Inch Cape Offshore Wind Farm

New Energy for Scotland

Offshore Environmental Statement:
VOLUME 2F
Appendix 15A: Offshore Ornithology Technical Report

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Inch Cape Offshore Wind Farm

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Offshore Ornithology Technical Report

Project Number: SGP6489

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Current Status:	**Final**			
Issue Date:	**28 June 2013**	Revision Number:	**3**	
		Revision Notes:	**-**	
Project File Path:	**Q:\Project 2 - Inch Cape\Phase 1 - Conceptual Phase\Environmental Statement\ES CHAPTERS\Chapter 15 Ornithology\Technical Appendices\MASTER PGC -Appendix 15A - Ornithology Technical Report-Offshore.doc**			

This report has been prepared within the RPS Planning and Development Quality Management System to British Standard EN ISO 9001 : 2008

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

AMR	Adult Mortality Rate
BTO	British Trust for Ornithology
BOU	British Ornithologists' Union
CEH	Centre for Ecology & Hydrology
CRM	Collision Risk Modelling
COWRIE	Collaborative Offshore Wind Research into the Environment
DTI's	Department of Trade and Industry's
ES	Environmental Statement
ESAS	European Seabirds At Sea
FTOWDG	Forth and Tay Offshore Wind farm Developers Group
GPS	Global Positioning System
HAT	Highest Astronomical Tide
HRA	Habitats Regulation Assessment
ICOL	Inch Cape Offshore Limited
IEEM	Institute of Ecology and Environmental Management
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LSE	Likely Significant Effect
MPA	Marine Protected Area
MS	Marine Scotland
MSS	Marine Scotland Science
MHWS	Mean High Water Spring Tide
MLWS	Mean Low Water Spring Tide
MPA	Marine Protected Area (Marine Scotland Act 2010)
OSP	Offshore Substation Platform
OfTW	Offshore Transmission Works
OnTW	Onshore Transmission Works
PCH	Potential Collision Risk Height

PVA	Population Viability Analysis
RSPB	Royal Society for the Protection of Birds
SD	Standard Deviation
SMP	Seabird Monitoring Programme
SNH	Scottish Natural Heritage
SOSS	Strategic Ornithological Support Services
SPA	Special Protection Area
TCE	The Crown Estate
VOR	Valued Ornithological Receptor
WeBS	Wetland Bird Survey
WTG	Wind Turbine Generator

15A.1 INTRODUCTION

15A.1.1 Background

Inch Cape Offshore Limited (ICOL) proposes to develop the Inch Cape Offshore Wind Farm in the outer Firth of Tay region in Scottish Territorial Waters (STW). It is anticipated to consist of up to 213 Wind Turbine Generators (WTGs) covering an area of about 150 km^2 (see Figure 15A.1.1).

RPS has been commissioned as the lead consultant on birds for the Project, with Natural Research (Projects) Limited undertaking the offshore survey programme as well as fulfilling an advisory role.

RPS drafted a study design and monitoring protocol in August 2010, outlining the most appropriate methods for boat-based surveys of the Inch Cape Offshore Wind Farm for seabirds and marine mammals. The data obtained from these surveys form an integral part of the environmental assessment for the Wind Farm.

The surveys were designed to collect data to the highest standard, providing a robust baseline for a subsequent Ecological Impact Assessment as well as Habitat Regulation Assessment (HRA) in relation to Special Protection Areas (SPAs, EC Birds Directive 2009/147/EC) for birds.

15A.1.2 Site Description

The Inch Cape Development Area lies approximately 15 – 22 km to the east of the Angus coastline in Scotland, entirely within Scottish Territorial Waters, in water depths between 35 m – 63 m at lowest astronomical tide (LAT), with a tidal range of up to 5.5 m and maximum marine current of circa 1.2 knots. The majority of the Inch Cape Development Area is expected to vary between 40 and 57 m LAT (Admiralty Chart 1407, 1409; Smith & Sandwell 1997).

15A.1.3 Definition of Terms

In the following sections the term ‘Development Area’ (see Chapter 1: Introduction, Table 1.1) refers to the area which includes WTGs, inter-array cables, Offshore Substation Platforms (OSPs) and initial part of the Offshore Export Cable (part of the Offshore Transmission Works (OfTW) and any other associated works, while the term ‘Boat-based Study Area’ refers to the entire area covered by the boat surveys conducted between September 2010 and September 2012 on which this assessment is based, which includes a buffer zone of 4 km around the Development Area (Figure 15A.1.1).

- Development Area: the area designated for offshore wind farm development;
- Buffer Zone: a 2 - 4 km wide buffer around the Development Area; and
- Study Area/ Survey Area: an area encompassing the Development Area and a 4 km buffer zone for which boat-based surveys are deployed.

15A.1.4 Purpose and Scope of this Appendix

The purpose of this Appendix is to provide a detailed quantitative and qualitative baseline which will form the basis for the Ornithology Chapter (Chapter 15) of the ICOL Environmental Statement. The appendix will therefore;

- Collate all ornithological data gathered to date for the Inch Cape Offshore Wind Farm and provide a baseline characterisation of the ornithological interests within the Development Area, the Firth of Forth and the wider potential zone of influence;
- Establish the ornithological significance of the Development Area throughout the year through analysis of data from boat-based surveys; and

- Provide collision risk and displacement estimates for a range of turbine and array dimensions, contextualising potential impacts in relation to background populations at international, national and regional levels.

The format of the remainder of this appendix is as follows:

- **Section 15A.2** provides an overview of the methodologies used to gather and analyse baseline data for the Development Area. Where applicable, the methods used to generate population estimates (e.g. statistical approaches such as Distance 6.0 analysis, Buckland *et al.* 2001), collision risk, displacement and barrier effect estimates are discussed in detail.
- **Section 15A.3** presents the baseline conditions determined from the boat-based surveys undertaken between September 2010 and September 2012. Subsections provide individual species accounts for each key species identified. These present the results of surveys and the interpretation of any trends in spatial, seasonal or inter-annual variation, as well as providing a determination of the relative ornithological importance of the Development Area to the species in a wider spatial context.
- **Section 15A.4** presents the Collision Risk Modelling (CRM) estimates for each species of principal concern. The potential for collision for sensitive species during the operational phase of the wind farm is provided for three turbine layout scenarios across a range of bird avoidance rates.
- **Section 15A.5** provides baseline information for the assessment of the displacement for key species in the Chapter 15.Ornithology, presenting population estimate of birds at risk of displacement from the Development Area and a surrounding 2 km Buffer Zone in the context of appropriate receptor populations.

Annex 15A.1 contains figures showing foraging ranges of the regional seabird populations as well seasonal distribution of boat-based survey observations for key species. Annexes 15A.2 to 15A.5 hold information on bird and environmental survey data, density and population estimates, as well as analysis results for collision risk, displacement and barrier effects.

15A.1.5 Available Ornithological Data

The British Ornithologists' Union (BOU) vernacular English names are used for bird species throughout this appendix. Baseline information on species is presented in taxonomic order.

Boat-based monthly bird surveys of the Development Area and 4 km buffer zone were undertaken between September 2010 and September 2012 using standard boat based methods (Camphuysen *et al.* 2004).

The data obtained from these surveys forms the core of this appendix. However, there are a range of other ornithological data sources available for this area, collected during recent years, summarised below:

- Aerial surveys of the Firth of Forth Round 3 Development Zone, commissioned by TCE, were undertaken during the summer of 2009 and the winter of 2009-10. These surveys covered a substantial part of the Forth and Tay area, including all of the Inch Cape Development Area and Buffer Zone;
- During the 2010 breeding season, the Centre for Ecology and Hydrology (CEH) fitted global positioning system (GPS) tags on individuals from four seabird species (kittiwake, guillemot, razorbill, and puffin) which breed on the Isle of May - part of the Forth Islands Special Protection Area (SPA) to track their foraging movements (CEH, 2010). This work builds on long term studies by the CEH on the island and was part-funded by the Forth and Tay Offshore Wind Farm Developers Group (FTOWDG);
- During the 2010 breeding season, the Joint Nature Conservation Committee (JNCC) fitted tracking devices on Arctic tern and common tern individuals from the Isle of May (both species) and the Leith Imperial Docks SPA (common tern only); and
- During the 2011 breeding season, individuals from two seabird species (kittiwake, guillemot) breeding in the Fowlsheugh and St. Abbs Head to Fast Castle SPAs respectively were fitted with GPS tags to track foraging movements, and studied to obtain trip durations and flight directions (CEH, 2011).

15A.2 METHODOLOGY

15A.2.1 Survey Methodology

Boat-based Surveys

The seabird survey methodology deployed for the Development Area survey programme has been adapted from the European Seabirds At Sea (ESAS) methods and guidelines for Collaborative Offshore Wind Research into the Environment (COWRIE) (Camphuysen *et al.* 2004; Maclean *et al.* 2009; see RPS 2010a). Table 15A.1 provides an overview of the key components of the survey methodology.

Two survey vessels were used throughout the survey programme: the Fleur de Lys from September 2010 to January 2011 inclusive, and the Eileen May from February 2011 onwards. Both vessels comply with the main survey requirements as outlined in Camphuysen *et al.* (2004), although the Eileen May is actually only 17 m in length, short of the 20 m recommendation in the COWRIE guidelines. Prior to deploying this vessel, ICOL agreed with Scottish Natural Heritage (SNH) that it could be used for survey purposes.

Monthly seabird surveys at the Development Area plus a 4 km Buffer Zone began in September 2010, and continued for two consecutive years until September 2012 inclusive.

A power analysis and buffer width simulation undertaken by RPS for the Development Area established that a buffer distance of at least 4 km in combination with a 2 km transect interval distance should be sufficient to permit reliable detection of displacement effects of 15 per cent or more amongst more abundant seabird species (RPS 2010b).

Fourteen transects with a total length of 219 km were spaced at two kilometre intervals to minimise double-recording of mobile bird species (Figure 15A.1.1, Annex 15A.1), with each complete survey involving a single ‘run’ of each transect. Transects are situated approximately perpendicular to the coast in an east-west orientation, i.e., parallel to the depth gradient – a design consistent with COWRIE recommendations (Camphuysen *et al.* 2004).

During each survey the vessel’s GPS system continuously recorded the survey track. In addition, the surveyors used a handheld GPS device to record the vessel’s location every 60 seconds, i.e. approximately every 300 m at a speed of 10 knots.

Seabird surveys were generally not undertaken in sea states of five or more (Beaufort Sea Scale), and data collected in such sea states have not been used for distance sampling analysis. Furthermore, surveys were not undertaken in visibility levels below 300 m, which would effectively reduce the visible strip width.

Environmental conditions were recorded every 15 minutes, including information on wind direction and force, sea state, swell height and direction, precipitation, glare and visibility.

Two surveyors focussed on a single side of the vessel; one surveyor operated as the primary observer, the other surveyor as scribe and secondary observer. A third surveyor was present on the vessel to allow for rest breaks.

Distance Bands

Within one minute recording intervals (at an average speed of 10 knots) surveyors recorded all seabirds, both on the water and in flight, focussing on a 300 m zone from the vessel. Observations beyond 300 m were recorded as well, though with lower priority. For the purpose of distance sampling (Thomas *et al.* 2010; Stone *et al.* 1995) the recording zone for birds on the water was divided into five bands, with distances perpendicular to the travel direction of the vessel.

Distance categories are divided in bands A-E as follows:

- Band A: 0-50 m;
- Band B: 50-100 m;
- Band C: 100-200 m;
- Band D: 200-300 m; and,
- Band E: beyond 300 m.

No distance bands were allocated to observations of birds in flight. Birds in flight which were clearly associated with the survey vessel were labelled “followers” (coded ‘18’ in the flight direction column) and were excluded from analysis.

Observations of note recorded on the ‘off-effort’ side of the vessel or on transect tails were labelled as such (coded ‘3’ and ‘4’ respectively in the in/out transect column) and were excluded from analysis.

Snapshots

Instantaneously at the end of each recording interval (i.e. every 60 seconds), a ‘snapshot’ was taken of all birds seen in flight within a 300 x 300 m snapshot box on the relevant side of the boat. These data provide the basis for density estimates of birds in flight. Surveyors were alerted to the snapshot moment by means of an alarm clock set to one minute intervals. The clock was synchronised with the handheld GPS at the start of each survey day.

Flight Heights

Height and direction were recorded for all birds in flight, regardless of whether or not these were seen during a snapshot. Height classes were determined in 5 m bands up to 50 m, above which 10 m bands were used up to 100 m, after which 50 m bands were used; direction was recorded using cardinal and ordinal points.

TABLE 15A.1: KEY COMPONENTS OF SURVEY METHODOLOGY

Study design	
Survey effort	Monthly, over 2 years
Study area	Development Area plus 4 km buffer (430 km^2)
Transect interval	2 km separation
Transect orientation	East-west; parallel transects
Transect tails	Not surveyed
Total transect length	219 km
Weather constraints	No surveys in sea state 5 or more; visibility less than 300 m
Navigation	
Recording of location	60 second intervals
Sampling	
Detection	Predominantly through naked eye, binoculars used for identification, although the latter are used more regularly for bird feeding concentrations and in rougher sea states
Scan arc	90 degrees; single side of the vessel during all surveys
Number of surveyors	1 primary observer, 1 scribe, 1 extra surveyor allowing for rotation of roles
Strip width	300 m (distance bands A-E; 0-50 m, 50-100 m, 100-200 m, 200-300 m, 300 m+)

TABLE 15A.1: KEY COMPONENTS OF SURVEY METHODOLOGY	
Basic recording interval	1 minute
Snapshot interval	1 minute
Snapshot box	Parallel to vessel, 300x300 m
Height classes	Bands: on the sea surface, 5 m, 10 m, 15 m, 20 m, 25 m, 30 m, 35 m, 40 m, 45 m, 50 m, 60m …100 m, 150 m, 200 m)
Data	
Primary bird data collected	Species, number, distance, flight height, behaviour, flight direction, in / out of snapshot for birds in flight
Secondary bird data collected	Age, sex, moult status, plumage, associations
Other data collected	Weather conditions, visibility, glare, activity of other vessels

Marine Mammals

As part of the boat-based survey effort a dedicated marine mammal observer was present on the vessel from December 2010. Data were collected independently from the ESAS bird surveyors. Survey results and analysis are reported on separately (Appendix 14A: Marine Mammals Baseline).

15A.2.1.1 Survey Effort

A total of 24 surveys were undertaken between September 2010 and September 2012 inclusive (Table 15A.2). Where possible, surveys were undertaken over consecutive days, although recurring poor weather conditions made this impossible in December 2010, and February, August and December 2011. Twenty baseline surveys were undertaken in consecutive days or in single days (summer). Thus, for the majority of surveys, bias in capturing the seasonal composition of highly mobile bird communities in the Study Area due to extensive time required for full coverage is considered minimal.

On a single occasion prolonged bad weather conditions prevented mobilisation of a survey (November 2010), whilst the September 2010 survey was partially completed only, due to deteriorating weather conditions and the subsequent lack of suitable weather windows. A survey planned for May 2011 was delayed until early June 2011.

With the exception of the very first survey, the subsequent 23 surveys fully covered the Study Area each month. Slight differences in vessel tracks between months resulted in different actual distances surveyed in relation to the ideal transect layout (Table 15A.2), although essentially 100 per cent coverage was achieved every survey.

ICOL agreed to the addition of a survey for September 2012, meaning that effectively two whole, consecutive breeding seasons (2011 and 2012) were covered.

TABLE 15A.2: SPATIAL AND TEMPORAL COVERAGE OF BOAT-BASED SURVEYS

Survey	Month	Survey dates	Distance surveyed (km)	Proportion completed (%)
1	September	21 – 23 September 2010	90.2	41.19
2	October	13 – 15 October 2010	211.4	96.53
-	November	No survey	-	-
3	December	21, 30-31 December 2010	214.6	97.99
4	January	18 - 20 January 2011	211.7	96.67

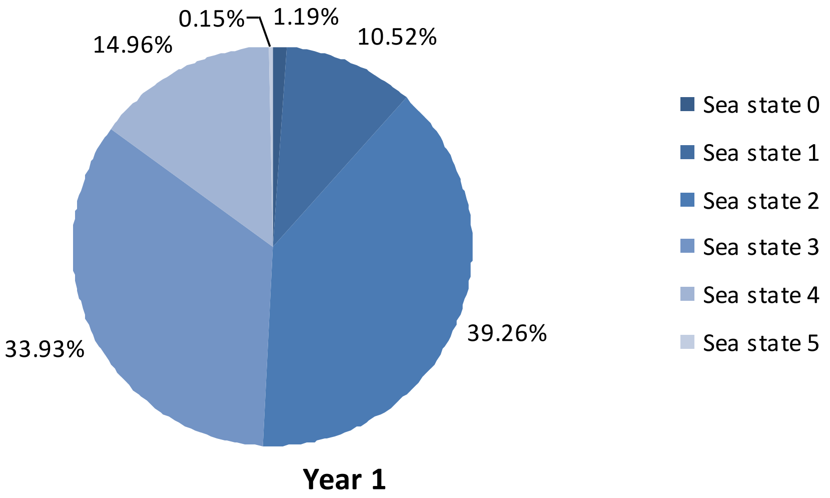
TABLE 15A.2: SPATIAL AND TEMPORAL COVERAGE OF BOAT-BASED SURVEYS				
Survey	**Month**	**Survey dates**	**Distance surveyed (km)**	**Proportion completed (%)**
5	February	22, 27 February 2011	219.3	100.14
6	March	4 – 5 March 2011	219.3	100.14
7	April	14 – 15 April 2011	218.2	99.63
8	May	3 June 2011	213.4	97.44
9	June	19 – 20 June 2011	215.7	98.49
10	July	10 – 11 July 2011	218.2	99.63
11	August	3, 5 August 2011	218.9	99.95
12	September	29 - 30 September 2011	218.3	99.68
13	October	12 -13 October 2011	218.6	99.82
14	November	5 – 6 November 2011	218.5	99.77
15	December	15 – 16, 19, 21 December 2011	216.7	98.95
16	January	13 – 15 January 2012	218.0	99.54
17	February	2 – 3 February 2012	218.6	99.82
18	March	11 – 13 March 2012	218.2	99.63
19	April	7 – 8 April 2012	218.4	99.72
20	May	6 May 2012	218.7	99.86
21	June	5 June 2012	218.3	99.68
22	July	10 July 2012	218.5	99.77
23	August	7 – 8 August 2012	218.2	99.63
24	September	20 – 21 September 2012	217.4	99.26

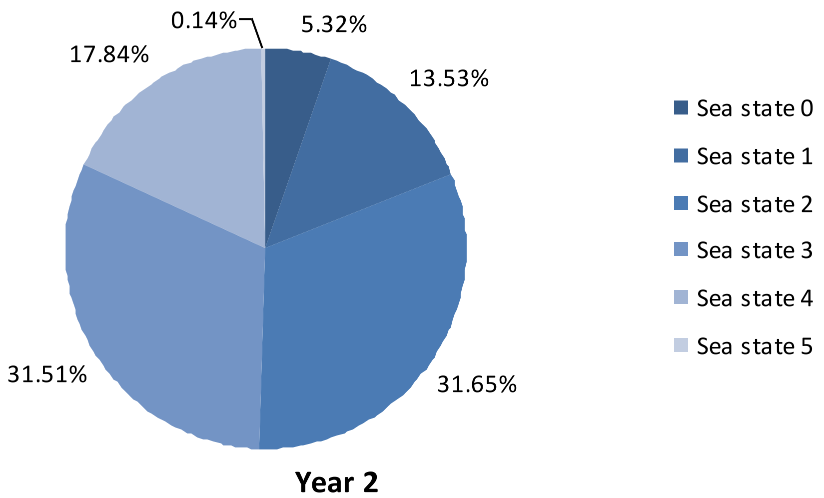
Sea State Conditions

Year 1 surveys (September 2010 to August 2011) were carried out in predominantly good to excellent sea state conditions (Figure 15A.1). Nearly 85 per cent of all survey effort was undertaken in sea states 0-3, with 15 per cent undertaken in sea state 4. Sea state 5 was only encountered briefly in October 2010 for a period of 15 minutes.

In Year 2 (September 2011 to September 2012) surveys encountered very similar conditions, with 82 per cent of all survey effort undertaken in sea states 0-3 and nearly 18 per cent in sea state 4. In December 2011 a total of 15 minutes of sea state 5 was observed. The few observations made in sea state 5 were omitted from analysis.

Figure 15A.1: Proportional Distribution of Sea State Conditions During Boat-based Surveys of the Inch Cape Study Area in Years 1 and 2





15A.2.2 Desk Study

Background information on seabird distributions within the bio-geographic region and the North Sea in particular was taken from BirdLife International (2004), Stone *et al.* (1995), Skov *et al.* (1995), Forrester *et al.* (2007) and Mitchell *et al.* (2004) and other sources as appropriate. Colony counts were derived from the JNCC's Seabird Monitoring Programme (SMP) database (JNCC, 2010) These sources were used to determine regional breeding, passage and non-breeding or wintering numbers and distributions for each species. Much of the information on bird behaviour and ecology has been taken from Birds of the Western Palaearctic (Snow and Perrins 1998), which provides a comprehensive text on each species.

For a few offshore wind farms there are publicly available studies which provide information on how birds have responded to the construction of a wind farm (e.g. Horns Rev and Nysted, Denmark, Petersen *et al.* 2006; Southern Kalmar Sound, Sweden, Pettersson 2005; Egmond aan Zee, The Netherlands, Lindeboom *et al.* 2011). For these wind farms a range of studies have been conducted, looking at changes in bird distributions and migration routes. Where appropriate these studies are referred to in this appendix.

15A.2.2.1 Seasonality

Table 15A.3 provides an overview of the definitions of seasonality used for the key species assessments in this document. Note that these have been reviewed and update the information provided in the Habitats Regulations Screening Report (Annex 15B.1 HRA Screening Report).

