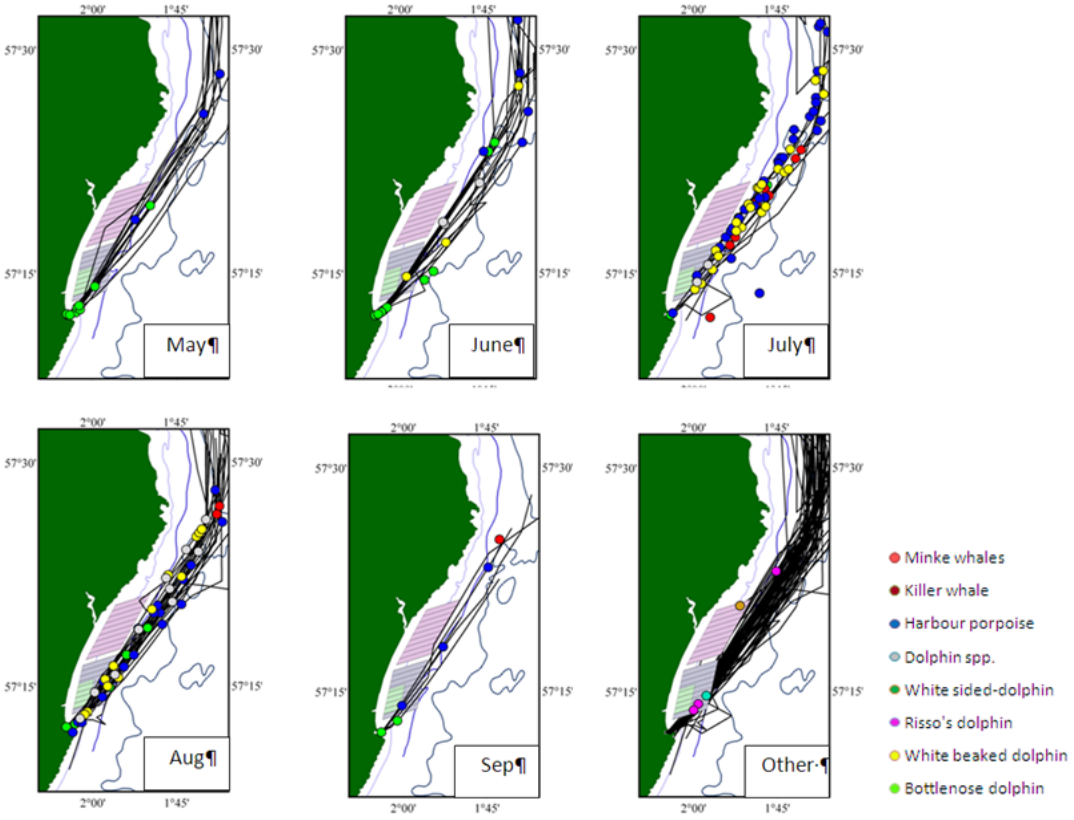


Figure 2-4 Cetacean species detected along the north east coast of Scotland during NORCET Ferry crossings 2002-2006 (MacLeod *et al*., 2007).

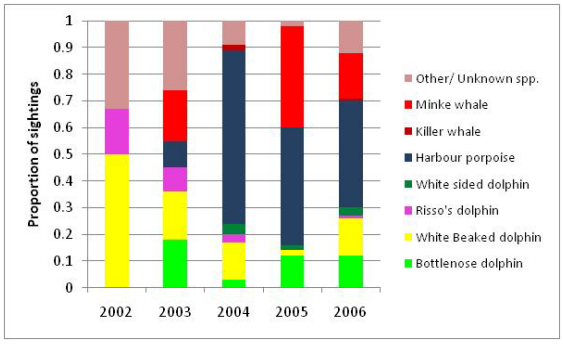


Figure 2-5 Proportion of cetacean sightings per month during the NORCET surveys 2002-2006(Data used from MacLeod *et al*., 2007).

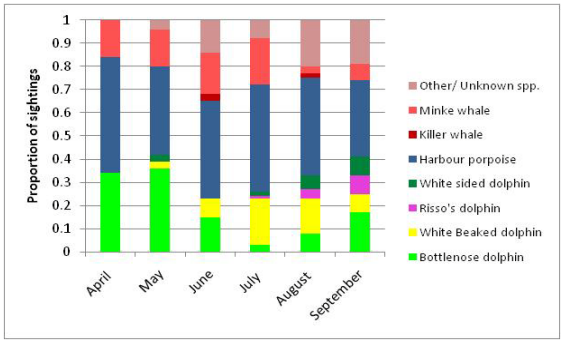


Figure 2-6 Proportion of cetacean sightings per year during the NORCET surveys 2002-2006(Data used from MacLeod *et al*., 2007).

2.6 MORAY FIRTH STUDY ASSESSING IMPACTS OF POTENTIAL OIL AND GAS SEISMIC SURVEYS

The Department and Energy and Climate Change (DECC), with co-funding from the Scottish Government, COWRIE and Oil and Gas UK, funded a three year research programme due to finish in 2012 to assess the potential impacts of proposed oil and gas activities on cetaceans in the Moray Firth. The project involved the collection of boat based survey, aerial survey data and deployment of acoustic hydrophones (C-Pods to detect the vocalisations of cetaceans). The interim results of the first two years of surveys have been published and results applicable to the two main cetacean species observed in the Moray Firth, the harbour porpoise and bottlenose dolphin are discussed in Section 5.1 and Section 5.2 (Thompson, *et al*., 2010; Thompson *et al*., 2011).

2.7 CETACEAN STRANDING DATA: FRASERBURGH TO INVERBERVIE (JANUARY 1992 – MARCH 2010)

The Scottish Agricultural College Veterinary Services at Inverness carry out post mortems on stranded and by-caught cetaceans in Scotland for the DEFRA funded Marine Mammal Strandings Program as part of the UK's commitment to a number of international conservation agreements. Post mortem procedures, sampling and data collection by the SAC follow the recommended procedure of the European Cetacean Society (Kuiken and Hartmann, 1991) and the UK Marine Mammal Project (Law, 1994).

Nine cetacean species have been recorded in the strandings database by the Scottish Agriculture College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and March 2010 (SAC, 2006; CSIP, 2010). Of the 167 cetaceans in

the stranding records for the north-east coast the majority (approximately 78 %) were harbour porpoises. Other species included white-beaked dolphins, sperm whales, minke whales, common dolphins, Risso's dolphins, bottlenose dolphins, long-finned pilot whale and Sowerby's beaked whale (Table 2-7).

Table 2-7 Strandings data recorded from Fraserburgh to Inverbervie 1992-2006 (SAC, 2006; CSIP, 2010).

Species	Number
Harbour porpoise	130
White-beaked dolphin	14
Sperm whale	9
Minke whale	5
Common dolphin	3
Risso's dolphin	2
Bottlenose dolphin	2
Long-finned pilot whale	1
Sowerby's beaked whale	1

3. ANALYSIS METHODS

Boat based survey data has been presented in the format of GIS plots illustrating sighting location and also tabulated data for each species recorded. Where sufficient sightings have allowed abundance and density estimates have been created for the Harbour porpoise using Multi-Covariate Distance Sampling (MCDS). A Density Surface Model (DSM) was applied to the EOWDC boat based harbour porpoise data to illustrate the variation in marine mammal density across the site, and also allow comparison with EOWDC boat survey data collected in 2007-2008. An explanation of the MCDS and DSM is provided in the following sections.

3.1 MULTI-COVARIATE DISTANCE SAMPLING (MCDS) ANALYSIS OF MARINE MAMMAL DATA

Multi-covariate distance sampling was carried out using the software programme Distance 6 (Thomas *et al*. 2009). The standard equations for estimating density and abundance are:

$$\hat{D} = \frac{n}{2\mathrm{L}.\,\mathrm{esw}}$$

Where *n* is the number of sightings, *L* is the total length of transect surveyed and *esw* is the effective strip half width.

Species with greater than 40 individual observations across all surveys and strata were initially judged as potentially suitable for analysis in Distance (Buckland *et al*., 2001; SMRU, 2011d). Observations made during transits between transects ('off-effort') were excluded from the analyses. Seasonal and monthly estimates of density and abundance of porpoise were calculated for each survey stratum.

The probability of observing an animal on the transect line, which is referred to as 'g(0)' influences the density estimates, where g(0) = 1 assumes that all the animals present are actually detected. When dealing with marine mammal surveys, where animals are not visible for large proportions of time, g(0) is expected to be less than 1. There are published estimates for g(0) for boat-based harbour porpoise surveys; for example SCANS surveys estimated g(0)=0.34 (Hammond *et al*., 2002) and SCANS-II g(0) = 0.22 (SCANS-II, 2008). The true g(0) for EOWDC surveys has not been estimated and it is likely to be quite different from the SCANS surveys given the differences in the observation platforms and protocols being used. However, the value of g(0) on EOWDC surveys is certainly less than 1, as some animals would have been missed due to them having been underwater. As the actual g(0) value is unknown for this study site/vessel, models were run with a range of g(0) values to provide a demonstration of the relationship between g(0) and the final density and abundance estimates, and data are presented for g(0)=0.34 and g(0)=1. Appendix 1 demonstrates the influence on varying the value of g(0) on abundance and density estimates.

A range of models for the detection function were assessed against one another by eye and using Akaike's Information Criteria (AIC), with the Half-Normal key function with Cosine expansion providing the best model fit. Models including potentially confounding covariates (e.g. sea state, observer, time since sunrise) were included in model selection using the MCDS engine in Distance 6.

Due to limited sample sizes across survey strata (Area and Month), all species specific observations were used to produce 'global' detection functions for the respective species.

Post-stratification was then used to produce density and abundance estimates for each survey area during individual months.

3.1.1 Density Surface Modelling

Density surface modelling (DSM) is a method to estimate the density of animals taking into account the effects of detectability on sightings rate and the effects of environmental heterogeneity on their distribution. The output of the model is a continuous density "surface" made up of a grid of cells, each with its own density estimate and associated coefficient of variation.

The steps in the DSM method can be summarised as:

- Survey effort data were prepared by splitting transects into approximately 1 km segments.
- Animal sightings and values of environmental variables were assigned to each segment.
- A detection function (f(x)) was fitted to the sightings on the line transect segments of effort. This function was used to adjust the number of animals detected in each survey segment for detectability so that an estimated number of animals per survey segment were produced.
- A series of Generalised Additive Models (GAMs) and Generalised Additive Mixed Models (GAMMs) were fitted to the estimated number of animals per survey segment to generate estimates of abundance of individuals per segment using environmental covariates. The covariates used were average depth, distance from coast and distance from Aberdeen harbour, with a class effect of season.
- The abundance of individuals on each segment (the response variable) was explored and, where necessary, adjusted to fit to a standard distribution. As the data were over-dispersed (sightings were clumped and not evenly distributed throughout the survey area) a quasi-Poisson error distribution was used with a logarithmic link function.
- With a factor of Season being fixed in all models, each of the additional explanatory variables was fitted in turn and in combination to allow model selection based on the improvement in the model as assessed through the change in deviance explained and the General Cross Validation (GCV) score. Models with a small GCV score tend to do best at predicting the response variable. Plots of the fit of the smoothed density against each explanatory variable were visually inspected to check for unusual behaviour of the variables or interactions in the model.
- Once the 'best' model was determined, density was predicted over a grid of environmental variables which covered the area of interest.
- The resolution of the predictive grid was 1x1 km and covered the entire survey area. Values for each of the explanatory variables were associated with the centre of each grid cell.
- A variance surface was produced by bootstrapping the density estimates over the predicted surface.
- The variance associated with the density estimates was estimated using a parametric moving-block bootstrap such as in Distance (Künsch, 1989). This method uses blocks

of segments as the sampling unit, with the user specifying the block size in Distance. A block size ('m') equal to the number of segments in one transect will allow only a small amount of re-sampling within each transect. Whereas a block size of 1 ignores issues of autocorrelation. Ideally, block size should be set so that segments more than 'm' units apart will be independent, while also being small enough so that the correlation present in segments less than m units long will be retained. The number of bootstrap resamples generated was 999 for each dataset.

- To create estimates for these models, transects and associated porpoise or bird observations were divided into 1 km segments. Best models, as selected above, were used to create density estimates and estimates of variance per segment.

Following the above criteria Density Surface Model was built for harbour porpoise, with modelled surface maps being created for both estimates of population density and for bootstrapped variance estimates.

4. SUMMARY OF MARINE MAMMALS IN ABERDEEN BAY AND SURROUNDING AREA

The East Grampian coast of Scotland and adjacent areas of the northern and central North Sea are important for marine mammal species. The most frequently sighted species within near-shore waters (within 60 km of the coast) are the harbour porpoise and the bottlenose dolphin, but white beaked dolphins and minke whales also occur every summer (Anderwald, *et al*., 2010). Atlantic white-sided dolphin, short-beaked common dolphin, Risso's dolphin, killer whale and long-finned pilot whale are uncommon with these species being recorded in the northern North Sea more or less annually (Anderwald, *et al*., 2010). Other cetacean species recorded infrequent/rare in the region include striped dolphin, northern bottlenose whale, Sowerby's beaked whale, sperm whale, humpback whale and fin whale (Hammond *et al*., 2001, 2002, 2004; Northridge *et al*., 1995; Reid *et al*., 2003; Stone, 1997, 1998, 2000, 2001, 2003a, b; Weir and Stockin, 2001; Weir *et al*., 2007; Wilson *et al*., 2000). The abundance of marine mammal species that are known to occur, or have been previously recorded, in Aberdeen Bay area is shown in Table 4-1.

Table 4-1 Summary of abundance of marine mammals within Aberdeen Bay.

Common name	Latin name	Abundance
Bottlenose dolphin	*Tursiops truncatus*	common/regular
Harbour porpoise	*Phocoena phocoena*	common/regular
White-beaked dolphin	*Lagenorhynchus albirostris*	common/seasonal
Minke whale	*Balaenoptera acutorostrata*	common/seasonal
White-sided dolphin	*Lagenorhynchus acutus*	occasional
Killer whale	*Orcinus orca*	rare
Common dolphin	*Delphinus delphis*	infrequent/rare
Risso's dolphin	*Grampus griseus*	occasional
Striped dolphin	*Stenella coeruleoalba*	rare
Long-finned pilot whale	*Globicephala melas*	infrequent/rare
Sperm whale	*Physeter macrocephalus*	infrequent/rare
Humpback whale	*Megaptera novaeangliae*	rare
Fin whale	*Balaenoptera physalus*	rare
Sowerby's beaked whale	*Mesoplodon bidens*	rare
Northern bottlenose whale	*Hyperoodon ampullatus*	rare
Harbour seal	*Phoca vitulina*	common/regular
Grey seal	*Halchoerus grypus*	common/regular

Table 4-2 Summary of the presence, seasonal occurrence and seasonal sensitivities of marine mammals in the Aberdeen Bay area.

Species	Presence	Seasonal Occurrence											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bottlenose dolphin	regular				*	*	*	*	*	*			
Harbour porpoise	regular				*	*	*	*	*	*			
White-beaked dolphin	regular/seasonal						*	*	*				
Minke whale	regular												
White-sided dolphin	occasional												
Killer whale	rare												
Common dolphin	occasional												
Risso's dolphin	occasional/regular												
Striped dolphin	rare												
Long-finned pilot whale	occasional												
Sperm whale	rare												
Humpback whale	rare												
Fin whale	rare												
Northern bottlenose whale	rare												
Sowerby's beaked whale	rare												
Harbour seal	regular						*	*	*	*			
Grey seal	regular		*	*	*						*	*	
Hooded seal	rare												

Key	
	Present in area (sighting and/or stranding)
	Peak abundance
	Potential to be present in area
*	Seasonal sensitivities (e.g. calving period, moulting period)

5. CETACEANS

This section describes the distribution and abundance and life histories of the main cetacean species found in Aberdeen Bay. Information is taken from the main data sources described in Section 2 as well as other applicable studies.

5.1 BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*)

5.1.1 Distribution

Bottlenose dolphins are found worldwide in virtually all tropical and temperate seas and occupy most marine habitats from the open ocean to coastal lagoons. They occur in European waters along the Atlantic shores from Portugal to the Faroe Islands. Their distribution appears to be linked to sea temperature; in the north-east Atlantic resident coastal populations extend only as far north as Scotland. The species has been caught in the Faroes drive fishery, suggesting that it may be more abundant and widespread than is generally thought (Hammond *et al*., 2001). Bottlenose dolphins are not particularly common in the north-eastern area of the North Atlantic but there are a number of well-documented and, in some cases, well-studied coastal populations along the Atlantic margin of Europe (Hammond *et al*., 2004).

There are two main areas of UK territorial waters where there are semi-resident groups of bottlenose dolphins: Cardigan Bay in Wales and the Moray Firth on the north-east coast of Scotland. Both of these areas have been designated Special Areas of Conservation (SAC) for bottlenose dolphins. There are also smaller populations of bottlenose dolphins off south Dorset, around Cornwall and in the Sound of Barra in the Outer Hebrides. Other bottlenose dolphin groups, presumed to be of transients, have been recorded further offshore in deeper water to the west of Scotland.

Figure 5-1 shows the locations of bottlenose dolphin sightings made during systematic surveys and some platforms of opportunity off north-east Scotland (reproduced from Hammond *et al*., 2004). The few observations offshore in the North Sea may indicate that animals from the Moray Firth population could be distributed offshore at least for part of the year (Hammond *et al*., 2004).

During the SCANS II surveys in July 2005, bottlenose dolphins were encountered around the coasts of Britain, Ireland, France, Spain and Portugal. They were also sighted in outer shelf waters off Scotland and Ireland and in the Celtic Sea. The total abundance of bottlenose dolphins for the entire SCANS II survey area is estimated to be 12,645 (CV=0.27) (SCANS II, 2008).

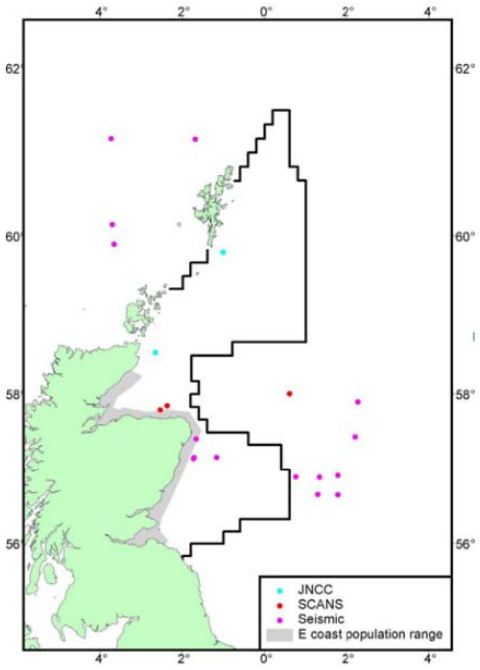


Figure 5-1 Scottish east coast range and sightings of bottlenose dolphins from various sources (Hammond *et al*., 2004 black line outlines SEA5 area).

5.1.1.1 Occurrence in Aberdeen Bay and surrounding area

Bottlenose dolphins are known to occur regularly in the Aberdeen Bay area. Observations indicate they are present in the area throughout the year, with a peak occurrence during the winter and spring months (November-May), when they can be observed almost daily feeding at Aberdeen Harbour (Canning, 2007; Stockin *et al*., 2006).

The habitation of Aberdeenshire's coastal waters by bottlenose dolphins appears to have increased since the early 1990s and they are now the most frequently reported cetacean species in the area (Stockin *et al*., 2006; Weir and Stockin, 2001). There has been a recent increase in sightings along the east coast of Scotland as far south as St Andrews (Wilson *et al*., 2004).

Analysis of cetacean distribution and habitat use along the Aberdeenshire coast, indicate that the entrance to the River Dee (Aberdeen harbour) is an important feeding area for bottlenose dolphins, especially during the winter and spring when dolphins are most abundant (Canning, 2007). The majority of sightings away from Aberdeen were of groups travelling while those sighted at Aberdeen generally exhibited foraging behaviours (Canning, 2007).

Bottlenose dolphin presence at Aberdeen harbour showed a strong correlation with tidal height and river flow. These factors are also known to influence salmon migration up river, suggesting that salmon presence is the factor attracting these dolphins to this site. The seasonal pattern in the age of salmon that move upstream (with the older, multi-winter fish coming inshore during the winter and spring), matches the seasonal pattern in the bottlenose dolphin sightings suggesting they could be targeting these older fish (Canning, 2007).

The importance of the Aberdeen harbour area during the winter is the opposite of what has been observed within the Moray Firth, where the majority of sightings are during the summer

(Wilson *et al.*, 1997a). Bottlenose dolphins are now also regularly recorded off St Andrews (70 miles south of Aberdeen) and again the sightings here are mainly during the summer, with peak sightings occurring between June and August (N. Quick, *pers. comm*.; Hammond *et al*., 2004).

Bottlenose dolphin sightings recorded during targeted project Vantage Point surveys (August 2005 – March 2008) are summarised in Table 5-1 .

Table 5-1 Bottlenose dolphin sightings recorded during Vantage Point surveys (August 2005 – March 2008).

VP site	Observations
Donmouth	April 2006, May 2006, March 2007, April 2007, July 2007, August 2007, September 2007 and March 2008
Blackdog	April 2006, May 2006, July 2006, August 2006, January 2007, and July 2007
Balmedie	December 2005, August 2007 and April 2007
Drums	August 2005, November 2005, August 2006, December 2006, February 2007 and July 2007.

During the JNCC aerial survey of Aberdeen Bay, bottlenose dolphins were recorded in December 2004, February 2005, December 2005 and April 2007 (Table 2-6).

5.1.1.2 EOWDC Boat based survey results 2007-2008: Bottlenose dolphins

62 observations of 200 bottlenose dolphins were recorded both on and off effort during the EOWDC boat based surveys carried out 2007-2008 (Figure 5-2). The majority of sightings occurred in the mouth of the harbour when the vessel was transiting to the survey transects. There were 10 observations of 58 bottlenose dolphins collected on effort that would have been available for distance analysis. The mean group size of all sightings both on and off effort was 5.2 individuals. The majority of sightings occurred during the spring months with sightings occurring throughout the year. A higher number of individuals were observed in the wind farm survey area in comparison to the control site (Table 5-2).

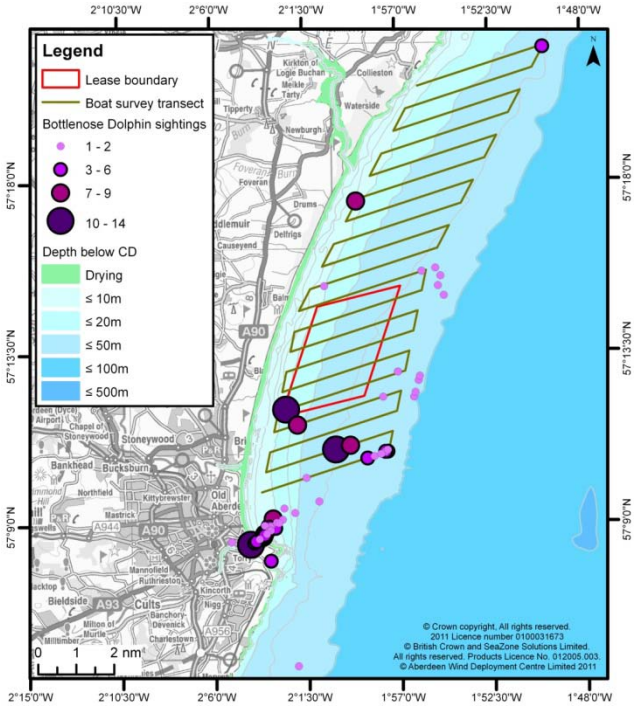


Figure 5-2 Bottlenose dolphins observed on and off effort during the 2007-2008 AOWFL boat surveys.

Table 5-2 Sightings information for bottlenose dolphins recorded during the boat based surveys 2007-2008.

	Season				Total Individuals				
Common name	**Wi**	**Sp**	**Su**	**Au**	**On effort**	**Off effort**	**On and Off effort**	**Windfarm**	**Control**
Bottlenose dolphin	0 (9)	20 (76)	34 (45)	3 (13)	58	142	200	46 (69)	13 (71)

5.1.1.3 EOWDC based survey results 2010-2011: Bottlenose dolphins

A total of 9 observations of bottlenose dolphins of 59 individuals were located on effort during all the EOWDC surveys carried out in 2010-2011 (Table 5-3 and Figure 5-3). Bottlenose dolphins were present during all seasons. Dolphins occurred in larger groups with a mean group size of 12 individuals. Consistent with previous years the majority of sightings were observed in the vicinity of the harbour mouth.

As Passive Acoustic Monitoring is unable to identify to a species level cetaceans whistles and clicks the Unidentified Detection rates of odontocete species during acoustic boat surveys 2010-2011 are presented in Appendix 2.

Table 5-3 EOWDC surveys 2010-2011 (only showing months where bottlenose dolphins detected).

Year	Month	Stratum	Observations	Individuals
2011	February	North	0	0
		Offshore	0	0
		South	1	7
		Total	1	7
	March	North	0	0
		Offshore	0	0
		South	1	10
		Total	1	10
	June 2nd survey	North	0	0
		Offshore	0	0
		South	1	3
		Total	1	3
	July 1st survey	North	0	0
		Offshore	0	0
		South	2	9
		Total	2	9
	July 2nd survey	North	0	0
		Offshore	0	0
		South	2	13
		Total	2	13
	August survey	North	0	0
		Offshore	0	0
		South	2	17
		Total	2	17
		Total	**9**	**59**

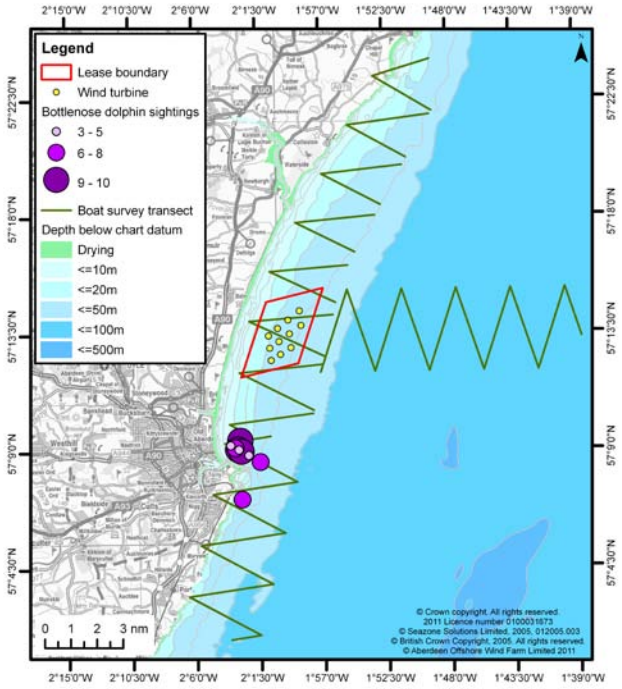


Figure 5-3 Bottlenose dolphins observed during the 12 months of EOWDC survey effort 2010-2011.

5.1.1.4 Observations from ferry surveys

Cetacean surveys were conducted from the bridge of the *MV Hascosay* ferry between Aberdeen, Orkney and Shetland during the summer months (April to September) from 2002 to 2006. During these surveys, bottlenose dolphins were not sighted evenly throughout the study area, and the sightings were concentrated in the region along the coast of mainland Scotland, and particularly in the waters around Aberdeen Harbour (Figure 5-4). Thirty nine sightings of bottlenose dolphins were recorded during more than 100 survey days, making it the fourth most commonly sighted marine mammal in the region. Bottlenose dolphins were recorded in all months surveyed. The average group size was five individuals, but groups ranged from one to 25 individuals (MacLeod *et al*., 2007).

Observations during the ferry surveys are consistent with studies conducted in the outer Moray Firth and along the Aberdeenshire coast, which indicate that bottlenose dolphins primarily use coastal waters in this region, and suggest that this population of bottlenose dolphins rarely use the deeper, more open waters of the outer-most Moray Firth and the northern North Sea. In addition, observations during the ferry surveys suggest that bottlenose dolphins rarely, if ever, occur in the coastal waters around Orkney and Shetland (MacLeod *et al*., 2007).

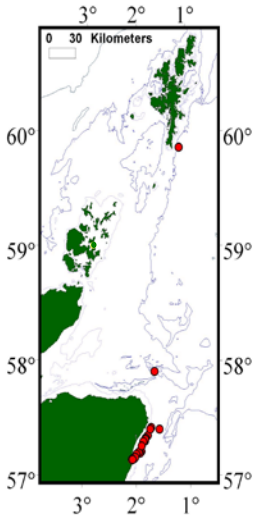


Figure 5-4 Distribution of bottlenose dolphin sightings during ferry surveys (April to September, 2002-2006).

5.1.1.5 Moray Firth Bottlenose dolphin population

Distribution and occurrence

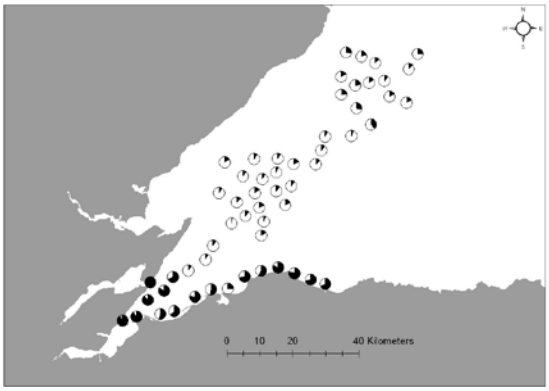
In March 2005, an area of the inner Moray Firth (with an outer boundary from Helmsdale on the north coast to Lossiemouth on the south coast) was designated as a marine SAC for the conservation of the bottlenose dolphin population. In the 1980s, the core of this population's range was in the inner Moray Firth. Dolphins are distributed throughout the inner Moray Firth and there are three areas 'hotspots' where sightings are concentrated: the Kessock Channel, Channory narrows, and around the mouth of the Cromarty Firth, all of which are narrow, deep channels associated with strong tidal currents (Wilson *et al.*, 1997a; Hastie *et al.*, 2003b).

Spatial patterns of cetacean distribution within the Moray Firth have been investigated using a combination of visual and passive acoustic boat-based line-transect surveys in the inner and outer Moray Firth during the summers of 2004 and 2005. Bottlenose dolphins had a predominately near-shore distribution with a confirmed preference for hotspots within the inner Moray Firth. However, some regular, but sporadic, dolphin activity was present at the Beatrice wind farm site (offshore) during the late summer/autumn of the sampling period (Lusseau *et al.*, 2005; Talisman, 2005).

Bottlenose dolphins are observed all year round within the Moray Firth SAC, although there is a seasonal pattern to their sightings with peak sightings occurring during the summer months between May and September and lower numbers in winter and spring (Wilson *et al.,* 1997a).

The analysis of the acoustic hydrophone data (C-Pods) collected as part of the Moray Firth study has contributed to the knowledge of dolphin species presence in the Moray Firth area. Although the C-Pods used are unable to distinguish between dolphin species, the results can be corroborated with visual sightings data. The results of the study have shown that dolphins were detected most often in the inner Moray Firth and along the southern Moray Firth and less frequently in the central Moray Firth.

The results from the 2nd year of the study have been reproduced in this report Figure 5-5 and Figure 5-6. The location and proportion of time dolphins were detected is represented as a pie chart in Figure 5-5. These results are considered to be comparable to the results from the previous years, with the data indicating that the spatial variation in dolphins was consistent between years (Thompson *et al*., 2011). Sightings data corroborated with the acoustic data with the majority of bottlenose dolphins recorded along the southern Moray Firth coast, hence why there was a higher proportion of days of acoustic detections (Figure 5-6).



*The pie chart in the figure above illustrates the location of the hydrophone and also the proportion of time where acoustic detections were received in relation to the deployment period.

Figure 5-5* Proportion of days that dolphin detections were recorded at the C-pod location sites (reproduced from Thompson *et al*. 2011).

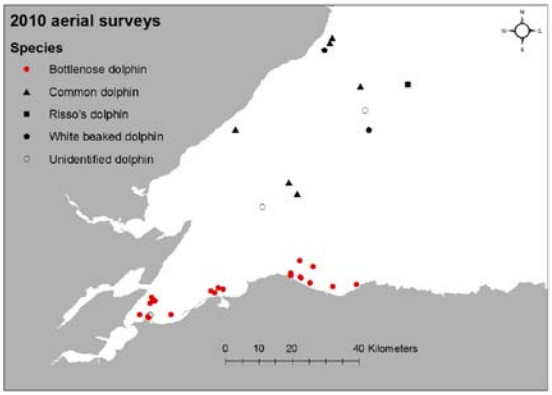


Figure 5-6 Dolphin observations during the aerial surveys carried out August-November 2010 (reproduced from Thompson *et al*. 2011).

5.1.2 Abundance

Data collected during 1990 and 1993 estimated that 129 individuals (95% Confidence Interval (CI): 110-174) used the Moray Firth area at this time (Wilson *et al*., 1999a). Analysis of survey data between 1990 and 2002 indicated considerable variability among years, with estimates ranging between 75-200 (Thompson *et al*., 2004a) and similarly, analysis of data collected in 2001 estimated an average population size of around 85 (95% probability interval = 76-263) (Durban *et al*., 2005), although there is uncertainty about current trends in abundance (Thompson *et al*., 2004a).

Data collected up to 1997 were analysed to estimate rates of survival and reproduction, which were incorporated in a Population Viability Analysis (PVA) to predict likely future population trends (Sanders-Reed *et al*., 1999). These models predicted that, if conditions remained the same, the Scottish east coast population was likely to decline at a rate of around 5% per annum. The results of the modelling study were used to assign the bottlenose dolphin population to 'unfavourable – declining' (according to the framework categories within the Common Standards Monitoring). However, the calculated annual estimates of abundance from 1990 to 2002 showed no clear trend (Hammond *et al*., 2004). Subsequent results from the monitoring programme that SNH established to follow changes in the number of dolphins using the SAC, indicated that whilst the numbers had declined during the 1990's, these appeared to be stabilising by 2004. As a result, the condition was assessed as "unfavourable recovering" in 2005 (Thompson *et al*., 2009).

5.1.3 Genetic and social structure

From genetic studies it appears that Scottish east coast bottlenose dolphins are more closely related to the Welsh population in Cardigan Bay and to individuals stranded around the southern coast of England than to individuals encountered in the Scottish Western Isles (Parsons *et al*., 2002).

Analysis of the social structure of bottlenose dolphins along the Scottish east coast suggest that the population is composed of two social units with restricted interactions via a few common individuals (Lusseau *et al*., 2005). These two units appear to be related to known differences in the ranging pattern of individuals (Wilson *et al*., 2004). Individuals commonly seen in the inner Moray Firth were not observed in other locations and these individuals tend not to interact with individuals coming into the inner Moray Firth area during summer and mostly remained within their communities. The home ranges of the two social units largely overlap and this may be related to the presence of abundant prey in the area that allows the two communities to co-inhabit in the same area at this time (Lusseau *et al*., 2005).

5.1.4 Range expansion

Recent evidence suggests that the Moray Firth bottlenose dolphin population has been extending its range beyond the boundaries of the Moray Firth and associated SAC, with an increase in sightings along the east coast of Scotland as far south as St Andrews and the Firth of Forth (Wilson *et al*., 2004).

Between 1990 and 2000, photo-identification surveys were conducted within the inner Moray Firth, along the coastal waters of the outer Moray Firth and along the coasts south of Fraserburgh (Wilson *et al*., 2004). Examination of the data for 54 distinctly marked individuals

(approximately 42% of the estimated population, identified in the inner Moray Firth between 1990 and 1992), found that the majority (74 %) had subsequently been identified in the outer Moray Firth and 61 % had been seen along the coasts south of Fraserburgh, confirming that they had come from the 'Moray Firth population' (Wilson *et al*., 2004). The animals seen in other areas continued to be seen within the inner Moray Firth, indicating an expansion, rather than shifting of their range (Wilson *et al*., 2004).

There appears to be a spatio-temporal pattern of movement within the population, with those animals using areas outside the inner Moray Firth also occupying the areas furthest from the head of the inner Moray Firth. This is in contrast to those animals that were predominantly sighted within the inner Moray and tended to be found most often closest to the headwaters (Wilson *et al*., 2004).

Animals that used areas outside the inner Moray Firth appeared to move greater distances between sightings and moved faster during sightings. For example, one individual was identified south of Aberdeen in June 1996 and was re-identified off Burghead 52 hours later, representing a distance of 218 km and a minimum swimming speed of 4.2 km/h (Wilson *et al*., 2004). For consecutive sightings 5 or less days apart, the median rate of travel for dolphins identified primarily within the inner Moray was 0.071 km/h, whereas for dolphins observed using areas outwith the inner Moray Firth it was significantly greater at 0.22 km/h. Similarly, during sightings in the outer Moray Firth and along the coasts south of Fraserburgh the median rate of progress was 7.6 km/h, which was twice as fast as in the inner Moray Firth (3.9 km/h) (Wilson *et al*., 2004).

The reasons for the apparent range expansion appear to be related to changes in prey resources (Wilson *et al*., 2004). For example, the rapid and long-range movements observed outside the inner Moray Firth suggests that prey resources may be more widely dispersed and/or different in these areas. The stratification among individuals may indicate competition for resources (Wilson *et al*., 2004).

5.1.5 Diet

Bottlenose dolphins are opportunistic feeders and take a wide variety of fish and invertebrate species. Despite the large amount of information on bottlenose dolphins in the area, relatively little is known about their diet. Stomach content analysis of bottlenose dolphins (n= 10) from Scottish waters indicate that the main prey eaten were cod (*Gadus morhua*), saithe (*Pollachius virens*) and whiting (*Merlangius merlangus*) although several other fish species were also eaten, including salmon (*Salmo salar*) and haddock (*Melanogrammus aeglefinus*) and cephalopods (Santos *et al*., 2001a).

5.1.6 Habitat use and foraging

The presence of bottlenose dolphins at the mouth of the River Dee (Aberdeen harbour) has been associated with salmon migration, suggesting that salmon presence is a factor in attracting these dolphins to this site (Canning, 2007). Although the River Dee is situated in a large bay, it flows out through a man-made harbour, the entrance to which is narrow and deeper than the surrounding waters, therefore creating a potential "bottleneck" for migrating fish (Canning, 2007).

Within the inner Moray Firth, feeding behaviour by bottlenose dolphins was significantly higher in areas used intensively by dolphins. These discrete areas occur in deep narrow entrances to coastal inlets that have steep seabed gradients and strong tidal currents (Hastie *et al*., 2004; Wilson *et al*., 1997a). Behaviours that were associated with feeding on large prey peaked in deep waters over steep seabed gradients, particularly during June and July (Hastie *et al*., 2004). It has been suggested that these areas create bottlenecks for migratory fish, most likely migrating salmonids (*Salmo salar* and *trutta*) potentially increasing foraging opportunities (Wilson *et al*., 1997a).

Passive acoustic monitoring within the deep (55 m), narrow channel at the entrance to the Cromarty Firth, indicated that bottlenose dolphins used the full water column and consistently dived to depths of around 50 m, close to the seabed. However, the majority of their time appeared to be spent within the surface layers and feeding behaviour occurred primarily at depths between 20 m and 30 m (Hastie *et al*., 2006).

During land-based observations at Aberdeen harbour between early May and late July 2002, bottlenose dolphins were found to be present throughout the day during high and low tide. However, they were more frequently observed around midday and early afternoon, while their abundance was greater around high tide and late afternoon. Foraging was the most commonly observed activity (Sini *et al*., 2005).

5.1.7 Life history

Bottlenose dolphins are long-lived animals with life spans of up to 40-50 years. Females are sexually mature at between 5-12 years of age and can produce a calf every 2-3 years, although 3 to 6 year intervals are more common (Connor and Smolker, 1990; Scott *et al*., 1996; Connor *et al*., 2000). Calves stay with their mothers for at least 4 years (Smolker *et al*., 1992), with studies in the Moray Firth indicating that the association between calves and mothers remains can last until the calf is 8 years old (Grellier *et al*., 2003).

Immature bottlenose dolphins (juveniles/calves) have been observed off Aberdeenshire throughout the year, with an increase in the proportion of calves during the spring, between April and June (Canning, 2007; Stockin *et al*., 2006; Weir and Stockin, 2001). Very young calves have been recorded during spring and early summer (Weir and Stockin, 2001).

In surveys along the outer Moray Firth (May to October, 2001-2005), calves were recorded in 84 % of all bottlenose dolphin encounters, with newborn animals being observed from July to October inclusive (Robinson *et al*., 2008).

5.1.8 Strandings

Two bottlenose dolphins have been recorded stranded by the Scottish Agricultural College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and March 2010 (CSIP, 2010). The first was a male with a body length of 267 cm, recovered in December 1999 near Balmedie. The second had a body length of approximately 200 cm, the sex was not determined and it was recovered from Peterhead in December 2005 (SAC, 2006). The low number of recorded standings likely reflects the relatively small bottlenose dolphin population associated with the area.

5.1.9 Threats

Post-mortem analyses of stranded animals have identified that some fishery by-catch occurs. In addition some calf mortality results from infanticide (Patterson *et al*., 1998).

Bottlenose dolphins from eastern Scotland have a higher prevalence of several different types of skin lesion (Thompson and Hammond, 1992; Wilson *et al*., 1997b). The causal links underlying these patterns remain unknown, but it is possible that they are related to an increase in physiological stress, potentially making the animals more prone to other factors, including anthropogenic agents such as contaminants (McKenzie *et al*., 1997) or infections from viruses, bacteria or fungi. Exposure to water of low salinity and temperature could also be a factor (Wilson *et al*., 1999b). Studies have shown that severity and prevalence of lesions vary among individuals in the Moray Firth and that these variations patterns can be related to the behaviour of infectious diseases (Wilson *et al*., 2000).

5.2 HARBOUR PORPOISE (*PHOCOENA PHOCOENA*)

5.2.1 Distribution

Harbour porpoises are found in the temperate and sub-arctic waters of the northern hemisphere, mainly on the continental shelves. They are distributed around the fringes of the North Atlantic Ocean basin, extending from North Carolina to Greenland and northern Norway and south through European waters as far as North Africa (Hammond *et al*., 2004).

The species is widespread throughout the cold and temperate seas of north-west Europe, including the North Sea, the Skagerrak, Kattegat, Irish Sea, west of Ireland and Scotland, northwards to Orkney and Shetland and off the coast of Norway (Jackson and McLeod, 2002). In the North Sea they are widely and almost continuously distributed, with important concentrations in the central North Sea and along the Danish and northern German coasts (Donovan and Bjørge, 1995; Hammond *et al.*, 2002; IWC, 1996). Harbour porpoises are highly mobile and distributed around the UK coast (Reid *et al*., 2003).

Figure 5-7 (taken from Hammond *et al*., 2004) shows the numerous locations of harbour porpoise sightings made during systematic surveys and some platforms of opportunity in the north and east of Scotland.

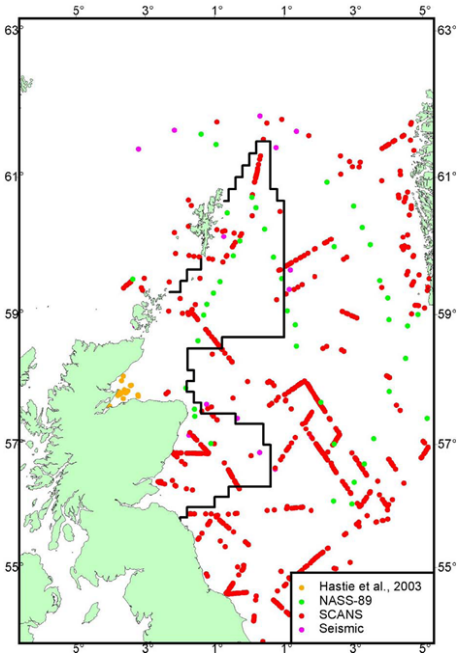


Figure 5-7 Harbour porpoise sightings made during various surveys. Sightings are represented by a coloured circle (Hammond *et al*., 2004 black line outlines SEA5 area).

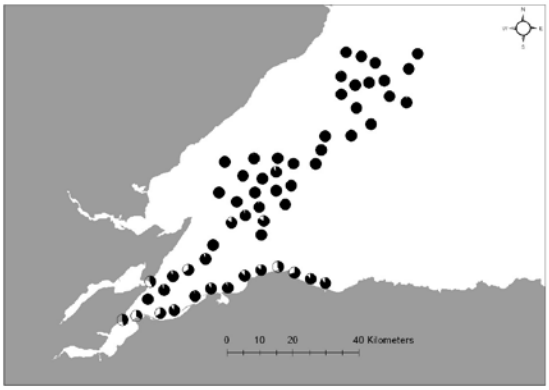
Harbour porpoises are generally described as a shelf species that frequents relatively shallow bays, estuaries and tidal channels, generally in depths less than 200 m in continental shelf waters (Klinowska, 1991). However, they have been observed in the deeper waters: for example in the Norwegian Rinne, in deep water areas between Iceland and the Faroe Islands, and on the Rockall and Faroe Banks (Northridge *et al.*, 1995). Summer surveys in the North Sea and adjacent waters found porpoises in large numbers offshore as well as in coastal waters (Hammond *et al.*, 2002). Porpoises have also been sighted in offshore waters with depths between 953 and 1502 m off north-west Scotland (Atlantic Frontier) (MacLeod *et al.*, 2003). By-catch data from Ireland also suggest that porpoises occur regularly offshore, with records of showing their presence upto 220 km from land (Rogan and Berrow, 1996). Aggregations of harbour porpoises are often associated with strong tidal features, such as headlands, and areas with upwellings, tidal races and rips, often close to reefs and small islands, where prey are likely to concentrated in patches (Gaskin, 1992; Pierpoint, 2001; Read and Westgate, 1997).

Spatial patterns of cetacean distribution within the Moray Firth were investigated using a combination of visual and passive acoustic boat-based line-transect surveys in the inner and outer Moray Firth during summers 2004 and 2005. These surveys indicate that harbour porpoises tended to have a diffuse and offshore distribution (Hastie *et al.*, 2003a; Lusseau *et al.*, 2005).

During systematic boat surveys conducted along the southern outer Moray Firth coastline between the ports of Lossiemouth and Fraserburgh from May to October 2001 to 2005, harbour porpoises were encountered throughout the study area, although they were usually more abundant in deeper waters, further from shore, with sightings typically occurring along the 20-50m isobaths. Porpoises were observed throughout the study period, with an increase in encounters from May through to October (Robinson *et al*., 2008).

During the Moray Firth surveys carried out during 2009 and 2010 as part of the research study to investigate potential impacts from oil and gas exploration on cetaceans, the harbour porpoise was the most frequently observed cetacean. The results of the acoustic monitoring, using C-pods in 2009 and 2010, found that harbour porpoises were typically detected at each of the monitoring locations on most days, especially at the offshore sites. Figure 5-8 shows the proportion of days that harbour porpoise were detected was very high across the majority of the sampling locations covered in the Moray Firth (Thompson *et al*., 2011). The acoustic survey was repeated the following year, with the spatial occurrences of harbour porpoise during 2009 and 2010 being comparable.

The harbour porpoise was the most frequent cetacean detected during the aerial survey programme as part of the Thompson *et al*., (2011) study, a total of 230 encounters of harbour porpoise were encountered with the mean group size being 1.52 (Thompson *et al*., 2011).



*The pie chart in the figure above illustrates the location of the hydrophone and also the proportion of time where acoustic detections were received in relation to the deployment period.

Figure 5-8* Proportion of days that harbour porpoise were detected by C-pods during 2010 (Thompson *et al*., 2011).

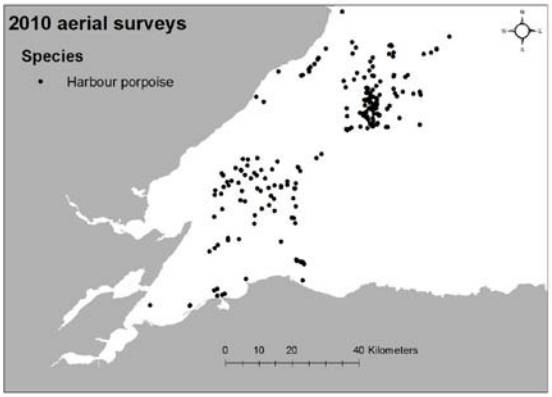


Figure 5-9 Observations of harbour porpoise during aerial surveys carried out in 2010 (Thompson *et al*., 2011).

The seasonal movements and migratory patterns of harbour porpoises in the North East Atlantic and North Sea are not well understood. Porpoises may reside within an area for an extended period of time, however, onshore/offshore migrations and movements parallel to the shore are

also thought to occur (Bjørge and Tolley, 2002). In the North Sea, there may be a general westward movement from the eastern North Sea and possibly from the very northern areas of the North Sea into the western edge of the northern North Sea (along the east coast of Scotland) during April to June and a further influx to the northern North Sea during July to September (Northridge *et al.*, 1995). These seasonal movements are thought to coincide with the calving and mating seasons, respectively.

Animals in the eastern North Atlantic are not known to perform long migrations, but satellite-tagged animals in Canada and Denmark have been shown to move some hundreds of kilometres within a year. Satellite-tracking data from Denmark have shown animals moving from northern Denmark to the northern North Sea and Shetland (Hammond *et al*., 2004). While studies in the Bay of Fundy have demonstrated harbour porpoises travelling distances varying from 14 to 58 km per day (Read and Westgate, 1997).

5.2.2 Abundance

The harbour porpoise is the most abundant cetacean recorded in the North Sea (Evans, 1992; Hammond *et al.*, 2002) and was the most commonly sighted cetacean during surveys along the southern outer Moray Firth coastline and the second most frequently sighted cetacean along the south Grampian coastline (Weir and Stockin, 2001).

The estimated summer abundance of harbour porpoises in North Sea areas during the first SCANS (Small Cetaceans In the North Sea) survey in July 1994 was 268,452 (approximate 95% confidence interval of 210,000 – 340,000). This estimate includes shelf waters to the west of Shetland and Orkney (Hammond *et al.,* 2002). Bjørge and Øien (1995) estimated that there were 82,600 porpoises in the North Sea north of 56^{o}N. This estimate is known to be biased downwards because the probability of detection on the transect line was assumed to be one (certain detection). Seabirds At Sea data from 1979 to 1991 show the highest rate of porpoise sightings in the northern North Sea is in April to June (the calving season), and July to September (Hammond *et al*., 2004).

Initial harbour porpoise abundance estimates in the entire North Sea are 231,000 from the SCANS II surveys conducted July 2005. The total abundance of harbour porpoises for the entire SCANS II survey area is estimated to be 385,616 (CV=0.20) (SCANS II, 2008). During the SCANS II surveys harbour porpoise density was highest in the south central North Sea and coastal waters of northwest Denmark (~0.6 animals/km^2), elsewhere there was relatively little variation in porpoise density (0.3-0.4 animals/km^2) (SCANS II, 2008).

Numbers of porpoises present in UK waters vary seasonally and more animals are likely to pass through UK waters than are present at any one time (Jackson and McLeod, 2002).

5.2.3 Occurrence in Aberdeen Bay and surrounding area

Harbour porpoises are known to occur regularly in the Aberdeen Bay area throughout the year. Land and vessel based sightings between March 1999 and October 2001, along the Aberdeenshire coast (between St Cyrus and Collieston, indicated that harbour porpoises were present throughout the year with peak occurrence during August and September (Weir *et al*., 2007).

Land based surveys carried out by the Seawatch Foundation indicated that porpoises were sighted more frequently between Aberdeen and Stonehaven to the south, than between

Aberdeen and Collieston to the north, with the majority of sightings occurring off Cove and Girdleness to the south of Aberdeen (Weir *et al*., 2007). Tidal height and sea depth appears to have a strong influence on where and when porpoises are sighted and it is thought this is a reflection of prey behaviour (Canning, 2007).

Harbour porpoise sightings were frequently recorded during vantage point surveys of the wind farm area between August 2005 – March 2008 and the sightings are summarised in Table 5-4.

Table 5-4 Harbour porpoise sightings recorded during AOWFL Vantage Point surveys (August 2005 – March 2008).

VP site	Observations
Donmouth	August 2006, September 2006, February 2007, September 2007, December 2007 and January 2008
Blackdog	May 2006, August 2006, September 2006, January 2007, February 2007, July 2007, August 2007 and September 2007,
Balmedie	September 2006, December 2006, January 2007, August 2007 and March 2008
Drums	December 2006, January 2007, February 2007, June 2007, August 2007, December 2007 and February 2008

During the JNCC aerial survey of Aberdeen Bay, harbour porpoises were recorded in December 2005 and January 2006 (Söhle *et al*., 2006).

Harbour porpoises were the most recorded cetacean species over 100 days of surveys conducted from the bridge of the *MV Hascosay* ferry as it travelled between Aberdeen, Orkney and Shetland in summer months between 2002 and 2006 (MacLeod *et al*., 2007). Porpoises were recorded throughout the region and in all months surveyed with no obvious changes in distribution over time (Figure 5-10). Recorded group sizes ranged from one to six, with an average of two. There was no variation in average group size across the summer months, but the maximum group size peaked in August and was lowest in April and September (MacLeod *et al*., 2007).

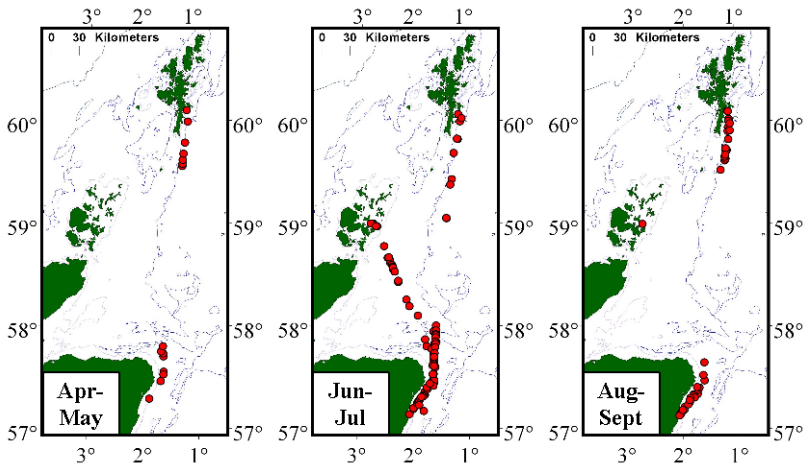


Figure 5-10 Distribution of harbour porpoise sightings during ferry surveys (April-September, 2002-2006).

5.2.4 Boat based survey results: Harbour porpoise

The harbour porpoise was the only species detected in sufficient numbers to allow a detection function to be applied. The detection function was applied to both phases of boat based surveying, the initial survey period 2007-2008 and the 12 months of survey carried out 2010-2011. The results of each phase of boat based surveys are discussed in the following sections.

5.2.4.1 Harbour porpoise AOWFL 2007-2008 survey results

There were 197 observations of 291 individuals recorded both on and off effort during the boat based surveys carried out during 2007-2008. The distribution of all observations recorded, including those off effort are displayed in Figure 5-11.

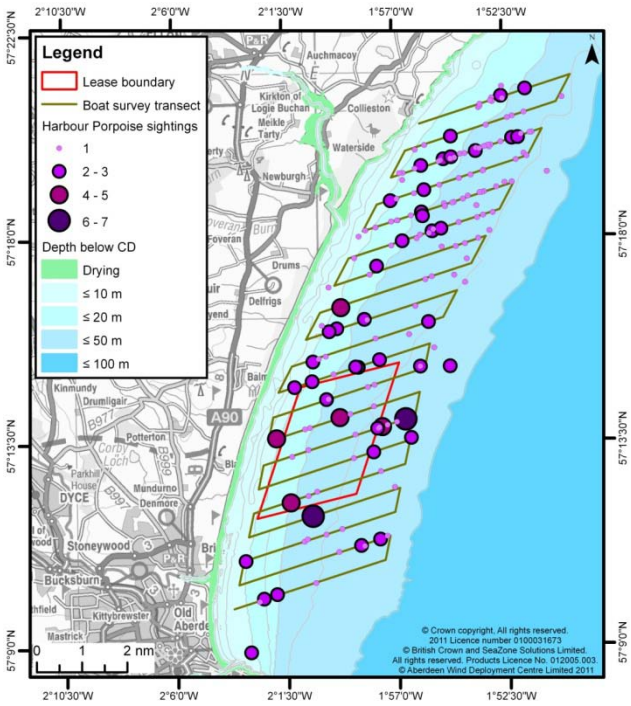


Figure 5-11 Harbour porpoise individuals recorded on and off effort during EOWDC boat surveys 2007-2008.

5.2.4.2 Estimation of harbour porpoise density during EOWDC 2007-2008 surveys using Multi-Covariate Distance Sampling (MCDS)

There were 175 observations of 251 individuals recorded during 1,950 km of survey effort. Only on transect effort was used in the analysis (i.e. short transit legs between transects were discarded).

The radial distance and angles recorded to each sighting were converted to perpendicular distances and examined as a histogram (Figure 5-12).The histogram shows that there was a peak in sightings within 100 m of the transect. The data are spiked at the transect line which means that there are more sightings than would be expected on the transect line. To fit the detection function, the perpendicular distance was grouped with a wide first perpendicular distance bin, extending from the transect line to 200 m. This was done to 'force' Distance to fit a shoulder near the transect line distances rather than the reality, which is a spike. The data were also right truncated at 800 m (n = 167).

The best model of the detection function was a simple Hazard-rate without adjustment terms (p = 0.68) (Figure 5-13). The *esw* was 355 m (%CV = 9.7).

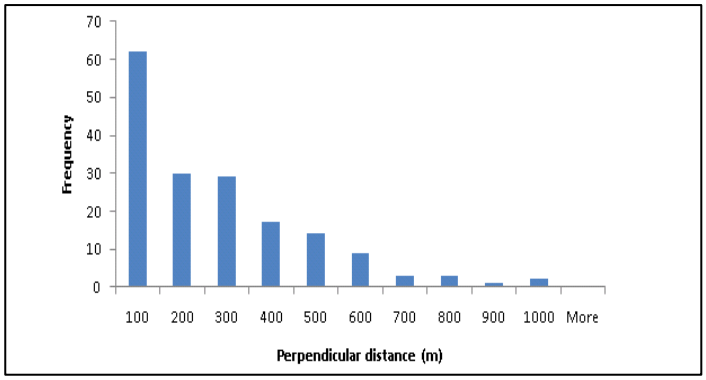


Figure 5-12 Histogram of the perpendicular distances associated with the harbour porpoise sightings 2007-2008 data.

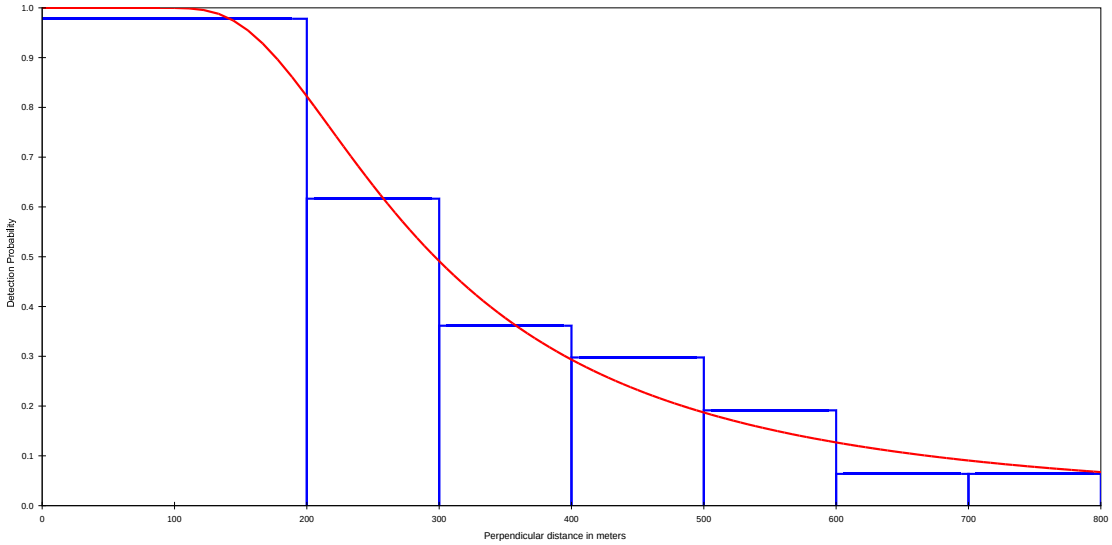


Figure 5-13 Detection probability fitted to perpendicular distances of harbour porpoise sightings February 2007-April 2008.

The pooled detection function was then applied to the estimation of density and abundance by month and season. Multiple surveys within the same month were pooled to generate the density and abundance estimates. The mean group size was 1.42 (SE=0.07)). Density and abundance estimates by area/season and area/month are given in Table 5-5 and Table 5-6. The probability of detecting an animal on the transect line, g(0), is normally assumed to be 1 which would be for a certain detection, but for marine mammals, which spend a proportion of the time below the surface, this assumption is not generally valid. The density estimates for harbour porpoise assume a g(0) value of 1, and are therefore expected to result in an underestimation. The effect of varying g(0) is discussed further in Appendix 1.

The density of harbour porpoise was higher in the control area in all seasons except summer (Table 5-6). The highest densities at both sites occurred during autumn (September-November). Lowest densities of harbour porpoises occurred during May and June at both the

wind farm and control site. Peak densities were recorded during November at the wind farm site but during October and January at the control site (Figure 5-14).

Table 5-5 Density and abundance of harbour porpoises by month and area estimated from year 1 survey data (February 2007 – April 2008, where n= number of sightings, DS = density of schools, D = density of animals and N = abundance. CV is the coefficient of variation and CI is the confidence interval.