TABLE 15A.3: DEFINITIONS OF SEASONALITY USED IN ASSESSMENT

Species	Season			Source and rationale
	Breeding	Post-breeding	Non-breeding	
Fulmar	Apr-Sep	-	Oct-Mar	Kober *et al.* (2010)
Manx shearwater	May-Sep	-	Apr, Oct-Nov	Kober *et al.* (2010) Assumed no regional breeding population in existence due to foraging range limitations – May to September treated as 'passage or non-breeding' population
Sooty shearwater	-	-	Jul-Nov	Forrester *et al.* (2007)
Gannet	Apr-Sep	-	Oct-Mar	Core breeding season defined per SNH recommendation. It is recognised the gannet breeding season can start as early as January, with attending birds slowly building up through to late March. Although an ecologically relevant distinction, this time of year has been categorised as 'non-breeding' as the bulk of breeding gannets have not moved into the area by that time of year. Numbers in the Study Area were exceedingly low during Jan-Mar months throughout the baseline programme.
Shag	Mar-Sep	-	Oct-Feb	Core breeding season at Isle of May is Apr-Aug, (Wanless & Harris 1997). Kober *et al.* (2010) consider Mar-Sep to contain breeding / summer population. Latter period used here from a precautionary perspective due to species' SPA status.
Great skua	-	-	Jun-Nov	Summer / autumn passage defined per seasonal occurrence at Hound Point (Lothian). Spring migration largely occurs along Atlantic coast in April, directly to colonies (Forrester *et al.* 2007).
Arctic skua	-	-	Jul-Nov	Summer / autumn passage defined per seasonal occurrence at Hound Point (Lothian). Spring migration occurs along Atlantic coast (Forrester *et al.* 2007).
Pomarine skua	-	-	Aug-Nov	Summer / autumn passage defined per seasonal occurrence at Hound Point (Lothian). Spring migration occurs along Atlantic coast (Forrester *et al.* 2007).
Kittiwake	Apr-Aug	Sep-Oct	Nov-Mar	Core breeding season defined per SNH recommendation; post-breeding season defined based on species' ecology.
Little gull	-	-	Jul-Nov, Dec-Apr	Autumn passage period defined as Jul-Nov (Forrester *et al.* 2007, Kober *et al.* 2010)
Common gull	-	-	Aug-Mar	Forrester *et al.* (2007); very small population within range, largely prefers coastal and inland habitats during breeding, thus considered no likely connectivity with regional breeding population.
Herring gull	Apr-Aug	-	Sep-Mar	Core breeding season defined per SNH recommendation.
Great black-backed gull	Apr-Aug	-	Sep-Mar	Kober *et al.* (2010)
Lesser black-backed gull	Apr-Aug	-	Sep-Mar	Core breeding season: Snow & Perrins (1998).
Arctic tern	May-Aug	Aug-Oct	-	Kober *et al.* (2010); possibly considerable overlap between late breeding (into early Aug) and post-breeding dispersal (Aug), when substantial proportion of birds in Study Area were juveniles.
Common tern	May-Sep	Sep	-	Kober *et al.* (2010); breeding can extend into Sep, though post-breeding aggregations can occur in the Firth of Forth area in the same month Forrester *et al.* (2007)

TABLE 15A.3: DEFINITIONS OF SEASONALITY USED IN ASSESSMENT				
Species	**Season**			**Source and rationale**
	Breeding	**Post-breeding**	**Non-breeding**	
Guillemot	Apr-Jul	Aug-Oct	Nov-Mar	Core breeding season defined per SNH recommendation; post-breeding period incorporates post-fledging (parent birds with chicks out at sea) as well as Sep-Oct period when regional aggregations peak in Study Area before moving further offshore.
Razorbill	Apr-Jul	Aug-Oct	Nov-Mar	Core breeding season defined per SNH recommendation; post-breeding period incorporates post-fledging (parent birds with chicks out at sea) as well as Sep-Oct period when regional aggregations peak in Study Area before moving further offshore.
Puffin	Apr-Aug	Sep-Oct	Nov-Mar	Core breeding season defined per SNH recommendation; post-breeding period in line with peak in regional aggregations before moving further offshore.
Little auk	-	-	Nov-Mar	Kober *et al.* (2010)

15A.2.2.2 Survival Rates

Table 15A.4 provides an overview of the annual adult survival values used to calculate the potential additional mortality for CRM estimates.

TABLE 15A.4: ANNUAL SURVIVAL RATES USED IN COLLISION RISK ASSESSMENT			
Species	**Adult survival rate**	**Source**	**Rationale**
Gannet	0.919	Wanless *et al.* (2006)	Rate specific to region (Bass Rock)
Kittiwake	0.88	Harris *et al.* (2000)	Rate specific to region (Isle of May)
Herring gull	0.88	Wanless *et al.* (1996)	Rate specific to region (Isle of May)
Great black-backed gull	0.93	Glutz von Blotzheim & Bauer (1982)	Rate from non-UK population, best available
Lesser black-backed gull	0.913	Wanless *et al.* (1996)	Rate specific to region (Isle of May)
Note: survival rates are only in this report to provide an approximation of a potential impact given a particular background population. Thus no measure of variance is presented here. The separate Population Viability Analysis (PVA) modelling for key species provides detailed information on e.g. variance instead (see Appendix 15B).			

15A.2.3 Determination of Zone of Influence

15A.2.3.1 Geographic Framework

To establish the ornithological importance of the Study Area and ultimately the potential impact magnitude of the Wind Farm on bird populations the following range of geographic scales was used:

- International: the bio-geographic population estimate for each species as per BirdLife International (2004);
- National: the national (UK) population estimate for each species (breeding and non-breeding) as per Baker *et al.* (2006), and other sources where relevant. At the time of writing the latest UK population estimates were published in Musgrove *et al.* (2013), however, estimates for seabird populations were left unchanged from Baker *et al.* (2006).The latter source is used in this Technical Appendix as it provides exact estimates as opposed to the rounded off estimates in Musgrove *et al.* (2013);
- Regional (breeding): the regional population estimate for each species as per the SMP database and Mitchell *et al.* (2004). Region was defined for each species separately based on foraging range (Thaxter *et al.* 2012, see below);

- Regional and North Sea (passage, post-breeding, wintering): published estimates for (parts of) the North Sea or interpretation of likely flyway populations as per Skov *et al.* (1995), Stone *et al.* (1995), Forrester *et al.* (2007), Wright *et al.* (2012) and other sources where relevant.

15A.2.3.2 Defining Regional Populations

In line with recommendations from SNH, regional breeding populations were defined according to the likely connectivity of the Wind Farm, in turn based on species-specific foraging ranges. This was achieved through using information on foraging ranges and most recent colony count data from the SMP database (Thaxter *et al.* 2012, JNCC 2012). Although it is accepted that such regions do not necessarily represent closed ecological systems, and therefore potential development impacts could exceed beyond them, it is considered that the approach taken here is sufficiently focussed to both determine regional importance levels as well potential development impacts on a scale ecologically relevant to each receptor species.

Connectivity with Seabird Colonies

Seabird foraging ranges are strongly linked to food resource availability. In the marine environment such resources tend to be patchily distributed, with often marked inter-annual variation in distribution. Thus, for the purpose of this assessment using mean or maximum ranges would likely substantially under- or overestimate average site-colony connectivity.

Instead spatial connectivity between the Development Area and seabird colonies was calculated - for most seabird species - by using the mean maximum foraging range plus one standard deviation (+ 1 SD) as per Thaxter *et al.* (2012). This is considered to be a reasonably robust indicator of connectivity for the key breeding seabird species involved.

Colonies within each species-specific foraging range from the Study Area (Development Area plus 4 km buffer) were selected in ArcGIS 10.0. Distances to each colony were measured from the outer extent of the Study Area – it is considered that if a bird can reach the 4 km buffer zone it can reach the Development Area as well.

Colonies which fell just outside a foraging range were considered for inclusion on a case by case basis. For example, for kittiwake and herring gull the Buchan Ness to Collieston colonies fall outside the foraging range by a few kilometres. However, given its location relative to the Development Area, with the potential of a direct line of flight and the species capacity to forage over reasonably long distances, connectivity with the Study Area was assumed.

In contrast, although the Sule Skerry and Sule Stack colonies fall within the gannet foraging range (mean maximum + 1 SD), both were considered to lack connectivity with the Study Area given the distance involved (near the upper range), the non-linear routes to the Study Area and the likelihood of birds from both colonies predominantly foraging in the Atlantic Ocean.

Where the mean maximum range + 1 SD exceeded a species' maximum foraging range, the mean maximum alone was used instead (fulmar, herring gull, lesser black-backed gull). This approach is considered suitably precautionary while it avoids basing the impact assessment on improbably large receptor populations.

For shag the maximum foraging range fell short of most colonies other than a few locations on the Fife coast, not monitored since Seabird 2000.

Due to a lack of available foraging range information for great black-backed gull (not included in Thaxter *et al.* 2012) a maximum range of 40 km was assumed based on estimates in Ratcliffe *et al.* (2000).

Table 15A.5 provides an overview of the foraging ranges used to establish likely connectivity (and thus regional population sizes) for species which **a.** were recorded in the Study Area during the breeding season and **b.** are known to breed within foraging range from the Study Area.

TABLE 15A.5: SEABIRD FORAGING RANGES USED TO DEFINE REGIONAL POPULATIONS				
Species	Foraging range (km)			Range used to establish likely connectivity
	Mean Maximum	+1 SD	Maximum	
Fulmar	**400**	+245.8	580	Mean maximum
Gannet	**229.4**	+124.3	590	Mean maximum
Shag	14.5	+3.5	**17**	Maximum
Kittiwake	60	+23.3	120	Mean maximum +1 SD = **83.3**
Herring gull	61.1	+44.0	92	Mean maximum +1 SD = **105.1**
Great black-backed gull	10-40?	Unknown	**40**	Maximum
Lesser black-backed gull	**141**	+50.8	181	Mean maximum
Guillemot	84.2	+50.1	135	Mean maximum + 1 SD = **134.3**
Razorbill	48.5	+35.0	95	Mean maximum + 1 SD = **83.5**
Puffin	105.4	+46.0	200	Mean maximum + 1 SD = **151.4**
Arctic tern	24.2	+6.3	30	Mean maximum + 1 SD = **30.5**
Common tern	15.2	+11.2	30	Mean Maximum + 1 SD = **26.4**

Note: foraging ranges in **bold** are those selected to define regional populations

Accounting for Population Trend

For each colony within a species' foraging range the most recent count data were derived from the SMP database (JNCC, 2010). These counts were then added to provide a regional population total for each species. This approach was followed regardless of designated (SPA) status, i.e. recent counts were used as opposed to the population size at the time of citation. It is considered that for the purpose of exploring the relative importance of the Inch Cape Study Area it is more ecologically sound to do so in the context of "real time" populations, more so in light of the declines many east coast colonies have undergone in recent years.

As data for many colonies originates from the last national census (Mitchell *et al.* 2004) and they have not been monitored since, it is important to at least nominally account for population trends, despite the possibility of inter-colony variation in actual trend. This was done by correcting - for each colony - Seabird 2000 and other count data collected before 2007 using the national (UK) 2000-2010 population trend (JNCC 2012).

Colony counts undertaken within the past five years (2007-2011) were considered sufficiently recent to reflect current population trends and were not adjusted for trend.

Attributing Birds to Colonies

It is likely that for most species a multitude of breeding colonies within foraging range contribute to the on-site population in the Study Area during the breeding season. A method for estimating the contribution of SPA species to the on-site population during the breeding season is included in Appendix 15B: Population Viability Analysis for SPA Bird Species (Section 15B.2.1.4).

15A.2.4 Determination of Impacts

15A.2.4.1 Defining Species Nature Conservation Importance

Evaluation of the ornithological features identified by the baseline studies as 'Valued Ornithological Receptors' has been guided by the Institute of Ecology and Environmental Management (IEEM) guidelines (IEEM 2010). In accordance with these guidelines, the nature conservation importance of each species was defined across the range of geographical scales as described above in Section 15A.2.3.1.

Conservation importance was defined as follows:

- International importance: a population regularly occurring in the Study Area (or parts thereof), exceeding one per cent of the international population estimate (as per BirdLife International 2004);
- National importance: a population regularly occurring in the Study Area (or parts thereof), exceeding one per cent of the national population estimate (UK, as per Baker *et al.* 2006) or exceeding 50 individuals for species where no such estimate is available; and,
- Regional importance: a population regularly occurring in the Study Area (or parts thereof), exceeding one per cent of the regional population estimate (as per Mitchell *et al.* 2004, SMP 2012 database; and,
- Local importance: all other species present in the Study Area in numbers not exceeding any of the above thresholds.

15A.2.4.2 Identifying and Defining Potential Impacts

Potential impacts from offshore developments on ornithological communities include a range of issues across different development stages, for at least the lifespan of the development and possibly beyond. Impacts can be fairly generic or species-specific, and often differ across seasons, with a range of different colonies or wider populations potentially affected depending on the time of year and origin of birds in a given area.

Five potential impact categories are conventionally used in relation to impact assessments for offshore wind farm developments, and are considered here for each of the three main development stages (construction, operation, decommissioning). These are:

- Direct habitat loss (e.g. physical loss of seabed habitat due to construction of foundations, inter-array cabling etc.);
- Disturbance from construction, operational or decommissioning activities, generally temporary;
- Displacement during the operational phase, leading to effective loss of habitat;
- Collision risk with wind farm structures (predominantly rotating turbine blades); and,
- Barrier effect during the operational phases, where avoidance of the array leads to disruption of existing flight pathways between e.g. colonies and feeding grounds.

The focus of this appendix is on those potential impacts that could have the most significant effects:

- Collision risk in relation to operational turbines; and,
- Displacement during the construction and operational phases due to disturbance, displacement and barrier effects the development and associated construction and maintenance activities could have on birds.

It is considered that displacement and barrier effects are related. Bird densities within an operational wind farm might be reduced compared with those before the wind farm was constructed because birds approaching the wind farm perceive the turbine array as a barrier and do not enter, or because they enter but find the habitat unsuitable and move away elsewhere. For seabirds, analysis has focussed on calculating maximum displacement estimates for each species in terms of likely reductions in numbers, rather than allocating these estimates to any specific reason for displacement. For non-seabird species which pass through the Development Area on migration, barrier effects rather than displacement are considered. A quantitative analysis of barrier effects has not been undertaken, instead barrier effects are considered qualitatively in the ornithology chapter (Chapter 15).

15A.2.5 Analysis for the Assessment

Depending on the sample size for each species, analysis of boat-based data to provide density and population estimates was undertaken in several ways. Table 15A.6 provides an overview of the different approaches and the criteria used for analysis. The section below explains these in detail.

TABLE 15A.6: DATA ANALYSIS OF BOAT-BASED SURVEY DATA

Data type	Excluded data	Filtered dataset	Analysis criteria for density estimation		
			>50 observations	20-49 observations	<20 observations
Birds on the water	- Off-effort data[1]; - Data collected in sea state 5; - Data collected in band E (>300 m); - Data collected in the wider Study Area, out with the 4 km buffer zone	Birds on the water in bands A to D only	Distance sampling	Extrapolation	Use of raw counts
Birds in flight	- Off-effort data; - Data collected in sea state 5; - Data collected out with snapshots - Followers (birds clearly associated with the survey vessel) - Data collected in the wider Study Area, out with the 4 km buffer zone	Birds in flight in snapshot	Extrapolation	Extrapolation	Use of raw counts

[1] off-effort data refers to observations of note that were recorded on the side of the vessel that was not surveyed, or observations made during transit between transects.

15A.2.5.1 Density and Population Estimates

An overview of the different analytical techniques used to calculate density and population estimates is summarised in Table 15A.7 and are detailed in the text below.

TABLE 15A.7: CALCULATION OF DENSITY AND POPULATION ESTIMATES

Species	Birds on water			Birds in flight	
	Distance sampling	Extrapolation	Raw count	Extrapolation	Raw count
Fulmar*	X			X	X
Manx shearwater		X		X	
Sooty shearwater			X		X
Gannet	X			X	
Shag			X		X
Little gull			X		X
Kittiwake**	X			X	
Common gull			X		X
Herring gull			X	X	
Great black-backed gull		X		X	X
Lesser black-backed gull			X		X
Great skua			X		X

TABLE 15A.7: CALCULATION OF DENSITY AND POPULATION ESTIMATES					
Species	**Birds on water**			**Birds in flight**	
	Distance sampling	Extrapolation	Raw count	Extrapolation	Raw count
Arctic skua			X		X
Pomarine skua			X		X
Common tern			X		X
Arctic tern			X	X	
Guillemot*	X			X	
Razorbill*	X			X	
Puffin*	X			X	
Little auk	X			X	

*: species for which sea state was incorporated as a covariate in the analysis
**: species for which cluster size was incorporated as a covariate in the analysis

Birds on the Water

Distance Sampling

Observations of birds on the water (within distance bands A to D) were analysed using line transect methods in the MCDS engine in Distance 6.0 (Buckland *et al.* 2001, Thomas *et al.* 2010). Considering the combined data from all surveys, only those species (or species groups, e.g. auks) with a total of at least 50 observations of birds on the water were analysed using Distance. This led to the inclusion of seven species in the analysis: fulmar, gannet, kittiwake, guillemot, razorbill, puffin and little auk.

Half-normal models with cosine adjustment terms were initially used for all species with sufficient observations, a choice based on analytical experience with boat-based surveys which effectively only have three distance bands to base a function on (A+B, C and D). Adjustment terms were limited to no more than two and were automatically (stepwise) incorporated into models where they improved the fit of a detection function. Other models (hazard rate, uniform) were only chosen if they provided a better fitting detection function based on lowest Akaike Information Criterion. Sea state was incorporated into models as a covariate where this made an improvement (fulmar, auks). Cluster size was used as a covariate for kittiwake to correct for the occurrence of a disproportionate number of large flocks at 300 m from the survey vessel.

To improve estimation, observations from all surveys were pooled to create species-specific global detection functions. The default settings for size-bias adjustment for flock size were used. Confidence intervals around density estimates were calculated for all six species in Distance 6.0.

As more data were collected during the ongoing survey programme, the accuracy of distance sampling estimates improved. For the same reason, population and density estimates in this appendix might differ at times from those presented in earlier reports.

Allocation of Unknown Species Group Observations to Species

Following Maclean *et al.* (2009), in order to account for unidentified birds (e.g. auk species, unidentified guillemot/ razorbill, gull species) in the distance sampling analysis, an attempt was made to assign unidentified birds to a species, based on the relative abundances of the species within the species-group from which they were derived. For the current dataset this was only investigated for observations of unidentified auks (n=88) and unidentified guillemot / razorbills (n=228). The latter amounts to four per cent of the total number of guillemot, razorbill and guillemot/ razorbill observations of ‘in transect’ birds. Numbers of unidentified gulls, skuas, terns and waders were so low as to be considered of negligible importance to consider further.

However, there are behavioural differences between guillemot and razorbill in relation to their response to (survey) vessel disturbance, and thus likely differences in detection probability, potentially making reassigning unidentified birds unreliable. In addition, given the small proportion of observations involving such birds, it is considered there is limited value in trying to incorporate these into detection models.

Extrapolation

An extrapolation approach was applied to species with between 20 - 49 observations of birds on the water in bands A to D. This led to the inclusion of two species: Manx shearwater and great black-backed gull.

For each survey, the surface area of the total transect strip - i.e. the actual surveyed transect length per survey derived from GPS vessel tracks multiplied by the transect width (300 m) – was calculated for the Study Area and its subsections. Bird numbers on the water in bands A to D were multiplied by published species-specific correction factors (Stone *et al.* 1995) and subsequently divided by the surface area of the total transect strip, producing a density estimate for each survey. Densities were then extrapolated to the extent of the Study Area (Development Area and buffer zone). Given the relatively low number of observations for most of these species, estimates are considered to be indicative and no confidence intervals are provided.

Birds in Flight

Distance sampling of boat-based data is not suitable for birds in flight as this tends to overestimate the number of birds present (Maclean *et al.* 2009). Instead, for all species, birds in flight were treated separately. Density estimates were calculated by dividing the number of flying birds seen in snapshot with the combined surface area for all snapshots taken during a survey. Densities were then scaled up to the spatial extent of the Development Area and the 4 km buffer zone to provide a population estimate of the number of flying birds.

These estimates are provided in conjunction with the density and population estimates as derived through distance sampling for birds on the water.

Where “monthly densities” are reported in this document, these reflect the sum of densities for birds on the water and in flight, unless stated otherwise.

Use of Raw Counts

For bird species occurring in very low numbers (<20 observations) the monthly peak count and associated month of observation were used.

15A.2.5.2 <u>Collision Risk for Seabirds</u>

CRM was undertaken to quantify the possible extent of collision mortality for each key seabird species. The Band 2012 model, recently developed as part of TCE’s Strategic Ornithological Support Services (SOSS) work output, was used for analysis.

The indicative turbine and array dimensions as per the Inch Cape Design Envelope were used to generate collision risk estimates. The Design Envelope will continue to evolve during the consenting process but the current envelope enables an impact assessment for likely worst case parameters. An overview of the input data used for the CRM model is provided in Annex 15A.4: Collision Risk Results.

In the Band (2012) model, the flight density of each species is used in conjunction with the total rotor swept area to generate predicted rates of collision. In all cases birds are assumed to be moving through the Development Area continuously and each species’ densities are maintained, irrespective of any collisions that might deplete the population.

Turbine Dimensions

Table 15A.8 provides an overview of the different turbine dimensions and scenarios used in the CRM. Modelling was undertaken for three turbine types: small, medium and large.