	CONTROL AREA				WIND FARM AREA				Area with highest animal density
Month	***n***	***DS (CV)***	***D (CV)***	***N (CV) [95% CI]***	***n***	***DS (CV)***	***D (CV)***	***N (CV) [95% CI]***	
January	29	0.6 (26.4)	0.92 (26.9)	47 (26.9) [27-83]	0	0	0	0	CONTROL
February	10	0.10 (39.1)	0.14 (39.4)	7 (39.4) [3-16]	11	0.12 (35.1)	0.18 (35.4)	9 (35.4) [4-18]	WIND FARM
March	7	0.16 (44.1)	0.22 (44.3)	11 (44.3) [4-29]	1	0.02 (100.5)	0.03 (100.6)	2 (100.6) [0-10]	CONTROL
April	14	0.10 (86.4)	0.14 (86.6)	7 (86.6) [2-33]	1	0.007 (100.5)	0.01 (100.6)	1 (100.6) [0-3]	CONTROL
May	0	0	0	0	0	0	0	0	-
June	1	0.02 (100.5)	0.03 (100.6)	2 (100.6) [0-11]	0	0	0	0	CONTROL
July	6	0.16 (57.5)	0.22 (57.7)	11 (57.7) [3-38]	8	0.18 (27.0)	0.26 (27.4)	13 (27.4) [7-23]	WIND FARM
August	5	0.10 (36.11)	0.15 (36.4)	7 (36.4) [3-16]	7	0.16 (32.1)	0.22 (32.5)	11 (32.5) [6-23]	WIND FARM
September	16	0.33 (38.9)	0.46 (39.1)	24 (39.1) [10-54]	7	0.14 (33.5)	0.20 (33.9)	10 (33.9) [5-21]	CONTROL
October	25	0.56 (26.8)	0.80 (27.2)	40 (27.2) [23-72]	6	0.12 (39.4)	0.17 (39.7)	9 (39.7) [4-20]	CONTROL
November	4	0.09 (77.1)	0.13 (77.2)	6 (77.2) [1-30]	9	0.20 (43.8)	0.29 (43.6)	15 (43.6) [6-37]	WIND FARM
December	4	0.09 (77.1)	0.13 (77.2)	6 (77.2) [1-30]	1	0.02 (100.5)	0.03 (100.6)	2 (100.6) [0-10]	CONTROL

Table 5-6 Density and abundance of harbour porpoises by season and area estimated from year 1 survey data (February 2007 – April 2008), where n= number of sightings, DS = density of schools, D = density of animals and N = abundance, CV is the coefficient of variation and CI is the confidence interval.

	CONTROL AREA				WIND FARM AREA				Area with highest animal density
Season	***n***	***DS (%CV)***	***D (%CV)***	***N (%CV) [95% CI]***	***n***	***DS (%CV)***	***D (%CV)***	***N (%CV) [95% CI]***	
Winter	42	0.24 (27)	0.34 (27.7)	17 (27.7) [10-29]	12	0.07 (35.7)	0.10 (36.0)	5 (36.0) [2-10]	CONTROL
Spring	21	0.09 (59.9)	0.13 (60.1)	6 (60.1) [2-20]	2	0.009 (70.7)	0.01 (70.9)	1 (70.9) [0-2]	CONTROL
Summer	13	0.09 (36.0)	0.13 (36.4)	7 (36.4) [3-14]	15	0.11 (25.36)	0.15 (25.8)	8 (25.8) [5-13]	WIND FARM
Autumn	45	0.35 (24.5)	0.46 (25.0)	24 (25.0) [14-39]	22	0.16 (24.1)	0.23 (24.6)	11 (24.6) [7-19]	CONTROL

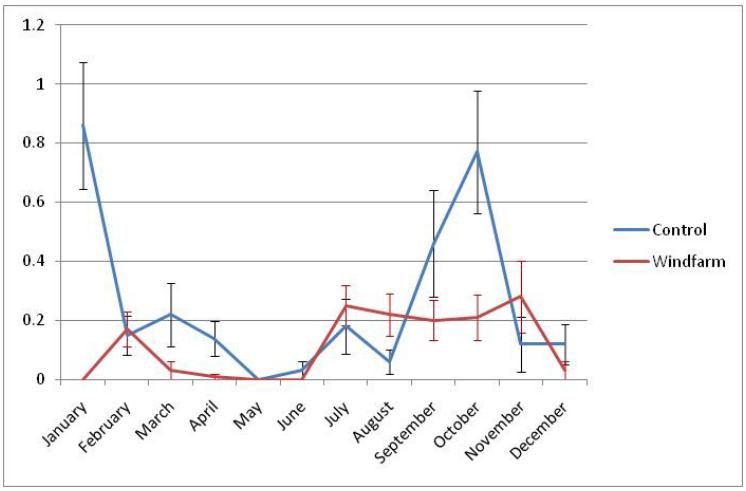


Figure 5-14 Monthly patterns in harbour porpoise density at the wind farm and control site (vertical bars represent +/- standard error)

5.2.4.3 Harbour porpoise: EOWDC 2010-2011 surveys

A total of 215 sightings consisting of a total 404 individuals were recorded during the 12 EOWDC surveys carried out during 2010-2011 (Figure 5-15). Groups of harbour porpoise ranged from 1-9 individuals, while the mean group size was 1.8 individuals (Figure 5-16) and individual animals were most commonly recorded. Harbour porpoise sightings were concentrated primarily in the northern stratum. In the seasonal surveys the dominance of sightings in the northern transects was most notable in winter (Figure 5-17) and autumn (Figure 5-20), although this was less pronounced in summer (Figure 5-19) with sightings being evenly spread amongst the southern and northern transects. In spring (Figure 5-18) individuals were recorded evenly throughout all three survey areas although this season corresponded with the lowest number of individuals recorded.

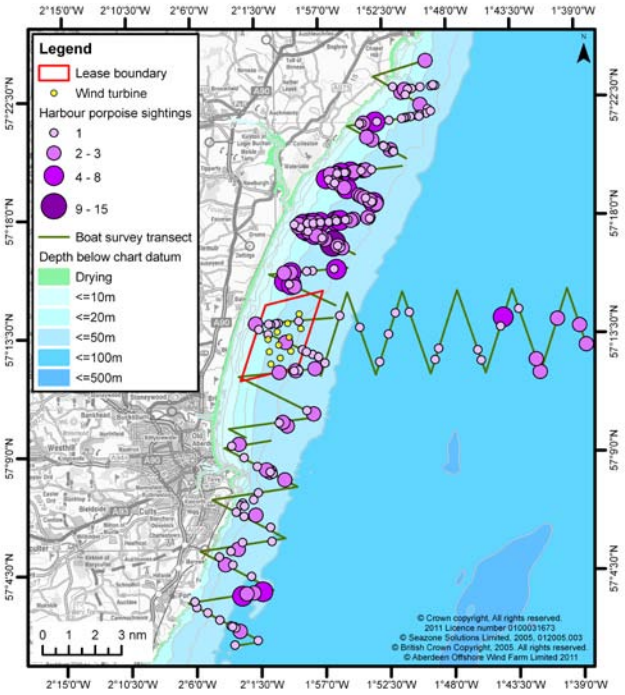


Figure 5-15 All Harbour porpoise individuals recorded on-effort during the 12 months of EOWDC surveys 2010-2011.

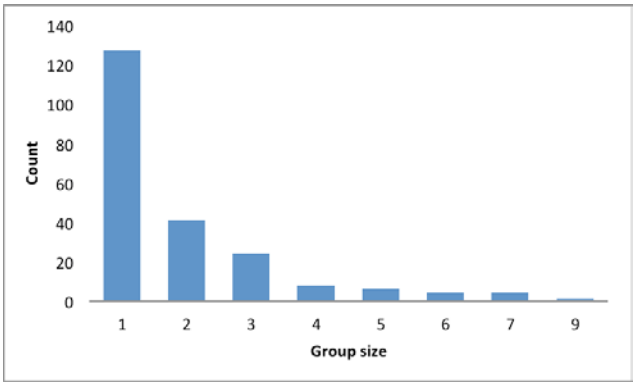


Figure 5-16 Group size of harbour porpoises seen during the 12 months of EOWDC surveys 2010-2011.

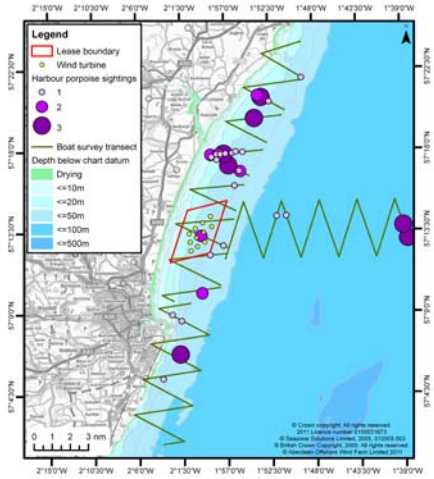


Figure 5-17 Harbour porpoise individuals recorded on-effort during winter in the 12 months of EOWDC surveys 2010-2011.

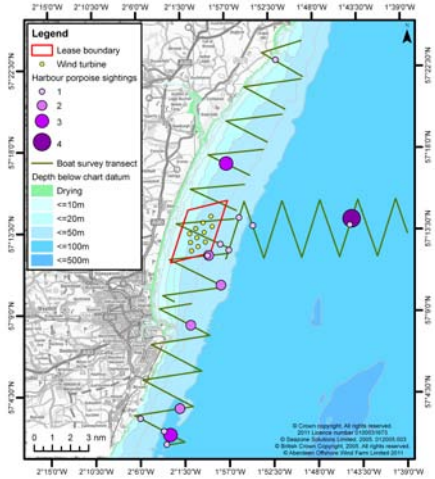


Figure 5-18 Harbour porpoise individuals recorded on-effort during spring in the 12 months of EOWDC surveys 2010-2011.

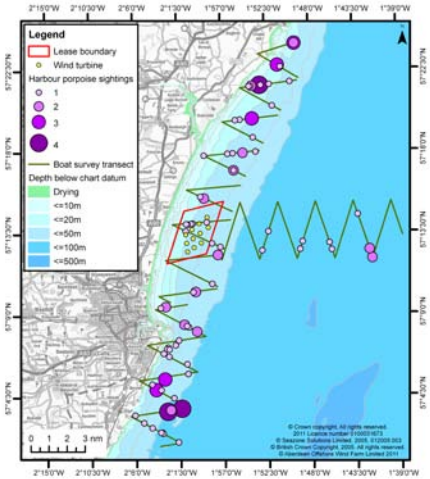


Figure 5-19 Harbour porpoise individuals recorded on-effort during summer in the 12 months of EOWDC surveys 2010-2011.

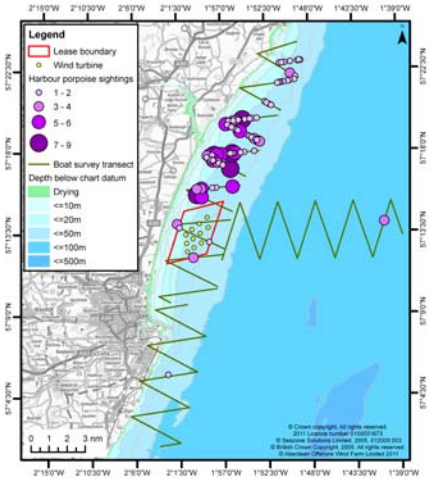


Figure 5-20 Harbour porpoise individuals recorded on-effort during autumn in the 12 months of EOWDC surveys 2010-2011.

Table 5-7 Summary of dedicated sightings and individual of harbour porpoises. Table also Includes unidentified porpoises (presumed to be harbour porpoises) in EOWDC surveys 2010 - 2011.

Year		Stratum	Harbour porpoise Observations	Harbour porpoise individuals	Unidentified porpoise Observations	Unidentified porpoise Individuals
2010	August	North	3	3	0	0
		Offshore	7	9	0	0
		South	13	21	1	1
		Total	23	33	1	1
	September	North	22	84	0	0
		Offshore	1	3	0	0
		South	0	0	0	0
		Total	23	87	0	0
	November	North	62	125	0	0
		Offshore	0	0	0	0
		South	1	1	0	0
		Total	63	126	0	0
2011	January	North	19	28	0	0
		Offshore	2	2	1	1
		South	0	0	0	0
		Total	21	30	1	1
	February	North	7	12	0	0
		Offshore	2	6	0	0
		South	4	6	0	0
		Total	13	24	0	0
	March	North	3	4	0	0
		Offshore	5	8	0	0
		South	3	5	0	0
		Total	11	17	0	0
	April	North	3	6	0	0
		Offshore	0	0	0	0
		South	3	5	0	0
		Total	6	11	0	0
	June _01	North	6	6	0	0
		Offshore	0	0	0	0
		South	2	2	0	0
		Total	8	8	0	0
	June_02	North	2	2	0	0
		Offshore	1	1	0	0
		South	3	3	0	0
		Total	6	6	0	0
	July_01	North	15	21	0	0
		Offshore	1	1	0	0
		South	2	3	0	0
		Total	18	25	0	0
	July_02	North	2	3	0	0
		Offshore	0	0	0	0
		South	6	9	0	0
		Total	8	12	0	0
	August	North	13	23	0	0
		Offshore	0	0	0	0
		South	2	2	0	0
		Total	15	25	0	0
Total			**215**	**404**	**2**	**2**

5.2.4.3.1 Harbour porpoise density and abundance estimates from EOWDC 2010-2011 surveys using Multi-Covariate Distance Sampling

The only cetacean with sufficient observations to allow density estimates to be calculated was the harbour porpoise, and this was done according to the method described in Section 3.1 . All observations (Table 5-7) were pooled to fit a single global detection function. However, observations were truncated at 600 m to avoid a long tail in the detection function, resulting in 9 % of observations being excluded from the analysis. A hazard rate model with no additional covariates was selected and the effective strip width was 206 m (CV=11%). This detection function was used to estimate density and abundance for each season and survey area (Figure 5-21,Figure 5-22, Table 5-8 and Table 5-9). The data from multiple surveys within a month were pooled to obtain average monthly estimates and data within seasons were pooled to obtain average seasonal estimates. The mean group size was 1.83 animals (Figure 5-16) (CV=5.38%) and the size-bias regression estimate was 1.63 (CV=4.4%). The latter was used to convert estimates of groups of harbour porpoise to estimates of individual animals.

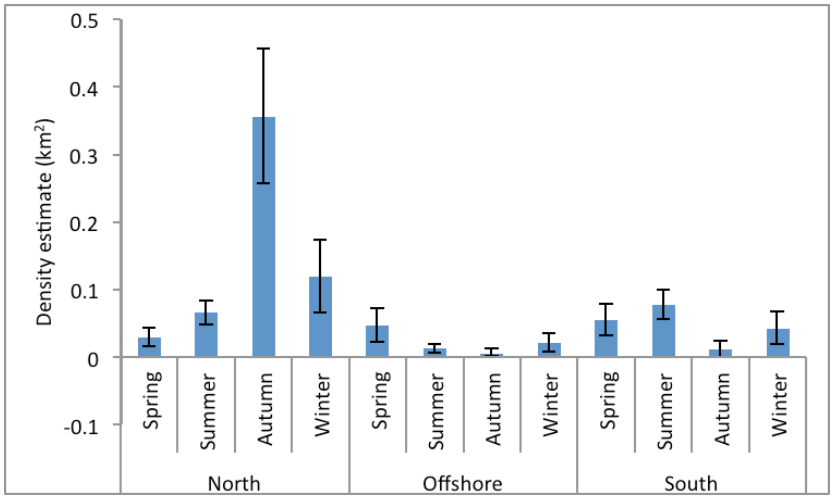


Figure 5-21 Density estimates (individuals/km^2) ± CV for harbour porpoise in each study strata and in each season. Note: g(0) was assumed to be 1 in generating these estimates. This is likely to be an overestimation of g(0) and so estimates are likely to be underestimates.

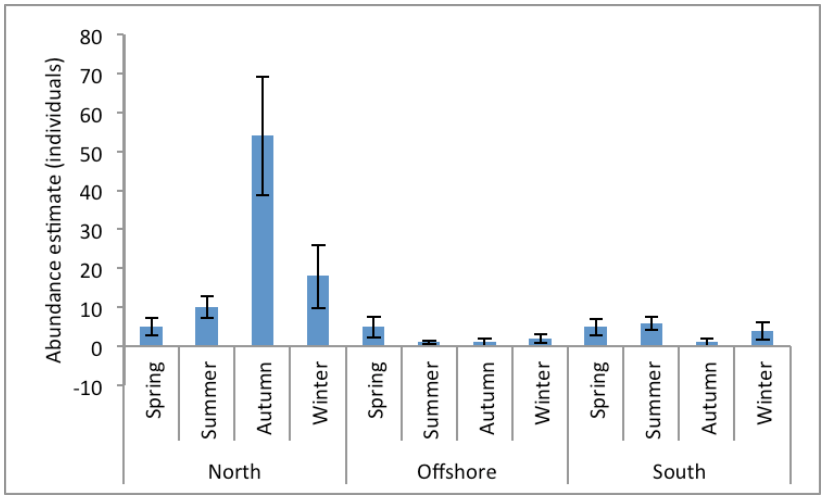


Figure 5-22 Abundance estimates ± CV for harbour porpoise in each study strata and in each season. Note: g(0) was assumed to be 1 in generating these estimates. This is likely to be an overestimation of g(0) and so estimates are likely to be underestimates.

Table 5-8 Harbour porpoise density and abundance estimates per study strata and per season where n is the number of sightings (truncated at a perpendicular distance of 600 m), DS = density of schools, D = density of animals and N= abundance. The 95 % CI are log-normal CI for N and the numbers in parentheses are CVs expressed as a percentage. Note: g(0) was assumed to be 1 in generating these estimates.

Season	Block	Sightings	D_s (groups/km^2)	Density (animals/km^2)	(N) Abundance	95% CI
Winter	N	25	0.073 (45)	0.119 (45)	18 (45)	8 – 43
	O	4	0.013 (61)	0.022 (61)	2 (61)	1 – 7
	S	4	0.027 (56)	0.043 (56)	4 (56)	1 – 11
Spring	N	6	0.018 (46)	0.030 (46)	5 (46)	2 – 11
	O	5	0.029 (54)	0.047 (54)	5 (54)	2 – 16
	S	6	0.034 (43)	0.055 (43)	5 (43)	2 – 11
Summer	N	41	0.040 (27)	0.066 (28)	10 (28)	6 – 17
	O	8	0.008 (47)	0.013 (47)	1 (47)	1 – 3
	S	24	0.048 (28)	0.078 (28)	6 (28)	4 – 11

Table 5-9 Harbour porpoise density and abundance estimates per study strata and per season where n is the number of sightings (truncated at a perpendicular distance of 600 m), DS = density of schools, D = density of animals and N = abundance. The 95 % CI are log-normal CI for N and the numbers in parentheses are CVs expressed as a percentage. Note: g(0) was assumed to be 1 in generating these estimates.

Strata	Month	n	D_s (groups/km^2)	D (animals/km^2)	(N) Abundance	95% CI
North	January	18	0.105 (58)	0.172 (58)	26 (58)	8-81
	February	17	0.040 (52)	0.066 (52)	10 (52)	4-28
	March	3	0.016 (73)	0.027 (73)	4 (73)	1-16
	April	3	0.021 (56)	0.035 (56)	5 (56)	2-16
	June	10	0.029 (55)	0.047 (55)	7 (55)	2-10
	July	16	0.047 (36)	0.077 (48)	12 (36)	6-23
	August	15	0.046 (47)	0.075 (47)	11 (47)	5-28
	September	17	0.100 (48)	0.163 (48)	25 (48)	9-65
	November	58	0.333 (31)	0.545 (31)	82 (31)	43-156
Offshore	January	2	0.014 (66)	0.023 (66)	2 (66)	1-9
	February	2	0.012 (105)	0.020 (105)	2 (105)	0-15
	March	5	0.029 (54)	0.047 (54)	5 (54)	2-16
	June	0	0	0	0	0
	July	1	0.003 (100)	0.005 (100)	0 (100)	0-3
	August	7	0.020 (49)	0.033 (49)	3 (49)	1-9
	September	1	0.007 (99)	0.011 (99)	1 (99)	0-8
	November	0	0	0	0	0
South	January	0	0	0	0	0
	February	4	0.045 (52)	0.074 (52)	6 (52)	2-18
	March	3	0.034 (75)	0.055 (75)	5 (75)	1-21
	April	3	0.034 (43)	0.056 (43)	5 (43)	2-12
	June	2	0.012 (100)	0.019 (100)	2 (100)	0-9
	July	7	0.040 (43)	0.066 (43)	5 (43)	2-13
	August	**15**	0.092 (34)	0.150 (34)	12 (34)	6-25
	September	**0**	0	0	0	0
	November	**1**	0.016 (100)	0.025 (100)	2 (100)	0-15

5.2.4.3.2 Harbour porpoise abundance estimates from EOWDC 2010-2011 surveys using Density Surface Modelling

The Density Surface Modelling (DSM) techniques described in Section 3.1.1 were used to produce abundance estimates for the survey areas and seasons (Table 5-10 and Figure 5-23-Figure 5-30). These estimates were calculated assuming that g(0)=1 and as discussed in Section 3.1.1 this is not valid, with the true g(0) value likely to be closer to the estimate for the area of 0.34 produced during the SCANSII surveys. The potential impact of this would be to increase abundance estimates approximately three-fold.

In many cases, DSM and MCDS estimates for season/stratum lie within one another's Confidence Intervals, with a few notable exceptions such as for North and autumn, but note the large CV values for the DSM estimates. Where discrepancies in abundance occur, there are several possible contributing factors, including increased error (when looking at this spatial scale) for the DSM estimates which have involved an additional level of modelling. In contrast, DSM estimates are likely to be more robust to the influence of outlier observations, such as a dense cluster of observations, or an unusually large group. It is also possible that with the available set of covariates, DSM GAMs remained under-parameterised, with potentially key environmental influences, such as local currents or localised fish movements/availability remaining outwith the scope of any but the most intensive research. The predominance of observations in the North survey area will have introduced errors in the South and Offshore areas due to estimating outside of the observed range. While these seasonal/stratum estimates are provided for reference, it is worth noting that DSM estimates are designed to allow estimation at small scales where as the MCDS estimates were modelled for the season/stratum scale, and thus a direct comparison is not necessarily informative.

Table 5-10: Harbour porpoise DSM seasonal estimates for each survey block (with estimates from MCDS also reproduced from above for comparison). The 95% CI are log-normal CI for N and the numbers in parentheses are CVs expressed as a percentage. Both estimates assume g(0) =1.

		Density Surface Model		Multi Covariate Distance Sampling	
Strata	**Season**	**N**	**95% CI**	**N**	**95% CI**
North	**Spring**	11 (94)	3-37	5 (46)	2-11
	Summer	5 (98)	2-19	10 (28)	6-17
	Autumn	7 (105)	2-28	54 (28)	31-94
	Winter	8 (152)	2-27	18 (45)	8-43
Offshore	**Spring**	2 (89)	0-9	5 (54)	2-16
	Summer	3 (108)	1-12	1 (47)	1-3
	Autumn	11 (106)	4-33	1 (100)	0-3
	Winter	1 (141)	0-4	2 (61)	1-7
South	**Spring**	3 (116)	1-9	5 (43)	2-11
	Summer	67 (110)	16-	6 (28)	4-11
	Autumn	3 (111)	1-12	1 (101)	0-6
	Winter	9 (128)	2-34	4 (56)	1-11

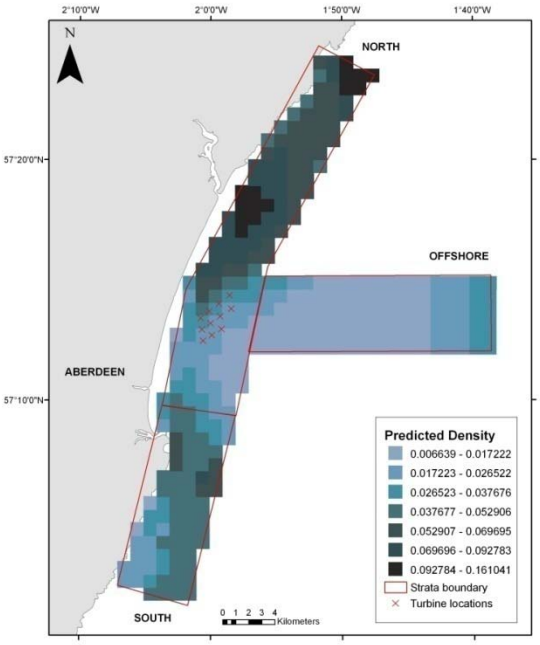


Figure 5-23 Density Surface Model results for harbour porpoise during Spring based on analysis of data from September 2010 to August 2011. Note: g(0) was assumed to be 1 in generating these estimates.

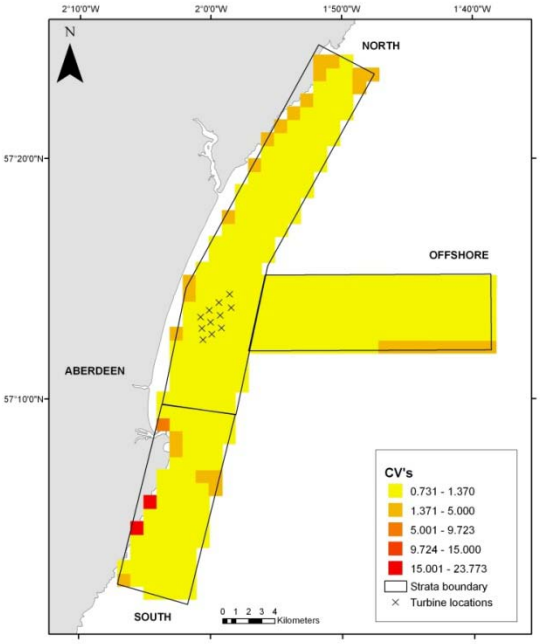


Figure 5-24 Density Surface Model CV values for harbour porpoise during Spring based on analysis of data from September 2010 to August 2011.

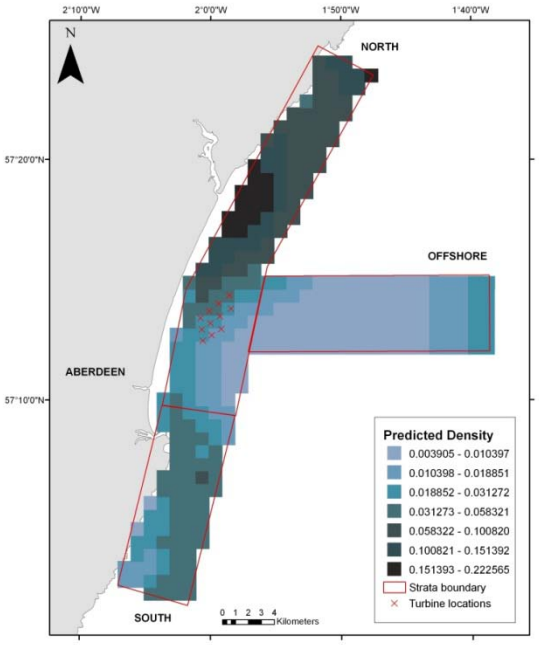


Figure 5-25 Density Surface Model results for harbour porpoise during Summer based on analysis of data from September 2010 to August 2011. Note: g(0) was assumed to be 1 in generating these estimates.

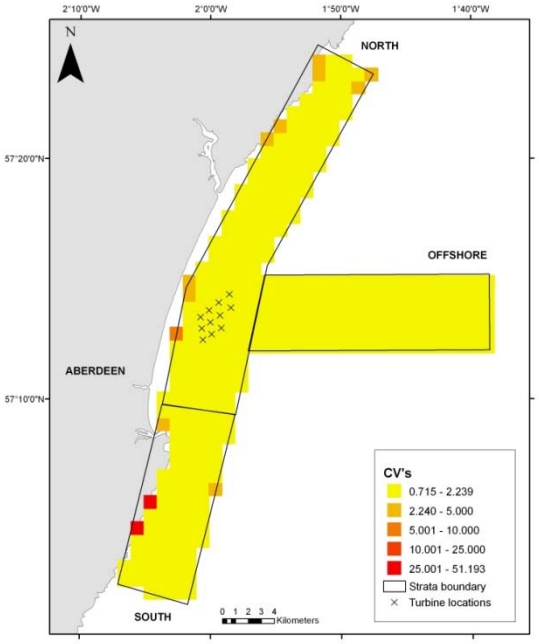


Figure 5-26 Density Surface Model CV values for harbour porpoise during Summer based on analysis of data from September 2010 to August 2011.

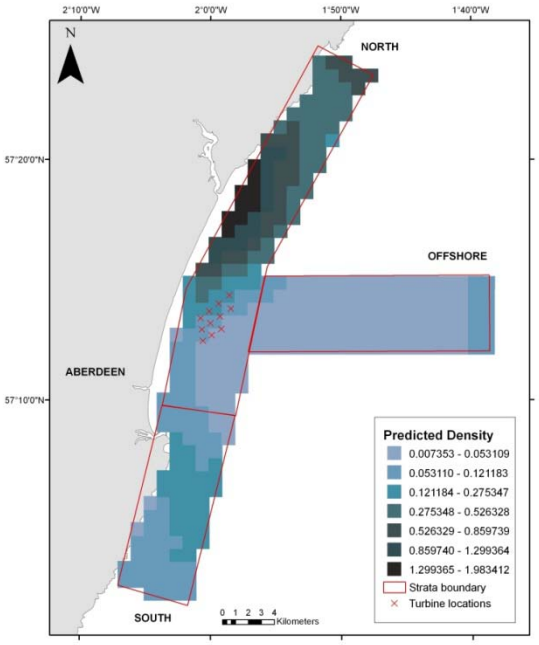


Figure 5-27 Density Surface Model results for harbour porpoise during Autumn based on analysis of data from September 2010 to August 2011. Note: g(0) was assumed to be 1 in generating these estimates.

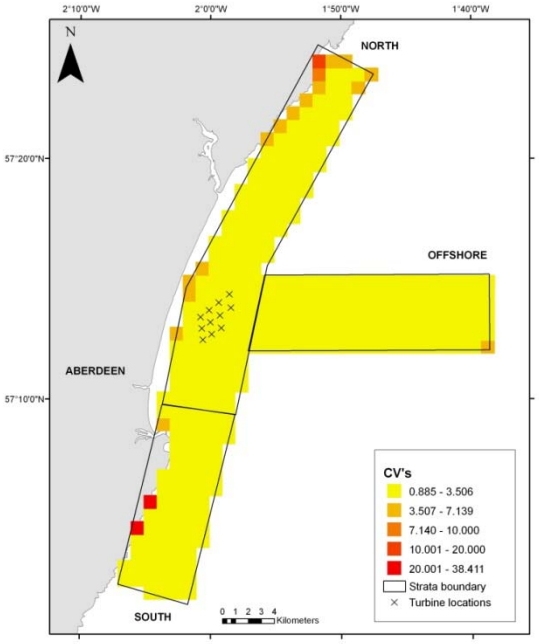


Figure 5-28 Density Surface Model CV values for harbour porpoise during Autumn based on analysis of data from September 2010 to August 2011.

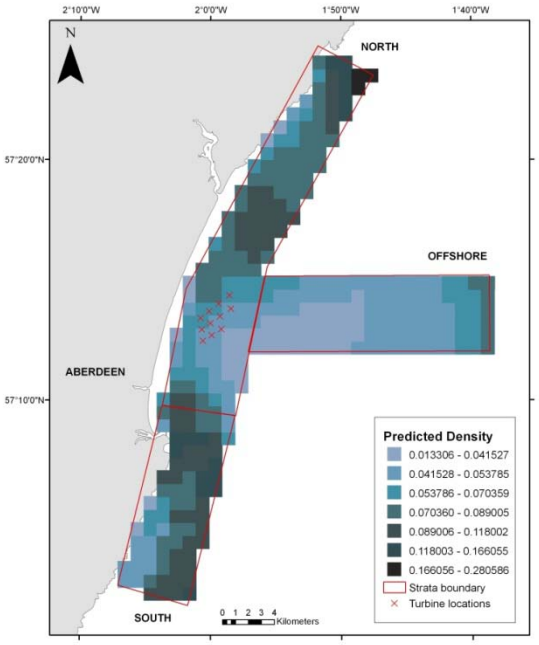


Figure 5-29 Density Surface Model results for harbour porpoise during Winter based on analysis of data from September 2010 to August 2011. Note: g(0) was assumed to be 1 in generating these estimates.

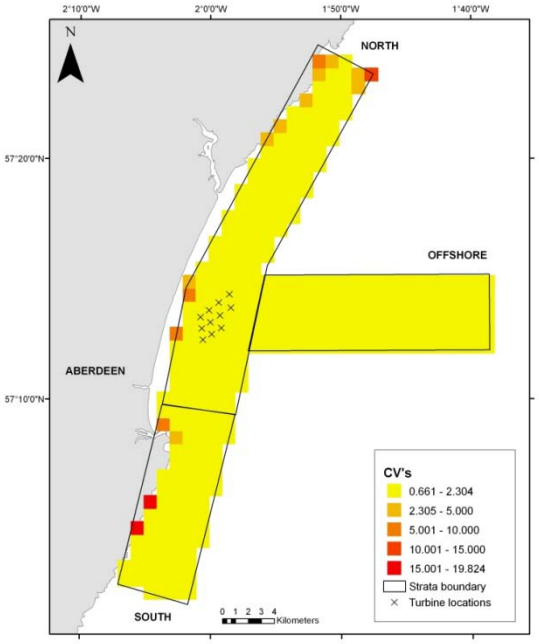


Figure 5-30 Density Surface Model CV values for harbour porpoise during Winter based on analysis of data from September 2010 to August 2011.

5.2.4.4 Using Density Surface Models to provide comparable porpoise estimates for prior EOWDC surveys

The creation of modelled density surfaces made it possible to extract density estimates for geographic areas matched to survey areas covered in surveys carried out prior to EOWDC 2010-2011 surveys. Prior surveys carried out by IECS (EOWDC 2007-2008) covered two roughly equal and adjacent areas covering the windfarm and buffer area ('Windfarm'), and an area to the North intended to act as a control ('Control'). GIS layers of these two areas were overlaid with density surface models outlined above, and average density estimates and variance estimates were extracted for each area (EOWDC 2010-2011). These data are presented below (Table 5-11) against seasonal estimates per area obtained from Distance sampling, as presented in SMRU Ltd (2011b).

Considerable differences in estimated density are apparent between the two years. However, as discussed in Section 5.2.4.3.2 the DSM did not perform as well as anticipated, resulting in the high CV values for the Year 2 density estimates from the Wind Farm and Control areas. There is also likely to be underlying inter-annual variation in harbour porpoise.

Table 5-11 Estimated density of harbour porpoise for two study areas used in EOWDC 2007-2008, and in each season. EOWDC 2007-2008 data are density estimates obtained from Distance sampling, where-as EOWDC 2010-2011 data are extracted from Density Surface Models. Note: g(0) was assumed to be 1 in generating these estimates.

Season	Survey Area	EOWDC 2007-2008	EOWDC 2010-2011
Spring	**Wind farm**	0.01 (71)	0.06 (87)
	Control	0.13 (60)	0.08 (94)
Summer	**Wind farm**	0.15 (26)	0.03 (97)
	Control	0.13 (36)	0.08 (94)
Autumn	**Wind farm**	0.23 (25)	0.03 (111)
	Control	0.46 (25)	0.13 (92)
Winter	**Wind farm**	0.10 (36)	0.10 (147)
	Control	0.34 (30)	0.95 (158)

5.2.5 Acoustic results: Harbour porpoise

5.2.5.1 Towed Passive Acoustic Monitoring (PAM) results for EOWDC 2007-2008 surveys

The harbour porpoise was the most frequently detected marine mammal species during the acoustic surveys. Only the dedicated acoustic effort was used to assess the acoustic detection rates of marine mammals across both the wind farm area and the control area. Both on-effort detections and off-effort opportunistic detections are shown in Figure 5-31.

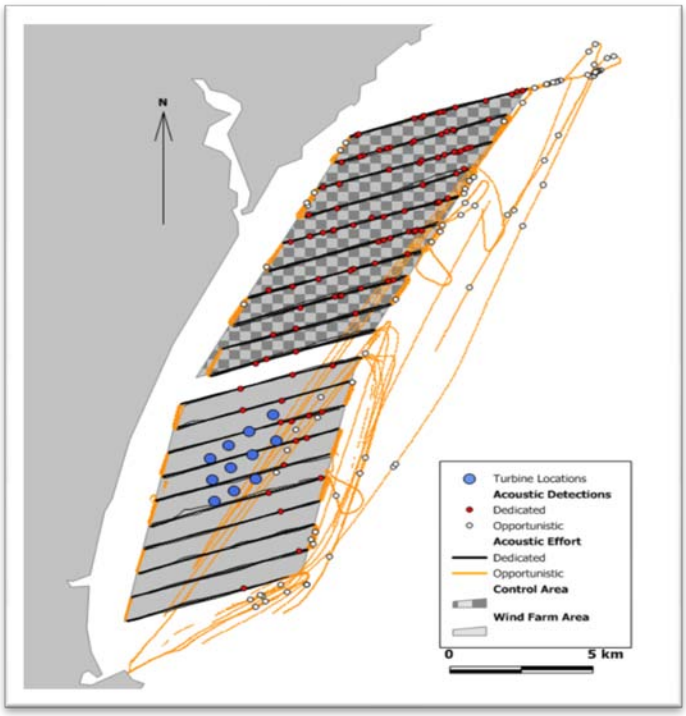


Figure 5-31 Combined acoustic effort from October 2007 to April 2008 across both the control and wind farm areas. Yellow lines show the opportunistic acoustic effort. Dedicated acoustic effort is shown by the black lines.

Harbour porpoises were detected in all seven surveys in which the hydrophone was deployed (Table 5-12). Combined detection rates ranged from 0.03 detections per km of dedicated effort, (early April survey, 2008) to 0.22 detections per km of dedicated effort (November survey, 2007). Detection rates were much lower in both of the April surveys than in any of the preceding five surveys.

Table 5-12 Number of porpoise detections and detection rate (detection/km) for each of the 7 surveys for which acoustic data were collected

Month of survey	Number of detections	Effort (km)	Detection rate (detections per km)
Oct-07	16	111	0.14
Nov-07	23	102	0.22
Dec-07	23	127	0.18
Jan-08	17	88	0.19
Feb-08	25	127	0.20
Early April-08	3	101	0.03
Late April-08	6	126	0.05

From the results of the 7 surveys carried out there was a marked differences in spatial distribution of porpoises over the area surveyed, with more detections made in the control area than in the wind farm area. A total of 113 harbour porpoise detections were made overall, of which 96 were made within the control area (0.23) detections per km dedicated acoustic effort), and 17 were made within the wind farm area (0.05 detections per km dedicated acoustic effort)

(Figure 5-31). Figure 5-32 shows the detection rate per survey in both the control and the wind farm areas, for each monthly survey the detection rate is higher in the control area.

The detection rate per transect is shown in Table 5-13. All transects recorded acoustic detections with the exception of transect 'WC' (Figure 2-1) located in the wind farm area.

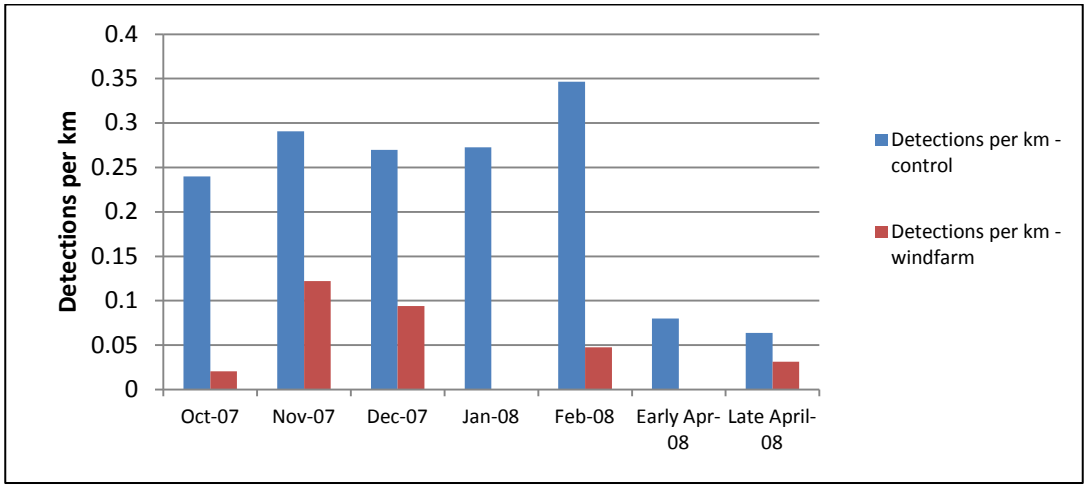


Figure 5-32 Histogram comparing the detection rate for harbour porpoises in the control area and the wind farm area across all survey months.

Table 5-13 Harbour porpoise detection rate for each individual survey transects, combined across all surveys 2007-2008.

Transect ID	Number of detections	Effort (km)	Detection rate
WA	1	29.72	0.03
WB	1	33.35	0.03
WC	0	40.99	0.00
WD	1	38.57	0.02
WE	2	39.20	0.05
WF	1	38.37	0.03
WG	2	38.71	0.05
WH	4	38.48	0.10
WI	2	33.57	0.05
WJ	3	38.92	0.09
CA	3	42.03	0.07
CB	4	43.25	0.09
CC	8	44.30	0.18
CD	8	44.96	0.18
CE	9	42.51	0.21
CF	17	45.04	0.38
CG	6	36.19	0.17
CH	14	38.20	0.37
CI	13	37.78	0.34
CJ	14	39.11	0.39

5.2.5.2 Towed Passive Acoustic Monitoring (PAM) results for EOWDC 2010-2011 surveys

The locations of harbour porpoise detections in each of the 12 surveys conducted between 2010-2011 can be seen in

Figure 5-33-Figure 5-44. In addition, the locations of harbour porpoise detections made during periods of opportunistic survey effort, combined across all 12 surveys can be seen in Figure 5-45.

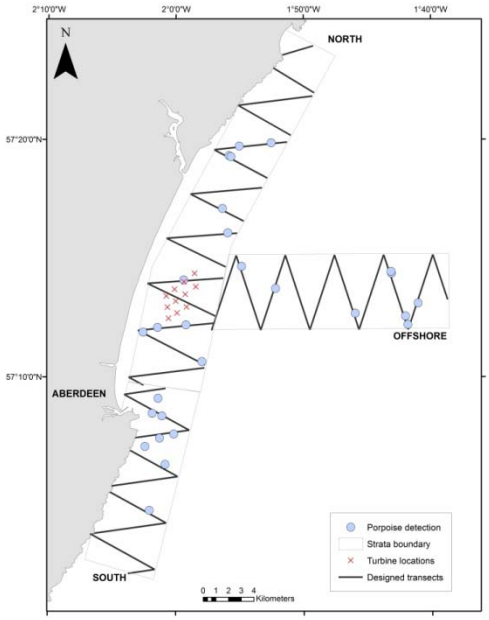


Figure 5-33 Locations of "on effort" harbour porpoise detections during the August 2010 survey.

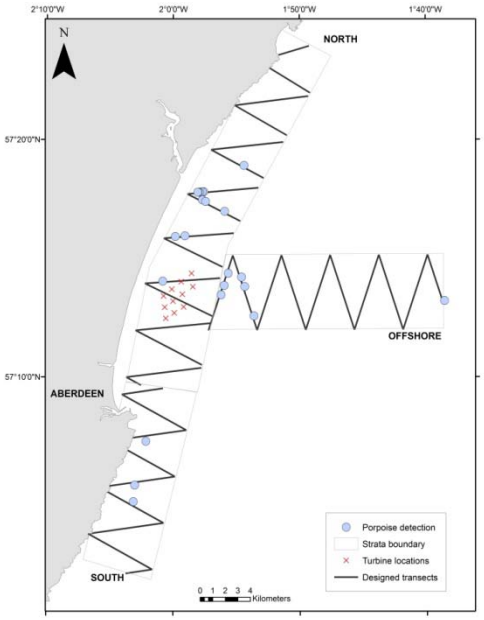


Figure 5-34 Locations of "on effort" harbour porpoise detections during the September 2010 survey.

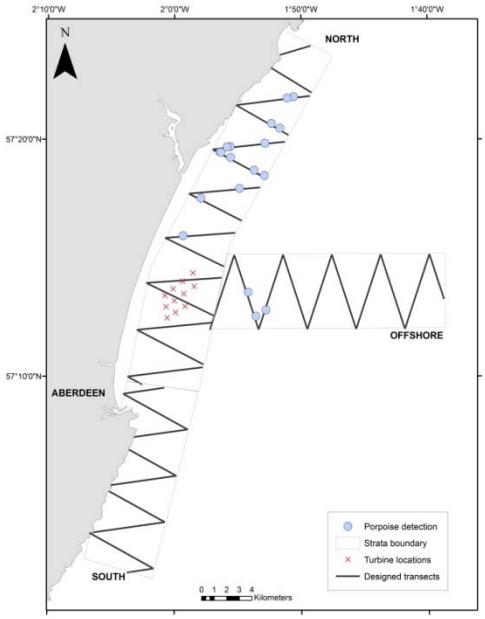


Figure 5-35 Locations of "on effort" harbour porpoise detections during the November 2010 survey.

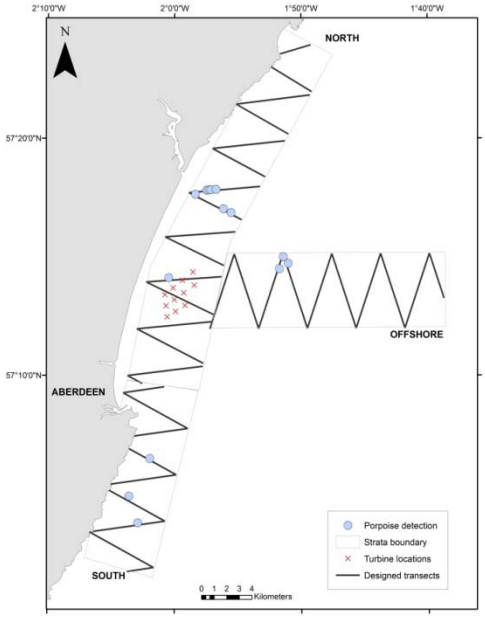


Figure 5-36 Locations of "on effort" harbour porpoise detections during the January 2011 survey.

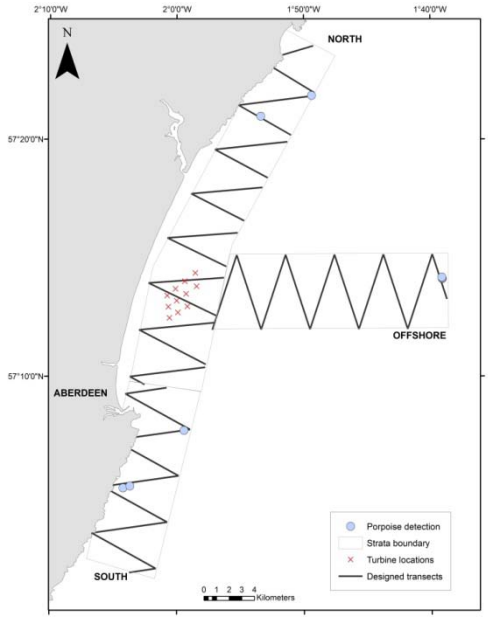


Figure 5-37 Locations of "on effort" harbour porpoise detections during the February 2011 survey.

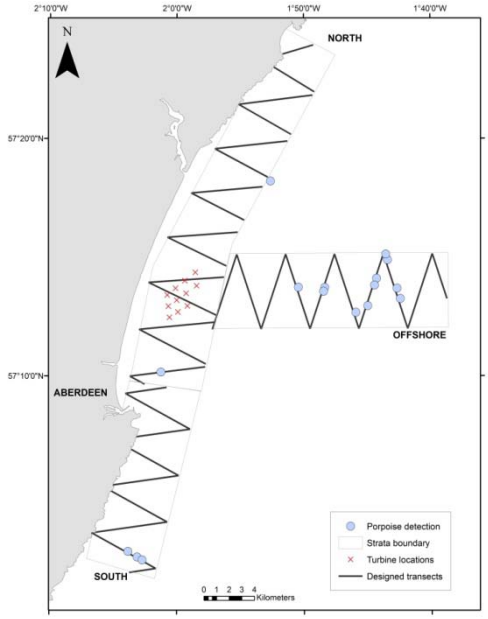


Figure 5-38 Locations of "on effort" harbour porpoise detections during the March 2011 survey.

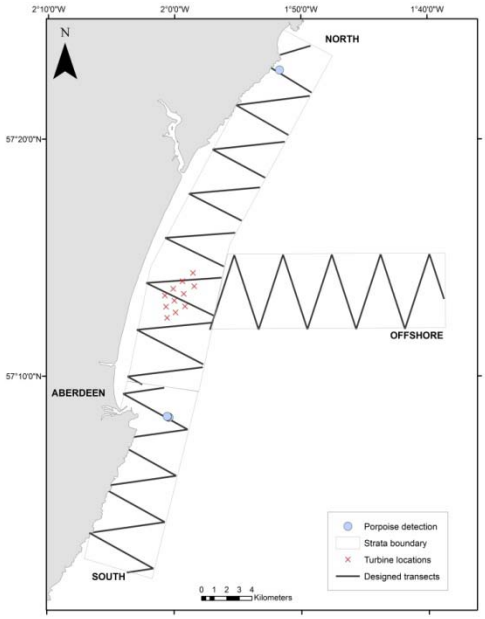


Figure 5-39 Locations of "on effort" harbour porpoise detections during the April 2011 survey.

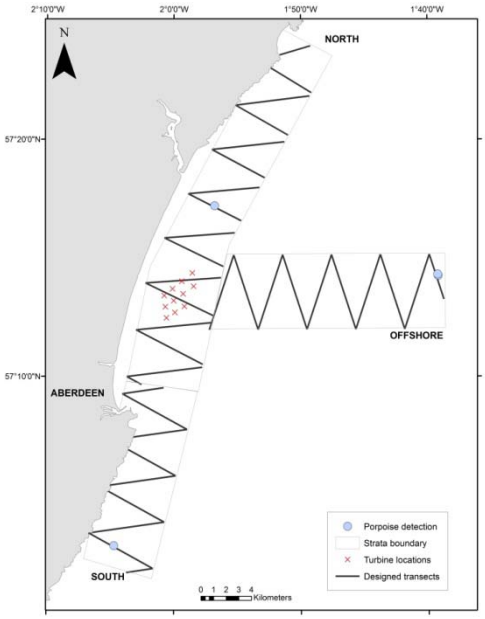


Figure 5-40 Locations of "on effort" harbour porpoise detections during the first June 2011 survey.

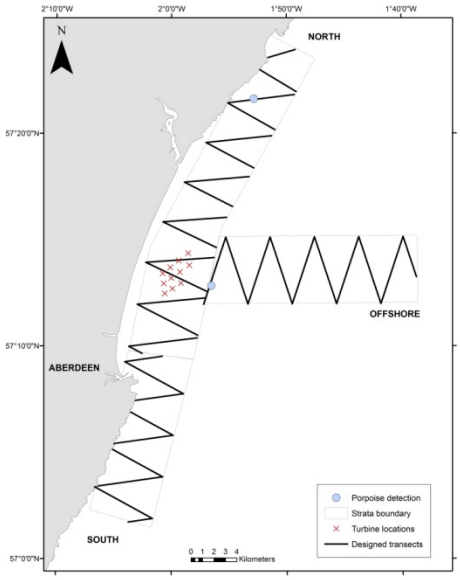


Figure 5-41 Locations of "on effort" harbour porpoise detections during the second June 2011 survey.

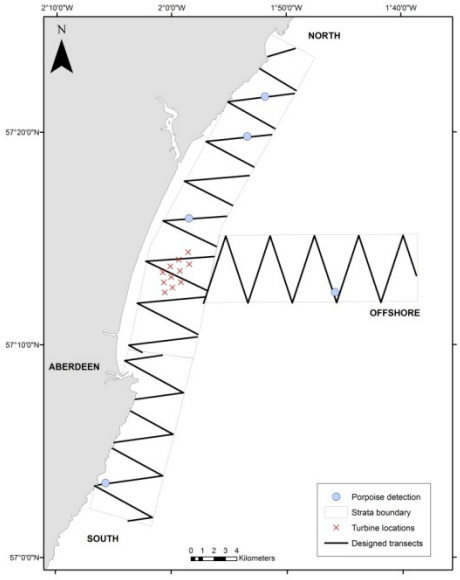


Figure 5-42 Locations of "on effort" harbour porpoise detections during the first July 2011 survey.

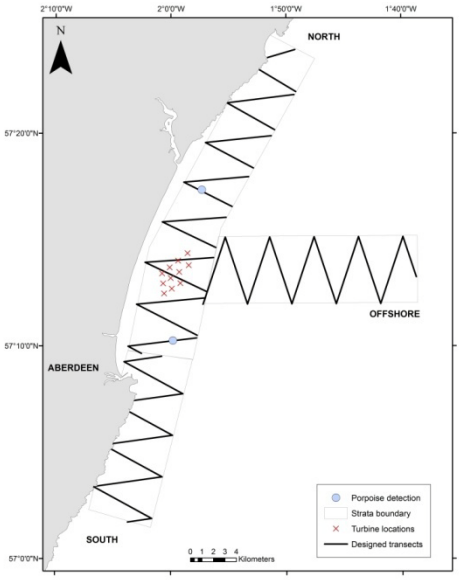


Figure 5-43 Locations of "on effort" harbour porpoise detections during the second July survey.

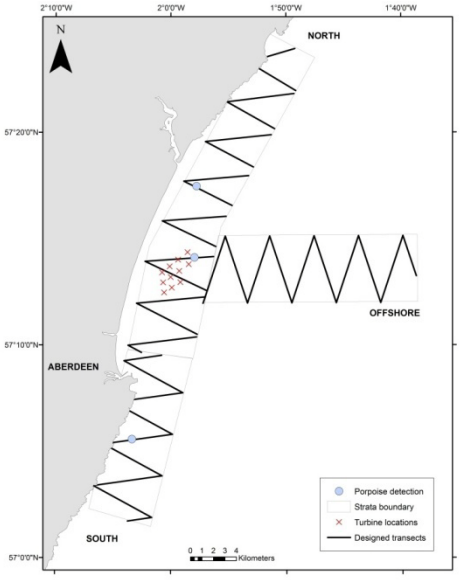


Figure 5-44 Locations of "on effort" harbour porpoise detections during the August 2011 survey.

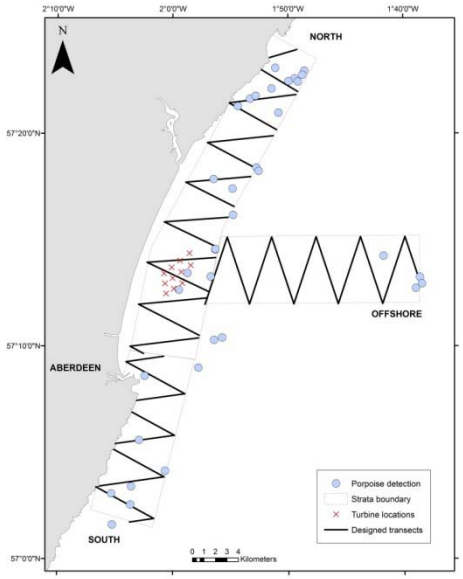


Figure 5-45 Locations of "opportunistic" harbour porpoise detections during all twelve completed surveys. "Opportunistic" detections are those made whilst the survey vessel is not steaming a transect line. Although some of the detections in the southern stratum look like they were made on transect, the vessel was at the time was actuality conducting a northerly passage from the end of the southern transects back to the harbour.

A visual comparison of the dedicated harbour porpoise acoustic detections and the dedicated harbour porpoise sightings is shown in Figure 5-46. This shows that more porpoises are seen than detected in the North stratum, more porpoises are detected than seen in the Offshore stratum, and approximately similar numbers of porpoises are seen and detected in the South stratum. In many cases, the acoustic detection and sighting coincide sufficiently in time to suggest they are of the same animal.

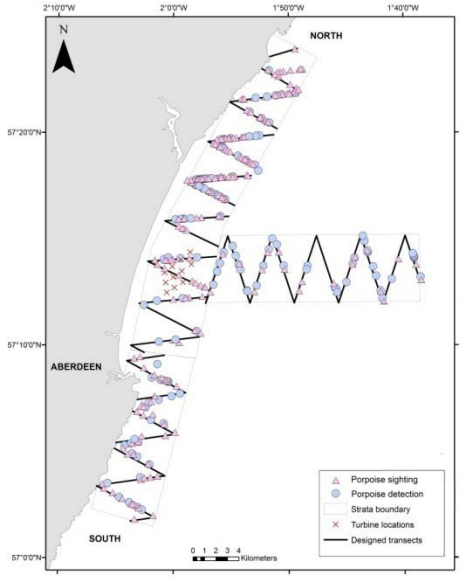


Figure 5-46 Locations of all "on effort" sightings and acoustic detections of harbour porpoises combined across the twelve surveys. In some cases, the sighting and detection appear in close enough association for them to be assumed to be the same animal.

5.2.5.3 Acoustic detection rates of harbour porpoise

Harbour porpoises were detected acoustically on all 12 of the surveys (Table 5-14 and

Table 5-15), giving a total of 131 dedicated porpoise detections across the 12 surveys. The number of acoustic detections per kilometre ranges from 0.012 (July 2nd survey) 2011 survey to 0.158 (September 2010) (Table 5-14). Detections were not evenly distributed along the trackline, but showed higher concentrations in certain areas – transect 18 (Figure 2-2) in the North stratum has the highest over-all detection rate (0.2 detections per km), whilst transects 2, 9, 13, 15 24 and 35 have no detections at all. The detection rates per km are very similar across the three strata – 0.074 detections per km in the northern stratum, 0.07 in the southern stratum and 0.06 in the offshore stratum. The spread of harbour porpoise detections across the three strata, per survey is shown in Figure 5-47.

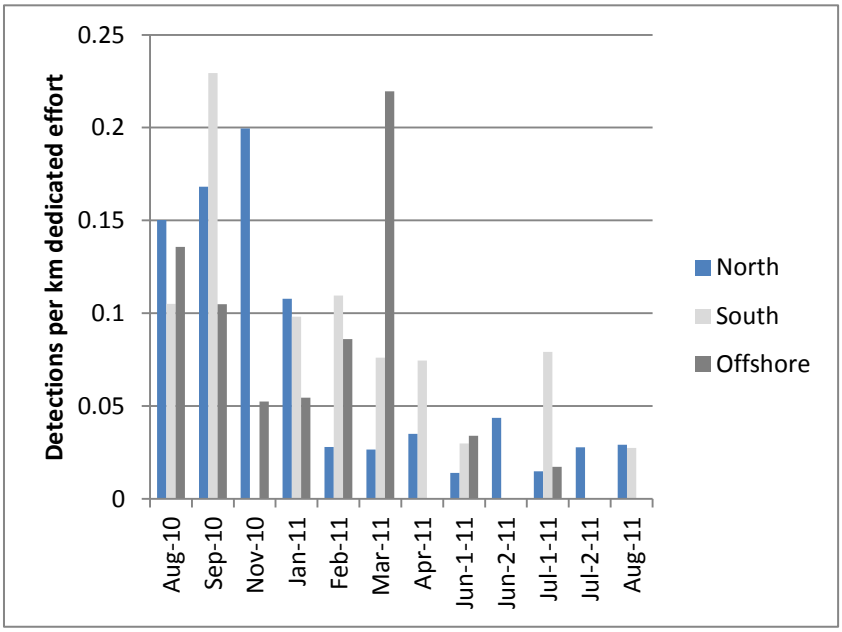


Figure 5-47 Monthly detection rates of harbour porpoises in the North, South and Offshore strata during the EOWDC 2010-2011 surveys. The Offshore stratum was not surveyed during the April-11 survey. No detections were made in the South stratum during the November-10 or June 2nd 2011 surveys, nor in the offshore stratum during the June 2nd 2011, July 2nd 2011 or August 2011 surveys.

Table 5-14 Number of porpoise detections and detection rate for each of the EOWDC 2010-2011 surveys.

Survey	Number of "on effort" detections	Kilometres of effort	Detection rate (detections per km)	Detection rate (detections per 100 km)
August 2010	27	205.4	0.131	13.1
September 2010	26	165.0	0.158	15.8
November 2010	18	164.3	0.109	10.9
January 2011	14	159.8	0.088	8.8
February 2011	11	166.0	0.066	6.6
March 2011	18	173.7	0.104	10.4
April 2011	5	97.2	0.051	5.1
June 1st survey 2011	4	163.3	0.024	2.4
June 2nd survey 2011	3	148.6	0.02	2.0
July 1st survey 2011	5	163.1	0.031	3.1
July 2nd survey 2011	2	165.9	0.012	1.2
August 2011	3	161.9	0.019	1.9

Table 5-15 Detection rates for each of the survey stratum, for each of the EOWDC surveys 2010-2011. The stratum detection rate has been calculated by dividing the total number of detections per stratum by the total number of km survey effort per stratum.