TABLE 15A.8: TURBINE DIMENSIONS USED IN COLLISION RISK MODELLING

Scenario	Number of WTGs	Rotor radius (m)	Hub Height (m above LAT)	Lower blade-swept height (m above HAT)	Average rotation speed (rpm)	Maximum chord (m)	Average pitch (degrees)
Small	213	60	87.95	22	7.842	4.5	10
Medium	213	77	104.95	22	7.612	4.5	10
Large	213	86	113.95	22	7.383	6	10

Note: rotation speed for medium turbines is an approximate mid-point for those turbines; for small and large turbines average monthly rotation speeds were available (see Table 15A.9)

Determining the Collision Risk Zone

The Design Envelope specifies the turbine hub heights to be in meters relative to lowest astronomic tide (LAT). However, specifications also include a minimum blade clearance of 22 m above highest astronomic tide (HAT).

A lower blade-swept height of 22 m above HAT was used for all scenarios. In other words - the potential collision risk height (PCH) zone is considered to start at that height for all turbine types. This precautionary approach provides an equal starting point for comparison of collision estimates for different scenarios. However, in reality differences between turbines will be larger as hub height and turbine numbers are unlikely to be the same for the different scenarios.

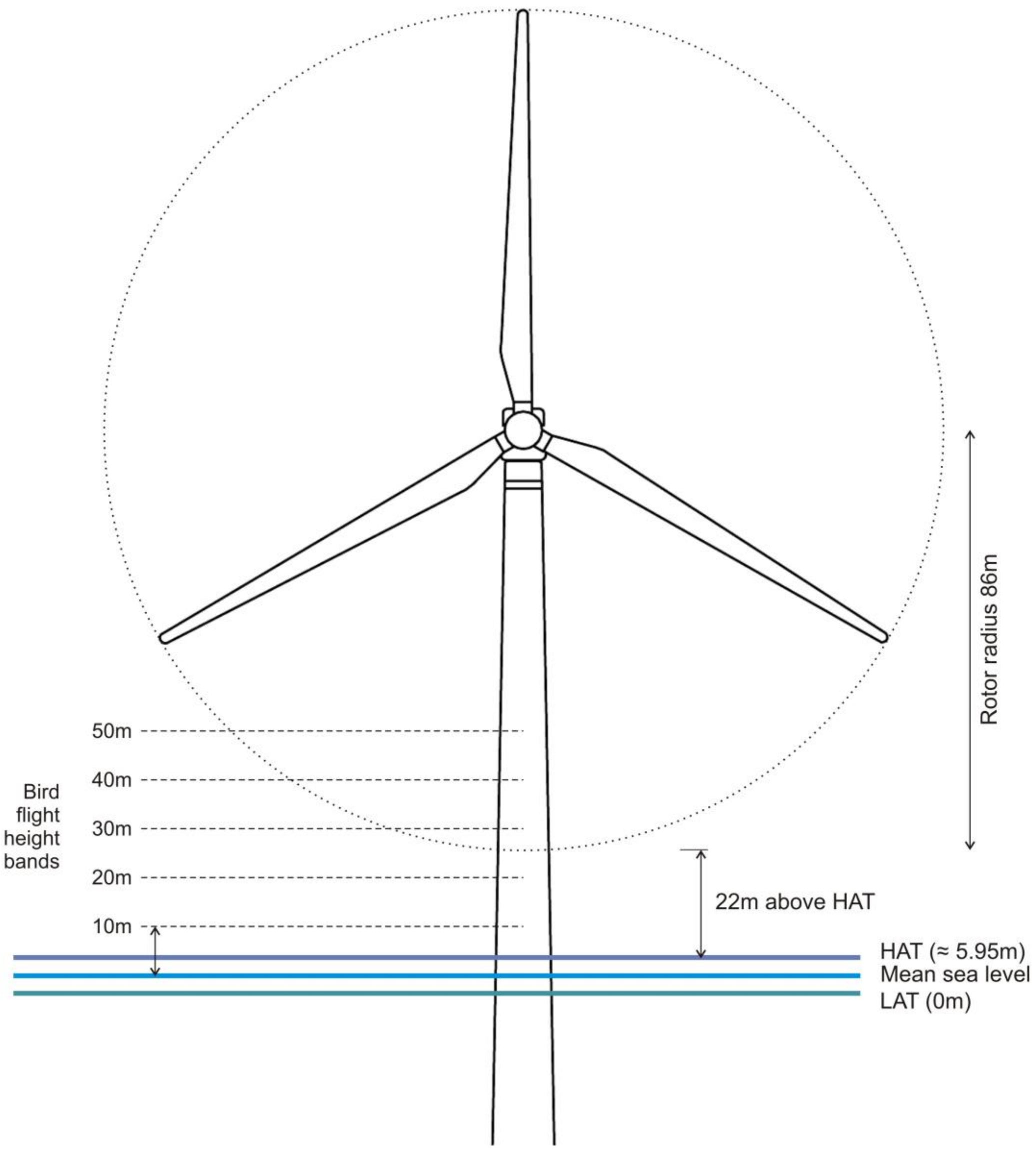
It is considered that because baseline boat-based surveys were undertaken across a range of tides, bird flight height observations were essentially made at mean sea level. However, as the minimum clearance is relative to HAT, the collision risk zone should also be expressed in relation to mean sea level. The Band (2012) model incorporates a tidal option, which accounts for changes in tide relative to turbine dimensions and flight heights. In lieu of detailed tidal data for the Inch Cape Development Area a straightforward approach was used for this analysis instead.

In order to establish the relationship between the flight height data and a 22 m lower blade-swept height above HAT, the relationship between HAT/LAT and mean high water springs/mean low water springs (MHWS/LHWS) was defined as per the following sources: Angus Council Shoreline Management Plan (Angus Council, 2004) and Port of London Authority (2013).

The spring tide range at Arbroath is 5.3 m for MHWS to 0.8 m for MLWS (data from Admiralty chart 1407). LAT lies 0.75 m below MLWS and thus places LAT at 0.05 m, which in turn approximates to zero, i.e. chart datum. HAT is 0.65 m above MHWS, and thus equates to 5.95 m.

Figure 15A.2 visualises the relationship between the dimensions of the large turbines, the astronomic tide levels and the flight height bands used during boat-based surveys.

Figure 15A.2: Large Turbine Dimensions Relative to Astronomic Tide and Bird Flight Height Bands (not to scale)



Proportion of Birds at Potential Collision Height

The proportion of birds at PCH was estimated from survey data collected across all surveys, and included birds from the entire Study Area in order to draw from a larger sample size. For large species all observations were used, regardless of snapshot status. It is considered that observation probability of such birds in flight (gannet, large gulls) is unlikely to significantly decrease with increasing distance from the vessel. For smaller species (particularly small gulls), it is possible that low-flying birds beyond 300 m from the vessel are under-recorded, leading to bias in flight height distributions. To minimise such an effect only observations of birds in snapshot (and thus within 300 m) were used to calculate PCH proportions for kittiwake, common gull and little gull.

Calculating the proportion of birds at PCH was done in a straightforward manner. In order to account for the observer-related tendency of "rounding off" estimated flight heights in the field, flight height data was first amalgamated into 10 m height bands as opposed to the 5 m intervals recorded during surveys. Subsequently, the proportion overlap (50 per cent) between the lower rotor-swept height (at 25 m relative to mean sea level) and the 30 m (amalgamated) flight height band was used to calculate the proportion of birds in that height band assumed to fly in the overlapping section of air space (Figure 15A.2). This was done on the precautionary assumption that flying birds are equally distributed throughout a height band.

To account for potential seasonal differences in flight behaviour, proportions at PCH for key breeding bird species were calculated separately for the breeding season and the non-breeding season. Information on seasonality was derived from Snow and Perrins (1998).

Ultimately modelling provided three different outputs, one for each scenario, reflecting the range of possible turbine dimensions.

Turbine Speed

Table 15A.9 provides average rotation speeds per month for the large and small turbine scenarios. These were used to calculate a monthly collision probability in the Band model for each species.

TABLE 15A.9: MONTHLY AVERAGE ROTATION SPEED FOR TURBINE SCENARIOS

Turbines	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Large	9.30	8.57	8.46	6.93	6.11	5.55	5.11	5.60	6.98	8.12	8.87	9.07
Small	9.65	8.95	8.87	7.42	6.64	6.10	5.67	6.15	7.48	8.56	9.25	9.44

Note: for the medium turbines these have been set at an average of the values for large and small turbines

Wind Availability

Table 15A.10 provides an overview of the average month wind availability – i.e. wind speeds above cut-in but below cut-out turbine rotation speeds – for all three turbine scenarios.

TABLE 15A.10: MONTHLY AVERAGE WIND AVAILABILITY FOR ALL TURBINE SCENARIOS

Scenario	Wind availability per month (%)											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Large	98.61	98.55	98.25	96.81	95.97	96.67	95.43	95.56	97.26	98.37	98.88	98.58
Medium	96.28	96.53	95.83	92.78	90.86	92.22	89.11	89.92	93.71	96.14	97.14	96.41
Small	97.84	98.47	98.21	96.81	95.97	96.67	95.43	95.56	97.26	98.33	98.74	98.33

Turbine Operational Time

In CRM accounting for variability in wind speed, values for the proportion operational time are typically set at 85 per cent - which also includes time lost to breakdowns and maintenance. The Department of Trade and Industry's (DTI's) Capital Grant Scheme for Offshore Wind Annual Reports (BERR, 2007), showed that both North Hoyle and Kentish Flats OWF were operational for 87 per cent of the time in 2006-07, with Scroby Sands available for 81 per cent of the time in 2006. In contrast, Barrow Offshore Wind Farm was only operational for 67 per cent of the time in 2006/07 due to some maintenance problems.

For the Inch Cape Offshore Wind Farm specific calculations were available: down time due to technical failure and maintenance time was assumed to lie between 2.5 and 10.1 per cent depending upon turbine manufacturer and model. To limit the number of scenario outputs an average of 6.3 per cent downtime was used in the CRM.

Flight Density Calculation

Bird flight densities within the Development Area were calculated based on boat-based survey data collected between September 2010 and September 2012 inclusive. Using boat-based GPS survey tracks the number of snapshots was calculated for each survey independently. For each survey all observations of birds in snapshot within the Development Area as well as the total number of snapshots within the Development Area were included in the CRM, allowing the model to calculate monthly flight densities.

To account for the missing November 2010 survey, flight density estimates were assumed to be an average of those for October and December 2010.

Although two surveys were conducted in June 2011, the first one (undertaken on 3 June 2011) was nonetheless treated as a "May" survey for the purposes of data presentation, as flight activity was likely to be representative of late May. The actual June survey was undertaken 2.5 weeks later.

To avoid artificially low flight densities data from the incomplete survey in September 2010, data were omitted from CRM as only a small portion of the Development Area was surveyed that month.

Nocturnal Activity

Nocturnal activity rates were incorporated using a species specific index of nocturnal activity (1-5, Furness and Wade 2012), expressed as a percentage (0-100 per cent). The total monthly hours of daylight and darkness were calculated from the Development Area's location (latitude 56.4945 decimal degrees) and day of year using the method of Forsyth *et al.* (1995).

Collision Risk Model

Stage 1 – Estimation of Rotor Transits

Total potential monthly rotor transits were calculated as the product of bird density at rotor height, total rotor frontal area (number of turbines multiplied by rotor area) and flight speed, divided by the product of rotor diameter, seconds in an hour, daylight hours and potentially active night-time hours.

The risk window for birds passing through the wind farm was taken to be the average width of the Development Area (6,774 m) multiplied by the diameter of the rotors. However, this is only applicable to the "large array" function in the Band model, which enables a correction to be made for large arrays where the collision rate is such that bird density might significantly decline as birds pass through the wind farm (Band 2012). This correction was tested on all collision estimates, but resulted in very small differences in comparison to the estimates not subjected to this procedure and subsequently was not used further.

Stage 2 – Probability of Collision

The probability of collision (p) spreadsheet which is part of the Band (2012) model was used to estimate the probability that a bird will collide with turbines, assuming no avoidance action. This spreadsheet remains unchanged from that used with the previous CRM developed for onshore wind farms (Band 2007). Upwind and downwind ratios were always considered to be 50:50.

The probability of collision is calculated using bird and turbine specific metrics. For birds these include body length, wingspan and flight speed (see Section 15A.4). These were taken from the following published sources: Snow and Perrins (1998), Alerstam *et al.* (2007) and Pennycuick (1987, 1997).

Collision probability was calculated for each month specifically through incorporating the average monthly turbine speed and wind availability values (Table 15A.9, 15A.10).

Stage 3 – Predicted Mortality

Step 1 – Predicted Mortality With No Avoidance

The number of wind farm transits per month (Stage 1) was multiplied by the probability of collision (Stage 2), and corrected for the predicted proportion of time when the turbines will not be rotating. In turn this gives the predicted number of collisions per month, assuming no avoidance action.

Step 2 – Predicted Mortality With Avoidance

However, birds do take avoiding action to avoid collisions with turbines. This can be divided in 'far-field' or 'macro' avoidance – avoiding the wind farm area altogether, and 'near-field' or 'micro' avoidance through the selection of routes between or above turbines, or last minute evasion of approaching rotor blades.

Several attempts to estimate avoidance rates empirically have been made (for a review see Cook *et al.* 2012). These have either estimated macro avoidance or micro avoidance. For CRM these need to be combined as: 1 – (macro * micro) to generate overall avoidance rates. However, inconsistencies in the distance over which these terms have been applied makes combination of these avoidance rates potentially unreliable. Consequently, Cook *et al.* (2012) recommend that a lower avoidance rate of 99 per cent is appropriate, although the inclusion of 98 per cent is seen as useful to permit comparisons with previous assessments.

SNH and JNCC recommend the use of avoidance rates of 98 per cent for all species (except geese), unless sufficient evidence can be provided that avoidance is higher. A range of avoidance rates from 95 per cent to 99.5 per cent are presented in this appendix (the rationale behind which is described further in Section 15A.4.2.1).

The monthly mortality estimates were combined to give breeding, post-breeding and non-breeding season mortality figures (where applicable). These are then discussed in relation to regional, national, passage and North Sea populations (breeding and non-breeding season) and known adult survival rates (breeding season) or the proportion of the population these represent (post- and non-breeding). Where two values are available for a month (i.e. based on Year 1 and Year 2 surveys) the mean collision estimate is used for assessment purposes.

15A.2.5.3 <u>Collision Risk for Migratory Birds</u>

Boat-based seabird surveys are not well-suited to survey migrating waterfowl and waders as birds tend to fly at high altitude - away from the main focus of the survey effort, which is on the transect line, can be detected at long range (introducing bias into distance sampling) or migrate to an extent nocturnally. Crucially, as migration windows are often quite narrow, the chance to entirely miss a species' passage is substantial.

Migratory modelling was undertaken for a range of geese, waterfowl and skua species recorded during 2010-2012 boat-based surveys, using the migration section of the SOSS (2012) model. This model uses a flux (birds per unit flyway corridor width) rather than an on-site flight density. The migration model was also run for bean goose (not seen during surveys) as CRM for this species was specifically requested by SNH in their response to the Scoping Report for Inch Cape Offshore Wind farm (letter from Catriona Gall, SNH, to Fiona Thompson, Marine Scotland, dated 29 October 2010).

Flyway populations were largely determined following Wright *et al.* (2012), flyway corridors were considered and measured in ArcGIS. Modelling was only undertaken for the large turbine scenario.

An overview of species-specific parameters, population sizes and flyway corridor considerations are provided in Section 15A.4.

15A.2.5.4 <u>Displacement</u>

Following recommendations from Marine Scotland, SNH and the JNCC a simple displacement rate approach was used for analysis. This approach was based on the proportion of birds which may be displaced from the Development Area and a 2 km buffer around it, based on estimated bird densities for a given season. Peak mean densities were used for this analysis to represent the populations utilising the Study Area across an entire breeding or non-breeding season in a precautionary manner. The peak mean density was derived through calculating the average density in the Development Area and a 2 km buffer for each season in Year 1 and Year 2 and then selecting the highest seasonal value.

Marine Scotland / SNH / JNCC recommended that for each species in the breeding season it was assumed that 50 per cent of all adult birds or birds in summer plumage (auks) recorded in the Development Area were in fact breeding birds (advice received 26 August 2011 in a request to FTOWDG; Niras 2012, Appendix 1). However it was also noted that if species specific information was available then it could be used in preference to this more generic assumption. In line with this, the assumption that 50% of adult plumage birds are breeding has been changed for some species. For kittiwake, guillemot, razorbill and puffin stable age distributions from PVA modelling (Appendix 15B) have been used to calculate the expected proportion of a population making up each age class (including the proportion breeding adults). For gannet, a PVA commissioned by SOSS (WWT Consulting 2012) found no evidence of non-breeding adults at monitored colonies and it has been assumed that 100 per cent adult plumage birds present during the breeding season are breeding.

Species were primarily included based on importance levels of the numbers present in the study area (e.g. nationally or regionally important) or likely SPA status (where connectivity with an SPA is considered likely). Little gull was included due to the important numbers present off the Scottish east coast during autumn passage, sooty shearwater for its international conservation status.

Displacement Scenarios

Section 15A.5 below presents seasonal population estimates for seabirds within the Development Area and a 2 km buffer - an area of 278 km^2. These population estimates are used as the basis for the assessment of displacement in the Ornithology chapter (Table 15.11). The inclusion of the 2 km buffer reflects the available evidence from post construction monitoring that displacement effects are likely to extend beyond the turbine array of an offshore wind farm, and the 2 km distance is based on advice received from Marine Scotland / SNH and JNCC to FTOWDG in August 2011 (copy of this advice in Niras 2012, Appendix 1). In the Ornithology chapter, a review of evidence for displacement for each species is presented and a realistic worst case scenario (in terms of the likely percentage reduction in numbers within the Development Area post-construction) is identified. This is then used in Section 15A.5 to predict the numbers of birds displaced based on the seasonal peak mean population estimates.

For each species, seasonal peak mean population estimates for the Development Area and a 2 km buffer were calculated and are considered to represent the maximum number of birds ‘at risk’ of displacement (or adult birds ‘at risk’ in case of breeding season displacement). These population estimates are multiplied by the relevant displacement rates and used to estimate the number of displaced birds in a given season.

A range of displacement scenarios (ranging from 10 to 100 per cent displacement) are also given in Annex 15A.5. These are based on preliminary advice from Marine Scotland / SNH in a request to FTOWDG dated 26 August 2011; Niras 2012, Appendix 1).

15A.3 BASELINE CONDITIONS

15A.3.1 Overview of Bird Survey Results

A total of 65,879 individual birds were recorded between September 2010 and September 2012 across the entire boat-based study area. Observations were distributed over 54 species and seven unidentified species groups. Of these, 54,049 birds were recorded within the area under consideration in this report - the Development Area plus a 4 km buffer. All survey and environmental data collected during the baseline are provided in Annex 15A.2: Boat-Based Survey Data.

The 10 most numerous species or species groups were gannet (12,803), guillemot (11,496), kittiwake (10,577), razorbill (6,098), puffin (5,797), guillemot/razorbill (2,787), fulmar (893), little auk (809), unidentified auk (554), and Arctic tern (362).

Table 15A.11 provides an overview of survey results in 2010-2012, outlining observations 'in transect' and 'in snapshot', i.e. those used to derive density and population estimates.

TABLE 15A.11: NUMBER OF BIRDS RECORDED IN TRANSECT AND IN SNAPSHOT DURING 2010-2012 BOAT SURVEYS

Species	Bird numbers observed during boat surveys			
	In transect		In snapshot	
	Development Area	4 km buffer	Development Area	4 km buffer
Great northern diver	0	0	1	0
Fulmar	32	77	85	122
Manx shearwater	21	23	13	13
Sooty shearwater	16	22	4	12
Storm petrel	0	3	0	1
Gannet	299	553	950	1,964
Shag	0	1	0	1
Pink-footed goose	0	0	6	0
Barnacle goose	0	0	0	2
Shelduck	0	0	0	1
Common scoter	0	0	0	1
Peregrine	0	0	0	1
Arctic skua	0	2	0	6
Great skua	5	1	2	6
Pomarine skua	1	0	3	6
Kittiwake	1,211	2,181	582	1,799
Common gull	4	2	3	17
Little gull	14	30	11	13
Lesser black-backed gull	0	4	4	7
Herring gull	5	18	21	87

TABLE 15A.11: NUMBER OF BIRDS RECORDED IN TRANSECT AND IN SNAPSHOT DURING 2010-2012 BOAT SURVEYS

Species	Bird numbers observed during boat surveys			
	In transect		In snapshot	
	Development Area	4 km buffer	Development Area	4 km buffer
Great black-backed gull	13	35	22	41
Unidentified large gull	0	2	0	1
Unidentified gull	0	0	1	0
Sandwich tern	0	1	0	0
Common tern	0	0	0	9
Arctic tern	20	23	75	50
Common / Arctic tern	0	0	0	5
Guillemot	2,711	6,805	118	278
Razorbill	1,573	3,137	65	231
Guillemot / Razorbill	584	1,373	17	73
Black guillemot	0	1	0	0
Puffin	1,816	2,912	72	188
Little auk	212	445	11	24
Unidentified auk	74	300	4	3
Ringed plover	0	0	0	1
Purple sandpiper	0	0	0	1
Grey phalarope	6	9	0	1
Meadow pipit	0	0	50	14
Swallow	0	0	10	0

Note: observations in this table represent species that were only observed in transect or in snapshot, i.e. birds seen on the water within 300 m from the survey vessel or birds in flight recorded during a snapshot (see Methods section for details).

Table 15A.12 provides an overview of incidental species not recorded “in transect” or “in snapshot”. All of these occur in very small numbers and have often been observed on a single occasion only.