Survey	North		South		Offshore	
	Detections per km	Detections per 100 km	Detections per km	Detections per 100 km	Detections per km	Detections per 100 km
Aug-10	0.150	15.0	0.105	10.5	0.136	13.6
Sept-10	0.168	16.8	0.229	22.9	0.105	10.5
Nov-10	0.2	20.0	0	0	0.052	5.2
Jan-11	0.108	10.8	0.087	8.7	0.055	5.5
Feb-11	0.028	2.8	0.11	11.0	0.086	8.6
March-11	0.027	2.7	0.076	7.6	0.22	22.0
April-11	0.035	3.5	0.074	7.4	0	0
June_1-11	0.014	1.4	0.03	3.0	0.034	3.4
June_2-11	0.044	4.4	0	0	0	0
July_1-11	0.015	1.5	0.079	7.9	0.017	1.7
July_2-11	0.028	2.8	0	0	0	0
Aug-11	0.029	2.9	0.027	2.7	0	0
Stratum detection rate:	0.074	7.4	0.07	7.0	0.066	6.6

5.2.6 Diet

The diet of harbour porpoises in Scottish waters has been determined through stomach content analysis and, although fish from 15 taxa, cephalopods from five taxa and crustaceans from four taxa were recovered from the stomachs of harbour porpoises between 1992 and 2003, the diet is dominated by whiting; sandeels (Ammodytidae spp.); haddock, saithe, pollack and *Trisopterus* spp. (Norway pout and poor cod) (Santos *et al.*, 2004a). Whiting and sandeels are the most important prey types, in terms of contribution by number and mass, in the diet of harbour porpoises from Scottish waters (Santos *et al.*, 2004a). These findings are supported by earlier studies (Rae 1965, Rae 1973).

5.2.7 Life history

Harbour porpoises in Scottish waters have a distinct reproductive season. Examination of the reproductive status of stranded harbour porpoises (1992-2005) indicates that conception takes place between April and September, gestation appears to last 10-11 months and the calving period is between April and June. Lactation appears to last 9 to 10 months with weaning taking place in March/April (Learmonth, 2006).

The period of conception for harbour porpoises in Scottish waters coincides with observations of larger group sizes of porpoises in July and August off the North Sea coast (N. Quick, *pers. comm*.).

In the coastal waters off Aberdeenshire juvenile porpoises and calves have been observed between May and September, with a peak during June (Weir *et al*., 2007). Sightings of very small calves in June support Learmonth (2006) observation that calving occurs at that time (Weir and Stockin, 2001).

In surveys along the southern coast of the outer Moray Firth (May to October, 2001-2005), neonatal porpoise calves were typically observed between May and July and the progressive increase in harbour porpoise encounters from May through to October was believed to result from the inshore movements of lactating females with their calves, followed thereafter by the males (Robinson *et al*., 2008).

5.2.8 Strandings

One hundred and thirty stranded harbour porpoises have been recorded by the Scottish Agricultural College along the north east coast of Scotland from Fraserburgh to Inverbervie between January 1992 and March 2010 (CSIP, 2010). Of these 33 were females, 51 were males and the sex was not determined for 48 individuals. Body lengths were between 76 cm and 165 cm. Harbour porpoises were recovered all along the north east coast of Scotland throughout the year, with the majority recovered in the 1st and 2nd quarters (January-June: approximately 84 %), in all years (SAC, 2006; CSIP, 2009).

Stranding records indicate that harbour porpoises are regularly present in the area throughout the year, with an increase in the number of stranded porpoises between January and June.

5.2.9 Harbour porpoises killed by bottlenose dolphins

Of the 389 harbour porpoises for which cause of death was established in Scottish waters between 1992 and 2004, 143 (37 %) died as a result of attacks by bottlenose dolphins (Learmonth, 2006). All fatal bottlenose dolphin attacks were recorded on the North Sea coast, ranging from Brora in the north to the Firth of Forth in the south, with the majority (66 %) in the Moray Firth. The distribution of bottlenose dolphin attacks on harbour

porpoises is consistent with an overlap in the distribution of the two species on the Scottish east coast (Wilson *et al*., 2004).

Fatal bottlenose dolphin attacks on harbour porpoises in Scottish waters were recorded in all months of the year, with higher numbers between April and June (Learmonth, 2006). There was some evidence of a seasonal shift in bottlenose dolphin attacks on porpoises along the east coast, with 75 % of bottlenose dolphin attacks within the Moray Firth occurring between April and September and 77 % of bottlenose dolphin attacks outside the Moray Firth occurring between January and June (Learmonth, 2006). The increase in bottlenose dolphin attacks outside the Moray Firth between January and June is consistent with an increase in the number of sightings of bottlenose dolphins off Aberdeen between the months of February and May (Weir and Stockin 2001; Canning, 2007).

Significant annual variations in the number of harbour porpoises killed by bottlenose dolphin attacks in Scottish waters were observed between 1992 and 2004, with no overall trend being detectable except in the final years when there was evidence of an increase in the number of bottlenose dolphin attacks outside the Moray Firth. The increase in bottlenose dolphin attacks on harbour porpoises out with the Moray Firth is consistent with range expansion of bottlenose dolphins during that period (Wilson *et al.*, 2004).

Sightings reports suggest fine-scale segregation, both temporal and geographical, in the occurrence of harbour porpoises and bottlenose dolphins (Canning, 2007; Thompson *et al.,* 2004b). Segregation within a small area may result from different uses of the area between the two species or could be due to avoidance behaviour by porpoises as a result of the violent attacks by bottlenose dolphins (Thompson *et al.,* 2004b).

5.3 WHITE-BEAKED DOLPHIN (*LAGENORHYNCHUS ALBIROSTRIS*)

5.3.1 Distribution

White-beaked dolphins are most commonly sighted in the central part of the North Sea between 54°N and 59°N (Hammond *et al*., 2001). They are restricted to temperate and sub-Arctic waters of the North Atlantic and are mainly distributed over the continental shelf, usually in waters of 50-100 m depth (Reid *et al*., 2003). In the North Sea they are thought to be more numerous within about 370 km of the Scottish and north-eastern English coasts (Northridge *et al.,* 1995). White-beaked dolphins are present year round in the North Sea, including waters of Shetland and Orkney (Northridge *et al.,* 1997).

The locations of white-beaked dolphin sightings made during systematic surveys and some platforms of opportunity off north-east Scotland are presented in Figure 5-49 (Hammond *et al.,* 2004). During the SCANS II survey in July 2005, white-beaked dolphins were seen in the northern and central North Sea and west of Britain and Ireland (SCANS II, 2006). Analysis of the UK stranding database suggested that sea temperature influences the distribution of this species around the UK (Canning *et al*., 2008). The white beaked dolphin has been recorded in the NORCET surveys with a higher occurrence of observations in the summer months coincident with the increased in sighting of white beaked dolphins in more coastal waters (Figure 5-48).

There has been a decline in the relative frequencies of strandings and sightings of white-beaked dolphins, a colder-water species and a relative increase in strandings and sightings of common dolphins, a warmer-water species off northwest Scotland. Theses changes in the cetacean community off northwest Scotland have been linked to climate change (MacLeod *et al*., 2005).

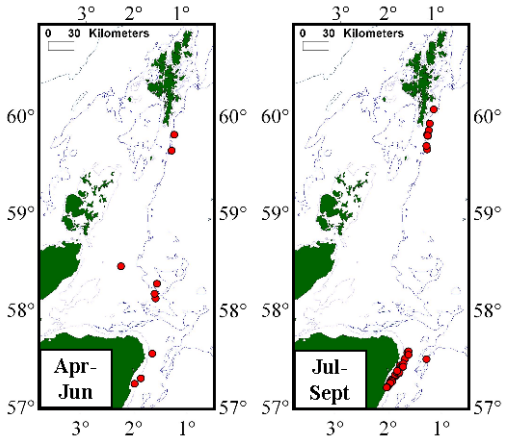


Figure 5-48 Distribution of white-beaked dolphin sightings during NORCET ferry surveys (April-September, 2002-2006).

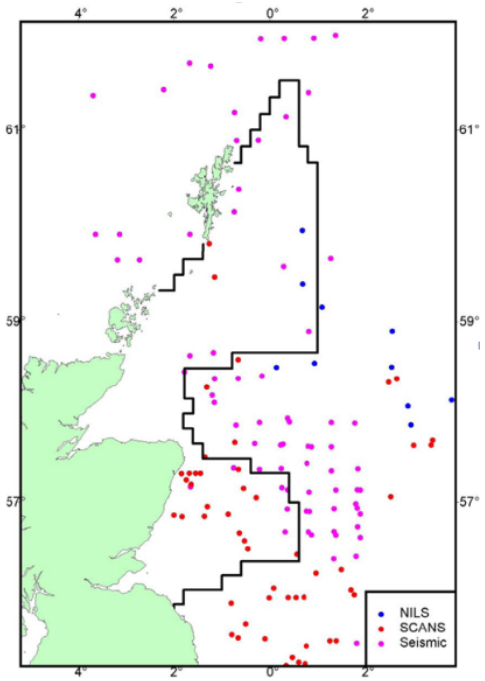


Figure 5-49 White-beaked dolphin sightings made during various surveys (Hammond *et al*., 2004; black line outlines SEA5 area).

5.3.2 Seasonal Movements

White-beaked dolphins are present year-round in the North Sea, with most sightings recorded between June and October (Evans, 1992; Northridge *et al*., 1995; Reid *et al*., 2003). Seasonal aggregations of white-beaked dolphins have been recorded along the north east English coast during April and June (Northridge *et al*., 1997).

5.3.3 Abundance

The summer abundance of white-beaked dolphins in the North Sea areas during the first SCANS survey in July 1994 was 7,856 (95% confidence interval 4,000–13,300). This estimate includes shelf waters around Shetland and Orkney in which there were an estimated 1,157 animals (Hammond *et al*., 1995, 2002, 2004).

Current estimated abundance in UK and adjacent waters (shelf only) is 22,400 individuals (SCANS II, 2008). White-beaked dolphins are usually found in schools numbering less than 10 individuals, but schools of up to 50 are not uncommon, and aggregations can comprise 100-500 animals in northern parts of their range and also in the North Sea (Reid *et al*., 2003).

5.3.4 Occurrence in Aberdeen Bay and surrounding area

The presence of white-beaked dolphins in the Aberdeen Bay area is seasonal. During land and vessel based surveys between March 1999 and October 2001, along the Aberdeenshire coast (between St. Cyrus and Collieston, primarily between Stonehaven and Aberdeen), white-beaked dolphins were recorded only between June and August, despite good coverage for both land- and vessel-based surveys in most other months. White-beaked dolphin calves were observed in all three months that the species was recorded (Weir *et al*., 2007).

The fine-scale distribution varied within the study area, with an apparent preference for sections of coast adjacent to deeper water. Most white-beaked dolphins were sighted along the Cove to Girdle Ness coast. During the land-based surveys, the incidence of white-beaked dolphins was significantly higher in the southern area between Aberdeen and Stonehaven than in the northern area between Aberdeen and Collieston (Weir *et al*., 2007).

Land and boat surveys along the Aberdeenshire coast (Stonehaven to Aberdeen) between 2002 and 2005 only recorded white-beaked dolphins during the summer months. During land based surveys at Aberdeen harbour (November 2002 – April 2005), white-beaked dolphins were recorded during the summer of 2004 and during land-based surveys at Stonehaven (March 2003 – March 2005), they were observed between May and August in 2003 and in July in 2004 (Canning, 2007). Analysis of the sightings indicate that seabed depth and slope influence the distribution of white-beaked dolphins in this area and this is thought to be related to prey distribution. Sea temperature was found to influence white-beaked dolphin group size, with smaller groups being recorded at higher temperatures (Canning, 2007).

The high number of calves observed during the boat surveys off Aberdeenshire and in the stranding data during the summer, suggests the inshore movement of this species at this time of year may be related to calving. The stranding data also suggested there may be a difference in when males and females move inshore (Canning, 2007).

White-beaked dolphins were the most commonly-sighted species of dolphin during northern NORCET ferry surveys in 2002 and 2006 (MacLeod *et al*., 2007). White-beaked dolphins were recorded throughout the study area and they were recorded more frequently in coastal waters, such as along the coast of mainland Scotland, in the late summer and early autumn (note surveys were only conducted from April to September). Group sizes ranged from one to 20, with an average of five individuals per group. White-beaked dolphins were the only species of cetacean recorded in all years when surveys were conducted. White-beaked dolphins made up the highest proportion of sightings in July, accounting for almost 20 % of all sightings in this month. White-beaked dolphins were never recorded in April (MacLeod *et al*., 2007).

During the EOWDC surveys 2007-2008 one sighting of three individuals occurred in August 2007, and this was an incidental sighting when the observers were off effort. In the EOWDC 2010-2011 surveys a total of 28 observations, consisting of 114 individuals, were recorded in August 2010 and June, July 2011 (Figure 5-50). All the observations of white-beaked

dolphins between 2010-2011 were recorded in water depths of 20 m or more, and were observed in the south or offshore survey area.

The sightings data collected during the two EOWDC survey periods supports other observational data records which suggests the species is a seasonal summer visitor to the Aberdeenshire coast and has a preference for deeper waters. This could also explain the lower number of observations in the EOWDC 2007-2008 survey data which covered a shallower water depth.

As Passive Acoustic Monitoring is unable to identify to species level cetacean whistles and clicks, which may be associated with white-beaked dolphins, the detection rates of unidentified odontocete species from EOWDC 2010-2011 surveys are presented in the Appendix 2.

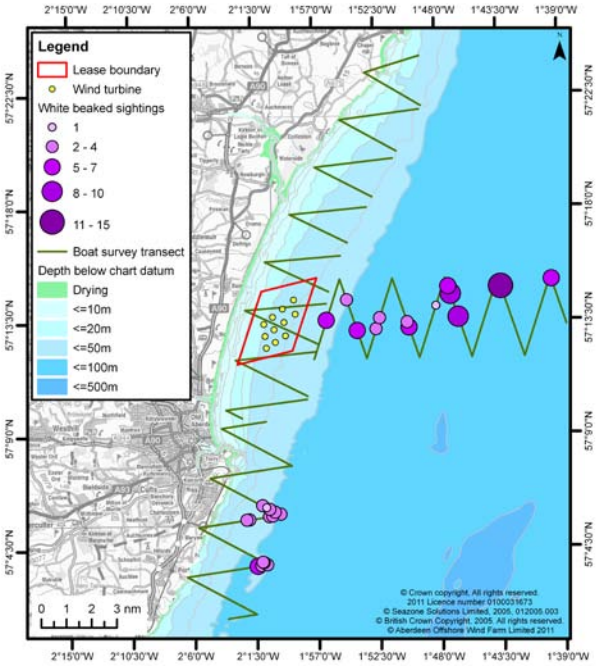


Figure 5-50 White-beaked dolphin observations and individuals recorded in all EOWDC 2010-2011 surveys.

5.3.5 Diet

White-beaked dolphins take a range of prey, including fish, cephalopods and some crustacean species (Reid *et al*., 2003). Herring and whiting have been recorded as prey items of this species in the North Sea (Fraser, 1974; Harmer, 1927). The diet of those found around Britain includes whiting, hake, herring, cod, mackerel, scad, sandeel, long rough dab, *Trisopterus sp*, and the octopus *Eledone cirrhosa* (Evans, 1992; Santos *et al.,* 1994). Stomach contents analysis of white-beaked dolphin (n=22) stranded around Scotland (1992-2003) identified a wide variety of prey species: haddock and whiting were the predominant fish species with other prey species including cod, herring and mackerel (Canning *et al*., 2008). Elsewhere in the North Atlantic herring and gadoid fishes also appear to be the main diet items (Reeves *et al.*, 1999a).

5.3.6 Life history

Little is known about the reproductive behaviour of this species but mating is thought to occur during the summer with calving occurring the following summer (Kinze *et al.,* 1997).

White-beaked dolphin calves have been observed off Aberdeenshire in all three months (June, July and August) that the species has been observed (Weir *et al*., 2007).

Information on the life history of white-beaked dolphins in Scottish waters is limited. However, the examination of the reproductive status of stranded individuals (1996-2002) suggests that mating occurs between July and August; however the majority of stranded white-beaked dolphins for which age and reproductive data are available, were sexually immature and aged four years and less.

5.3.7 Strandings

The majority of white-beaked dolphins stranded in the UK are found around Scotland and along the east coast of England (Canning *et al*., 2008). Fourteen white-beaked dolphins have been recorded by the Scottish Agricultural College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and December 2009. Of these seven were female and 7 were male and body length ranged from 119 cm to 263 cm (Table 5-16). White-beaked dolphins were recovered along the north-east coast of Scotland between February and October, with the majority in June and July, in 1992-1995 and 2001-2004 (Table 5-16).

Table 5-16 White-beaked dolphins stranded along the northeast coast of Scotland January 1992 – August 2009 (CSIP, 2010).

Date Found	Location	Sex	Body length
June 1992	Aberdeen	M	132 cm
March 1993	Aberdeen	F	225 cm
September 1994	Aberdeen	M	222 cm
July 1994	Balmedie	M	119 cm
July 1994	Aberdeen	F	134 cm
April 1995	Fraserburgh	F	188 cm
July 1995	Balmedie	F	122 cm
July 2001	Forvie	F	245 cm
June 2002	Forvie	M	263 cm
June 2002	Blackdog	M	155 cm
June 2002	Collieston	F	171 cm
October 2003	Aberdeen	M	158 cm
February 2004	Fraserburgh	M	200 cm
January 2008	Collieston	F	176 cm

Stranding records suggest that white-beaked dolphins may be present in the area throughout the year, with the exception of winter (November-January). The peak occurrence appears to be in summer, especially during the months of June and July.

5.4 MINKE WHALE (*BALAENOPTERA ACUTOROSTRATA*)

5.4.1 Distribution

Minke whales are widely distributed in the northern hemisphere, tropical, temperate and polar seas (Reid *et al*., 2003). There are three distinct populations: Southern Hemisphere, Northern Pacific and North Atlantic. In the North Atlantic the International Whaling Commission (IWC) recognises three stocks for management purposes: NE Atlantic, west Greenland and Canadian east coast. Minke whales off north east Scotland are part of the NE Atlantic stock (Hammond *et al*., 2004).

Minke whales occur throughout the central and northern North Sea, as illustrated by the distribution of sightings during the SCANS survey and other surveys on platforms of opportunity, Figure 5-51 (Hammond *et al*., 2001). Minke whales are widely distributed in the area off north-east Scotland, both in offshore and coastal areas. During the SCANS II survey in July 2005, minke whales were found in the northern and central North Sea and west of Britain and Ireland (SCANS II, 2008). They are more frequently sighted inshore during the summer months.

Robson *el al*., report on boat surveys carried out between May and October from 2001 to 2006. The surveys were conducted along an 83 km length of the southern coastline of the outer Moray Firth between Lossiemouth and Fraserburgh, using four dedicated survey routes positioned parallel to the shore: three outer routes, approximately 1.5 km apart in latitude, and an inner coastal route. Minke whales were encountered throughout the survey area, but were generally distributed towards the central and eastern area of the study site, with a notable absence to the far west. A large number of whales were also sighted on the innermost survey route, but once corrections for survey effort had been made, a considerably higher abundance of animals was shown for each of the outer survey routes, typically occurring along the 20-50 m isobaths. Whilst minke whales were recorded during all survey months (May to October inclusive), the animals were typically encountered in this region from mid-June onwards, showing a peak in occurrence during July and August. In addition, the temporal distribution of whales suggested an inshore movement of animals across the summer months, with the whales being recorded in deeper, offshore waters in May and June followed by increasing numbers of encounters of animals in more shallow, inshore waters from July onwards (Robinson *et al*., 2007).

5.4.2 Migration

There is no direct evidence that minke whales in the northern hemisphere migrate, but in some areas there appear to be shifts in latitudinal abundance with season (Hammond *et al*., 2004). This is true for the North Sea, where minke whales appear to move into the North Sea at the beginning of May and are present throughout the summer until October (Hammond *et al*., 2004; Northridge *et al.*, 1995).

5.4.3 Abundance

Minke whales are usually seen singly or in pairs although, when feeding, they sometimes form larger aggregations that can number 10-15 individuals (Reid, *et al*. 2003). A total abundance of 16,400 individuals has been estimated for UK and adjacent waters, and results from the Cetcean Offshore Distribution Abundance (CODA) survey in 2007 estimated a total abundance in the survey area to be 6,765 [95% CI=1,239-36,925] (Macleod, *et al*., 2008).

During the SCANS I survey, the highest densities were recorded in the north west North Sea, particularly off the mainland coast of Scotland (Hammond *et al*., 2001). Estimates of the number of minke whales in the North Sea, north of 56°N, were 5,430 (SE=1,870) for 1989 and 20,300 (SE=5,240) for 1995. These estimates are approximately 8-18% of the estimated size of the north-east Atlantic stock of 67,000 whales in 1989 and 112,000 whales in 1995 (Hammond *et al*., 2004; Schweder *et al.*, 1997). Abundance estimates for the North Sea from the Norwegian surveys in July 1998 were 11,700 (SE=3,460) (Hammond *et al*., 2004; Skaug *et al.*, 2003). The SCANS II survey calculated an increased abundance of minke whales for the whole of the North Sea (approximate 95% confidence interval = 10,445-33,171).

5.4.4 Occurrence in Aberdeen Bay and surrounding area

The status of minke whales in the Aberdeen Bay area is unclear. During land and vessel based surveys along the Aberdeenshire coast (between St. Cyrus and Collieston, primarily between Stonehaven and Aberdeen, from March 1999 to October 2001), minke whales were recorded only in the month of August (Weir *et al*., 2007). The five sightings all involved solitary individuals, of which three were adults and two were juveniles, with all observations occurring in a relatively small spatial region between Aberdeen and Stonehaven (Weir *et al*., 2007). During land-based surveys at Aberdeen harbour (November 2002 – April 2005) and Stonehaven (March 2003 – March 2005), minke whales were recorded during the summer of 2004 and August 2003, respectively (Canning, 2007). However, in recent years minke whales have been observed off the Aberdeenshire coast during most months of the year, with sightings occurring even during the winter in December.

NORCET surveys between Aberdeen, Orkney and Shetland in the summer months between 2002 and 2006 recorded minke whales throughout the region, and in all months surveyed (April to September) Figure 2-5 (MacLeod *et al*., 2007). Most observations of minke whales during the NORCET surveys occurred in more offshore waters in April to June and in more coastal waters in July and September (Figure 5-52). Minke whales were the second most commonly sighted species during the ferry surveys (MacLeod *et al*., 2007).

During vantage point surveys for this project, single minke whales were recorded at both Donmouth and Blackdog on 13th July 2007, although this may have been the same individual moving along the coast.

There have been a total of 12 observations of minke whales in all the EOWDC boat surveys. One minke whale was recorded during the surveys carried out in 2007-2008 (Figure 5-53) and 11 observations of solitary minke whales were recorded in the EOWDC 2010-2011 surveys (Figure 5-54).

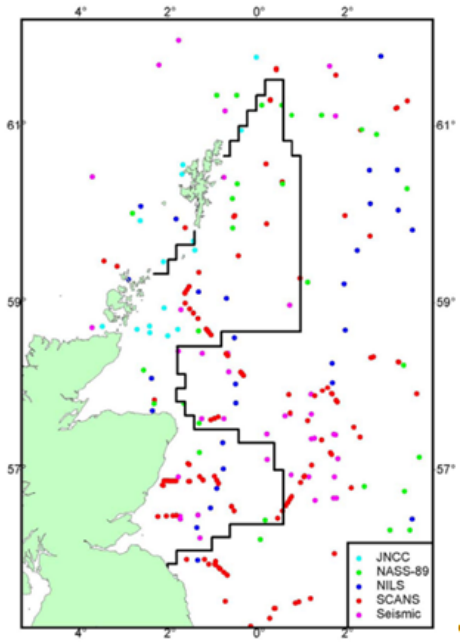


Figure 5-51 Minke whale sightings made during SCANS, NASS-89, NILS-95, JNCC and seismic surveys (Hammond *et al*., 2004; black line outlines SEA5 area).

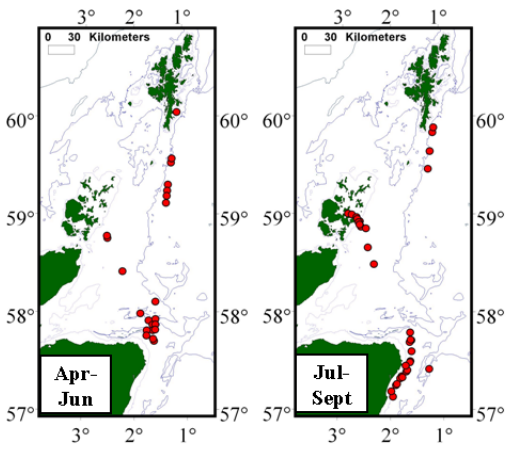


Figure 5-52 Distribution of minke whales sightings during NORCET ferry surveys (April-September, 2002-2006).

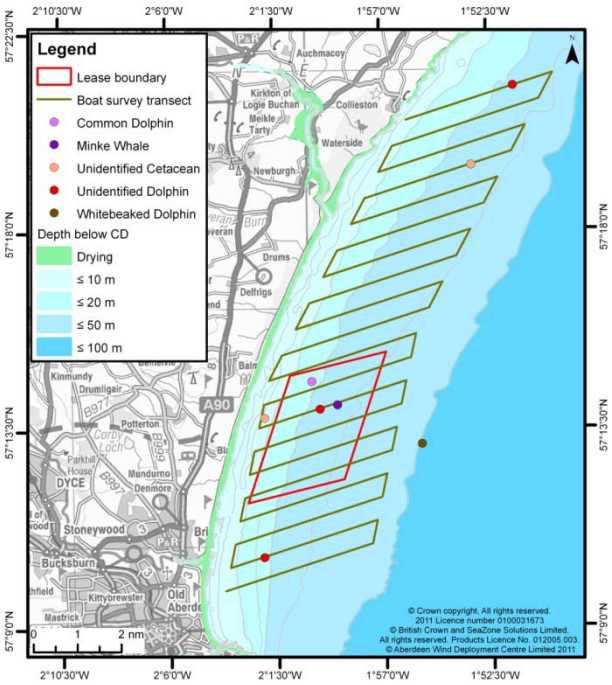


Figure 5-53 Common dolphin, Minke whale, White-beaked dolphin, unidentified dolphin and unidentified cetacean observations during the EOWDC boat based surveys 2007-2008.

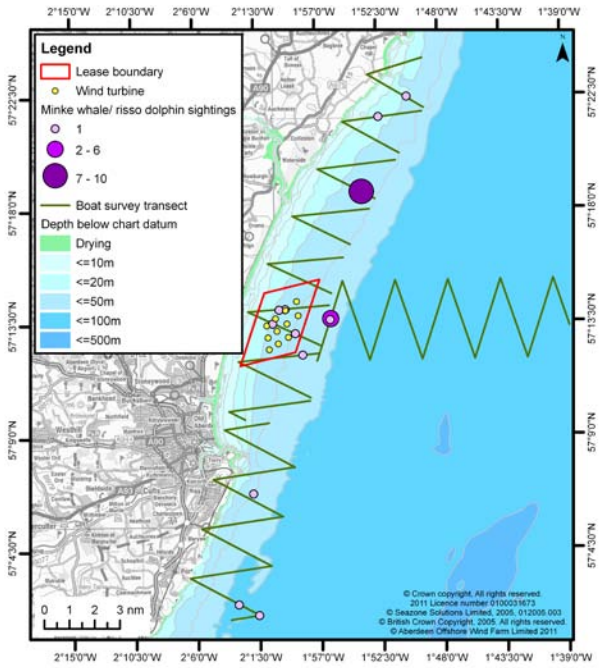


Figure 5-54 Minke whale and Risso's dolphin observations during 2010-2011.

5.4.5 Diet

Minke whales are known to feed on a variety of fish species, including herring, cod, haddock, saithe and sandeel (Reid *et al*., 2003). In the north-east Atlantic, minke whales feed on small pelagic fish and its distribution has been linked to concentrations of sandeels and herring in Scottish waters (Evans, 1980; Macleod *et al*., 2004; Northridge, 1988). Stomach content analysis of minke whales stranded around the Scottish coast between 1992 and 2002 indicates that the diet comprised mainly sandeels, herring and sprat (Pierce *et al*., 2004).

Sightings of minke whales in the outer Moray Firth were found to be significantly higher during warm water plume events than when the colder Dooley current was prevailing. In addition, GIS plots of the physiography of the coastal study site revealed a strong preference by the species for areas with steep, northerly-facing slopes, mean water depths of 38 m and sandy gravel sediment type. Sandy gravel sediments showed the strongest positive correlation with minke distribution, and this type of substrate is seen to be the optimal habitat utilised by burrowing sandeels (Robinson *et al*., 2007).

5.4.6 Strandings

During 1992-2002 approximately 110 strandings of minke whales were recorded in Scotland. Most strandings were recorded between April and November, with a peak strandings of males in July and August (Pierce *et al*., 2004).

Five of these strandings were recorded by the Scottish Agricultural College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and March 2010 (SAC, 2006; CSIP 2010). The body lengths of the whales were between 585 cm and 800 cm and three of the five minke whales were identified as male. Minke whales were recovered in the months of July, September, October and November within the years 1993, 1995 and 2000 between Peterhead and Inverbervie (Table 5-17). Strandings records indicate that minke whales are present along the north east coast of Scotland between July and November.

Table 5-17 Minke whales stranded along the northeast coast of Scotland (January 1992 – August 2000).

Date Found	Location	Sex	Body length
September 1993	Near Slains Castle	M	760 cm
July 1995	Peterhead	M	585 cm
October 1995	Inverbervie	Unknown	c700 cm
November 1995	Near Catterline	M	700 cm
September 2000	Balmedie	Unknown	800 cm

5.5 ATLANTIC WHITE-SIDED DOLPHIN (*LAGENORHYNCHUS ACUTUS*)

5.5.1 Distribution

Atlantic white-sided dolphins are confined to the North Atlantic (Reeves *et al*., 1999b). White-sided dolphins live mainly in cool waters (7-12^{o}C), particularly along the edges of continental shelves at depths of 100-500 m, but they can be numerous in deeper waters (Reid *et al*., 2003). The Atlantic white-sided dolphin is primarily an species occurring away from the coast, but has been recorded closer to the coast during a number of surveys in the North Sea, especially during summer (Northridge *et al.*, 1997; Reid *et al*., 2003). They share most of their range with the white-beaked dolphin, but in the eastern North Atlantic they adopt a mainly offshore distribution and are consequently rarer than white-beaked dolphins over shelf waters (Hammond *et al*., 2001). Around Britain, Atlantic white-sided dolphins have been recorded mainly in the north and appear to be most common in the north western parts of the North Sea (Hammond *et al*., 2001, 2004). Compared to white-beaked dolphins, Atlantic white-sided dolphins are generally distributed further north west in deeper waters. In the North Sea, their presence is seasonal, with the majority of sightings occurring between May and September (Northridge *et al*., 1997).