TABLE 15A.12: NUMBER OF INCIDENTAL RECORDS DURING 2010-2012 BOAT SURVEYS

Species	Development Area	4 km buffer
Red-throated diver	1	5
Heron	1	0
Long-tailed duck	0	3
Unidentified skua	0	2
Oystercatcher	17	3

TABLE 15A.12: NUMBER OF INCIDENTAL RECORDS DURING 2010-2012 BOAT SURVEYS		
Species	**Development Area**	**4 km buffer**
Golden plover	0	2
Dunlin	4	1
Knot	3	0
Curlew	0	3
Skylark	0	1
Pied wagtail	0	1
House martin	0	1
Swift	0	2
Wood pigeon	0	1
Feral pigeon	1	0
Song thrush	6	2
Fieldfare	8	73
Redwing	4	1
Starling	5	1
Carrion crow	1	0
Unidentified passerine	3	2

Note: observations in this table represent species that were only observed out of transect: i.e. birds either seen on the water beyond 300 m from the survey vessel or birds in flight recorded outside a snapshot.

15A.3.2 Species Accounts

Species for which accounts are presented in this section were selected on the basis of one or more of the following factors: a. being true seabirds, waterfowl or wader species, b. occurring in important numbers (relative to international, national or regional populations), c. having likely SPA connectivity, or d. being potentially sensitive to one or more aspects of offshore developments (as per e.g. Langston 2010, Furness and Wade 2012).

A range of bird species recorded during boat surveys (as listed in Tables 15A.11 and 15A.12) are either very rare in the study area (either actually rare on the Scottish east coast as per Forrester *et al.* 2007 or recorded in very low numbers during two years of baseline data collection) or exceedingly common (e.g. common migrant passerine species). For those reasons, the following species listed in Table 15A.11 are not considered any further in this document: great northern diver, storm petrel, peregrine, Sandwich tern, black guillemot, meadow pipit and swallow.

Of the incidental species listed in Table 15A.12, with the exception of waterfowl and wader species, all are considered to either be particularly rare or particularly common and are not considered further in this document.

Two bird species, goldeneye and tufted duck, were each recorded once immediately outside the study area. Given the suspected sensitivity of waterfowl in relation to collisions with turbines, and the limited capacity of boat surveys to capture migratory movements of such species, both species are considered further in this report.

Accounts for each species provide information background populations, including regional breeding, non-breeding and passage populations as applicable. An overview is presented of density and population estimates, temporal and spatial variation and illustrated with graphs and maps. As population estimates consist of birds on the sea surface and in flight (which are calculated differently), no confidence intervals are shown in the graphs – these are provided in Annex 15A.3: Seabird Population Estimates, instead. Where available, detail is provided on age distribution, flight direction and height patterns and foraging behaviour.

15A.3.2.1 Fulmar

Fulmars are one of the most common seabirds all year round in northern Britain. Adults show no pronounced pattern of migration, but rather disperse from the colonies at the end of the breeding season and return to nest the following year (Mitchell *et al.* 2004).

The European population of fulmar is estimated at between 2.8 and 4.4 million pairs, and is considered stable (BirdLife International 2004). The UK supports 504,756 pairs (Baker *et al.* 2006), or between 11 per cent and 18 per cent of the European total population, most of which breed in Scotland. Although the European population is stable and appears to be undergoing continued range expansion, fulmar is recognised as a species of conservation concern in the UK as the species has suffered a moderate decline in the past 25 years and over 50 per cent of the breeding population occurs within 10 or fewer breeding sites (Eaton *et al.* 2009).

Regional Population

The regional breeding fulmar population is considered to consist of up to 41,112 pairs (SMP database, including trend correction of +8%, JNCC 2012), encompassing an area between Flamborough Head and Caithness (using mean maximum foraging range, Figure 15A.1.2, Annex 15A.1).

The North Sea population during the non-breeding period has been estimated at 1,872,000 birds (November to February, Skov *et al.* 1995).

A cautious interpretation of areas 7, 8 and 9 in Skov *et al.* (1995) indicates the presence of up to 400,000 fulmars in the Western North Sea between November and February.

Density and Population Estimates

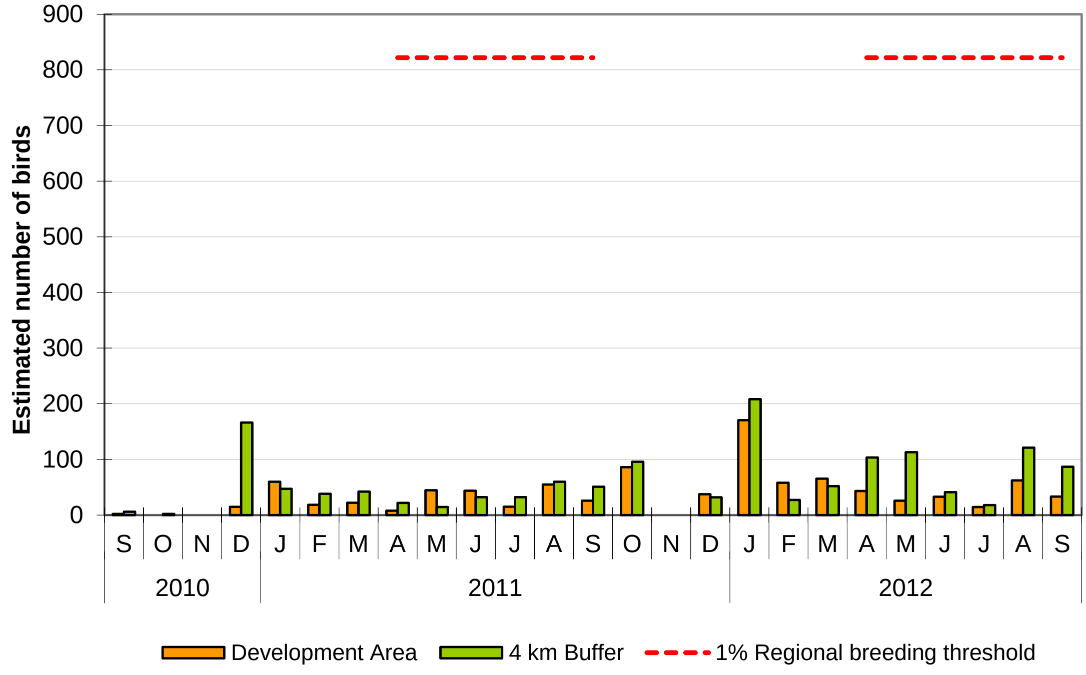
Boat surveys recorded year-round presence of fulmar in the study area (Figures 15A.1.3 and 15A.1.4, Annex 15A.1), with peak densities occurring in autumn and particularly midwinter, and generally lower densities during the breeding season between April and September (Figure 15A.3 below). These densities compare well with findings from Stone *et al.* (1995), who show the occurrence of year-round low fulmar densities (0.01-0.99 km^2) in the wider Firth of Forth and Tay area, reflecting the study area's inshore location compared to more favourable offshore feeding areas.

Population estimates for fulmar did not exceed the 1 per cent regional threshold of 822 birds during any month in the breeding season (Figure 15A.3).

Fulmar population estimates in the breeding season should be treated with caution as numbers will likely include a sizeable proportion of non-breeding or prospecting birds, as fulmars can take 6-12 years before first breeding (Snow and Perrins 1998), and can spend the first four years of life after fledging at sea (Anderson and Cosgrove, 2002).

Outside the breeding season, the study area does not appear to support important numbers when compared to the North Sea winter population estimate (Skov *et al.* 1995).

Figure 15A.3 Monthly Fulmar Population Estimates for the Inch Cape Study Area during 2010-2012 Surveys



Flight Behaviour

Observations during the breeding and the non-breeding season did not provide a clear indication of flight direction patterns, with birds recorded in comparable numbers in most directions. Due to the species' arcing flight behaviour and attraction to vessels, flight direction in fulmar is difficult to determine at sea without spending a considerable amount of time following individual birds – an effort that would not comply with the line transect survey protocol. Sample size is low overall, reflecting the low fulmar densities in the study area (Figure 15A.4).

Figure 15A.4 Fulmar Flight Direction Distribution for the Breeding and Non-breeding Season

A total of 776 fulmar flights were recorded in the study area during the 2010-2012 monitoring programme. The resulting flight height distribution reflects the species' characteristic sea surface skimming flight patterns (Table 15A.13). No birds were recorded at potential collision risk height.

TABLE 15A.13: FULMAR FLIGHT HEIGHT DISTRIBUTION				
Season	**% at PCH**	**Number of birds in flight**	**Height bands (m)**	
			5	**10**
Breeding	0%	408	404	4
Non-breeding	0%	368	361	7
Note: flight data summarised here is based on all data collected in the study area, regardless of snapshot				

Foraging Behaviour

Few observations of active feeding behaviour were made - fulmar were recorded surface pecking on only two occasions (<1 per cent of all birds). Associations with fishing vessels were only recorded on two occasions, with the biggest group involving up to 50 birds.

Up to 8 per cent of all birds recorded had a clear association with the sea surface, either through active foraging or other behaviour, with the remainder recorded in flight.

15A.3.2.2 Manx Shearwater

The UK Manx shearwater breeding population is estimated at between 281,382 and 319,499 breeding pairs (Mitchell *et al.* 2004), accounting for up to 90 per cent of the world population. The UK population has been assigned Amber conservation concern status (Eaton *et al.* 2009) due to its European Conservation Status, its long term moderate decline, its distribution across relatively few breeding colonies and its international importance. Birds attend Scottish colonies between March and September, with substantial passage movements recorded in spring and particularly July to September (Forrester *et al.* 2007).

Regional Population

Although small numbers of Manx shearwater have bred on Shetland and Orkney, their status in recent years is unclear (Forrester *et al.* 2007). Thus it is considered there is no realistic regional breeding population as the nearest colonies of any substance to the Inch Cape study area are on St. Kilda and Rum, substantially beyond the mean maximum foraging range of 330 km (Guilford *et al.* 2008).

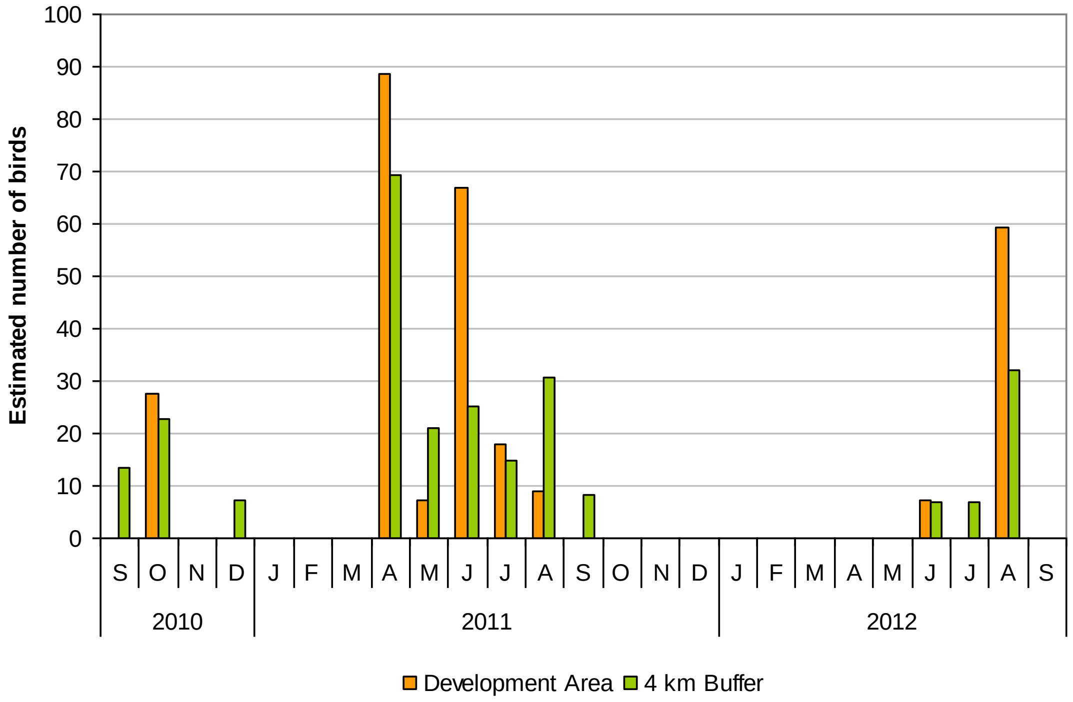
An estimate for the non-breeding season is not available as the species is rare in Scottish waters in winter (Forrester *et al.* 2007) with the vast majority of the UK population residing at its South American wintering grounds during that time. Manx shearwater numbers present in the region in winter are considered to be exceedingly low.

Density and Population Estimates

Boat-based surveys recorded Manx shearwaters on autumn passage in September and October as well on spring passage (April-May) and during the breeding season (June to August) in the study area (Figure 15A.5). Density estimates for the Development Area were highest during May passage at 0.29 birds / km^2 or 89 individuals. Birds recorded in June-August were probably a mixture of late breeders, early failed birds and immature individuals.

In the context of the UK population size of over half a million birds (lower range estimate) the peak estimate of 89 birds for the Development Area is rather small.

Figure 15A.5 Monthly Manx Shearwater Population Estimates for the Inch Cape Study Area During 2010-2012 Surveys



Flight Behaviour

In line with the species' characteristic flight behaviour, out of 106 birds in flight none were recorded above 5 m height.

Foraging Behaviour

Active foraging behaviour was only recorded once – with a single bird plunge diving. A third of all recorded birds in the study area (32.7 per cent) were recorded on the sea surface.

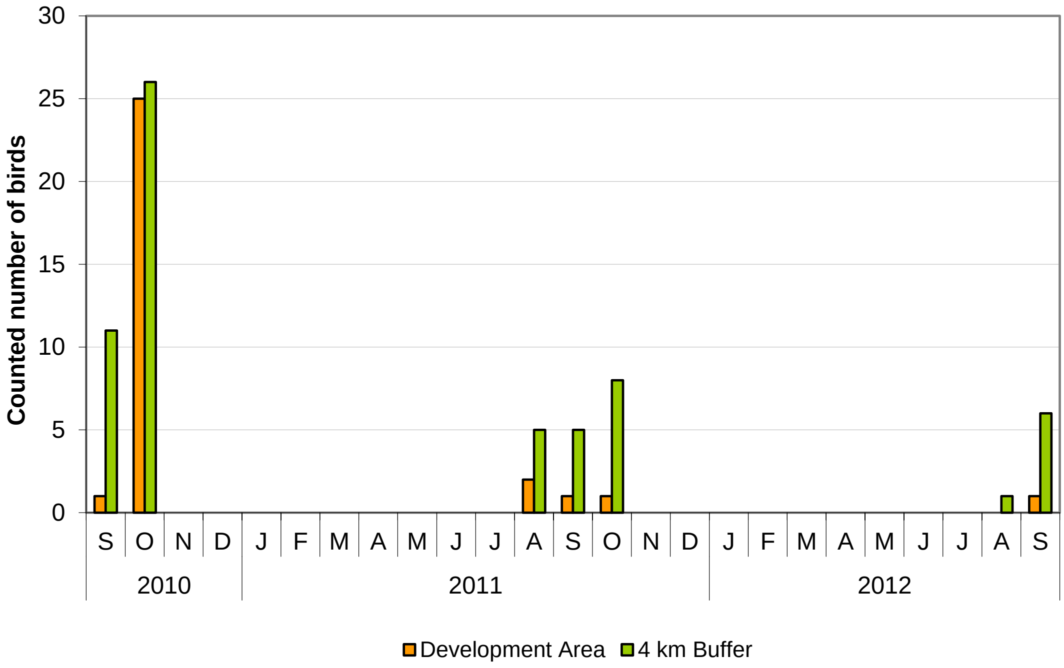
15A.3.2.3 <u>Sooty Shearwater</u>

The world population of sooty shearwater is estimated at over 20 million individuals but is of moderate global conservation concern due to a steady population decline (Brooke 2004). No official population estimate exists for the UK. The Scottish population is estimated at around 7,500 birds, although this is based on a peak year count and is unlikely to reflect true abundance (Forrester *et al.* 2007), particularly as counts are largely from made from land and probably underestimate offshore numbers.

Sooty shearwaters do not breed in Scotland, but migrate across the Atlantic and North Sea in large numbers on their way to and from their summer foraging grounds in the Arctic. Birds are mostly observed in Scottish waters between July and October (Forrester *et al.* 2007).

Survey observations from the Inch Cape study area are consistent with this pattern, with birds only recorded between August and October (Figure 15A.6). Insufficient observations were available for reliable density estimation. The peak count for the Development Area was 25 shearwaters present in October 2010. Using the Scottish peak count this approximates 0.3 per cent of the passage population.

Figure 15A.6 Monthly Sooty Shearwater Counts for the Inch Cape Study Area During 2010-2012 Surveys



Flight Behaviour

In line with the species' characteristic flight behaviour, no sooty shearwaters were recorded at potential collision height. Out of 59 birds in flight in the study area only one was seen flying at 10 m height, with the remainder recorded at five metre height.

Foraging Behaviour

Actively foraging sooty shearwaters were only seen in October 2010, when up to 10 birds were seen actively searching. Overall 41 per cent of all shearwaters recorded in the study area were seen on the sea surface.

15A.3.2.4 Gannet

The UK breeding population (218,546 pairs; Baker *et al.* 2006), amounts to more than half of the world breeding population, which is estimated at 390,000 pairs (Mitchell *et al.* 2004). Gannet is of Amber conservation concern within the UK as its population is of international importance and 50% of the population occurs at less than 10 sites (Eaton *et al.* 2009).

Gannets return to breeding colonies as early as January with variable attendance until April when the first eggs are laid (Cramp *et al.* 1974). The breeding season in the outer Forth and Tay areas has been defined as April to September (based on advice from Marine Scotland and SNH in a request to FTOWDG for a preliminary analysis of breeding season impacts dated 26 August 2011, see Table 15A.3).

Regional Population

Based on the mean maximum foraging range plus one standard deviation (as described above in Section 15A.2.3.2), the regional population nominally extends from Flamborough Head to Fair Isle, encompassing the Bempton Cliffs, Bass Rock, Troup Head and Fair Isle colonies.

Gannets at Bempton Cliffs have, however, been found to predominantly forage close to the colony (Hamer *et al.* 2011), making it unlikely these birds contribute substantially to the population in the Development Area. Similarly, it is considered that Fair Isle birds are probably more likely to forage in the seas around Shetland and Orkney, having vast foraging areas available unhampered by the mainland landmass. Excluding these two colonies and using the mean maximum range instead means that the regional population thus defined consists of 58,629 breeding pairs (Figure 15A.1.5 Gannet foraging range, Annex 15A.1).

Outside the breeding season, many birds breeding in Great Britain migrate south, for example, Hamer *et al.* 2011 estimate that over 80 per cent of all Bass Rock gannets overwinter outside British waters. Fort *et al.* (2012) present evidence of chain migration in gannets, whereby populations from breeding colonies at different latitudes move southward by a similar distance. Thus gannets recorded in British waters during winter may comprise a majority of birds from breeding colonies further north in Europe.

An estimate of the number of wintering gannets in British waters is not available. Skov *et al.* (1995) present gannet population estimates for the North Sea based on densities recorded in key areas at different times of year. They provide a mid-winter (November to February) population estimate of 157,800 individuals for the North Sea. The Inch Cape Offshore Wind Farm lies within the West Central North Sea, Firth and Forth, and Farnes Deep areas as defined by Skov *et al.* (1995), with an estimated winter population of 31,200 birds.

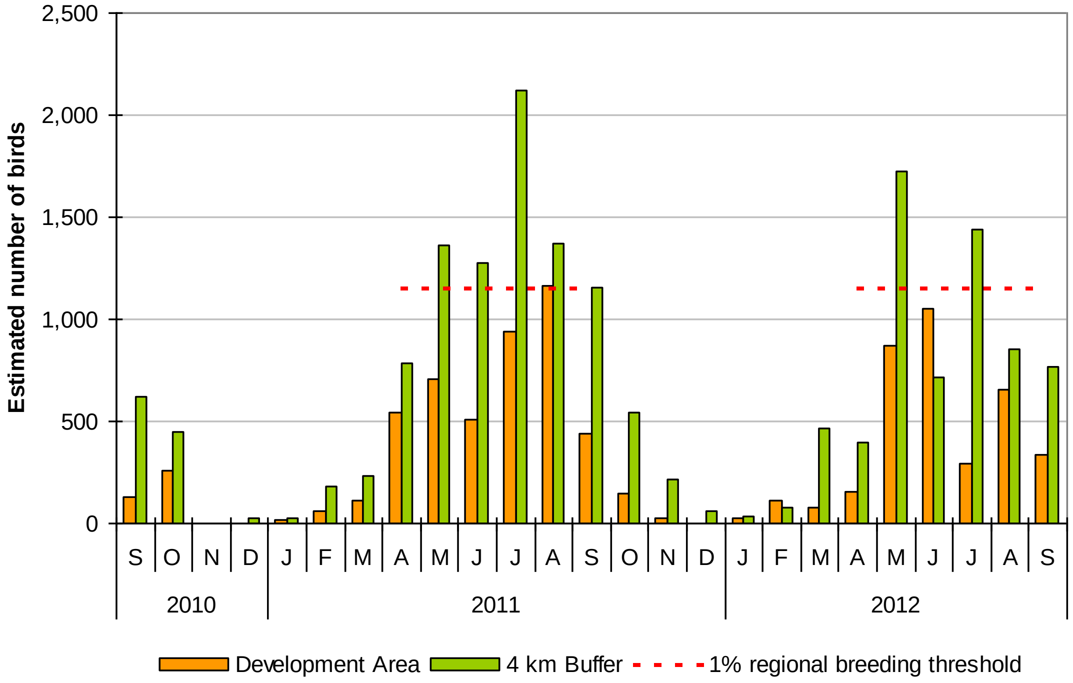
Density and Population Estimates

Surveys of the Development Area recorded the largest numbers during the height of the breeding season, with the peak estimate of 1,160 birds falling in August 2011(Figure 15A.7 below, Figures 15A.1.6 and 15A.1.7 in Annex 15A.1). Density estimates for birds in flight were generally two to five times higher than estimates for birds on the water.

Population estimates were considerably lower from October onwards (<2 birds/km^2), reaching their lowest point in mid-winter, as most birds reside in winter quarters south of the UK at that time of year.

Population estimates for 2010-2012 indicate that the ornithological importance of the Development Area only exceeded 1 per cent of the regional breeding population threshold (1,173 birds) in August 2011 (Figure 15A.7). Regionally important numbers of gannet were present in the 4 km buffer zone every month between May and August 2011 and in May and July 2012.

Figure 15A.7 Monthly Gannet Population Estimates for the Inch Cape Study Area During 2010-2012 Surveys



Age

Of 11,349 aged birds recorded during the breeding season, 97.9 and 96.4 per cent were adults in Year 1 and Year 2 respectively (average 97.2 per cent), with the remainder consisting of immature and juvenile gannets.

The age ratio in the non-breeding season is very similar with 96.8 per cent adults out of 2,073 aged gannets.

Flight Behaviour

Flight direction in the study area during the breeding season was recorded for 11,688 gannets (based on all flights, regardless of snapshot status). Data show a clear south - southwest and north - north east flight axis, corresponding with flight activity to and from the Bass Rock colony. Hamer *et al.* 2011 found a similar directional pattern where "incoming" birds were recorded much more often than "outgoing" birds, likely due to a converging effect towards the colony.

A similar pattern was recorded during the non-breeding season, albeit based on fewer observations (n=1,972, Figure 15A.8).

Figure 15A.8 Gannet Flight Direction Distribution for the Breeding and Non-breeding Season

During the breeding season a total of 10,158 flights were recorded in the study area, with a further 1,688 flights recorded in the non-breeding season. Table 15A.14 provides an overview of the flight height distribution. The majority of these birds were recorded flying at or below 20 m, with very large numbers flying at or below 10 m height. Group size for gannets in flight ranged from 1 to 75 birds.

TABLE 15A.14: GANNET FLIGHT HEIGHT DISTRIBUTION

Season	% at PCH	Number of birds in flight	Height bands (m)				
			10	20	30	40	50
Breeding	3.5%	10,158	8,515	1,058	427	136	22
Non-breeding	1.5%	1,688	1,462	173	51	2	0

Note: flight data summarised here is based on all data collected in the study area, regardless of snapshot

Foraging Behaviour

Of gannets recorded in the study area during the breeding season 12 to 15 per cent (Development Area and buffer zone respectively) exhibited a clear link with the sea surface habitat either through active foraging behaviour (plunge diving, active searching) or of birds being present on the water. Group size in foraging gannets ranged from one to 100 and between one and 30 for birds on the water.

Multi-species feeding associations were recorded on all surveys in the breeding season and were most often formed with kittiwake and the auk species. Exceptionally, gannets were recorded in a large multi-species feeding association in July 2011 (off-effort), with a group of approximately 100 birds foraging in conjunction with 500 kittiwakes, 250 guillemots, 30 razorbills and a minke whale.

Associations with fishing vessels were only recorded on a few occasions in October 2010.

15A.3.2.5 Shag

The shag is listed as a species of low conservation concern in Europe, with between 75,000 and 81,000 breeding pairs (BirdLife International 2004). The estimated number of pairs in the UK is 27,477 breeding pairs (Baker *et al.* 2006). This species is of moderate conservation concern (Amber-listed) in the UK due to its internationally important numbers, the localisation of important colonies (50% of the population at 10 or fewer sites) and breeding population decline (Eaton *et al.* 2009).

Regional Population

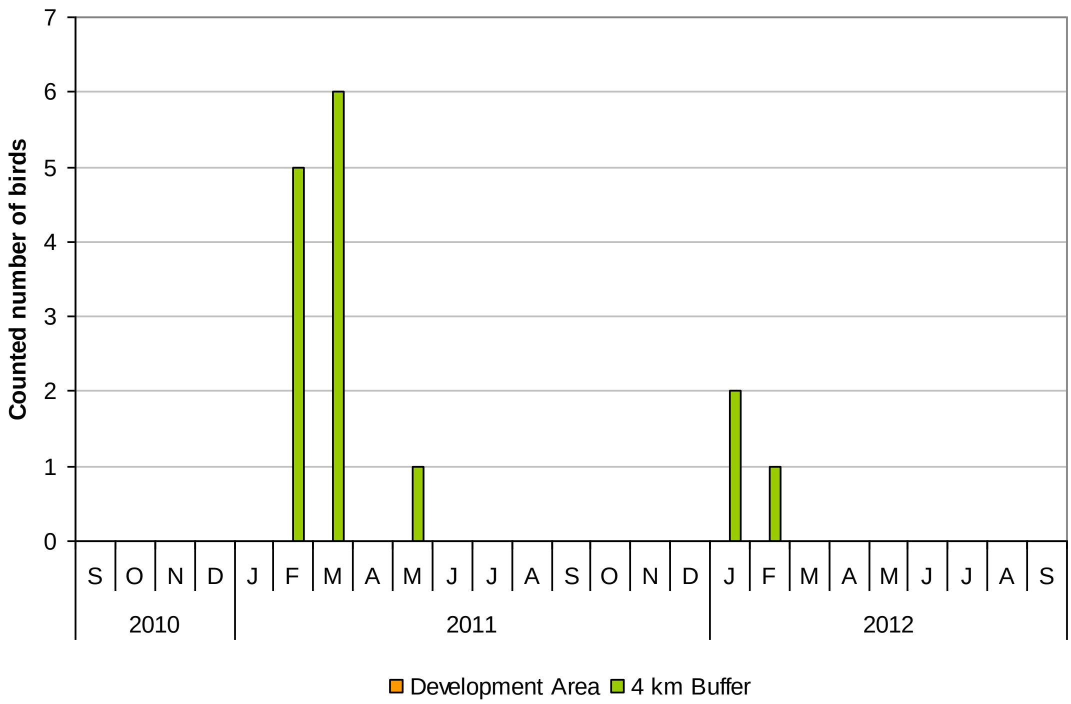
Arguably the study area is outside the foraging of most shag breeding colonies in the Forth and Tay area, although two small colonies between Whiting Bay and Ethie Haven (amounting to 21 breeding pairs, last monitored in 2000, Figure 15A.1.8) lie within the maximum foraging range of 17 km from the Development Area. Correcting for a national trend of -26 per cent since Seabird 2000 (JNCC, 2012), the regional population is estimated at 16 pairs. The only substantial colony in the wider area, the Isle of May with 465 pairs in 2009 (SMP database), lies at 26 km from the 4 km buffer zone, making connectivity unlikely.

Year-round population estimates for the North Sea equate to 29,115 birds (Skov *et al.* 1995). Based on the same source, using areas 11 to 15 (Peterhead to Farne Isles), the regional winter population amounts to an estimated 7,855 shags.

Density and Population Estimates

Shag were only recorded in low numbers in the buffer zone in mid-winter and on one occasion in spring. The peak count of six birds fell in March 2011. Insufficient observations were available for calculation of density estimates and thus raw have been used (Figure 15A.9).

Figure 15A.9 Monthly Shag Counts for the Inch Cape Study Area During 2010-2012 Surveys



Age

Ninety per cent of all aged shags were adults, with the remainder immature birds.

Flight Behaviour

The majority of shags in flight were heading south or southwest (79 per cent). Only a single (off-effort) bird was recorded on the sea surface.

In line with the species' characteristic sea surface-hugging flight behaviour none of the 15 individuals recorded were flying above 5 m height (Table 15A.15).

TABLE 15A.15: SHAG FLIGHT HEIGHT DISTRIBUTION

Season	% at PCH	Number of birds in flight	Height bands (m)			
			5	10	15	20
Year-round	0	15	15	0	0	0

Note: flight data summarised here is based on observations collected in the entire study area, regardless of snapshot

15A.3.2.6 Kittiwake

The European population of kittiwake of 2.1 – 3 million pairs has strongly fluctuated over time but has been provisionally evaluated as secure (BirdLife International 2004). Kittiwakes are the most numerous breeding gull in the UK with 379,892 pairs (Baker *et al.* 2006). The species conservation status in the UK has been classified as Amber (Eaton *et al.* 2009). In recent years breeding colonies bordering the North Sea have experienced large declines in reproductive success (Mavor *et al.* 2004, 2006, SMP database).

Regional Population

Based on the mean maximum foraging range plus one standard deviation, the regional breeding kittiwake population consists of up to 55,040 breeding pairs (SMP database, including national trend correction of -41%, JNCC 2012), encompassing an area extending from the Farne Islands to Peterhead (Figure 15A.1.9, Annex 15A.1). No breeding season connectivity is assumed with colonies in the Moray Firth as these lie substantially beyond the mean maximum foraging range. Based on the stable age distribution calculated for the kittiwake PVA it is assumed that the regional post-breeding population amounts to 181,832 birds, including fledged juvenile and immature (non-breeding) kittiwakes (see Appendix 15B, Table 15B.7).

The entire North Sea winter population present between October to March is estimated at 1,032,690 birds (Skov *et al.* 1995). The regional population amounts to 84,000 kittiwakes during this time of year, assuming areas 8, 9 and 10 in Skov *et al.* (1995) are a reasonable basis for a regional estimate.

Density and Population Estimates

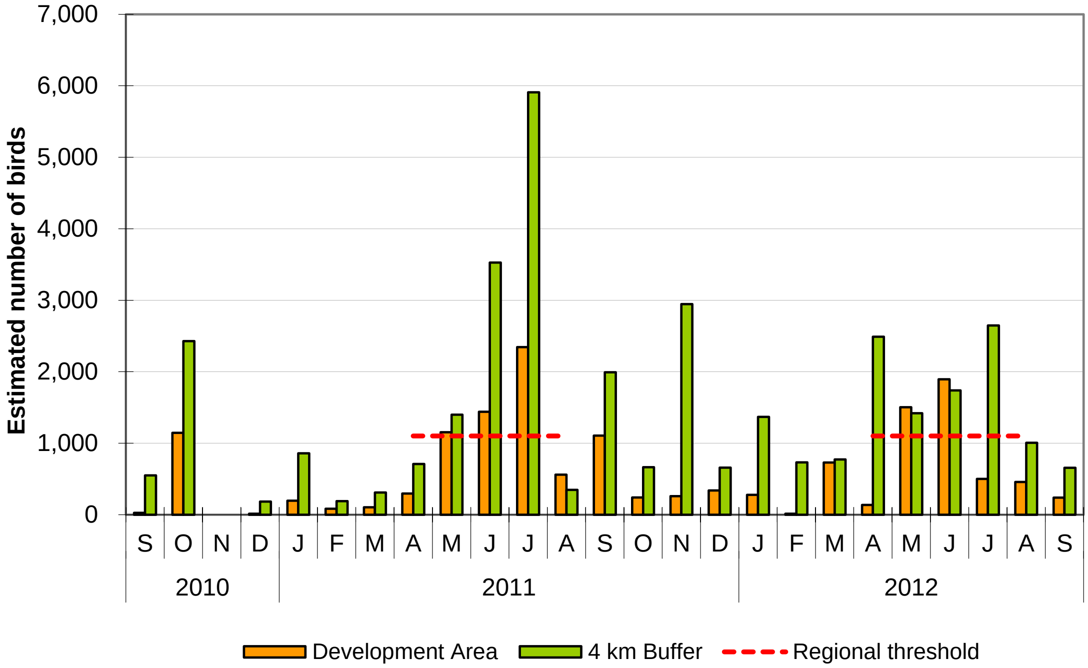
Surveys of the Development Area recorded the highest numbers in June and July, during the height of the breeding season, with the peak estimate of 2,344 kittiwakes in July 2011 (Figure 15A.10 below, Figures 15A.1.10 and 15A.1.11 in Annex 15A.1). Contrary to gannet, overall density estimates were more heavily influenced by birds on the water, and were generally two to five times higher than those for birds in flight. Estimates for July are the only exception to this, when two large flocks (500 and 100 individuals respectively) were recorded in snapshot.

During the 2011 breeding season, population estimates for the Development Area exceeded or neared the 1 per cent regional threshold of 1,101 in May to July. The peak estimate in July represents at least 2 per cent of the regional breeding population while estimates for the buffer zone in the same month are nearly three times as high. When considering the boat-based study area as a whole nationally important numbers (1 per cent threshold: 7,598 birds) were present in July 2011.

During the post-breeding period (September-October) kittiwake abundance peaked in October. Although colonies are no longer attended during that time of year, it is likely that most birds present in the study area originate from colonies within the region. As such kittiwake numbers in the Development Area during this period could be considered regionally important. The very low estimate in September 2010 is probably due to an incomplete survey undertaken that month.

Outside the breeding season, from November to March, densities are much lower as the species disperses widely across the North Sea. During the winter, it is likely that populations from many breeding localities mix together in the North Sea (Mitchell *et al.* 2004) and, by extension, the Inch Cape study area.

Figure 15A.10 Monthly Kittiwake Population Estimates for the Inch Cape Study Area During 2010-2012 Surveys



Age

Out of 3,190 aged birds recorded during the breeding season an average of 87 per cent were adults, with the remainder consisting of immature and juvenile birds (86 per cent in Year 1, 88 per cent in Year 2). In line with known fledging patterns from colonies the earliest juvenile birds appeared in the study area in August.

Flight Behaviour

The flight direction distribution during the 2011 and 2012 breeding seasons (n=2,063 birds, Figure 15A.11) show movements to lie predominantly between southern sectors and north to northwest sectors. Given the location of the study area, within mean maximum foraging range of the Fowlsheugh and Forth Islands SPA colonies, it is likely that birds from both sites utilise the study area. Tracking of kittiwakes in 2010 and 2011 indicated birds from both colonies foraging in the study area (CEH 2010, 2011).

Flight direction observations (n=2,227) in the non-breeding seasons provide a mixed picture, though with birds predominantly moving in between southern, western and northern sectors. This probably reflects passage movements during post-breeding as 70 per cent of all flight activity was recorded in September and October.

Figure 15A.11 Kittiwake Flight Direction Distribution for the Breeding and Non-breeding Season

During the breeding season a total of 1,508 flights in snapshot were recorded in the study area, with a further 873 flights in the non-breeding period (Table 15A.16).

Height distribution differs between both seasons, with a tendency towards lower flight heights (at or below 20 m) during the breeding season.

TABLE 15A.16: KITTIWAKE FLIGHT HEIGHT DISTRIBUTION

Season	% at PCH	Number of birds in flight	Height bands (m)				
			10	20	30	40	50
Breeding	0.4%	1,508	1,345	152	11	0	0
Post / Non-breeding	9.2%	873	436	289	135	5	8

Note: flight data summarised here is based on kittiwake observations in snapshot only, collected in the entire study area

Foraging Behaviour

During the breeding season active feeding behaviour was recorded for 3,325 kittiwakes (61 per cent of all birds recorded). Behaviour included active searching, plunge diving, dip feeding and surface pecking. Flight direction for a further 627 birds was recorded as “variable” or “circling”, indicating some form of foraging behaviour. Another 1,025 birds were recorded on the sea surface. Foraging activity in the Development Area and buffer zone amounted to 60 and 56 per cent of all birds recorded respectively.

During the breeding season, and particularly during post-breeding, flocks of several hundred birds were recorded foraging in the study area. In July 2011 a very large flock of 500 birds was recorded as part of the same large multi-species feeding association as mentioned for gannet.

15A.3.2.7 Little Gull

Little gull is relatively scarce in the UK, with the Forth and Tay area supporting substantial numbers originating from Scandinavia during late summer and autumn passage (Forrester *et al.* 2007). During spring passage the little gull occurs in much lower numbers. A small population resides along the Scottish seaboard in the winter period.

No official UK population estimate for little gull exists, although a minimum population size of 50 birds is generally used as a threshold to identify nationally important aggregations of scarce species. In the UK the species is considered to be of Amber conservation concern because the species is of European concern (Eaton *et al.* 2009). It is listed on Annex 1 of the EU Birds Directive.

Regional Population

Skov *et al.* (1995) estimated up to 9,000 little gulls in August-November (autumn passage) for the entire North Sea, with up to 450 present in Tay Bay. The latter estimate is now clearly out of date. Although more recent estimates for Scotland are largely based on peak passage counts, these have the advantage of being much more recent. Forrester *et al.*’s (2007) estimate of 1,500

- 3,000 individuals present between June and November in the Forth and Tay area has here been used as the regional population size during autumn passage.

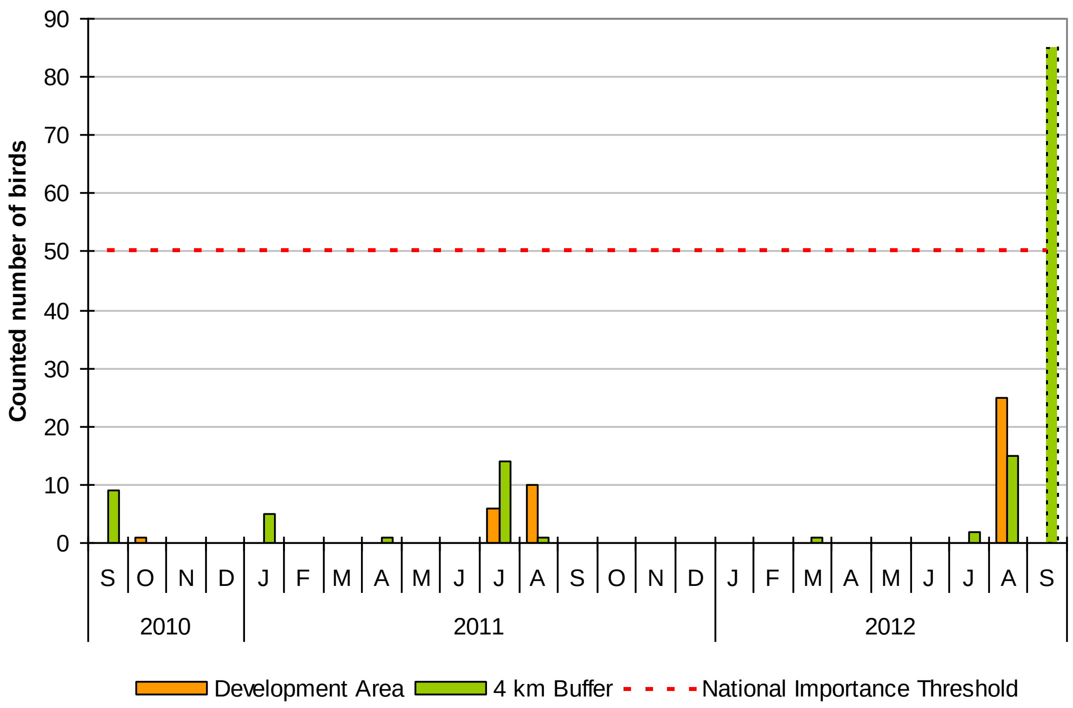
The North Sea winter population is estimated at 5,370 little gulls (Skov *et al.* 1995), while the Scottish winter population is thought to amount to 20 – 400 birds (Forrester *et al.* 2007).

Density and Population Estimates

Little gulls were predominantly recorded during passage in July to October, in mid-winter (and in very small numbers on spring passage (Figure 15A.12)). Insufficient observations were available for reliable density estimates and thus raw counts are presented. The study area as a whole did near national importance in August 2012 when 40 little gulls were recorded.

A flock of 80 little gulls was recorded feeding off-effort (i.e. not along a transect – thus not shown in Figure 15A.12) in the buffer zone in September 2012. As the national threshold for the species is set at 50, this flock represents a nationally important number of birds.

Figure 15A.12 Monthly Little Gull Counts for the Inch Cape Study Area During 2010-2012 Surveys (Hatched Bar Indicates Flock of Five Birds and Single, Off-effort, Flock of 80 Gulls in Buffer Zone)



Flight Behaviour

Too few observations on flight direction were available to establish any clear patterns.

Using only birds in snapshot within the study area, flight height distribution is based on only 26 little gulls in flight, one of which was recorded above 20 m (Table 15A.17).

TABLE 15A.17: LITTLE GULL FLIGHT HEIGHT DISTRIBUTION

Season	% at PCH	Number of birds in flight	Height bands (m)		
			10	20	30
Year-round	6.3%	26	24	1	1

Note: flight data summarised here is based on observations in snapshot only, collected across the entire study area

Foraging Behaviour

Eight birds out of a total of 53 little gulls recorded were seen foraging, involving active searching and dip feeding. The flock of 80 birds in September 2012 (recorded off-effort) was recorded dip-feeding.

15A.3.2.8 Common Gull

The European common gull population is estimated at 590,000 to 1.5 million breeding pairs (BirdLife International 2004). Common gulls breed in coastal and inland habitats across Scotland, with up to 48,720 breeding pairs in the UK (Mitchell *et al.* 2004). Although substantial spring and autumn passage movements occur, with influxes from Scandinavian and Baltic birds, the species is relatively scarce offshore, preferring inland areas, estuaries and coastal waters instead (Forrester *et al.* 2007, Stone *et al.* 1995). The species is considered of Amber conservation concern (Eaton *et al.* 2009).

Regional Population

Very few common gulls breed on the Scottish east coast and no SPA colonies lie within the species' maximum foraging range of 50 km from the Development Area. At 19 breeding pairs (Mitchell *et al.* 2004) within range, the regional population is extremely small and has not been monitored since 2000 (SMP database). Given the species' preference for coastal habitats it is considered that there is no connectivity with this population.