5.5.2 Occurrence in Aberdeen Bay and surrounding area

Atlantic white-sided dolphins were recorded on nine occasions in groups of between one and 50 individuals during the NORCET surveys in the summer months between 2002 and 2006 (MacLeod *et al*., 2007). The majority of the sightings occurred in the more northern part of the study area around Shetland, with only one recorded sighting near the Scottish mainland coast (Figure 5-55). The sightings primarily occurred between July and September, with a single sighting being recorded in May. This species appears to be a seasonal but regular member of the cetacean assemblage of the northern North Sea, and primarily occurs in the more northern waters of the area (MacLeod *et al*., 2007). During surveys along the southern outer Moray Firth coast (May to October, 2001-2005), a single sighting of 12 white-sided dolphins was recorded in August 2005 (Robinson *et al*., 2008).

The locations of Atlantic white-sided dolphin sightings made during systematic surveys and some platforms of opportunity off north-east Scotland are illustrated in Figure 5-56. White-sided dolphins have been observed off the Aberdeen coast at Girdle Ness in June 2002 (Seawatch Foundation, 2011).

No white-sided dolphins have been recorded in any of the surveys carried out as part of the EOWDC.

5.5.3 Abundance

There is no reliable total population estimate for this species at present. Abundance estimates have been difficult to obtain due to difficulties in separating white-sided dolphin

and white-beaked dolphin identification at long-range (Hammond *et al*., 2002). The white-sided dolphin is known to occasionally be involved in mass stranding events, although none of these have been reported along the east coast of Scotland (Hammond *et al*., 2001).

The SCANS I survey estimated 11,760 *Lagenorhynchus* dolphins (white-beaked plus white-sided) occur in the North Sea (approx. 95% confidence interval 5,900 - 18,800). This estimate includes shelf waters around Shetland and Orkney (Hammond *et al*., 1995, 2002, 2004). The SCANS II survey estimated a total abundance of 27,227 (CV=0.38) for *Lagenorhynchus* species in UK and adjacent waters (shelf only) in the summer of 2005 (Scans II, 2006). This species is very gregarious, with observed school sizes frequently numbering in the tens to hundreds, and sometimes up to 1,000, particularly offshore. Within large aggregations, clusters of 2-15 animals can often be distinguished (Reeves *et al*., 1999a).

5.5.4 Diet

The diet of Atlantic white-sided dolphins consists of a wide variety of fish, particularly gadoids such as blue whiting, whiting, *Trisopterus* spp., cod and clupeids in particular herring. Other species recorded in the diet include hake, mackerel, salmonids and squid (Reid *et al*., 2003). Different prey species may predominate at different times of year, representing seasonal movements of prey, or in different areas, indicating prey and habitat variability in the environment (Cipriano, 2002).

The stomach contents of three white-sided dolphins stranded around Scotland between 1993 and 1995 consisted of Gadidae and cephalopods (Santos *et al*., 1995).

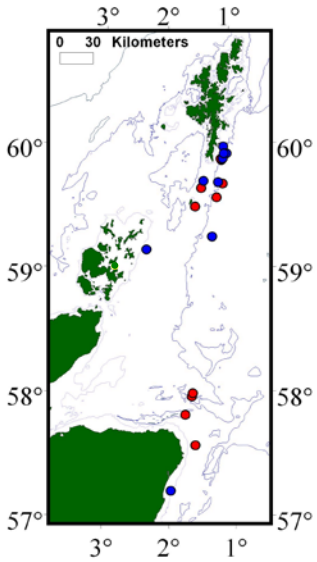


Figure 5-55 Distribution of Atlantic white-sided dolphin (blue) and common dolphin (red) sightings during ferry surveys (April-September, 2002-2006).

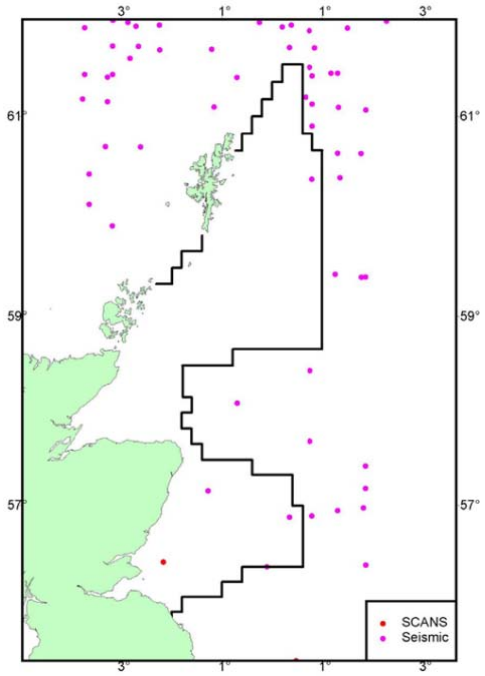


Figure 5-56 Atlantic white-sided dolphin sightings made during SCANS I survey and seismic surveys (Hammond *et al*., 2004).

5.6 KILLER WHALE (*ORCINUS ORCA*)

5.6.1 Distribution

Killer whales have a worldwide distribution and are found in tropical, temperate and polar waters in both the northern and southern hemisphere (Reid *et al*., 2003). In the eastern North Atlantic they occur in most areas from coastal fjords to oceanic waters. Any seasonal movements appear to be associated with prey, including seals and herring, and are region-specific (Hammond *et al*., 2001, 2004; Reid *et al.*, 2003).

Killer whales have been observed throughout the north western North Sea in most months (Hammond *et al*., 2001, 2004; Reid *et al.*, 2003). In UK near-shore waters the species is mainly recorded between April and October (Evans, 1988, 1992; Reid *et al*., 2003). Killer whales are not numerous in the North Sea in general, although they are recorded fairly frequently around Shetland in all months (Hammond *et al*., 2004). The locations of killer whale sightings made during systematic surveys and some platforms of opportunity off north east Scotland are illustrated in Figure 5-57.

Opportunistic surveys from Scottish pelagic trawlers fishing for mackerel (October to March) and herring (June to September) off north Scotland between 2000 and 2006, observed killer whales between January and February 2006 from the mackerel vessels. However no killer whale encounters were recorded from vessels fishing for herring (Luque *et al*., 2006).

Individual killer whales have been documented to move over very large areas, with ranges up to tens of thousands of km^2 for animals from both resident and transient populations (Baird, 2000).

5.6.2 Abundance

The most recent sighting surveys in the eastern North Atlantic (mainly from Iceland to the Faroes) indicate a population of between 3,500 and 12,500 individuals (Gunnlaugsson and

Sigurjonsson, 1990). Most sightings in UK waters are of singles or pods of less than eight individuals (mean 4.6), although aggregations of up to one hundred have been observed (Macleod, 2004).

5.6.3 Occurrence in Aberdeen Bay and surrounding area

Along the southern outer Moray Firth coast (May to October, 2001-2005), killer whales were only intermittently sighted between the months of June and August (*n* = 6) (Robinson *et al*., 2008). During NORCET ferry surveys, killer whales were encountered on three occasions in groups ranging from one to five individuals. Two of these encounters were in August (2004 and 2006) and one was in June 2006. This suggests that killer whales are rare, but regular members of the cetacean community in the northern North Sea (MacLeod *et al*., 2007).

No killer whales were sighted during any of the EOWDC surveys.

5.6.4 Diet

Killer whales have one of the most varied diets of all cetaceans, ranging from fish and squid to birds, turtles, seals and other cetaceans (Reid *et al*., 2003). Fish species taken in the eastern North Atlantic include herring, mackerel, cod and salmon (Evans, 1980; Reid *et al*., 2003). Little is known about the diet of killer whales in British waters (Hammond *et al*., 2001). Killer whales are thought to prey upon seals around haul outs in Shetland at least, and possibly offshore. There are also reports of them feeding on porpoise, along with reports of feeding on mackerel around Shetland (Fisher and Brown, 2001; Hammond *et al*., 2001).

The stomach contents of one killer whale stranded in Scotland between 1993 and 1995 consisted of oceanic cephalopods (Santos *et al*., 1995).

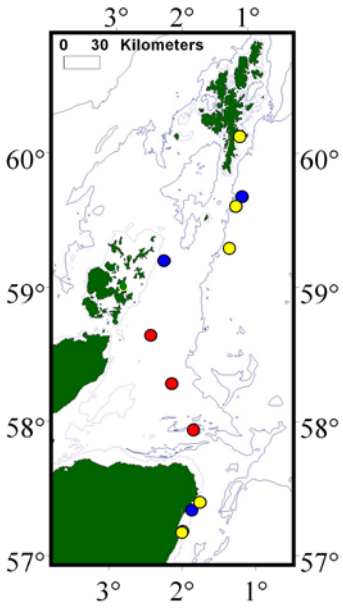


Figure 5-57 Distribution of killer whale (blue), Risso's dolphin (yellow) and fin whale (red) sightings during the NORCET ferry surveys (April-September, 2002-2006).

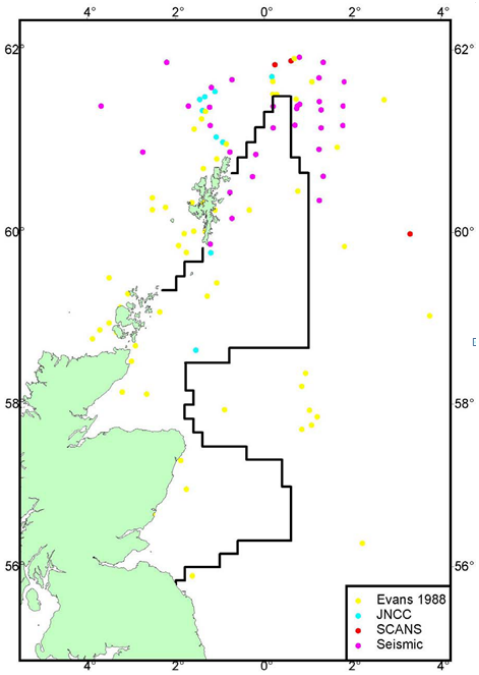


Figure 5-58 Killer whale sightings made during SCANS I survey, JNCC and seismic surveys and from Evans 1988 (Hammond *et al*., 2004).

5.7 COMMON DOLPHIN (*DELPHINUS DELPHIS*)

5.7.1 Distribution

Short-beaked common dolphins have a world-wide distribution in tropical and temperate waters (Reid *et al*., 2003). They are generally found in oceanic and shelf-edge waters but do occasionally use coastal areas. Around the British Isles, the species is most often reported from the west coast, especially the Celtic Sea (Hammond *et al*., 2004; Reid *et al*., 2003).

5.7.2 Abundance

There are no known local populations in UK waters, and those animals occurring in UK waters are part of a wider north east Atlantic population. SCANS II covered all European Atlantic continental shelf waters in June/July 2005 and estimated total abundance in the area as 63,366 (CV=0.46) (SCANS-II 2008).

5.7.3 Occurrence in Aberdeen Bay and surrounding area

There have been infrequent sightings during surveys in the North Sea, generally during summer months (Hammond *et al*., 2001). Occasional strandings have been recorded along the UK North Sea coast (Reid and Patterson, 1998). Figure 5-59 shows sightings records of common dolphins made during systematic surveys and some platforms of opportunity off northeast Scotland (Hammond *et al*., 2004). During the SCANS II survey in July 2005, common dolphins were sighted in the waters west of Britain and Ireland, in the channel, and in shelf waters off France, Spain and Portugal (SCANS II, 2006).

Nine groups of common dolphins, ranging in size from one to 25 animals, were recorded during NORCET surveys (MacLeod *et al*., 2007). Sightings occurred from June to August and in every year except 2005. This species primarily occurred in relatively coastal waters near Shetland and north-east Scotland (Figure 5-59). Common dolphins appear to be a regular, if rare and seasonal, member of the cetacean assemblage of the northern North Sea

(MacLeod *et al*., 2007). In the outer southern Moray Firth, along the Southern Trench, approximately 300+ common dolphins were encountered on 8th July 2007 (Earthwatch, 2011).

One solitary common dolphin was recorded during the EOWDC 2007-2008 surveys (Figure 5-53).

5.7.4 Seasonal occurrence

Common dolphins are occasional summer visitors to the North Sea (Hammond *et al*., 2001; 2004). Most sightings of in the North Sea have been recorded between June and September (Reid *et al*., 2003).

5.7.5 Diet

The diet of common dolphins comprises a wide range of small fish and squid (Reid *et al*., 2003). In the North Sea, small pelagic schooling fishes and squids are the likely main food items (Hammond *et al*., 2004). An influx of the squid *Todarodes sagittatus* to the North Sea during 1937 was accompanied by an influx of common dolphins that same year, and it was assumed that the common dolphins were feeding on these squid (Fraser, 1946; Hammond *et al*., 2004).

Fourteen fish taxa and two cephalopod taxa were identified from the stomachs of nine common dolphins from Scottish waters between 2000 and 2003. Mackerel, followed by whiting were the main prey. Other prey species included herring, sprat, *Argentine* sp., cod, haddock, blue whiting, *Trisopterus* spp., grey gurnard, scad, sandeels and plaice (Santos *et al*., 2004b).

5.7.6 Strandings

Three stranded common dolphins have been recorded by the Scottish Agricultural College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and August 2006 (SAC, 2006). The body lengths of the dolphins were between 150 cm and 220 cm; two were female and one was male. The stranded common dolphins were recorded between Fraserburgh and Aberdeen (Table 5-18).

Table 5-18 Common dolphins stranded along the northeast coast of Scotland (January 1992 – August 2006).

Date Found	Location	Sex	Body length
March 1992	Aberdeen	F	193 cm
April 2005	Aberdeen	F	151 cm
May 2005	Rattray Bay	M	219 cm

Strandings records indicate that common dolphins are present along the northeast coast of Scotland between March and May, although their occurrence in the strandings record is infrequent (SAC, 2006).

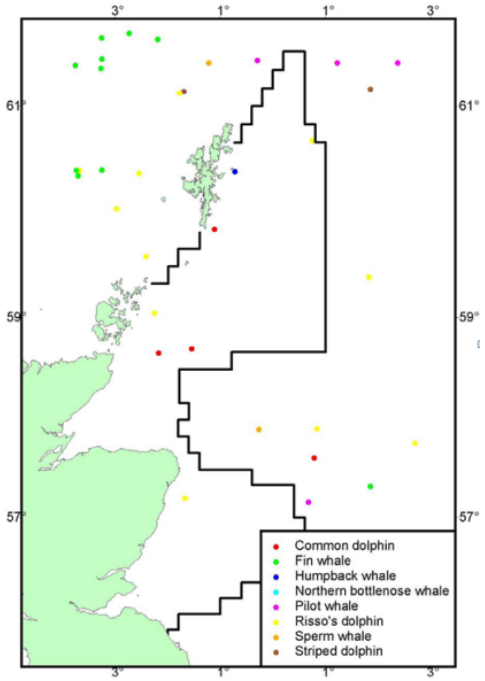


Figure 5-59 Sightings records of common dolphins, fin whales, humpback whales, northern bottlenose whales, pilot whales, Risso's dolphins, sperm whales and striped dolphins made during NASS-87, NILS-95 JNCC seismic and other surveys. Black line outlines SEA 5 area.

5.8 RISSO'S DOLPHIN (*GRAMPUS GRISEUS*)

5.8.1 Distribution

Risso's dolphins have a wide distribution and are generally found in oceanic waters. Risso's dolphins are primarily a warm water (4.5-28^{o}C) pelagic species generally found in continental slope waters (Reid *et al*., 2003). In UK continental shelf seas, Risso's dolphins have been recorded mainly over slopes of 50-100 m depth (Reid *et al*., 2003).

Most of the sightings recorded from the northern North Sea are around Shetland, Orkney, Fraserburgh, Aberdeen and Berwick, with only a few sightings in the central North Sea (Reid *et al*., 2003; Hammond *et al*., 2001). The sightings records of Risso's dolphins made during systematic surveys and some platforms of opportunity off north-east Scotland are illustrated in Figure 5-59.

5.8.2 Abundance

There have been no attempts to estimate the abundance of Risso's dolphins over wide areas of the North Sea, although the animals occurring in UK waters are likely to be part of a population ranging in size from 500 animals to the low 1,000s, similar to population sizes in the north west Atlantic (JNCC, 2010).

5.8.3 Occurrence in Aberdeen Bay and surrounding area

Sightings of Risso's dolphins in northern North Sea are mainly between July and August, although some animals were present off north east Scotland and Shetland in winter (Reid *et al*., 2003). Along the southern outer Moray Firth coast (May to October, 2001-2005), Risso's

dolphins were exclusively recorded in September and were seen in increasing abundance during the latter years of the study (Robinson *et al*., 2008).

During ferry surveys between Aberdeen, Orkney and Shetland in summer months between 2002 and 2006, Risso's dolphins were sighted on six occasions, with group size ranging from one to four individuals (MacLeod *et al*., 2007). These sightings all occurred in 2006 and were either in relatively coastal waters close to Shetland or north-east Scotland.

Risso's dolphins have been recorded off the Aberdeenshire coast since 2005, with sightings off Girdle Ness in September 2005 and off Cruden Bay/Bullars of Buchan in October 2005. There were several reported sightings around Aberdeen during July/August 2006 and February and April 2007. More recently (2010) a group of 4 Risso dolphins were observed at Longhaven Cliffs near Aberdeen (ACC, 2008; Seawatch Foundation, 2011).

During bird vantage point surveys for this project, 20 Risso's dolphins were recorded at Blackdog on the 28th April 2006 and 10 Risso's dolphins were observed at the Donmouth on the 24th April 2007. In the EOWDC boat survey in July 2011 two observations of Risso's dolphins consisting of ten and six observations were recorded.

The increase in recent sightings in the Aberdeen Bay area may indicate that Risso's dolphins are using the area more frequently, and although numbers are still low, the frequency of the utilisation of Aberdeen Bay area may change and this should be monitored in subsequent surveys.

5.8.4 Diet

Risso's dolphins are capable of deep dives and are thought to specialise in catching squid (Hammond *et al*., 2001). They have been reported to feed mostly on cephalopods, although small fish are also taken (Reid *et al*., 2003). Three Risso's dolphins stranded in Scotland between 1993 and 1995 had been feeding on cephalopods (Santos *et al*., 1995).

5.8.5 Strandings

Two Risso's dolphins have been recorded by the Scottish Agricultural College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and August 2006. The first a female with a body length of 325 cm was recovered in November 2004 from Blackdog, while the second had a body length of approximately 250 cm, the sex was not determined, and was recovered from Fraserburgh in January 2005 (SAC, 2006; CSIP 2009).

Strandings records suggest that although Risso's dolphins may be present in the area, their occurrence is occasional and the number of animals in the area is likely to be low.

5.9 STRIPED DOLPHIN (*STENELLA COERULEOALBA*)

5.9.1 Distribution

The striped dolphin has a worldwide distribution, occurring in both southern and northern hemispheres mainly in tropical, sub-tropical and warm-temperate oceanic waters. It tends to occur beyond the continental shelf in depths of 1,000 m or deeper, but has been occasional recorded in shelf waters and even in waters of 60 m or less (Forcada *et al*., 1990; Reid *et al*., 2003).

5.9.2 Abundance

The abundance estimate obtained from the CODA surveys is 82,585 (95% CI = 29,548 – 230,819) animals (Macleod, *et al*., 2008).

Striped dolphins were not reported in Scottish waters until 1988 (Reid *et al*., 1993). It has been suggested that it is a warm-water species, and may have recently expanded its distribution northwards in line with the increase in sea temperatures from climate change (Macleod *et al.* 2005).

5.9.3 Occurrence in Aberdeen Bay and surrounding area

As mentioned striped dolphins are generally rare in UK waters, with its normal distribution reaching its nothern limit at 50^{o}N, although they have been observed in the North Sea (Reid *et al*., 2003; Stone, 2001). Most near-shore records from the UK have been recorded between July and December (Evans, 1992; Reid *et al*., 2003). Sightings records of striped dolphins made during systematic surveys and some platforms of opportunity off north-east Scotland are illustrated in Figure 5-57.

No striped dolphins were recorded in any of the EOWDC project surveys.

5.9.4 Diet

The striped dolphin diet consists of a variety of mesopelagic and benthic fish, including sprat, blue whiting, *Trisopterus* spp. and whiting, as well as squid and crustaceans (Reid *et al*., 2003).

The stomach contents of four striped dolphins stranded around Scotland (1993-1995) contained mainly Gadidae (whiting and *Trisopterus* spp.), but also cephalopods, including the sepiolid *Sepietta oweniana* and the oceanic squid *Gonatus steenstrupi* (Santos *et al*., 1995). Ten fish taxa and four cephalopod taxa were identified in the stomach contents of seven striped dolphins stranded around Scotland between 2000 and 2003. Crustacean and polychaete remains were found in three and one of the stomachs, respectively. The main prey species were haddock/saithe/pollock (these species are grouped together as their otoliths are very similar and not always possible to distinguish), followed by *Trisopterus* spp. and whiting (Santos *et al*., 2004b).

5.9.5 Life History

Very little is known about the life history of striped dolphins in Scottish waters. The reproductive status was determined for 6 female and 6 male stranded striped dolphins between 2001 and 2003, with the majority being immature but the (small) sample included one pregnant female and one sexually active mature male. The pregnant female was recovered from Skye on the west coast of Scotland in September 2001 and the mature and sexually active male was recovered from the North Sea coast in May (Santos *et al*., 2008).

5.9.6 Strandings

During 1992-2003, 52 striped dolphin strandings were recorded in Scotland. Although strandings were recorded in every month of the year, highest numbers were found in January-March and August. Striped dolphins stranded all around the Scottish coast, but the majority were recovered from the west coast (Santos *et al*., 2008).

5.10 LONG-FINNED PILOT WHALE (*GLOBICEPHALA MELAS*)

5.10.1 Distribution

Long-finned pilot whales occur in temperate and sub-Arctic regions of the North Atlantic and in the southern oceans (Reid *et al*., 2003). Long-finned pilot whales in UK waters occur mainly off the continental shelf, but their numbers and distribution seems to be highly variable both between seasons and inter-annually. Most records were from waters greater than 200 m, with relatively few occurrences in the shallower waters of the North Sea (Hammond *et al*., 2001). The sightings of pilot whales made during systematic surveys and some platforms of opportunity off north east Scotland are illustrated in Figure 5-59.

5.10.2 Abundance

There is no recent population estimate for this species. The NASS-89 survey estimated 778,000 long-finned pilot whales in the eastern North Atlantic (Hammond *et al*., 2001). There has been a sustained catch of pilot whales off the Faroes for many hundreds of years, during which period more than 230,000 whales have been taken. Historically, there were enough whales around Shetland to support a drive fishery. The largest catch on record in this fishery was 1,540 animals caught in 1845 (Nature in Shetland, 2011).

5.10.3 Occurrence in Aberdeen Bay and surrounding area

Incidental sightings of pilot whales in the North Sea appear to be more numerous between November and January (Reid *et al*., 2003). There are a few sightings in the northern North Sea and there are also records from the south western North Sea during June, July, August, and December (Reid *et al.,* 2003). Pilot whales are seen in Shetland waters in most months of the year.

During land-based surveys at Stonehaven between March 2003 and March 2005, pilot whales were observed in November 2003 (Canning, 2007). Along the southern outer Moray Firth coast (May to October, 2001-2005), pilot whales were intermittently encountered in the study area between the months of July and August (Robinson *et al*., 2008).

No long-finned pilot whales were recorded in any of the EOWDC boat surveys.

5.10.4 Diet

Cephalopods generally form the majority of their diet, although they take a range of species. Twelve genera of cephalopods, as well as 15 genera of fish and crustaceans have been recorded from studies near the Faroes, with squid, especially *Todarodes sagittatus* as a key component (Desportes and Mouritsen, 1993; Reid *et al*., 2003).

5.10.5 Strandings

Strandings along the UK North Sea coast have increased since 1947; there were a number of mass strandings involving more than 150 animals in total between November 1982 and January 1985 (Hammond *et al*., 2001; Martin *et al.*, 1987; Sheldrick, 1976). Pilot whales are one of the most commonly mass-stranded whales.

One long-finned pilot whale has been recorded by the Scottish Agricultural College along the north east coast of Scotland from Fraserburgh to Inverbervie between January 1992 and March 2010. The female had a body length of 308 cm and was recovered from Fraserburgh in April 2001 (SAC, 2006; CSIP 2010).

Strandings records suggest that although long-finned pilot whales may be present in the area, the number of animals in the area is likely to be low.

5.11 SPERM WHALE (*PHYSETER MACROCEPHALUS*)

5.11.1 Distribution

Sperm whales have a wide distribution that includes tropical, temperate and sub-polar seas of the northern and southern hemispheres (Reid *et al*., 2003). Sperm whales are normally distributed to the west and north of the UK on and beyond, the continental shelf break. They have also been recorded fairly regularly in Orkney and Shetland waters, with sightings and strandings reported in most months (Hammond *et al*., 2001). A number of sightings and strandings have been recorded from the North Sea in the last decade. Males migrate to high latitudes to feed and, as a result, all sperm whales stranded in the North Sea to date have been males (Hammond *et al*., 2001) (Table 5-19). The sightings records of sperm whales made during systematic surveys and some platforms of opportunity off north east Scotland are illustrated in Figure 5-59. Sightings of sperm whales in British and Irish waters have been mainly recorded between July and December (Reid *et al*., 2003).

5.11.2 Abundance

The world population of sperm whales has been estimated at 2 million individuals, making them the most abundant species of large whale in the world (Hammond *et al*., 2001).

No sperm whales were detected in any of the EOWDC surveys.

5.11.3 Diet

Sperm whale diet is varied but primarily consists of medium to large-sized mesopelagic squid (Reid *et al*., 2003).

Stomach contents of sperm whales stranded in Scotland and Denmark during 1990-96 were analysed (Santos *et al*., 1999). All were sub-adult or adult males and stranded between November and March. The diet of these whales was found to consist almost entirely of cephalopods, principally squid of the genus *Gonatus* (probably *G. fabricii*, an oceanic species characteristic of Arctic waters). The other prey species identified were also mostly oceanic cephalopods: the squids *Histioteuthis bonnellii*, *Teuthowenia megalops* and *Todarodes sagjttatus* and the octopus *Hahphron atlanticus*. There was little evidence of predation on fish. Remains of single individuals of the veined squid *Loligo forbesi*, the northern octopus *Eledone cirrhosa* and the saithe *Pouachius virens* provided the only possible evidence of feeding in the North Sea. The study suggested that sperm whales do not enter the North Sea to feed (Santos *et al*., 1999).

5.11.4 Strandings

Nine sperm whales have been recorded by the Scottish Agricultural College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and December 2009, six of which stranded together in Cruden Bay in January 1996. Nine male stranded sperm whales were recorded along the north east coast of Scotland during 1996-2009 and their body lengths ranged between 1,200 cm and 1,375 cm (CSIP, 2010) (Table 5-19).

Table 5-19 Sperm whales stranded along the northeast coast of Scotland (January 1992 – March 2010).

Date Found	Location	Sex	Body length
January 1996	Cruden Bay	M	1,210 cm
January 1996	Cruden Bay	M	1,260 cm
January 1996	Cruden Bay	M	1,285 cm
January 1996	Cruden Bay	M	1,365 cm
January 1996	Cruden Bay	M	1,365 cm
January 1996	Cruden Bay	M	1,375 cm
May 2005	Cruden Bay	M	c1,350 cm
March 2006	Forvie	M	c1,200 cm
October 2009	Balmedie	M	1,400 cm

Stranding records suggest that although male sperm whales may be present in the area between January and May, their occurrence is occasional and the number of animals in the area is likely to be low (SAC, 2006).

5.12 HUMPBACK WHALE (*MEGAPTERA NOVAEANGLIAE*)

5.12.1 Distribution

The humpback whale occurs globally in tropical, temperate and polar seas of the northern and southern hemispheres (Reid *et al*., 2003). It is generally found along and over the edges of continental shelves. In summer the species tends to have a more coastal distribution in some areas that is largely depended on local prey availability (Reid *et al*., 2003).

5.12.2 Abundance

In the summer, a very small number of humpbacks are found in British shelf waters, particularly around the Northern Isles and also in western areas from the Hebrides to the English Channel (Evans, 2003).

5.12.3 Occurrence in Aberdeen Bay and surrounding area

Most sightings over the UK continental shelf have been made between May and September (Reid *et al*., 2003). The sightings records of humpback whales made during systematic surveys and some platforms of opportunity off north-east Scotland are illustrated in Figure 5-59.

During ferry surveys between Aberdeen, Orkney and Shetland in summer months between 2002 and 2006, one group of humpback whales, consisting of two adults and one juvenile, was seen in July 2005 (MacLeod *et al*., 2007). While this species was once almost completely absent from the North Sea due to the depletion of the North Atlantic humpback whale population by whalers, this species is now becoming regularly recorded in the North

Sea in small numbers possibly as a result of a recovery in the North Atlantic population (MacLeod *et al*., 2007). Along the southern outer Moray Firth coast, humpback whales were intermittently encountered in the study area between the months of July and August (Robinson *et al*., 2008).

Humpback whales have been recorded off the Aberdeen coast in the area between Girdleness and Cove, just south of Aberdeen in February 2003 and June 2002 and off Portlethen in 2010 (Seawatch Foundation 2011).

No humpback whales were recorded during the EOWDC surveys.

5.12.4 Diet

The diet of humpback whales in the North Sea area is unknown, but elsewhere they consume planktonic crustaceans and small schooling fish. The fish species most likely to be consumed are those that form dense pelagic schools such as sandeels, herring, sprats and mackerel (Hammond *et al*., 2001, 2004; Reid *et al*., 2003).

5.13 FIN WHALE (*BALAENOPTERA PHYSALUS*)

5.13.1 Distribution

Fin whales occur in the North Atlantic and are mainly found in deep waters (400-2,000 m depth) beyond the edge of the continental shelf, but in some areas they are known to occur in shallower waters less than 200 m deep (Reid *et al*., 2003). In north west Europe fin whales are mainly distributed along or beyond the 500 m depth contour (Reid *et al*., 2003). The sightings records of fin whales made during systematic surveys and some platforms of opportunity off north east Scotland are shown in Figure 5-59.

5.13.2 Abundance

The fin whale is the most abundant large baleen whale species in the North Atlantic. The best available estimates of recent abundance accepted by the IWC Scientific Committee are 25,800 (CV= 0.13) in 2001 for the central North Atlantic (East Greenland-Iceland, Jan Mayen, Faeroes and some waters within the UK 200 nm limit) (IWC, 2007); 4,100 (CV 0.21) in 1996-2001 for the north eastern North Atlantic (North and West Norway); and 17,355 (CV 0.27) in 1989 for the Spain-Portugal-British Isles area (Buckland *et al*., 1992).

5.13.3 Occurrence in Aberdeen Bay and surrounding area

Around the British Isles, fin whales occur mainly between June and December, with most sightings in northern Britain occurring between June and August (Reid *et al*., 2003).

Three groups of fin whales were recorded during NORCET surveys, all in the outer Moray Firth region. However, these were all during a single survey in June 2006 and may represent a small number of stray animals rather than indicating the regular occurrence of this species in the northern North Sea (MacLeod *et al*., 2007).

No fin whales were recorded during any EOWDC project surveys.