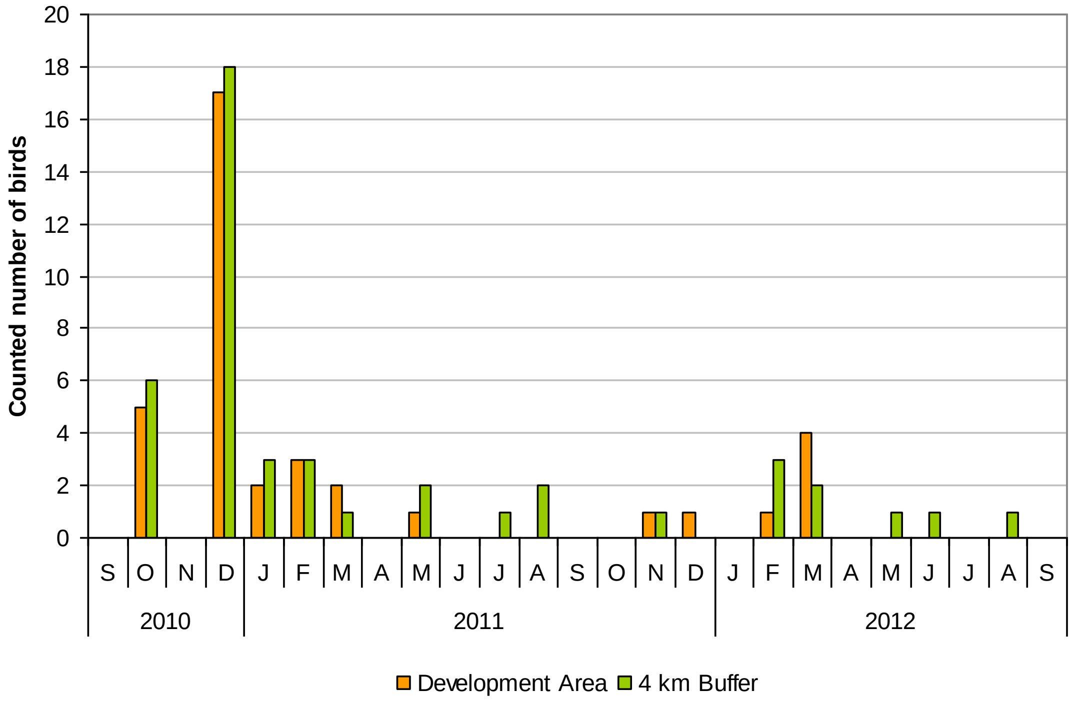
The North Sea population is estimated at approximately 175,530 birds between December and February (Skov *et al.* 1995). Regional estimates for the winter period amount to nearly 3,000 gulls (areas 1, 2 and 3 in Skov *et al.* 1995) whereas, in contrast, coastal counts in January 1993 totalled nearly 17,000 common gulls in coastal habitats in an area extending from Northeast Scotland to Lothian (Forrester *et al.* 2007). The former estimate is used as a regional winter population.

Density and Population Estimates

Surveys recorded common gull in small numbers in the Development Area predominantly between October and February, reflecting autumn passage movements as well as the presence of wintering birds. Insufficient observations were available for reliable density estimation. The peak count in the Development Area was 17 birds in December 2010, with a further 18 birds in the buffer zone (Figure 15A.13).

Population estimates for common gull in the Development Area did not exceed North Sea (1,755 gulls) or regional (170 gulls) importance thresholds.

Figure 15A.13 Monthly Common Gull Counts for the Inch Cape Study Area During 2010-2012 Surveys



Flight Behaviour

Too few observations on flight direction were available to establish any clear patterns.

Using only birds in snapshot within the study area, flight height distribution is based on only 20 common gulls in flight, most of which were recorded at or below 20 m (Table 15A.18). Up to 30 per cent of all birds were flying at potential collision risk height, although this is based on few observations.

TABLE 15A.18: COMMON GULL FLIGHT HEIGHT DISTRIBUTION

Season	% at PCH	Number of birds in flight	Height bands (m)				
			10	20	30	40	>40
Non-breeding	30%	20	8	5	2	4	1

Note: flight data summarised here is based on common gull observations in snapshot only, collected across the entire study area

Feeding Behaviour

Out of 85 common gulls recorded in the whole study area, 15 per cent were engaged in foraging behaviour (active searching, surface pecking). Very few birds were seen on the sea surface.

Associations with other species generally involved kittiwake or auks. On one occasion common gulls were seen associating with a harbour porpoise.

15A.3.2.9 <u>Lesser Black-backed Gull</u>

Lesser black-backed gulls are a species of low conservation concern in Europe, where the total population is between 530,000 and 570,000 breeding pairs (Wetlands International 2013). The UK population amounts to approximately 112,074 pairs, while the Scottish breeding population was estimated at 21,565 breeding pairs in 1998-2002 (Mitchell *et al.* 2004). However, the species is of Amber conservation concern due to the importance of the UK population in a bio-geographic context, with important numbers of breeding birds occurring at a limited number of sites (Eaton *et al.* 2009).

Regional Population

The regional population consists of 8,917 pairs (SMP database, including national trend correction of -32%, JNCC 2012) and extends approximately from the Farne Islands to Peterhead (Figure 15A.1.12, Annex 15A.1). Several large colonies are present within the region, most of which are part of the Forth Islands SPA.

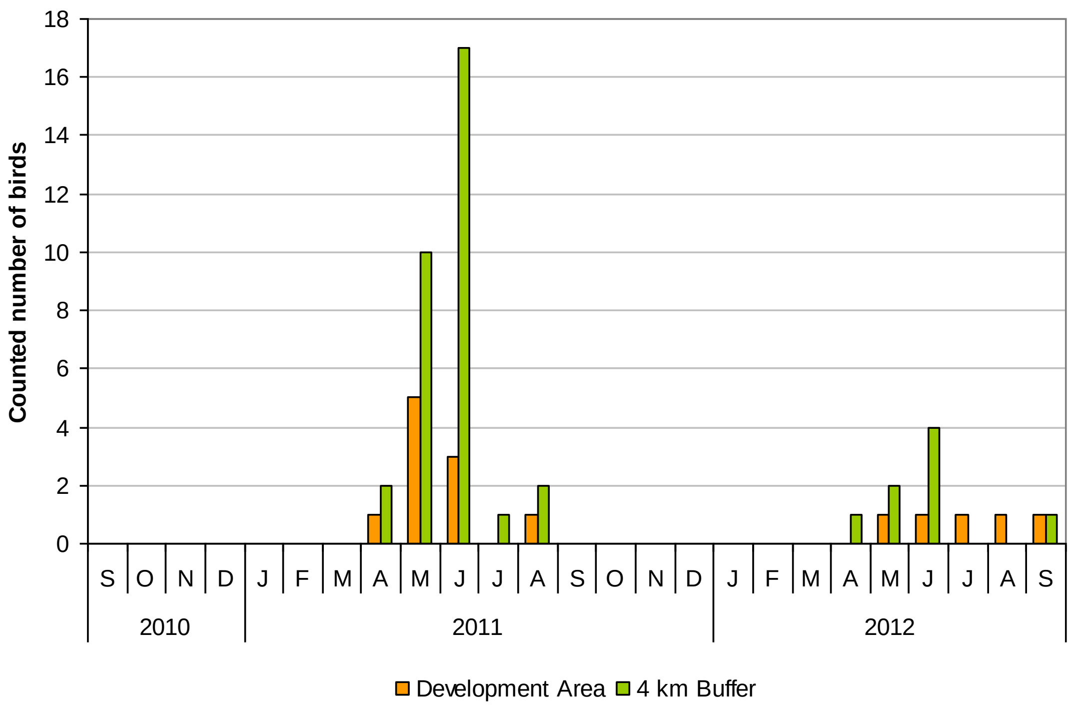
No regional winter population exists for the study area as the species moves towards more southerly wintering areas off mainland Europe.

Density and Population Estimates

Lesser black-backed gulls were only recorded in small numbers in the study area between April and August (Figure 15A.1.13, Annex 15A.1). The peak count for the Development Area of five gulls fell in May 2011 (Figure 15A.14) and consequently the Development Area did not support regionally important numbers (1% threshold: 178 birds) in the 2011 or 2012 breeding seasons.

Out with the non-breeding season, when the species resides in winter quarters in the southern North Sea and coastal areas off mainland Europe, the species was only recorded in September 2012.

Figure 15A.14 Monthly Lesser Black-Backed Gull Counts for the Inch Cape Study Area During 2010-2012 Surveys



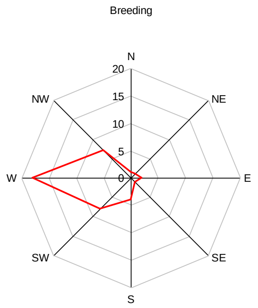
Age

A total of 58 gulls were aged, 85.9 per cent of which were adults, with the remainder immature birds. No juvenile birds were recorded during the baseline programme.

Flight Behaviour

Flight direction information was recorded for 43 gulls. The majority of these birds were seen flying between southwest and western sectors (Figure 15A.15).

Figure 15A.15 Lesser Black-backed Gull Flight Direction Distribution for the Breeding and Non-breeding Season



Flight height data was available for 47 lesser black-backed gulls (Table 15A.19). Most birds were recorded at or below 20 m height, with individuals recorded at heights up to 40 m, typical of large gull species.

TABLE 15A.19: LESSER BLACK-BACKED GULL FLIGHT HEIGHT DISTRIBUTION						
Season	% at PCH	Number of birds in flight	Height bands (m)			
			10	20	30	40
Breeding	10.5%	43	17	19	5	2
Note: flight data summarised here is based on all data collected in the study area, regardless of snapshot						

Feeding behaviour

A single (immature) bird was recorded in flight carrying a sandeel. Ten birds were recorded as "followers", associating with the survey vessel.

15A.3.2.10 Herring Gull

Herring gulls are a species of low conservation concern in Europe, where the total bio-geographic population lies between 760,000 and 1.4 million breeding pairs (BirdLife International 2004). The UK population is approximately 139,309 pairs (Baker *et al.* 2006), with the Scottish breeding population estimated at 71,659 breeding pairs in 1998-2002 (Mitchell *et al.* 2004). However, the species is a Red-listed species of conservation concern in the UK due to long term declines in breeding and non-breeding populations (Eaton *et al.* 2009).

Regional Population

Using the mean maximum foraging (plus one SD) the regional population extends from Peterhead to the Farne Islands and consists of up to 19,741 pairs (SMP database including national trend correction of -33%, JNCC 2012), see Figure 15A.1.14, Annex 15A.1. SPA colonies in the area include the Forth Islands, Buchan Ness to Collieston, Fowlsheugh and St Abb's to Fast Castle.

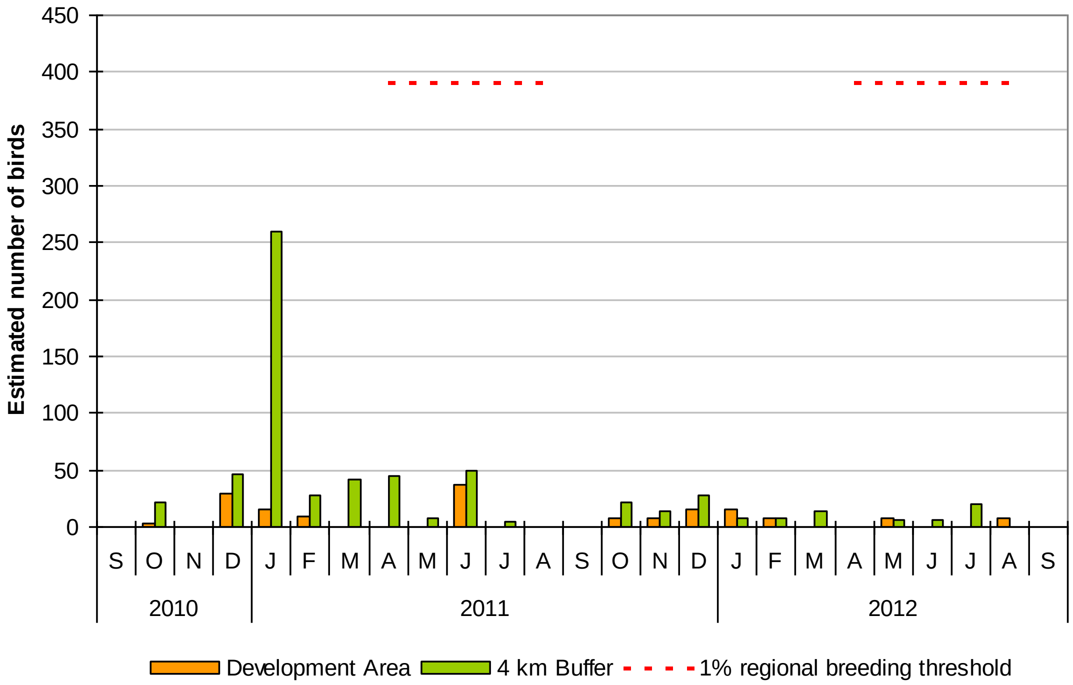
Skov *et al.* (1995) estimate the North Sea winter population at 971,700 birds between November and February. Based on estimates for areas 17, 18 and 19 at least 200,000 gulls make up the regional offshore population during the same time of year (Skov *et al.* 1995).

Density and Population Estimates

Herring gulls were present in the study area in most winter months, but were generally absent or present in very low numbers in the breeding season (Figure 15A.16 below, see Figure 15A.1.15 and 15A1.16 for distribution, Annex 15A.1). During the 2011 breeding season the species was only recorded in the Development Area in June, and in the breeding season of 2012 in very low numbers in May and August. A peak in abundance occurred in mid-winter of 2011 with an estimated 29 individuals present in the Development Area.

Herring gull population estimates for 2010-2012 show that neither national nor regional thresholds were exceeded during the breeding season (Figure 15A.16). Similarly, estimated herring gull numbers during the non-breeding season are far removed from the 1 per cent thresholds for regional and North Sea winter populations.

Figure 15A.16 Monthly Herring Gull Population Estimates for the Inch Cape Study Area During 2010-2012 Surveys



Age

A total of 77 herring gulls were aged during the breeding season, 80.5 per cent of which were adult birds.

Flight Behaviour

Herring gull observations on flight direction patterns indicate a weak north east to south-southwest pattern during the breeding season but this is based on very few observations, reflecting the species low abundance levels during that time of year.

In the winter season, directions tend to be dominated by gulls flying west and northwest, possibly indicating a link with coastal waters or inland roosts.

Figure 15A.17 Herring Gull Flight Direction Distribution for the Breeding and Non-breeding Season

Flight height data was recorded for 78 and 232 herring gulls in the breeding and non-breeding season respectively (Table 15A.20). Most birds were recorded at or below 20 m height, but a substantial number of gulls, particularly in winter time, was recorded at heights up to 30 to 50 m.

TABLE 15A.20: HERRING GULL FLIGHT HEIGHT DISTRIBUTION

Season	% at PCH	Number of birds in flight	Height bands (m)				
			10	20	30	40	50
Breeding	13.5%	78	46	16	11	4	1
Non-breeding	17.1%	232	103	61	57	7	4

Note: flight data summarised here is based on all data collected in the study area, regardless of snapshot

Foraging Behaviour

Herring gulls were seen engaging in active foraging behaviour on only seven occasions (involving a total of 10 birds), predominantly during the breeding season. No such behaviour was recorded in the Development Area, although this is likely due to the relatively low overall number of observations during this time of year.

15A.3.2.11 Great Black-backed Gull

An estimated 17,160 pairs of great black-backed gulls breed in the UK (Mitchell *et al.* 2004). Of the British population, 85 per cent breed in Scotland, with the majority of these populations occurring on Orkney, Shetland and the west coast (Lloyd *et al.* 1991). The British breeding population does not migrate, but remains resident year round (Stone *et al.* 1995). Population declines of up to 30 per cent have been recorded in the north of Scotland between 2003 and 2004. Complete colony failure occurred in several monitored locations in 1997 and 2003 (Mavor *et al.* 2004).

Regional Population

Using a maximum foraging range of 40 km the regional breeding population of 55 breeding pairs (SMP database, including national trend correction of -37%, JNCC 2012) extends from Stonehaven to the Isle of May (Figure 15A.1.17, Annex 15A.1).

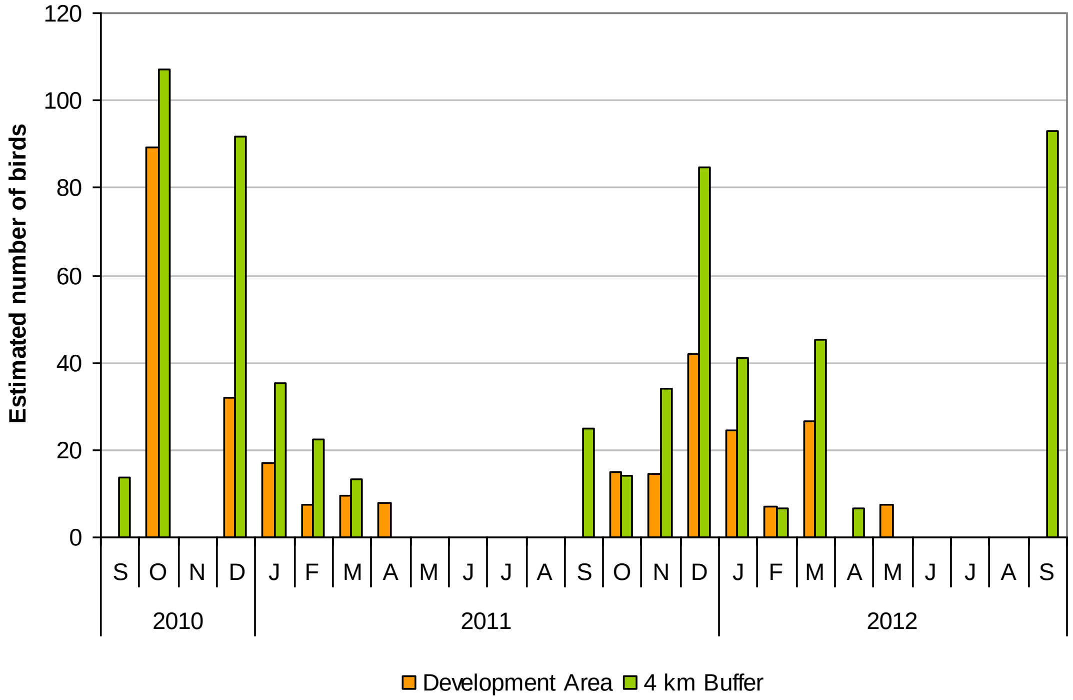
The North Sea winter population is estimated at 299,900 birds between November and February, with the regional offshore population amounting to 21,600 birds (areas 4, 5 and 6 in Skov *et al.* 1995).

Density and Population Estimates

From October to April great black-backed gulls were recorded in low densities in the study area with numbers peaking in autumn to mid-winter (Figures 15A.1.18 and 15A.1.19 in Annex 15A.1). The peak estimate of 89 birds for the Development Area in October 2010 coincided with fishing vessel activity in the wider area, with numerous birds seen associating with trawlers. Population estimates did not exceed the 1 per cent threshold for the wintering population in a regional or North Sea context.

Very low numbers were recorded in the 2011 and 2012 breeding seasons – a pattern in line with the species' scarceness as a breeding bird on the North Sea coast between Peterhead and Blyth (87 breeding pairs, Mitchell *et al.* 2004) as well as its limited foraging range during this time of year.

Figure 15A.18 Monthly Great Black-backed Gull Population Estimates for the Inch Cape Study Area During 2010-2012 Surveys



Age

A total of 13 great black-backed gulls were aged during the breeding season, 53.8 per cent of which were adult birds.

Flight behaviour

Out of 259 great black-backed gulls recorded in flight, 28.1 per cent were flying at potential collision risk height (Table 15A.21). Too few observations were made in the breeding season to calculate a season-specific at risk estimate for the percentage at collision risk height.

TABLE 15A.21: GREAT BLACK-BACKED GULL FLIGHT HEIGHT DISTRIBUTION

Season	% at PCH	Number of birds in flight	Height bands (m)					
			10	20	30	40	50	>50
Breeding	28.1%	5	1	1	1	3	0	0
Non-breeding		254	100	55	56	28	14	1

Note: flight data summarised here is based on all data collected in the study area, regardless of snapshot

Foraging behaviour

Foraging behaviour in the study area was recorded on a number of occasions in autumn and winter, all of which related to associations with working fishing vessels.

15A.3.2.12 Great Skua

The entire British breeding population of great skua nests in Scotland, primarily in Shetland. Mitchell *et al.* (2004) estimate that 9,634 pairs breed in the UK, accounting for 60 per cent of the global breeding population; this count, however, was taken before the sandeel fishery collapse and is a peak number (Furness 2007). A substantial part of the UK (SPA) population (predominantly those on Orkney and Shetland) are known to migrate through the North Sea towards southerly winter quarters.