5.13.4 Diet

Fin whales feed primarily on planktonic crustaceans, mainly euphausiids, but they also take a variety of fish such as herring, sandeel, mackerel and blue whiting as well as cephalopods (Reid *et al*., 2003).

5.14 BEAKED WHALES

5.14.1 Distribution

Three species of beaked whale have been sighted in UK waters: northern bottlenose whale (*Hyperoodon ampullatus*), Sowerby's beaked whale (*Mesoplodon bidens*) and Cuvier's beaked whale (*Ziphius cavirostris*). Northern bottlenose whales only occur in temperate, sub-polar and polar seas in the North Atlantic (Reid *et al*., 2003). Bottlenose whales are mostly recorded in deep water and most sightings have been made north and west of Scotland along the continental shelf edge over the 1,000 m isobath. The species is rarely seen in shelf waters of the North Sea (Reid *et al*., 2003). Sowerby's beaked whale has the most northerly distribution of all species of *Mesoplodon* in the Atlantic and is the most frequently seen and stranded *Mesoplodon* species in the north Atlantic (Reid *et al*., 2003). It is generally found in deep water, although has been recorded in the North Sea (Reid *et al*., 2003). Cuvier's beaked whale, is frequently recorded in the Bay of Biscay and further south. However, and there have been a few confirmed sightings in summer in UK waters (off west Scotland and in the northern North Sea), all in the summer (Reid *et al*., 2003).

5.14.2 Occurrence in Aberdeen Bay and surrounding area

The sightings records suggest that beaked whales are very rare visitors to the northern and central North Sea. In summer the northern bottlenose whale appears to move towards north-west European shelf waters, where most records occur between April and September. Peak sightings of northern bottlenose whales off northern Scotland have been recorded in August (Evans, 1992; Reid *et al*., 2003).

A northern bottlenose whale was sighted near the entrance to Aberdeen Harbour in 2009 (C. Bloomer *pers comm*.)

No beaked whale species were recorded during the EOWDC surveys.

5.14.3 Abundance

In the western Atlantic several estimates have been made for Mesoplodon spp. Grouped, and Cuvier's beaked whale and these have all been in the low hundreds. However, due to the cryptic nature of these species (deep diving and occurring in small groups) these estimates carry a substantial negative bias.

5.14.4 Diet

Northern bottlenose whales are predominantly squid feeders. They do not appear to enter the North Sea very frequently and it is likely that when they do, they would be following squid (Hammond *et al*., 2001). Their diet is dominated by a variety of squid species, particularly *Gonatus fabricii* and species of the genera *Histioteuthis* and *Octopoteuthis*, but also includes some fish species and crustaceans (Reid *et al*., 2003).

Stomach content analysis of northern bottlenose whales stranded in the North Sea (Netherlands, 1993 and 1956; Denmark, 1997; Dunbar, Scotland, 1885) found the food remains to consist almost entirely of cephalopod beaks, with only a few fish and crustacean remains. The cephalopod prey consisted mainly of oceanic species, in particular *Gonatus fabricii* (Santos *et al*., 2001b).

Sowerby's beaked whale diet is generally dominated by fish and squid. The stomach contents of three animals stranded in Scotland consisted of Merluccidae spp. and Gadidae spp. (MacLeod *et al*., 2003). The stomach contents of one Sowerby's beaked whale

stranded in Scotland (1993-1995) had only large Gadidae otoliths (haddock/saithe/pollack) in the stomach (Santos *et al*., 1995).

5.14.5 Strandings

One Sowerby's beaked whale has been recorded by the Scottish Agricultural College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and March 2010 (CSIP, 2010). The male had a body length of 470 cm and was recovered from Peterhead in January 2005 (SAC, 2006).

Strandings records suggest that although Sowerby's beaked whales may be present in the area, their occurrence is occasional/rare and the number of animals in the area is likely to be low.

6. SEALS

This section describes the distribution and abundance and life histories of the main seal species found in Aberdeen Bay. Information is taken from the main data sources described in Section 2 as well as other applicable studies and also the EOWDC surveys.

6.1 HARBOUR (OR COMMON) SEAL (*PHOCA VITULINA*)

6.1.1 Distribution and abundance

Harbour seals are one of the most widespread pinniped species and have a practically circumpolar distribution in the Northern Hemisphere. Harbour or common seals are found around the coasts of the North Atlantic and North Pacific from the subtropics to the Arctic. There are four sub-species. Only the eastern Atlantic harbour seal, *Phoca vitulina vitulina,* occurs around Britain (Hammond *et al*., 2004; SCOS, 2006).

Britain is home to approximately 40 % of the world population of the European sub-species. Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast, their distribution is more restricted with concentrations in The Wash, Firth of Tay and the Moray Firth (Hammond *et al*., 2004; SCOS, 2006). The Moray Firth supports a population of approximately 1,600 harbour seals, the largest on the east coast of Scotland (Thompson *et al*., 2007).

Figure 6-1 depicts the distribution of harbour seals in the north-western North Sea as it was believed to be before satellite telemetry studies (after Reijnders *et al*., 1997), at-sea sightings from Pollock *et al*. (2000) are also shown (Hammond *et al*., 2004).

Satellite telemetry of harbour seals found in Orkney and Shetland and seals hauling out in St Andrews Bay and the Moray Firth indicate the true distribution of seals around north-east Scotland as illustrated in Figure 6-2 (Hammond *et al*., 2004).

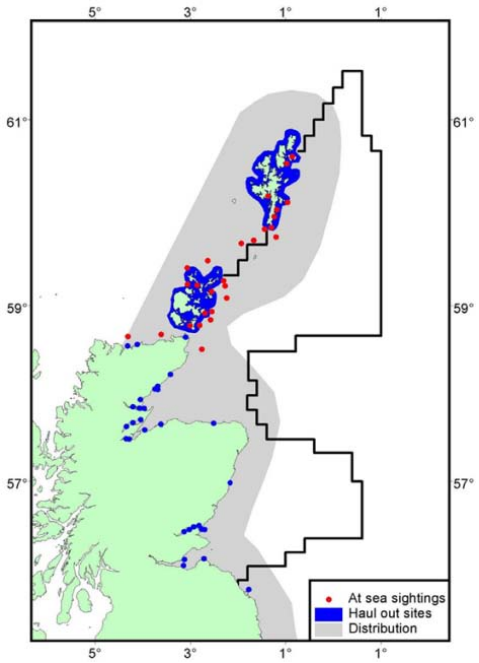


Figure 6-1 Harbour seal distribution in the north-western North Sea after Reijnders *et al*., (1997). Also shown are haul-out sites during the moult (SMRU unpublished data) and at-sea sightings from JNCC surveys Pollock *et al*., (2000) reproduced from Hammond *et al*., (2004).

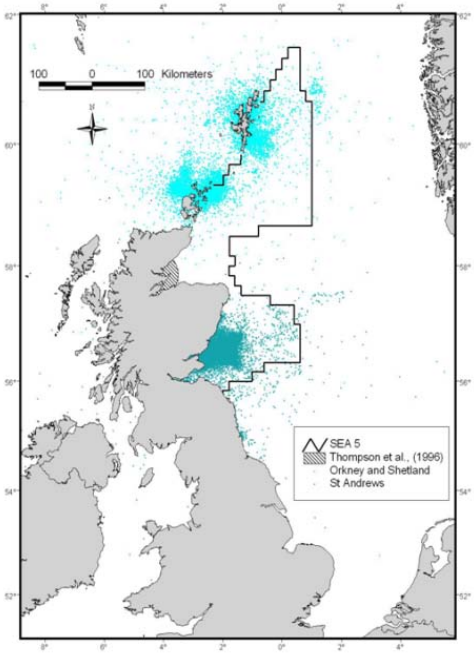


Figure 6-2 Locations of 55 harbour seals fitted with satellite-relay data loggers covering the period 2002-2004 (SMRU unpublished data) and the area used by VHF-tagged harbour seals in the Moray Firth reproduced from Hammond *et al*., (2004).

6.1.2 Occurrence in Aberdeen Bay area

Harbour seals are frequently observed in the River Don, and at least nine animals including juveniles are often seen in the mouth of the Dee or hauled out on sand banks near the Bridge of Don. They are also recorded in Aberdeen Harbour, and may be expected to occur year round in Aberdeen Bay. During project vantage point surveys, harbour seals were recorded at Blackdog in June 2007, Donmouth in July 2007 and at Blackdog and Donmouth in January 2008.

SMRU data on haul out locations of harbour seals that was collected during August 2005 indicates the nearest harbour seal haul-out site is located 7.9 km from the EOWDC development (presented in Figure 6-9 and Figure 6-10).

Detailed observations of the behaviour of harbour seals at sites within the estuaries of the Rivers Dee and Don, in north-eastern Scotland, were made over two full years between 1993 and 1996 (Carter *et al*., 2001). Small numbers of grey seals were also present. The presence of seals within the estuaries was strongly related to season, with maximum numbers observed in winter and early spring; seals were virtually absent in June and July. The River Don was used largely as a haul-out site, while the River Dee was used predominantly as a foraging site. It was not possible to determine whether the same seals were using the two estuaries. More seals were hauled-out on the River Don during twilight and dark than in daylight (Carter *et al*., 2001).

6.1.3 Abundance

The most recent estimate of the number of harbour seals in Scotland is 19,988, from surveys carried out in 2006-2008 (SCOS, 2009). The abundance estimates have a degree of error as only a proportion of the individuals in the population will be hauled out and counted during

surveys. The total British population has been estimated at 40,000-46,000, and this takes into account animals missed during the counting (SCOS, 2009).

Approximately 20 % of the eastern Atlantic harbour seal subspecies breeds in Orkney and Shetland and along the east coast of Scotland (Hammond *et al*., 2004).

Surveys of the east coast populations in 2008 showed continuing declines in the Firth of Tay population and a continued lack of recovery in the Moray Firth. The reasons for this recent decline are not known at present. The decline contrasts with the apparent rapid growth in populations in the nearest European populations in the Wadden Sea which increased by 15 % between 2007 and 2008 and has grown by approximately 13 % per annum since the 2002 PDV epidemic (SCOS 2008). The Phocine distemper virus resulted in the death of 730,000 harbour seals in Northern Europe.

Due to declines in the numbers of harbour seals in Shetland, Orkney, the Moray Firth and the Firth of Tay, the Scottish Executive put in place a Conservation Order protecting harbour seals on the east coast and Northern Isles in March 2007. The Order covers the coast from Garron Point by Stonehaven to Torness Point, south of Dunbar on the south side of the Firth of Forth. Seals in the Moray Firth are already protected by a Conservation of Seals (Scotland) Order 2004.

6.1.4 Haul-out sites and breeding

Harbour seals come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. They tend to be more localised than grey seals, staying in the same general area to breed, feed and rest, and do not form as large breeding colonies. Harbour seals haul out on land regularly in a pattern that is often related to the tidal cycle (SCOS, 2006).

Pupping occurs on land from June to July during which time females and pups spend a high proportion of their time ashore. The moult is centred around August and extends into September. Moulting seals also spend a high proportion of their time ashore, such that from June to September harbour seals are ashore more often than at other times of the year (Hammond *et al*., 2004).

6.1.5 Movements and foraging

Radio-tracking of adult female seals in the inner Moray Firth (1988, 1989, 1992) during the breeding season indicated that seals foraged up to 45 km from the haul-out site, but females with pups restricted their range markedly during the early part of the lactation period (Thompson *et al*., 1994).

Generally it has been thought that harbour seals forage relatively close inshore within a range of 60 km from their haul-out sites (Thompson *et al.*, 1996). However, recent information on foraging movements and the distribution at sea of harbour seals has highlighted greater travel distances, ranging from 10 km to 120 km, with a mean of 46 km (Hammond *et al*., 2004).

Data from satellite relay data loggers have highlighted different foraging behaviour of harbour seals off south east Scotland and around Orkney and Shetland. Off south east Scotland, animals were found to be very faithful in their use of haul-out sites on land, and moderately site-faithful in the areas individuals used to forage. Duration of trips ranged from less than one day to 23 days, with a mean of 4.5 days. Foraging in the Moray Firth tended to be closer to the shore. Around Orkney and Shetland there are indications that seals tend to move between haul-outs sites within a 40 km radius of where they were captured with one

animal hauling out as far as 200 km from where it was initially tagged. Foraging behaviour is also much more variable both in distance travelled and in the duration of trips. Most foraging trips are within 40 km of haul-outs but there are also longer distance trips to areas more than 200 km from haul-out sites (Hammond *et al*., 2004).

6.1.6 Diet

Harbour seals take a wide variety of prey including sandeels, whitefish, herring and sprat, flatfish, octopus and squid. Diet varies seasonally and from region to region (Hammond *et al*., 2004; SCOS, 2006). In Shetland, Brown and Pierce (1998) found that gadoids accounted for an estimated 53.4% of the annual diet by weight, sandeels 28.5 % and pelagic fishes 13.8 %. The dominant gadoid fishes were whiting and saithe. There were strong seasonal patterns in the contribution of sandeels and gadoids, with sandeels being important in spring and early summer, and gadoids in winter. Pelagic species (mainly herring, garfish and mackerel) were important in late summer and autumn (Hammond *et al*., 2004).

In the Moray Firth, Tollit and Thompson (1996) found the key prey during 1989-1992 to be sandeels, lesser octopus, whiting, flounder, and cod. Significant between-year and seasonal fluctuations were evident. In another study in the same area between 1992 and 1994, Tollit *et al*. (1997) found the diet composition was almost totally dominated by either pelagic species or species dwelling on or strongly associated with the seabed, depending upon the relative abundance of pelagic schooling prey (Hammond *et al*., 2004).

In the Firth of Tay, unpublished SMRU data from 1998-2003 show that the diet comprised primarily sandeels, gadoids and flatfish. Gadoid prey was dominated by whiting, followed by cod and haddock. Plaice was the main flatfish consumed followed by dab, flounder and lemon sole. Strong seasonal patterns in prey consumption were evident (Hammond *et al*., 2004).

During observation at the estuaries of the Rivers Don and Dee, the seals were observed to eat mostly salmonids, *Salmo salar* and *S. trutta*, unidentified roundfish and founder, *Pleuronectes flesus*. There were also observations of seals taking starfish and crabs. Predation on salmonids was observed more frequently on the Dee than the Don, while the reverse was true for predation on flounder. The otoliths identified in scats collected at the mouth of the River Don belonged to marine species, including whiting, sandeels, cod, *Trisopterus* spp., haddock, plaice and lemon sole, as well as three octopus beaks, indicating that the seals were also feeding outside the estuaries (Carter *et al*., 2001).

6.1.7 Special Areas of Conservation

Designated coastal SACs for harbour seals include Yell Sound and Mousa on Shetland, Sanday on Orkney, Wash and North Norfolk coast on the east coast of England, Dornach Firth and Morrich More, in the Moray Firth, and Firth of Tay and Eden Estuary on the Scottish east coast (JNCC, 2011).

6.2 GREY SEAL (*HALICHOERUS GRYPUS*)

6.2.1 Distribution

Grey seals are restricted to the North Atlantic and adjacent seas. There are three recognised populations: the northwest Atlantic (breeding primarily on Sable Island, Canada and in the Gulf of St Lawrence); the Baltic Sea; and the northeast Atlantic (breeding primarily on offshore islands around the British Isles but also in Iceland, the Faroe Islands, France, the Netherlands, central and northern Norway, and around the Kola peninsula in Russia)

(Hammond *et al*., 2004). Figure 6-3 shows the tracks of 108 grey seals recorded over a period of about 10 years and the locations at which it has been determined that the seals were foraging (McConnell *et al.*, 1999; taken from Hammond *et al*., 2004). More recent analysis of grey seal movements in the Pentland Firth area has been provided by SMRU Ltd, which further illustrates the large scale seasonal movements that occur between seals occurring at spatially separate haul out colonies in the North Sea (Figure 6-5).

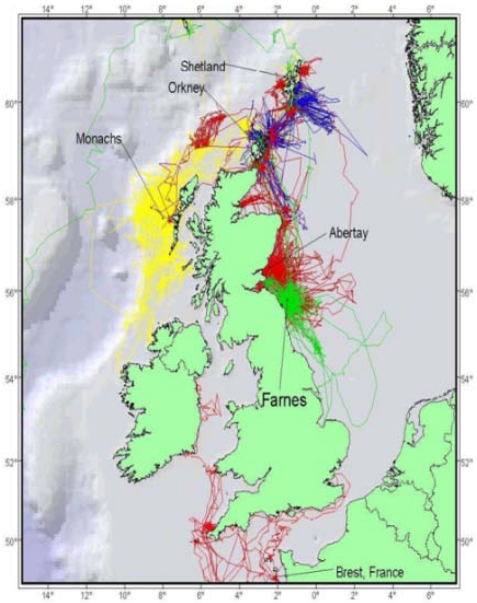


Figure 6-3 Tracks of 108 grey seals fitted with satellite-relay data loggers over a period of about 10 years (McConnell *et al.*, 1999; SMRU, unpublished data). Coloured lines illustrate tracks from various tagging locations.

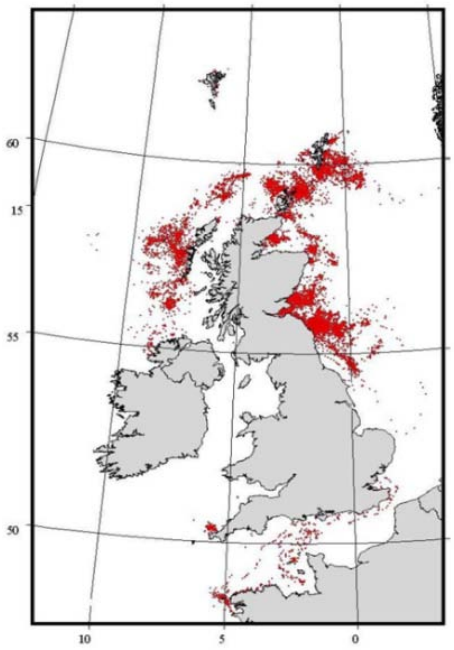


Figure 6-4 Locations of 108 grey seals fitted with satellite-relay data loggers over a period of about 10 years (McConnell *et al.*, 1999). Red points illustrate data transmission locations.

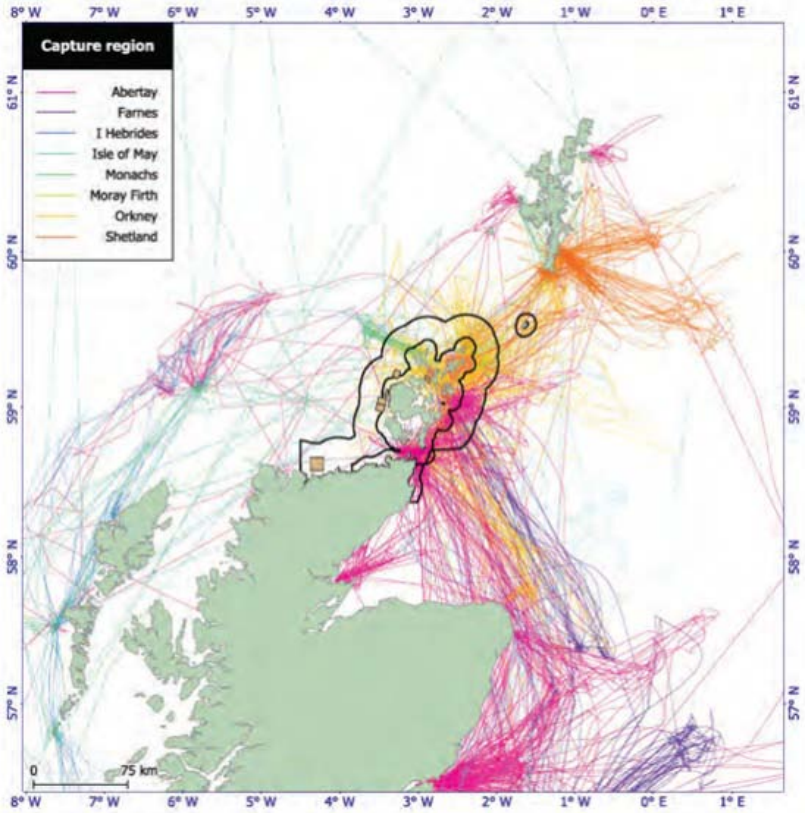


Figure 6-5 Grey seals tagged with SMRU Argos and SMRU GSM/GPS tags, the tracks are colour coded by capture region (SMRU 2011c).

6.2.2 Abundance

The grey seal population of the UK is significant in a global context as the UK population represents approximately 45 % of the world population on the basis of pup production (SCOS, 2009). Over 90 % of British grey seals breed in Scotland, the majority in the Hebrides and in Orkney (SCOS, 2006).

Combining the abundance estimates for the annually monitored seal colonies with the sites which are monitored less frequently provides an estimated seal population of 205,000, with a large confidence interval of 96,500; 405,000. A large proportion of the populations are associated with the colonies in Orkney, Shetland and the east coast of Scotland (Hammond *et al*., 2004).

The latest population estimate has suggested an increase of around 2.8 % between 2007 and 2008. The British grey seal population has been increasing by around 6 % annually since the 1960s.

6.2.3 Occurrence in Aberdeen Bay area

Grey seals, including large bulls, females and immature animals are frequently observed at sea during vessel-based cetacean surveys carried out by the Sea Watch Foundation. Seals use the waters between Stonehaven and Aberdeen as a feeding area, since animals are often observed eating fish at the surface.

Grey seals are frequently observed hauled out on the Skerry just outside Peterhead harbour and may be expected to occur year-round in the area. Grey seals also have important haul-out sites at Pennan Head, Rattray Head, Boddam, Catterline and Donmouth.

Grey seal sightings recorded during project vantage point surveys (August 2005 – March 2008) are summarised in Table 6-1.

Table 6-1 Grey seal sightings recorded during Vantage Point surveys (August 2005 – March 2008).

VP site	Observations
Donmouth	August 2006, December 2006, March 2007, May 2007, August 2007, September 2007
Blackdog	August 2006, December 2006, January 2007, March 2007, May 2007, August 2007, December 2007
Balmedie	December 2006, February 2007, August 2007
Drums	February 2007, August 2007, September 2007

In relation to the location of the EOWDC the nearest grey seal haul-out sites identified during the SMRU seal surveys in August 1997 and 2005 was located 7.9 km (presented in Figure 6-9 and Figure 6-10).

Grey seals were present throughout the survey area during all the boat based survey months and the results are presented in Section 6.3.

6.2.4 Haul-out sites and breeding

Grey seals haul out between foraging trips and for pupping and moulting, when they can form large colonies or aggregations (Hammond *et al*., 2004). Grey seals generally form breeding colonies on rocky shores, beaches and in caves, and on small, largely uninhabited, islands (JNCC, 2011). Large rookeries are located in the Inner and Outer Hebrides, Orkney, Isle of May, Farne Islands and Donna Nook (JNCC, 2011).

In Northern Britain, pupping occurs from October to late November and the moulting season is February-April, during which time they spend more time ashore than at other times of the year (Hammond *et al*., 2001).

Tagging of pups indicate that young seals disperse widely in the first few months of life. Pups marked in the UK have, for example, been recaptured or recovered along the North Sea coasts of Norway, France and The Netherlands, mostly during their first year of life (Hammond *et al*., 2004).

6.2.5 Movements

Adult grey seals routinely move large distances. Grey seal movements have been studied in the North Sea using satellite tagging. In a study of animals at the Farne Islands and Abertay Sands, McConnell *et al.* (1999) found that movements were on two geographical scales: long and distant travel (up to 2,100 km away) to known haul-out sites; and local, repeated trips from haul-out sites to discrete offshore areas. Long-distance travel included visits to Orkney, Shetland, the Faroes, and far offshore into the Eastern Atlantic and the North Sea (Hammond *et al*., 2004). Recent telemetry studies have found that seals tagged as far south as the Farne Islands, Isle of May and Moray Firth have been found to enter the Pentland Firth area (SMRU 2011c).

In 88 % of trips to sea, individual seals returned to the same haul-out site from which they departed. The durations of these return trips were short (typically 2-3 days) and their destinations at sea were often localized areas characterized by a seabed of gravel/sand. This is the preferred burrowing habitat of sandeels, an important component of grey seal diet. The limited distance travelled from the haul-out site (about 40 km return) indicates that the seals were foraging within the coastal zone, rather than further offshore (Hammond *et al*., 2004).

The analysis of the seal tagging data has shown that grey seals tagged in both the Isle of May SAC and Berwickshire and North Northumberland coast SAC appear to routinely travel past Aberdeen through the proposed location on the way to the Pentland Firth.

6.2.6 Diet

Grey seals feed mostly on fish that live on or close to the seabed. The diet is composed primarily of sandeels, whitefish (cod, haddock, whiting, ling), and flatfish (plaice, sole, flounder, dab) but varies seasonally and from region to region (SCOS, 2006).

Studies in 1985 showed that in Orkney sandeels accounted for almost 50% of the diet; the remainder was mostly cod, ling and plaice (Hammond, *et al.*, 1994). In the central North Sea, studies have shown that the diet was dominated by sandeels, cod and whiting (Hammond and Prime, 1990; Hall and Walton, 1999).

6.2.7 Special Areas of Conservation

Designated coastal SAC sites for grey seals include the Berwickshire and North Northumberland Coast in north-east England, Faray and Holm of Faray, on Orkney, and the Isle of May at the entrance to the Firth of Forth (JNCC, 2011).

6.3 EOWDC SEAL SURVEY RESULTS

A summary of the seal species that were recorded during the project boat based surveys are provided in Table 6-2. A total of 162 individual seals, of which a total of 61 were grey seals, 49 harbour seals and 52 were unidentified seals were observed (Figure 6-6 and Figure 6-8).

Table 6-2 Summary of the seal individuals recorded during the EWODC surveys: IECS (2007-2008) and SMRU Ltd (2010-2011) surveys (collected on effort).

Survey	Grey Seal	Harbour Seal	Unidentified
EOWDC 2007-2008	20	0	20
EOWDC 2010-2011	41	49	32
Totals	61	49	52

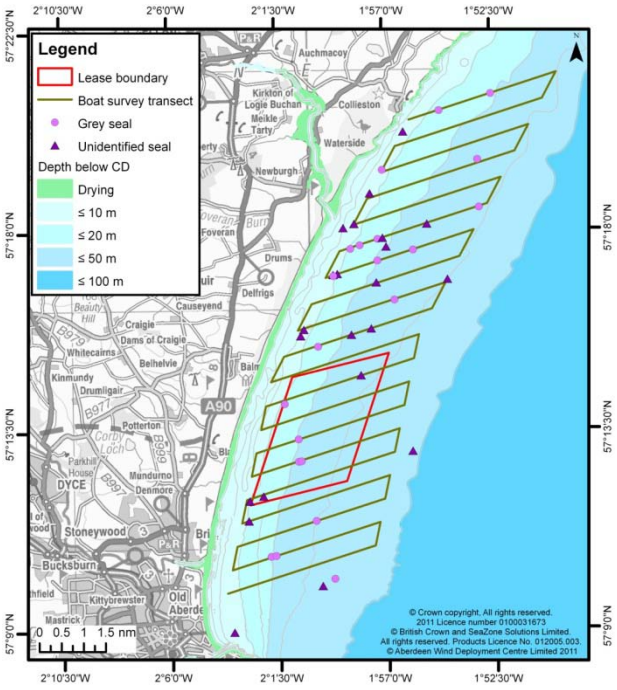


Figure 6-6 Grey and unidentified seals observed during the EOWDC boat based surveys during 2007-2008 (collected on and off-effort).

6.3.1 Harbour seals

Surprisingly no harbour seals were observed during the boat based surveys carried out during 2007-2008. In the 12 months of boat based surveys carried out during 2010-2011 there were 46 observations of 49 individuals; this suggest that either harbour seals were present at a lower abundance in Aberdeen Bay during prior EOWDC surveys in 2007-2008, or a proportion of the unidentified seal species were harbour seals. There was a moderate peak in encounter rates during November and the reason for this may related to optimal feeding opportunities near the vicinity of the Ythan Estuary during this time. The harbour

seals were distributed in higher concentrations around the mouth of the Don and near the Ythan estuary.

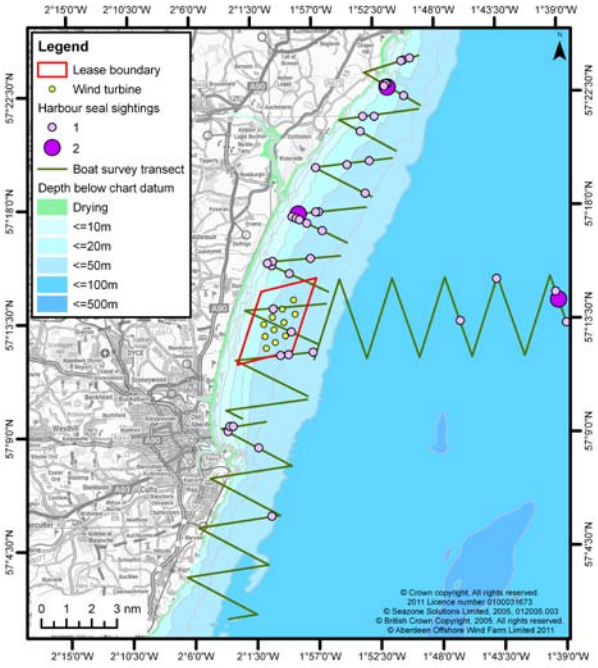


Figure 6-7 Harbour seal individuals recorded on-effort during the EOWDC surveys 2010-2011.

6.3.2 Grey seals

The grey seal was the most frequently recorded species, with a total of 21 individuals recorded on effort during the boat based surveys 2007-2008 (Figure 6-6), and a further 41 individuals recorded in EOWDC surveys carried out between 2010-2011. The grey seal was sighted throughout the survey period with no apparent increase in frequency of sightings with any particular season. In the 2007-2008 surveys there were a higher number of grey seals (n=13) observed in the control area in comparison to the wind farm area (n=8) (Figure 6-6). The majority of grey seal sightings in the 2010-2011 surveys were recorded in the northern half of Aberdeen Bay, this is consistent with the findings from previous surveys.

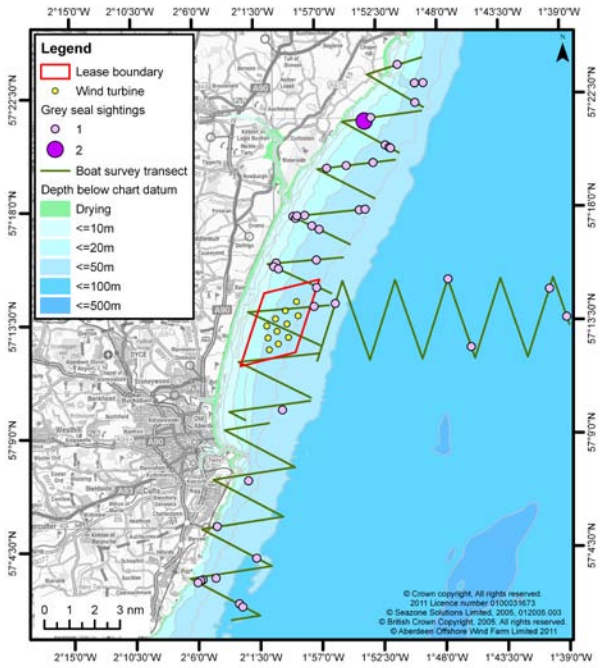


Figure 6-8 Grey seals individuals recorded on-effort during EOWDC boat surveys 2010-2011.

6.3.3 Unidentified seals

During the EOWDC 2007-2008 surveys there were 25 seals that could not be identified to a species level, three of which were observed off transect. A greater number of unidentified seals (n=18) were observed in the wind farm area that the control site. There were 32 unidentified seals recorded during the EOWDC 2010-2011 surveys.

6.4 Aerial Survey Data Seal Counts

SMRU has surveyed harbour both seal species along the east coast of Scotland as part of their routine monitoring of seal populations around the UK. Surveys were carried out in 1997 and 2005, 2007 and 2008 (Figure 6-9 and Figure 6-10). The surveys were conducted during the harbour seal annual moult, in August, when the most consistent numbers of harbour seals are hauled ashore. The surveys were conducted using a helicopter equipped with a thermal imaging camera which can detect seals hauled ashore up to a distance of 3 km. For consistency, surveys are restricted to within two hours either side of afternoon low tides on days with no rain.

Grey and harbour seals were distinguished using their thermal profiles and their group structure on shore. In most cases species identity was confirmed using a 'real' image from a camcorder and directly using binoculars. However, in some cases this is not possible and the seals are classified as 'species unknown'. Additional information on grey seals is also obtained during their breeding season, September to November, using fixed wing aerial photography. Repeat surveys were made of the breeding colonies which allowed subsequent estimates of pup production to be made on a colony-by-colony basis.

These seal counts described below only represent the seals that were ashore. They do not represent the total size of the local population, since a number of seals would have been at sea at the time of the survey. In addition, these data refer to the numbers of seals found within these areas in August only; numbers are likely to vary throughout the year. For instance, small numbers of harbour seals haul out during the winter on the small island at

the mouth of the River Don, in Aberdeen. In addition, the numbers of grey seals ashore during the summer can be highly variable from day to day and the numbers presented above should be interpreted with caution.

6.4.1 Aerial counts and distribution of seals Fraserburgh to Montrose

The numbers of seals counted during the August thermal imaging surveys between Fraserburgh and Montrose are provided in Table 6-3. The sections of coast for which numbers of seals are supplied extend from Fraserburgh to Aberdeen and from Aberdeen to the mouth of the River North Esk (SMRU, 2007).

Table 6-3 Numbers of harbour and grey seals counted between Fraserburgh and Montrose in 1997 and 2005.

Date	Region	Harbour Seals	Grey Seals	Species Unknown
Aug-97	Fraserburgh to Aberdeen	0	131	0
Aug-97	Aberdeen to North Esk	15	14	0
	Total	15	145	0
Aug-05	Fraserburgh to Aberdeen	14	400	3
Aug-05	Aberdeen to North Esk	22	11	0
	Total	36	411	3

During the August 2005 survey harbour seals were observed hauled out at the mouth of the River Ythan and at Catterline. Only small numbers of seals were at these haul-out sites at the time of survey. Another group of nine harbour seals were hauled out in the Montrose Basin, just outside the area covered by Table 6-3 (Figure 6-10).

Small numbers of grey seals were also hauled out at Catterline and at the mouth of the River Ythan but there were considerably more hauled out between the south end of Cruden Bay and Fraserburgh. The main haul-out sites were: The Scares at the south end of Cruden Bay; around Boddam, south of Peterhead; at the mouth (north side) of Peterhead Bay; Scotstown Head; and at Cairnbulg Point. Another group of grey seals was hauled out just outside this area, at Sandhaven, just to the east of Fraserburgh (Figure 6-9 and Figure 6-10).

6.4.2 Counts and distribution of seals in the wider area; Nairn to Kincardine Bridge

Outside the Fraserburgh to Montrose area, but still along the east coast of mainland Scotland, larger numbers of seals can be found. Information from at-sea tagging studies show the east coast of Scotland is used by individuals of both species which move and forage along this coast.

Under the EU's Habitats Directive, the Firth of Tay has been designated a Special Area of Conservation (SAC) for harbour seals and the Isle of May in the Firth of Forth, an SAC for grey seals. Animals from these areas will potentially move along the coast between Fraserburgh and Montrose.

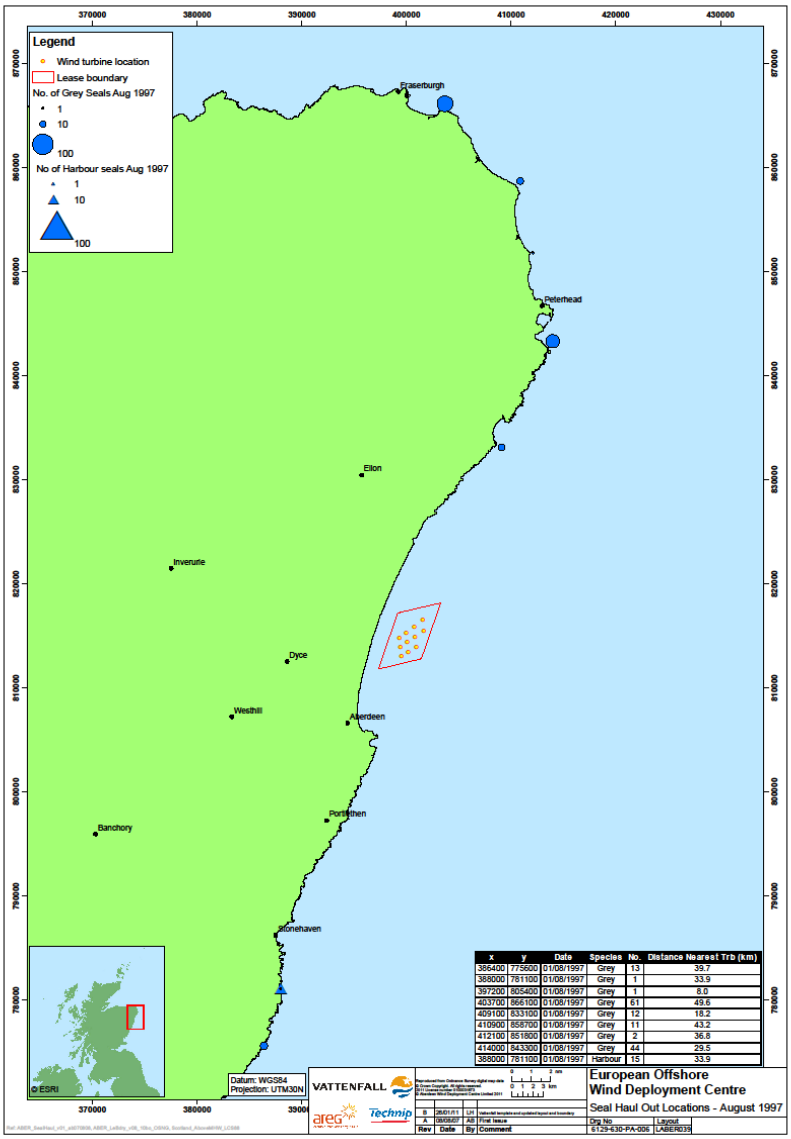
Consequently, survey data from a wider area (Nairn to Kincardine Bridge) is provided in Table 6-4, to allow the numbers of seals in the area of concern (Fraserburgh to Montrose) to be put into context.

Table 6-4 Numbers of harbour and grey seals counted between Nairn and the Kincardine Bridge from surveys carried out in the Augusts of 1997 and 2005 (SMRU, 2007).

Date	Region	Harbour Seals	Grey Seals	Species Unknown
Aug-97	Nairn to Fraserburgh	47	65	0
Aug-97	Fraserburgh to Aberdeen	0	131	0
Aug-97	Aberdeen to North Esk	15	14	0
Aug-97	North Esk to Buddon Ness	0	0	0
Aug-97	Buddon Ness to Newburgh	92	61	0
Aug-97	Newburgh to Tayport	56	0	0
Aug-97	Tayport to Fife Ness	485	1,849	0
Aug-97	Fife Ness to Kincardine Bridge	76	176	0
Aug-97	Isle of May	0	46	0
	Total	771	2,342	0
Aug-05	Nairn to Fraserburgh	77	245	0
Aug-05	Fraserburgh to Aberdeen	14	400	3
Aug-05	Aberdeen to North Esk	22	11	0
Aug-05	North Esk to Buddon Ness	9	0	0
Aug-05	Buddon Ness to Newburgh	92	43	0
Aug-05	Newburgh to Tayport	48	0	0
Aug-05	Tayport to Fife Ness	221	530	0
Aug-05	Fife Ness to Kincardine Bridge	176	73	8
Aug-05	Isle of May	0	18	0
	Total	659	1,320	0

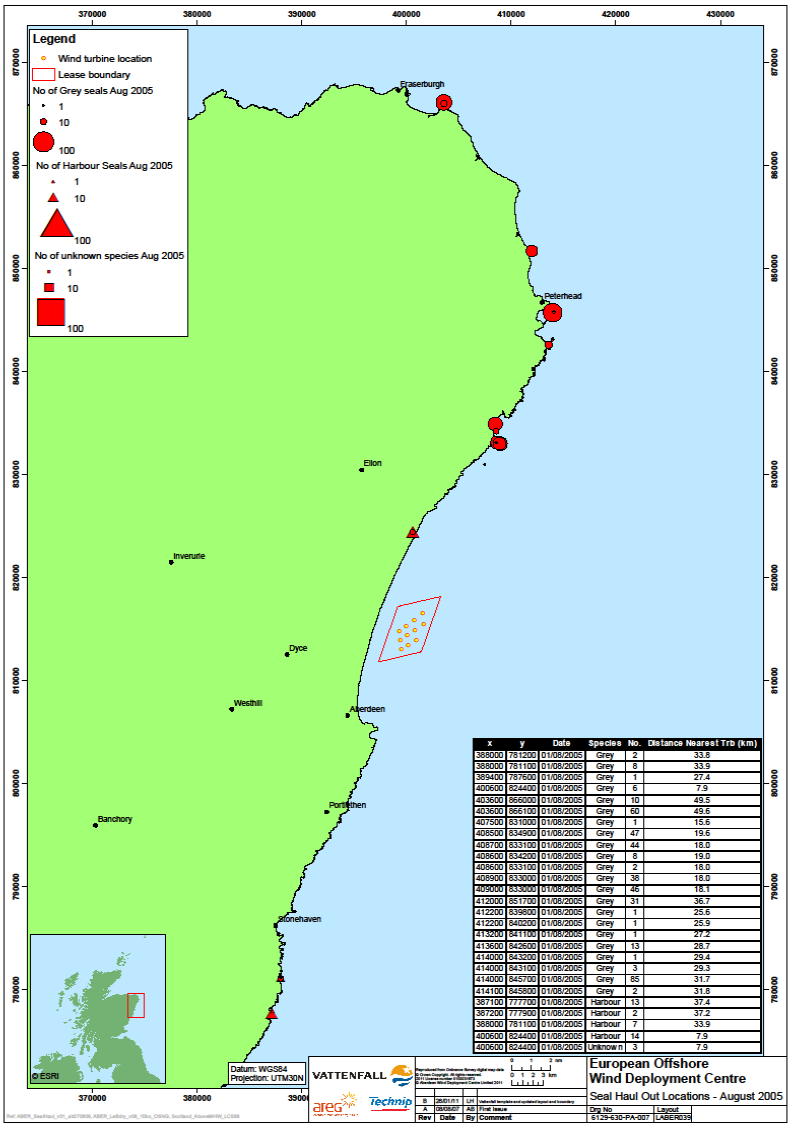
Between Nairn and Kincardine Bridge, the main harbour seal haulout sites are at Findhorn Bay, in the Firth of Tay and the Eden Estuary and between Kirkaldy and Dalgety Bay on the Fife (north) shore of the Firth of Forth.

The main grey seal haulout sites used during August are scattered along the north Grampian coast at Findhorn Bay, Covesea and Halliman Skerries off Lossiemouth, Craigenroan Skerries near Findochty and Strahangles Point near Rosehearty. South of the North Esk, the Firth of Tay and the River Eden are the main grey seal haul out sites, with smaller numbers also using the small islands in the Firth of Forth. The Isle of May, as already mentioned, is a SAC for grey seals, which has supported a total pup production of over 1,800 seals since 1998. It should be noted that the numbers of grey seals counted here during the August surveys are very low.



x	y	Date	Species	No.	Distance Nearest Trb (km)
386400	775600	01/08/1997	Grey	13	39.7
388000	781100	01/08/1997	Grey	1	33.9
397200	805400	01/08/1997	Grey	1	8.0
403700	866100	01/08/1997	Grey	61	49.6
409100	833100	01/08/1997	Grey	12	18.2
410900	858700	01/08/1997	Grey	11	43.2
412100	851800	01/08/1997	Grey	2	36.8
414000	843300	01/08/1997	Grey	44	29.5
388000	781100	01/08/1997	Harbour	15	33.9

Figure 6-9 Haul out locations of harbour and grey seals August 1997.



x	y	Date	Species	No.	Distance Nearest Trb (km)
388000	781200	01/08/2005	Grey	2	33.8
388000	781100	01/08/2005	Grey	8	33.9
389400	787600	01/08/2005	Grey	1	27.4
400600	824400	01/08/2005	Grey	6	7.9
403600	866000	01/08/2005	Grey	10	49.5
403600	866100	01/08/2005	Grey	60	49.6
407500	831000	01/08/2005	Grey	1	15.6
408500	834900	01/08/2005	Grey	47	19.6
408700	833100	01/08/2005	Grey	44	18.0
408600	834200	01/08/2005	Grey	8	19.0
408600	833100	01/08/2005	Grey	2	18.0
408900	833000	01/08/2005	Grey	38	18.0
408000	833000	01/08/2005	Grey	46	18.1
412000	851700	01/08/2005	Grey	31	36.7
412200	839800	01/08/2005	Grey	1	25.6
412200	840200	01/08/2005	Grey	1	25.9
413200	841100	01/08/2005	Grey	1	27.2
413600	842600	01/08/2005	Grey	13	28.7
414000	843200	01/08/2005	Grey	1	29.4
414000	843100	01/08/2005	Grey	3	29.3
414000	845700	01/08/2005	Grey	85	31.7
414100	845800	01/08/2005	Grey	2	31.8
367100	777700	01/08/2005	Harbour	13	37.4
367200	777900	01/08/2005	Harbour	2	37.2
388000	781100	01/08/2005	Harbour	7	33.9
400600	824400	01/08/2005	Harbour	14	7.9
400600	824400	01/08/2005	Unknown	3	7.9

Figure 6-10 Haul out locations of grey and harbour seals in August 2005.

6.5 OTHER SEAL SPECIES

There are occasional records of hooded seal, bearded seal, ringed seal and walrus in the north-east Scotland area (Hammond *et al.*, 2004). All these species are considered to be rare visitors to Aberdeen Bay area.

7. DISCUSSION AND CONCLUSIONS

The review of the distribution of each marine mammal species indicates that although several marine mammals have the potential to be in the area, for the majority of these species the EOWDC area is only a marginal part of their habitat. Most species, with the exception of bottlenose dolphins, have a wide range and regularly occur throughout the northern and central North Sea, both along the coast and in offshore areas.

Sightings, acoustic and strandings data provide useful information on the occurrence of marine mammals in an area. These data indicate that of the marine mammal species recorded in the EOWDC developmental area, bottlenose dolphins, harbour porpoises, white-beaked dolphins, minke whales, harbour and grey seals are regularly present in the area. Therefore, these species, could be affected by any potential impacts associated with the proposed development, such as underwater noise disturbance, changes in prey availability and foraging areas, displacement and barrier effects. Potential impacts to marine mammals and measures to address these in the form of mitigation measures will be detailed in the EIA technical report (addendum).

A summary of species accounts for the regularly occurring species is provided below.

7.1 SPECIES ACCOUNTS

7.1.1 Bottlenose dolphins

Previous data from land based and coastal boat surveys of Aberdeenshire show bottlenose dolphins to be present year round, with a peak in the spring months of March –May (Stockin *et al*., 2006). Young bottlenose dolphin calves have been observed in the area during spring and early summer. A further study using photo-identification methods reported a minimum abundance of 62 individuals with peaks in numbers in May-June (Weir *et al*., 2008). 84 % of the photos taken during the Weir *et al*., (2008) study were matched to individuals from the Inner Moray Firth dolphin catalogue, supporting evidence that these individuals are the same dolphins that use the designated SAC site in the Moray Firth. The bottlenose dolphin population of the Moray Firth has recently been expanding its range in a southerly direction, beyond the boundaries of the Moray Firth SAC, with an increase in sightings and identified individuals along the east coast of Scotland as far as St Andrews and the Firth of Forth. Although Aberdeen is recognised as an important area for bottlenose dolphins, further studies are required to more accurately determine the proportion of the population that utilises this area throughout the year.

Bottlenose dolphin were the second most frequently sighted cetacean species during the surveys carried out as part of the EOWDC, with a total of 249 individuals detected, with an average group size of 12 animals. The majority of the sightings occurred in the spring and summer months. The majority of the bottlenose dolphin sightings recorded were in close proximity to Aberdeen harbour. It has previously been suggested that bottlenose dolphins occur off Aberdeen harbour where the forage off winter salmon and that Aberdeen harbour is a key feeding site (Stockin *et al*., 2006). The EOWDC survey data presented here does give a clear indication of the most common location of bottlenose dolphins with respect to the wind farm site and is in line with previous studies.

7.1.2 Harbour porpoise

Harbour porpoises were the most recorded cetacean species during the EOWDC boat surveys, with 390 observations of 655 individuals. Harbour porpoise was the only species

that was detected in sufficient numbers to allow abundance and density estimates to be generated. The density of harbour porpoises was higher in the control area in all seasons except summer. Lowest densities occurred during May and June. The density estimates produced for harbour porpoise all show considerable error margins which is a reflection of the sampling effort.

A previous study in the coastal waters of Aberdeenshire showed harbour porpoise to be present throughout the year, with peak occurrence during August and September (Weir *et al*., 2007). The distribution of sightings was particularly high near the Ythan Estuary mouth. This area may represent good foraging ground due to the influx of estuarine water giving rise to local fronts and mixing. The calving period of harbour porpoises in Scottish waters is estimated to be between April and June, with calves being observed in the area between May and September.

Harbour porpoise acoustic detections appear to follow a broadly similar pattern of distribution to the visual sightings of animals. Although the pattern is similar, there are more sightings on the inshore strata than there are detections. This could be for a variety of reasons, including increased levels of surface activity from the porpoises leading to increased sightings levels. Reduction in vocalisation rate could be potentially due to porpoises hunting for prey using eyesight alone, or alternatively, they may also be reducing vocalisation rate to avoid detection by dolphin species which are also present in the area.

Whilst it is noted that this is a small survey area from which to conduct comparisons, porpoise detection rates obtained from EOWDC data are consistent with those of a high-density porpoise area (eg peak of 0.158 detections per km in September 2010 . Surveys of similar coastal locations conducted in high-density porpoise areas in the Western Baltic Sea reported a maximum detection rate of 0.037 detections per km, in Little Belt, Baltic Sea (Gillespie *et al*., 2005) and 0.072 – 0.189 detections per km in Skagerrak, Kattegat and the Danish straits (Sveegaard *et al*., 2011), although these were both taken from much wider scale surveys. Studies conducted in the Hebrides between 2004 – 2008 reported acoustic detection rates ranging from 0.084 detections per km (2004) to 0.152 detections per km (2005) (Booth, 2010).

7.1.3 White-beaked dolphins

White-beaked dolphins have been detected during the EOWDC surveys over the course of several years during the months of June, July August; this data supports the occurrence of this dolphin as a seasonal summer visitor that possibly moves to coastal waters following prey such as mackerel and or for calving purposes with the main peak in August (Weir *et al*., 2007).

7.1.4 Minke whales

Twelve minke whales have been observed during the EOWDC boat surveys. Minke whales are thought to have a preference for water depths of 38 m or deeper, these depths are generally found further offshore and beyond the EOWDC crown estate licence area, although a minke whale was detected within the EOWDC crown estate lease area during the EOWDC boat based surveys. Minke whales have only been sighted during June, July, August and September, with an apparent absence in these waters during the winter months. The seasonal movements of minke whales are not well understood but the observations from this study are in line with a previous study of Aberdeenshire coastal waters that reported minke whales to be highly seasonal with sightings occurring only in August (Weir *et al*., 2007).

7.1.5 Other cetaceans

Only one solitary short-beaked common dolphin was detected during the EOWDC boat based surveys, which supports the observation that this species does not appear to use the waters of Aberdeen Bay with any frequency.

Risso's dolphins were detected during vantage point surveys and in the July 2011 EOWDC boat survey when two observations of 15 individuals were recorded. The increase in sightings of Risso's dolphins may point towards an increase in the use of the Aberdeen area in comparison to historic levels. It has been suggested that this is linked to increased sea temperatures.

7.1.6 Grey seal

The grey seal was the most frequently recorded seal species, with a total of 21 individuals recorded on effort during the EOWDC 2007-2008 surveys (Figure 6-6), and a further 41 individuals recorded in EOWDC 2010-2011 surveys. In the 2007-2008 surveys there were a higher number of grey seals (n=13) observed in the control area in comparison to the wind farm area (n=8) (Figure 6-6). The majority of grey seal sightings in the 2010-2011 surveys were recorded in the northern half of Aberdeen Bay, a finding that is consistent with those from previous surveys.

Breeding and pupping in grey seals occurs during October and November off the east coast of Scotland. During these months the number of seals at sea might be expected to be low as a proportion of the population is hauled out to breed. There was no apparent seasonal peak in grey seals observed during the EOWDC 2007-2008 surveys. During the EOWDC 2010-2011 surveys the encounter rate with grey seals at sea peaked in November. The peak could be due to the many haul-out sites along the east coast of Scotland north of Aberdeen, primarily between the Ythan Estuary and Fraserburgh. However, these haul-outs are not used for breeding and pupping and the nearest breeding haul-outs for grey seals in this area are at the Isle of May and the Helmsdale coast in the Moray Firth. During November, these breeding haul-outs become extremely busy and it may be that non-breeding animals are forced off such haul-outs and move to other non-breeding haul-outs; such as those in the vicinity of the North stratum survey area. There may also be an abundance of fish in this area during this time of the year. In other east coast Scottish estuaries, peak feeding on salmonids by seals has been observed between September – January; this period covers the migration of salmon into the estuaries (Carter *et al*., 2001). The Ythan has stocks of potential prey fish for seals, including salmonids and flatfish, this could explain the tendency for most grey seal sightings to occur to the north of the proposed EOWDC lease area closer to the Ythan estuary.

Designated coastal SAC sites for grey seals include the Berwickshire and North Northumberland Coast in north-east England, Faray and Holm of Faray on Orkney and the Isle of May at the entrance to the Firth of Forth and it can be expected that individual seals from these colonies may be passing through the EOWDC development area.

7.1.7 Harbour seals

Harbour seals spend less time at sea during June-July when they haul-out for breeding and in August when they moult. This pattern is reflected in the monthly encounter rates during the EOWDC 2010-2011 surveys. There is also a moderate peak in encounter rates during November and the reason for this may related to optimal feeding opportunities near the vicinity of the Ythan Estuary during this time. Harbour seals were not recorded in any of the

EOWDC 2007-2008 surveys. The harbour seals were distributed in higher concentrations around the mouth of the Don and near the Ythan estuary.

Designated coastal SACs for harbour seals are present along the east coast of mainland Scotland. These are situated in the Dornoch Firth and Morrich Moore in the Moray Firth and Firth of Tay and Eden estuary, and it can be expected that individual seals from these colonies may be passing through the EOWDC development area.

A. APPENDICES

1. THE EFFECTS OF G(0) < 1

This section explains the influence that defining the number of 'missed animals' has on the abundance estimates generated from transect surveys. The probability of detecting an animal on the transect line, g(0), is normally assumed to be 1 which would be for a certain detection. However, for marine mammals, which spend a proportion of the time below the surface, this assumption is not generally valid. Double observer methods are needed to accurately calculate the g(0) value specific to each species and survey vessel, and thus for this study, the influence of differing g(0) values on the density and abundance estimates generated are discussed. For illustrative purposes the study used to demonstrate the effects of altering the g(0) <1 value was the survey that occurred in the Northern transect in November 2010.

This survey area and month had the highest number of observations of harbour porpoises, thus providing the most robust sub-set for demonstration. The detection probability used in the analyses will therefore have a key influence on resulting estimates as is illustrated in Table A-1. Detection values that are assigned a certain probability of detection g(0) are associated with the lowest standard error (165) and also the lowest abundance estimates (568).

Table A-1 Density and abundance estimates with Standard Errors, generated for the North Strata in November, when assuming a range of g(0) values.

g(0)	Density estimate	SE	Abundance estimate	SE
0.2	18.84	5.45	2841	824
0.34	11.08	3.21	1671	485
0.4	9.42	2.73	1421	412
0.6	6.28	1.82	947	275
0.8	4.71	1.36	710	206
1	3.77	1.09	568	165

2. DETECTION RATES OF ODONTOCETE SPECIES DURING ACOUSTIC BOAT SURVEYS 2010-2011.

Dolphin detections were recorded on a number of occasions during the EOWDC 2010-2011 surveys. It is currently not possible to identify, to a species level, clicks and whistles of the dolphin species that are likely to be present in the EOWDC area, although corroboration with observations of cetaceans during visual searches does support species identifications to a degree.

The locations of both dedicated and opportunistic dolphin click detections are shown in Figure A-1. Detections were made in all three strata, although the offshore stratum contains most of these.

All whistle detections, including the opportunistic ones, are shown in Figure A-2. Detections were made in all three strata, although the majority of these were made in the offshore stratum.

Dolphin click detections were made during six of the 12 surveys (August 2010, September 2010, November 2010, March 2011, July 2nd survey 2011 and August 2011), however the detections for one of these surveys (September 2010) occurred during a period of opportunistic effort and has therefore not been incorporated into the analyses. Where applicable, detection rates have been calculated and are shown in Table A-2. Dolphin whistle detections were made during four of the 12 surveys (August 2010, January 2011, March 2011 and July-2-2011), however the detections for one of these surveys (January 2011) occurred during a period of opportunistic effort and has therefore not been incorporated into these analyses. Due to the difficulty in meaningfully defining a discrete encounter with dolphin groups when analysing whistles, dedicated whistle data have been expressed as Whistle Positive Minutes (WPM). These are defined as minutes which contain one or more whistle detections. The proportion of whistle positive minutes for transects containing whistles is shown in Table A-3.

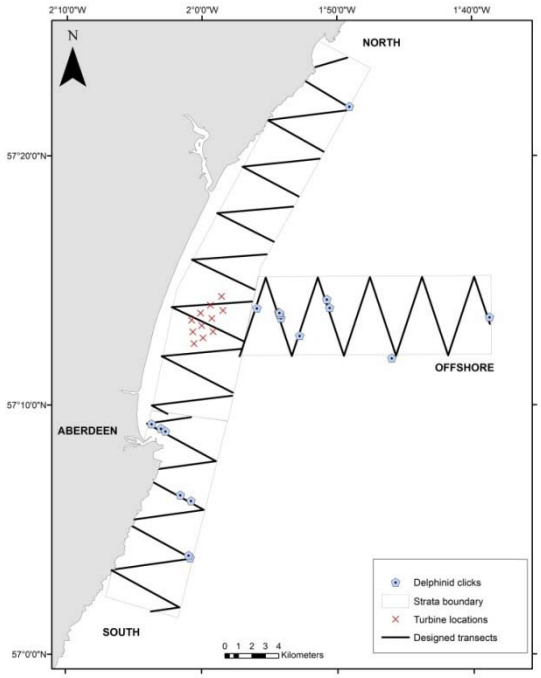


Figure A-1 Locations of all dolphin click detections across all surveys. This includes both opportunistic and dedicated data.

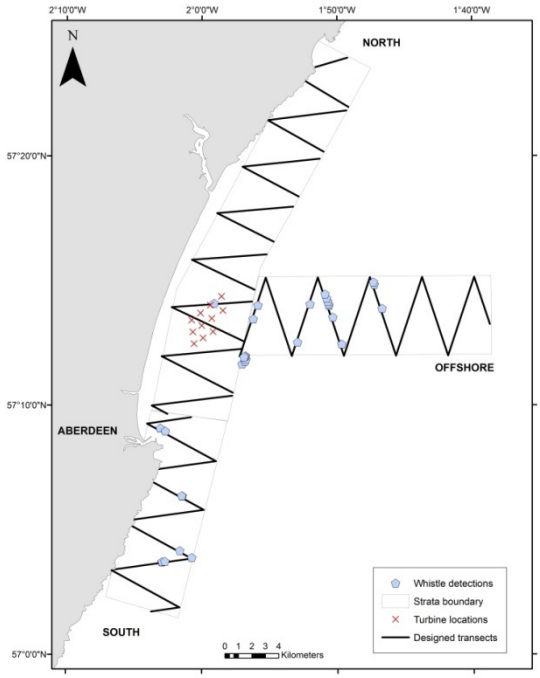


Figure A-2 Locations of all dolphin whistle detections across all surveys. This includes both opportunistic and dedicated data.

Table A-2 Number of dolphin click detections and detection rates for each of the surveys.

Survey	Number of "on effort" detections	Kilometres of effort	Detection rate (detections per km)	Detection rate (detections per 100 km)	Stratum to which detection rate applies
Aug- 2010	6	205.4	0.029	2.9	Offshore
Sept-2010	0	165.0	0	0	n/a
Nov-2010	2	164.3	0.012	1.2	North
Jan-2011	0	159.8	0	0	n/a
Feb-11	0	166.0	0	0	n/a
March-2011	2	173.7	0.012	1.2	South
April-2011	0	97.2	0	0	n/a
June-1st-2011	0	163.3	0	0	n/a
June-2nd-2011	0	148.6	0	0	n/a
July-1st-2011	0	163.1	0	0	n/a
July-2nd-2011	15	165.9	0.09	9	South and Offshore
Aug-2011	1	161.9	0.006	0.6	South

Table A-3 Proportion of dedicated effort found to be positive for whistle detections. Data are only shown for the transects which contained whistles; none of the other surveys or transects were found to be positive for whistle detections.

Survey	Transect	Stratum	Number of whistle positive minutes	Proportion of minutes on transect found to be "whistle positive"
Aug-2010	17	North	1	0.058
Aug-2010	32	Offshore	3	0.130
Aug-2010	30	Offshore	7	0.292
Aug-2010	29	Offshore	2	0.080
Aug-2010	27	Offshore	1	0.040
March-2011	8	South	3	0.143
July-2nd-2011	3	South	3	0.130
July-2nd-2011	4	South	1	0.556
July-2nd-2011	6	South	1	0.063
July-2nd-2011	27	Offshore	1	0.045

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