Regional Population

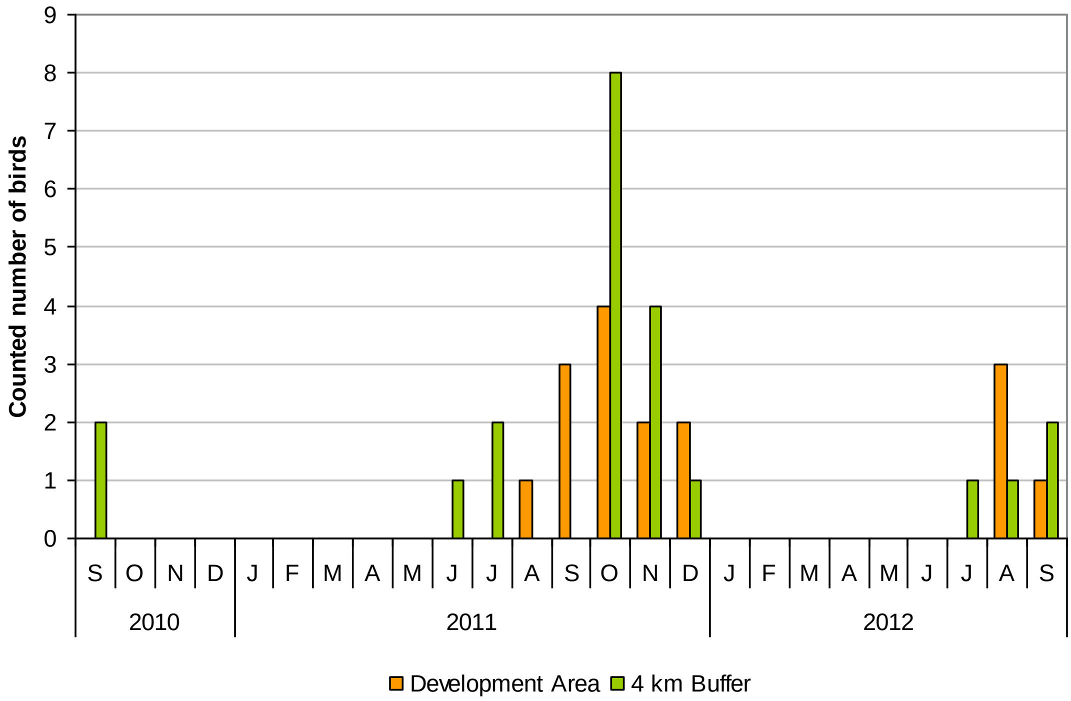
There is no regional population present within foraging range during the breeding season as the nearest great skua populations breed on Orkney.

During autumn passage an estimated 12,200 birds are present in the North Sea, of which an estimated 10,750 birds comprise the regional population (September to October, based on areas 1 to 7 in Skov *et al.* 1995).

Density and Population Estimates

Great skua is a typical autumn passage species, and was recorded in the study area between June and December (Figure 15A.19). Peak counts fell between September and November, when passage movements off the Scottish coast tend to be most prevalent (Forrester *et al.* 2007). Insufficient information was available to calculate reliable density estimates. The raw survey counts represent a fraction of the flyway population, as boat surveys with a monthly frequency can easily miss migration windows.

Figure 15A.19 Monthly Great Skua Counts for the Inch Cape Study Area During 2010-2012 Surveys



Flight behaviour

Of 39 recorded great skua flights in the study area, 8.9 per cent were at potential collision risk height.

Foraging behaviour

Great skuas were recorded engaging in klepto-parasitising behaviour on a number of occasions, preying on kittiwake, great black-backed gull and pomarine skua.

15A.3.2.13 **<u>Arctic Skua</u>**

An estimated 2,136 pairs of Arctic skua breed in the UK, comprising 8.4 per cent of the bio-geographic population and 1 per cent of the world population (Mitchell *et al.* 2004). All of the British population nests in Scotland, predominantly in Shetland and Orkney with a combined total of 1,840 pairs recorded on these island groups (Mitchell *et al.* 2004). The species has experienced a dramatic population decline in Scotland between 1986 and 2008, with current populations at 30 per cent to 50 per cent of their original numbers (Mitchell *et al.* 2004). Because of these trends, Arctic skuas are considered a Red-listed species of conservation concern in Britain (Eaton *et al.* 2009).

Regional Population

There is no regional population present within foraging range during the breeding season as the nearest Arctic skua populations breed on Orkney.

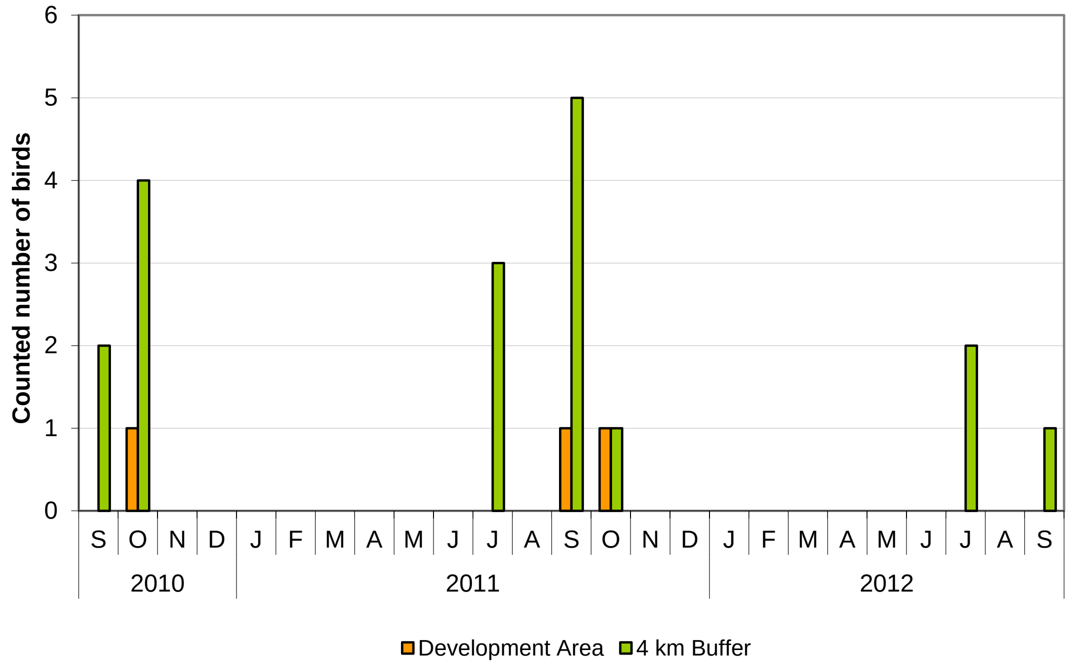
No estimates for the North Sea as a whole are available. Assuming that breeding populations from the UK, Norway, Finland, Sweden and the Faeroe Islands move through the North Sea, up to 25,900 birds could do so during autumn passage (derived from BirdLife International 2004).

A regional passage population is similarly difficult to define. Forrester *et al.* (2007) estimate a range of 1,000 to 10,000 Arctic skuas on autumn passage, the majority of which move along the Scottish east coast. Return passage in spring takes place almost exclusively along the Scottish west coast (Forrester *et al.* 2007).

Density and Population Estimates

On the Scottish east coast Arctic skua is almost exclusively seen on autumn passage, as spring migration tends to occur along the western seaboard. The species was recorded in the study area between July and October (Figure 15A.20). Peak counts fell between September and October at the height of passage movements off the Scottish coast (Forrester *et al.* 2007). Insufficient data was available to calculate reliable density estimates.

Figure 15A.20 Monthly Arctic Skua Counts for the Inch Cape Study Area During 2010-2012 Surveys



Flight behaviour

Of 21 recorded Arctic skua flights in the study area, 4.5 per cent were recorded flying at potential collision risk height.

Foraging behaviour

Arctic skuas were recorded engaging in klepto-parasitising behaviour on a number of occasions, preying on gull species.

15A.3.2.14 <u>Pomarine Skua</u>

Pomarine skua breeds in northern Russia (20,000 – 50,000 pairs, BirdLife International 2004) and migrates to the tropics in autumn. Similar to the other two skua species it tends to predominantly be seen along the North Sea coast on autumn passage, and along the west coast in spring (Forrester *et al.* 2007).

Regional Population

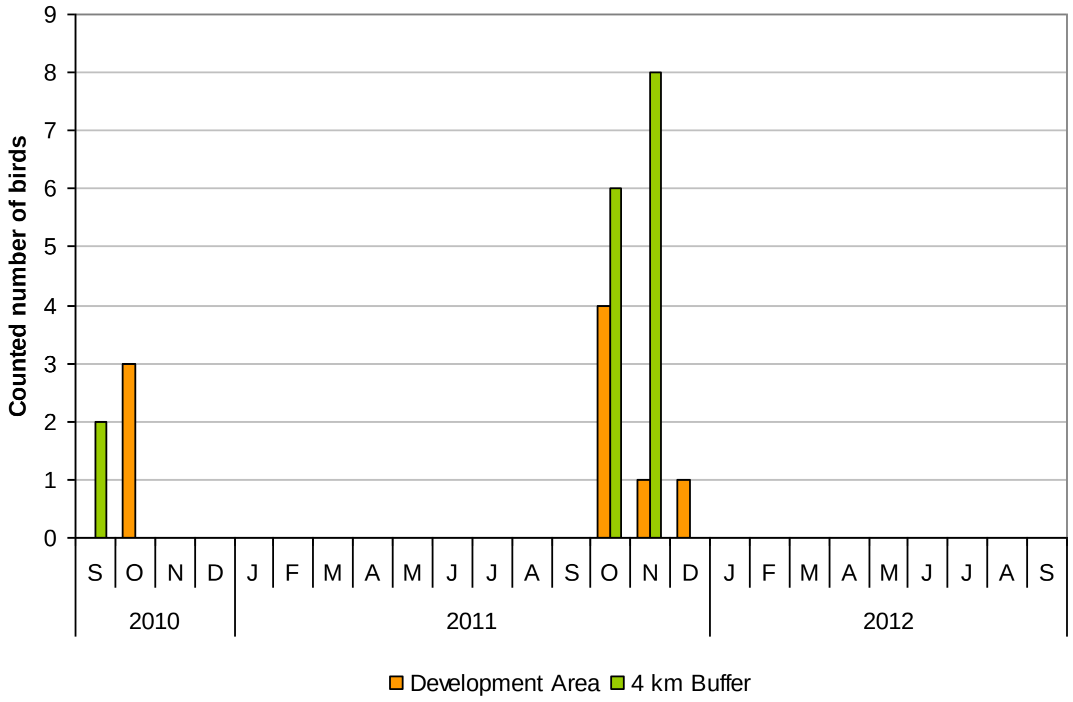
There is no regional population present within foraging range during the breeding season as the nearest populations breed in northern Russia.

No estimates for the North Sea as a whole are available. Forrester *et al.* (2007) estimate autumn passage numbers along Scottish coasts to vary between 100 and 2,000 birds. An average regional autumn passage population of 1,000 birds has been assumed to pass through the study area on an annual basis.

Density and Population Estimates

Pomarine skua was recorded in the study area between September and December (Figure 15A.21). Peak counts within the Development Area fell between October and November, when birds tend to be most numerous off the Scottish coast (Forrester *et al.* 2007). Insufficient information was available to calculate reliable density estimates.

Figure 15A.21 Monthly Pomarine Skua Counts for the Inch Cape Study Area During 2010-2012 Surveys



Flight Behaviour

Of 22 recorded pomarine skua flights in the study area, 6.8 per cent was recorded flying at potential collision risk height.

Foraging Behaviour

Similar to the other two skua species, pomarine skuas were recorded engaging in klepto-parasitising behaviour on a number of occasions, preying on gull species.

15A.3.2.15 <u>Arctic Tern</u>

Between 480,000 to 850,000 pairs of Arctic terns breed in Europe, with 53,388 of these pairs nesting in the UK. Of the British population, 47,306 pairs nested in Scotland, predominantly in Shetland and Orkney (Mitchell *et al.* 2004). Although Arctic tern are not of concern in Europe or worldwide, they are of moderate conservation concern (i.e. Amber listed) in the UK due to recent population declines (Eaton *et al.* 2009).

Regional Population

The regional population for Arctic tern consists of up to 293 breeding pairs (SMP database, including national trend correction of -15%, JNCC 2012), extending across an area from St Cyrus to the Isle of May (Figure 15A.1.20, Annex 15A.1).

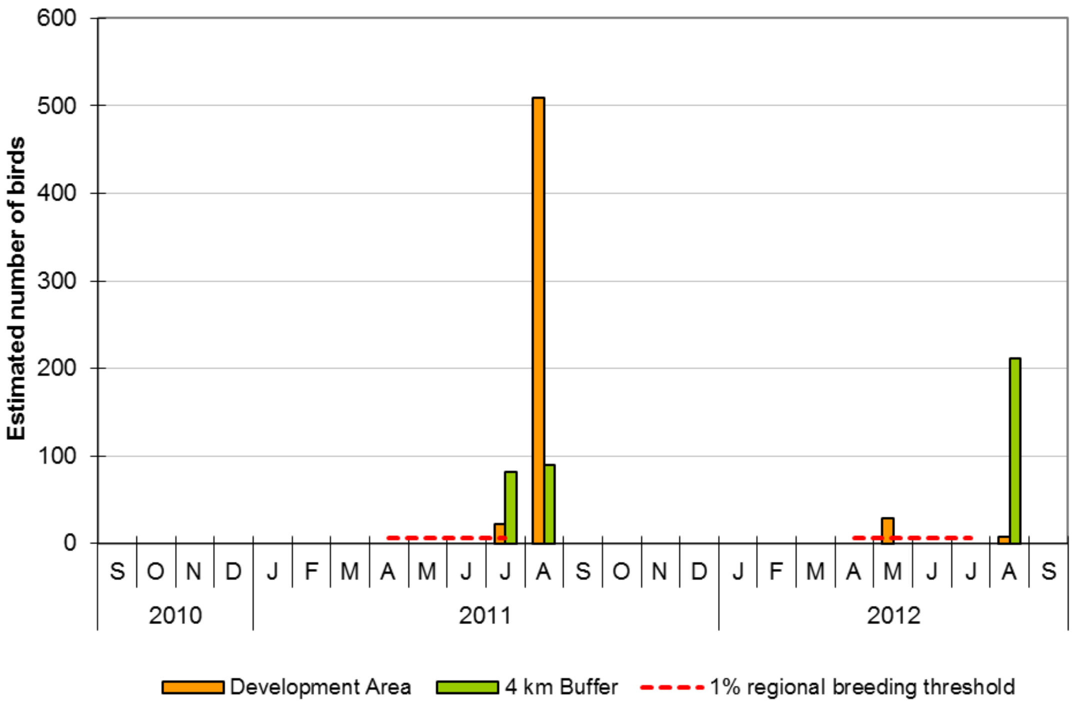
A North Sea population estimate for the non-breeding period is not available. A regional population during post-breeding dispersal and autumn passage could conceivably comprise of the breeding populations of Shetland, Orkney, NE Scotland and NE England moving along the Scottish east coast, totalling 87,230 birds (Mitchell *et al.* 2004). It is assumed that half of that population migrates through the North Sea, and the other half around Cape Wrath.

Density and Population Estimates

Arctic terns were predominantly recorded in the Development Area during post-breeding dispersal and passage movements in August (Figure 15A.22). Records in May and mid-July could indicate utilisation of the Development Area by local breeding birds. The (very low) regional importance threshold was exceeded in July 2011 and May 2012.

A peak density was estimated for August 2011, equating 509 terns present within the Development Area, exceeding 1 per cent of the passage population estimate of 430 birds. Up to 22 per cent of the terns recorded in August 2011 were juvenile birds.

Figure 15A.22 Monthly Arctic Tern Population Estimates for the Inch Cape Study Area During 2010-2012 Surveys



Flight Behaviour

Of 125 Arctic terns recorded in flight during a snapshot none were seen flying above 5 m height (Table 15A.22).

TABLE 15A.22: ARCTIC TERN FLIGHT HEIGHT DISTRIBUTION				
Season	**% at PCH**	**Number of birds in flight**	**Height bands (m)**	
			5	**10**
Year-round	0%	125	125	0

Note: flight data summarised here is based on observations in snapshots collected across the entire study area

Foraging Behaviour

No Arctic terns were recorded foraging in the Development Area during the breeding season, but post-breeding terns did so extensively, with 41 per cent of all birds engaged in active searching, dip feeding and shallow plunge diving.

15A.3.2.16 Common Tern

The UK common tern population is estimated at 11,838 breeding pairs (Baker *et al.* 2006).

Regional Population

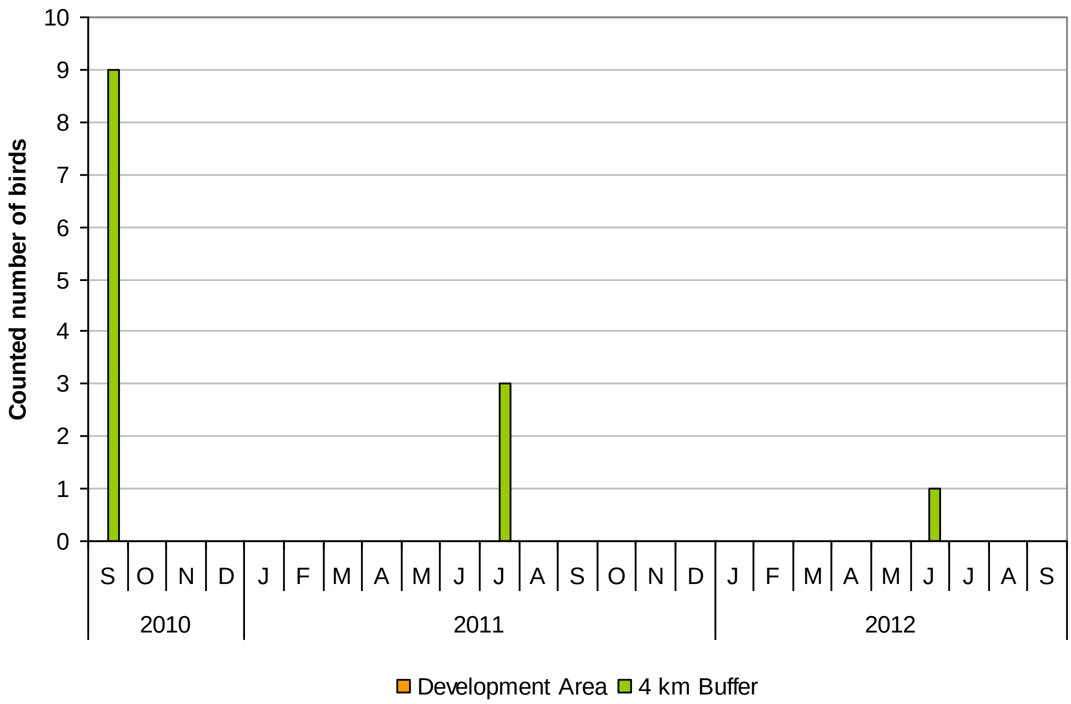
The regional population for common tern consists of up to 114 breeding pairs, extending across an area from Montrose to the Isle of May (SMP database, including national trend correction of -14%, JNCC 2012; see Figure 15A.1.21, Annex 15A.1).

Skov *et al.* (1995) estimate the North Sea population in July-September at 7,500 birds. As with Arctic tern, a regional population (post-breeding dispersal and autumn passage) could conceivably comprise of the breeding populations of Shetland, Orkney, NE Scotland and NE England moving along the Scottish east coast, totalling 7,286 birds (Mitchell *et al.* 2004).

Density and Population Estimates

Observations of common tern were only made on three surveys: during autumn passage in September and in the breeding season of both 2011 (July) and 2012 (June). Insufficient data were available for reliable density estimation. No birds were recorded in the Development Area during the entire baseline survey programme. The peak count of nine birds for the 4 km buffer fell in October 2010 (Figure 15A.23).

Figure 15A.23 Monthly Common Tern counts for the Inch Cape Study Area During 2010-2012 Surveys



Flight Behaviour

Out of nine terns in flight recorded in snapshot, none were flying at potential collision risk height.

Foraging Behaviour

None of the recorded terns were seen to forage in the study area.

15A.3.2.17 <u>Guillemot</u>

Guillemot is considered a species of low conservation concern worldwide. Between 2 and 2.7 million pairs breed in Europe (BirdLife International 2004), with 1,420,900 individuals estimated to breed in Britain (Baker *et al.* 2006), 1.1 million of which breed in Scotland (Mitchell *et al.* 2004). However, the species is of Amber conservation concern in Britain, as British guillemots account for a third of the bio-geographic population (Eaton *et al.* 2009).

Regional Population

The regional breeding population consists of up to 188,210 individuals (SMP database, including national trend correction of +6%, JNCC 2012)), encompassing an area from Boddam / Collieston to the Farne Isles (Figure 15A.1.22, Annex 15A.1). The total is given as individuals rather than breeding pairs as it is usually not possible to count apparently occupied sites or nests (AOS or AON). As counts of individuals may include off-duty adults away from a nest, non-breeders and immature birds, as well as breeding birds, a correction factor of 0.67 is applied to estimate the number of AON or breeding pairs (based on studies where counts of AON have been made, Mitchell *et al.* 2004). Thus 188,210 individuals is equivalent to 126,101 pairs.

It is assumed that the same number of (adult) birds make up the post-breeding season population as it is likely that the bulk of the guillemots present in the study area originate from the regional population at that time of year.

Skov *et al.* (1995) estimate the North Sea population in the non-breeding season at 1,562,400 birds. A regional population could amount to up to 521,000 guillemots based on areas 4, 6 and 7 (Northern England-Scotland, Firth of Forth-Scalp Bank, East Bank-Farn Deeps) in Skov *et al.* (1995).

Density and Population Estimates

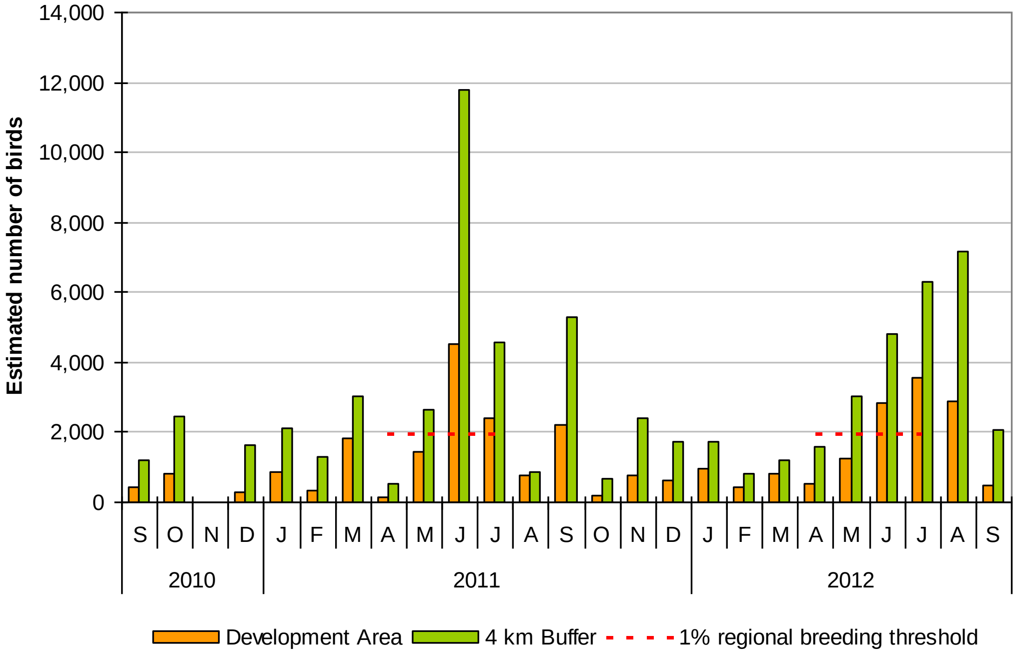
Guillemots were recorded in the study area in all months, with densities highest during the breeding and post-breeding season (Figures 15A.1.23 and 15A.1.24 in Annex 15A.1). Throughout winter, population estimates for the Development Area ranged between 500 and 1,000 birds. Numbers increased again in March, reflecting birds returning to their breeding colonies. Guillemot numbers increased throughout the breeding season, peaking in the Development Area in June 2011 (Figure 15A.24), when estimates reached up to 4,545 birds during the height of breeding activity. The first few fledged chicks were seen during this survey (19-20 June). Estimates for 2012 peaked in July with 3,549 guillemots, with parent birds moving into the study area with large numbers of fledged chicks.

Guillemot estimates peak again during the post-breeding period and reach their winter population levels again in October or November.

Population estimates for the Development Area during the 2011 and 2012 breeding seasons exceeded the 1 per cent regional threshold (1,882) in June and July, with estimates indicating at least 2 per cent of the regional population being present in June 2011 (Figure 15A.24). Numbers of national importance were not present within the Development Area, although population estimates for the whole study area exceeded the 1 per cent national population threshold of 14,209 birds in the same month.

Estimates for the 4 km buffer zone exceeded regional importance in all but one month (April) during the 2011 and 2012 breeding seasons.

Figure 15A.24 Monthly Guillemot Population Estimates for the Inch Cape Study Area During 2010-2012 Surveys



Flight Behaviour

Flight direction during the breeding season was predominantly arranged along N-NW and S-SE axis, possibly indicating movements through and from the large Fowlsheugh colony (Figure 15A.25).

In the non-breeding season flight directions were mostly orientated in northern and northwestern direction, possibly indicating autumn / winter passage movements from further offshore.

Figure 15A.25 Guillemot Flight Direction Distribution for the Breeding and Non-breeding Season

Flight height data was available for over 1,900 guillemots. None were seen at potential collision risk height, with only a very small number of birds flying as high as 10 m (Table 15A.23).

TABLE 15A.23: GUILLEMOT FLIGHT HEIGHT DISTRIBUTION				
Season	**% at PCH**	**Number of birds in flight**	**Height bands (m)**	
			5	**10**
Breeding	0%	937	930	7
Non-breeding	0%	1,095	1,084	11
Note: flight data summarised here is based on all data collected in the study area, regardless of snapshot				

Foraging Behaviour

Assuming that all auks on the sea surface are in fact present for foraging purposes, 81 per cent of all guillemots in the Development Area and 75 per cent of those in the buffer zone were seen foraging in the breeding season.

15A.3.2.18 <u>Razorbill</u>

The European razorbill population is estimated to be between 430,000 and 760,000 breeding pairs. An estimated 188,576 individuals breed in the UK (Mitchell *et al.* 2004, Baker *et al.* 2006). The species conservation status in the UK is considered to be Amber (Eaton *et al.* 2009).

Regional Population

The regional razorbill population is considered to consist of up to 20,181 individuals (SMP database, including national trend correction of +14%, JNCC 2012) extending from Boddam – Collieston to the north of England (including the Farne Isles, Figure 15A.1.25, Annex 15A.1). The total is given as individuals rather than breeding pairs as it is usually not possible to count apparently occupied sites or nests (AOS or AON). As counts of individuals may include off-duty adults away from a nest, non-breeders and immature birds, as well as breeding birds, a correction factor of 0.67 is applied to estimate the number of AON or breeding pairs (based on studies where counts of AON have been made, Mitchell et al 2004). Thus 20,181 individuals is equivalent to 13,521 pairs.

Skov *et al.* (1995) estimate the North Sea population in the non-breeding season at 324,000 birds. A regional population could amount to up to 14,400 razorbills based on areas 3, 4 and 5 (Buchan Deep, Scalp Bank-Tees Bay, Southwest Dogger Bank) in Skov *et al.* (1995).

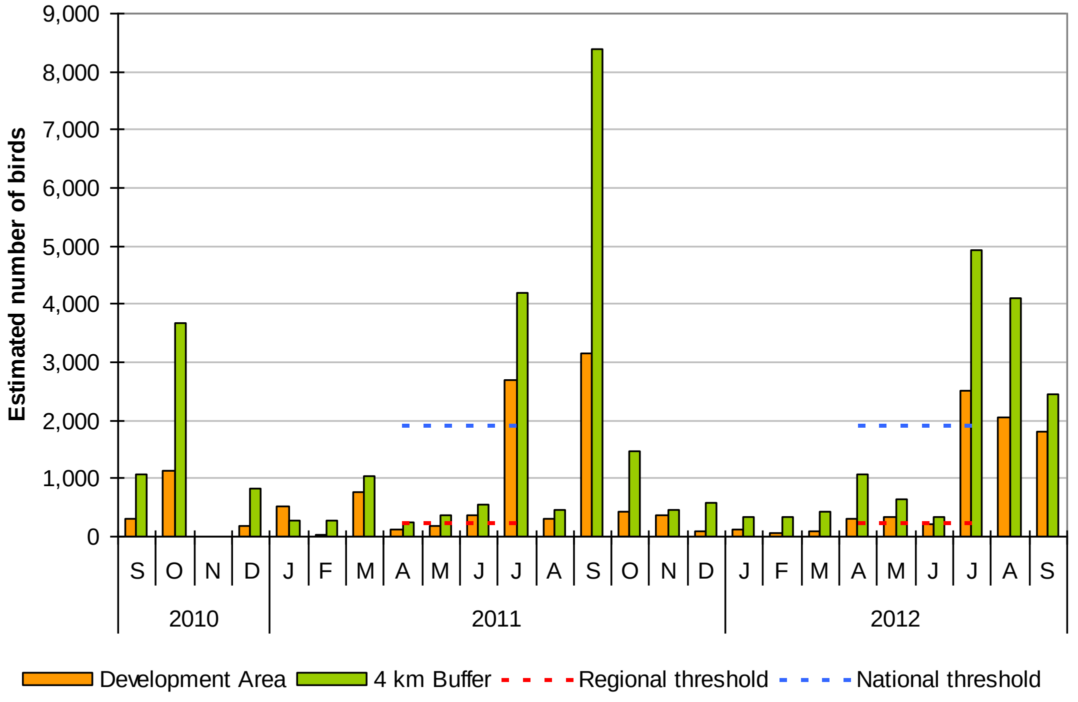
Density and Population Estimates

Razorbills were recorded year-round, largely in densities around 1.5 birds / km^2, with densities in mid-winter comparable to those during most of the breeding season (Figure 15A.26, Figures 15A.1.26 and 15A.1.27). In March-April a modest increase in density was recorded of 3.5 birds / km^2, coinciding with birds returning to their breeding colonies on the Scottish east coast. Between April and June razorbill densities were relatively modest. Very substantial peaks were recorded in July 2011 and 2012, when estimates for the whole study area reached nearly 18 birds / km^2, the equivalent of 7,500 birds. This increase in the population within the Development Area reflects post-fledging aggregations, with an average 18 per cent of all birds recorded on the sea surface consisting of razorbill chicks, accompanied by parent birds. Higher densities were recorded in September-October 2010 and 2011, during the post-breeding period, with densities reaching 20 birds / km^2 in September 2011, presumably as birds disperse to feeding areas further offshore

For the Development Area, the 1 per cent national breeding threshold (1,886 birds) was exceeded twice in 2010-2012: both times in July (Figure 15A.26). Whereas the former is associated with the post-fledging period, the latter is probably a result of post-breeding bird aggregations from a number of regional (SPA) colonies mixing in the wider area, including the Inch Cape study area, before moving to wintering areas further offshore. Albeit during post-breeding, estimates for August to October exceeded or neared the national threshold at least once during the baseline survey programme.

Population estimates indicate that the regional 1 per cent breeding threshold (202 birds) was exceeded or neared during all months in the breeding season in both the Development Area and the buffer zone, with in July possibly as much as 20 per cent of the regional population present in the study area (Figure 15A.26).

Figure 15A.26 Monthly Razorbill Population Estimates for the Inch Cape Study Area During 2010-2012 Surveys



Flight Behaviour

Relatively few observations of razorbills in flight were made in the breeding season, although a N-NW to SE pattern is apparent. This could indicate movements to and from the Fowlsheugh colony.

Flight direction distribution in the non-breeding season is similar to that of guillemot, with birds predominantly moving northwest and north.

Figure 15A.27 Razorbill Flight Direction Distribution for the Breeding and Non-breeding Season

Flight height information was recorded for over 1,300 razorbills, the majority of which fell in the non-breeding season. The overwhelming majority of birds flew at or below 5 m height with a few individuals flying as high as 20 m above the sea surface (Table 15A.24). No razorbills were seen flying at potential collision risk height.

TABLE 15A.24: RAZORBILL FLIGHT HEIGHT DISTRIBUTION					
Season	**% at PCH**	**Number of birds in flight**	**Height bands (m)**		
			5	**10**	**20**
Breeding	0%	267	258	3	6
Non-breeding	0%	1,119	1,113	5	1
Note: flight data summarised here is based on all data collected in the study area, regardless of snapshot					

Foraging Behaviour

Assuming that all auks on the sea surface are in fact present for foraging purposes, 81 per cent of all razorbills in the Development Area and 63 per cent of those in the buffer zone were seen foraging in the breeding season.

15A.3.2.19 Puffin

The European population of puffins is thought to be between 5.7 and 7.3 million pairs, of which about 580,799 pairs nest in the UK, comprising 9.6 per cent of the global population, while in Scotland an estimated 493,042 pairs breed (Baker *et al.* 2006, Mitchell *et al.* 2004). The Atlantic puffin is listed as a species of Amber conservation concern in the UK, due to localised populations and population declines in Europe (Eaton *et al.* 2009).

Regional Population

The regional puffin population consists of up to 114,642 pairs (SMP 2012), an area extending from Peterhead to the Farne Isles based on the mean maximum foraging range plus 1 SD (Figure 15A.1.28, Annex 15A.1).

The North Sea population in the non-breeding season consists of up to 74,600 puffins, with an estimated 37,400 puffins present regionally during that time of year (based on interpretation of areas 1 to 3 for October-January and February-March in Skov *et al.* 1995).

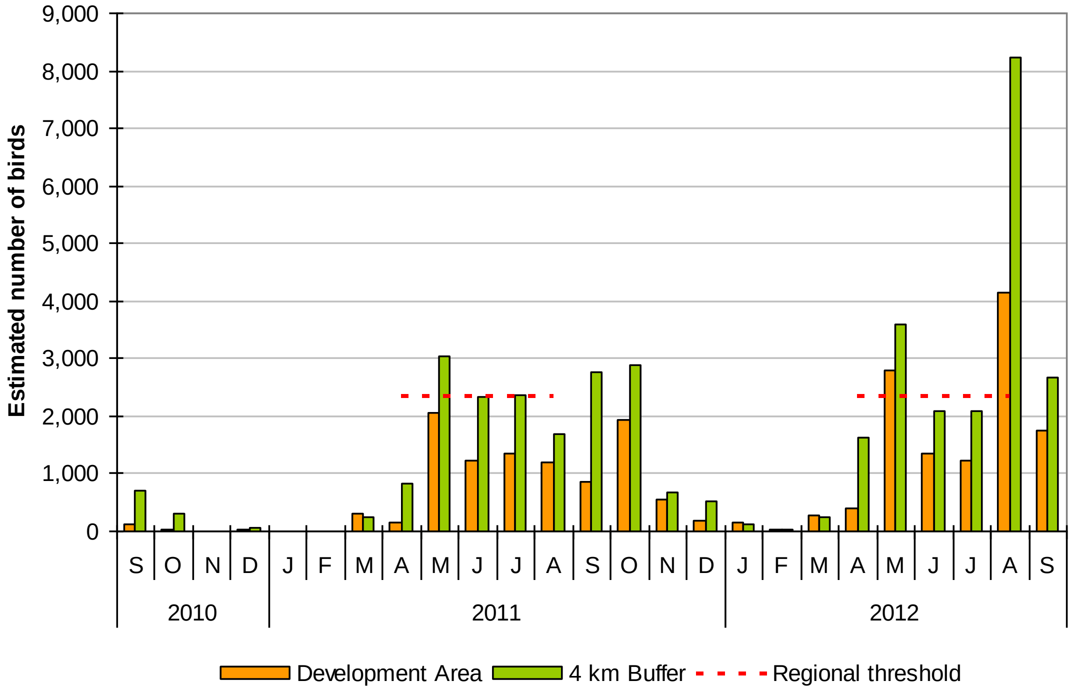
Density and Population Estimates

In keeping with the species' largely pelagic wintering tendencies, puffin density estimates during the non-breeding season are low to very low, with no birds recorded at all in January and February 2011. Densities first increased again in March, when birds start to move back into the region to return to breeding colonies and peaked in May for 2011, and in August 2012, in the Development Area (Figure 15A.28, Figures 15A.1.29 and 15A.1.30 in Annex 15A.1). While both other auk species show marked variation in density estimates throughout the core breeding season, data appears to indicate puffins utilised the Development Area in a more consistent manner, with estimates between June and July ranging from 1,200 to 1,500 birds for both years. A very substantial peak occurred in August 2012, when an estimated 4,000 puffins were present in the Development Area and over 8,000 birds in the buffer zone.

Puffin numbers peaked again in the post-breeding period in September and October 2011 when most of the Isle of May population is likely to be present at sea within the region. Once the species starts dispersing the population in the study area dwindles rapidly towards mid-winter.

Population estimates for the Development Area did not exceed the 1 per cent regional threshold (2,293 birds) during any month in 2011, although estimates for May came close. In contrast, during the breeding season the estimated number of birds present within the 4 km buffer zone exceeded this threshold between May and July (Figure 15A.28). In 2012 regionally important numbers were present in the Development Area in both May and August.

Figure 15A.28 Monthly Puffin Population Estimates for the Inch Cape Study Area During 2010-2012 Surveys



Flight Behaviour

In line with the location of the Isle of May colony relative to the Development Area, flight direction in the 2011 and 2012 breeding seasons were orientated along a N-NE to S-SW axis. Based on the species' foraging range – the most far-ranging of the three breeding auk species - it is likely that a substantial proportion of birds moving north or north-east forage in areas beyond the Inch Cape study area.

Flight direction distribution in the non-breeding season is based on relatively few observations, reflecting the species' scarcity and in the study area during that time of year.

Figure 15A.29 Puffin Flight Direction Distribution for the Breeding and Non-breeding Season

An overview of puffin flight height distribution in the breeding and non-breeding seasons is shown in Table 15A.25. The vast majority of birds flew at 5 m height, although a few birds were seen in flight at 10-20 m. No puffins were recorded flying within the PCH zone.

TABLE 15A.25: PUFFIN FLIGHT HEIGHT DISTRIBUTION				
Season	**Number of birds in flight**	**Height bands (m)**		
		5	**10**	**20**
Breeding	974	969	4	1
Non-breeding	87	87	0	0

Note: flight data summarised here is based on all data collected in the study area, regardless of snapshot.

Foraging Behaviour

Assuming that all puffins on the sea surface are in fact present for foraging purposes, 76 per cent of all birds in the Development Area and 71 per cent of those in the buffer zone were seen foraging in the breeding season.

15A.3.2.20 Little Auk

Little auks were recorded in the study area between November and February in accordance with their status as a mid-winter visitor to Scottish North Sea waters (Figures 15A.1.31, Annex 15A.1). The species year to year presence in these waters has a strongly irruptive character, with significant variation in distribution and abundance patterns between years (Forrester *et al.* 2007). .

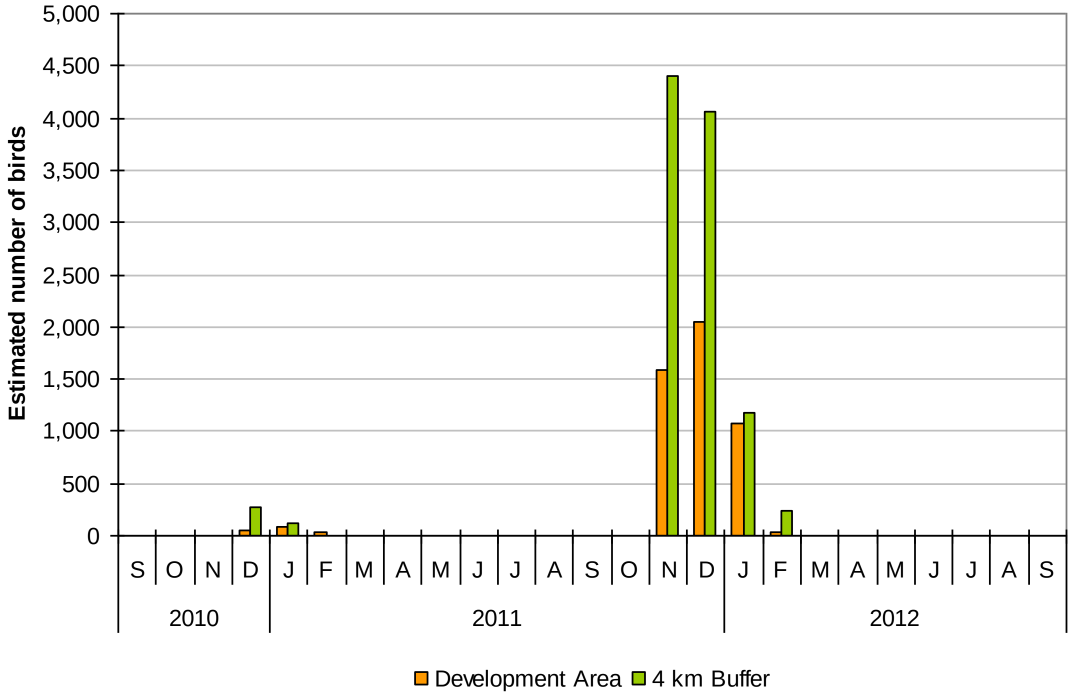
Forrester *et al.* (2007) provide a winter population estimate of 100 to 35,000 individuals for Scottish waters, but acknowledge that this range is fraught with uncertainty. Stone *et al.* 1995 indicate that as many as one million little auks overwinter offshore in the North Sea. An estimate of 852,690 birds for the entire North Sea has been assumed here (Skov *et al.* 1995). A regional winter population estimate has been not been defined as it is considered that the species annual occurrence is of such a wide-ranging nature, with a very high turnover in birds, that spatially defining a regional population would not be meaningful. .

Density and Population Estimates

Estimates for the 2010-2011 winter are very low, with the November survey missed and few birds recorded later in winter. In line with the strong year to year variation in numbers, estimates for November and December 2011 are approximately 1,500-2,000 birds for the Development Area and 4,000-4,500 little auks for the 4 km buffer (Figure 15A.30).

It is difficult to attach a realistic measure of importance to these estimates, given that no reliable population estimate is available at a UK or Scottish level.

Figure 15A.30 Monthly Little Auk Population Estimates for the Inch Cape Study Area During 2010-2012 Surveys



Flight Behaviour

Out of 152 little auks recorded in flight, none were seen flying above five metre height.

15A.3.2.21 Waterfowl

Barnacle Goose

The Svalbard barnacle geese population migrate across the North Sea and move overland over southern Scotland and northern England in order to reach their wintering grounds on the Solway where they gather in internationally important numbers (SPA designation: 13,595 individuals, JNCC website http://jncc.defra.gov.uk/page-1980; up to 35,640 individuals in 2009-10 in the Solway Estuary as per WeBS counts, Holt *et al.* 2012).

A total of 338 barnacle geese in seven separate flocks were recorded in October 2010 (partially out with the study area). Group size varied from two to 175 birds. Due to the low number of observations, extrapolation is unlikely to yield reliable population estimates. As such the 338 birds should be considered as a minimum population estimate for the relevant October survey days. Given that barnacle geese are flying through the Development Area on migration rather than making use of the marine habitat, the relevant parameter for assessment is the total numbers that pass through the Development Area rather than a population estimate per se.

Pink-footed Goose

Three skeins of pink-footed geese were recorded on three different surveys: September 2010, January 2012 and March 2012, totalling 105 birds.

Pink-footed geese are winter visitors to Scotland, arriving in large numbers in late September with return migration occurring between March and early May. The autumn population amounts to at least 200,000 birds, with the population in spring estimated at 100,000 geese (Forrester *et al.* 2007).

Other Species

Other waterfowl species recorded in the Development Area or the buffer zone on one or more surveys (number of birds in brackets): shelduck (1), eider (5), common scoter (3), long-tailed duck (3), goldeneye (2), and tufted duck (2). These are all species that predominantly occur in coastal habitats but for which substantial populations cross the North Sea each year to spend the winter in Great Britain.

15A.3.2.22 <u>Waders</u>

A number of wader species were recorded during the surveys. Although most of these were seen in (very) small numbers, it does give an indication that these migratory species move through the Development Area on passage (Tables 15A.11 and 15A.12). This is of particular importance for golden plover and ringed plover as both are designated (wintering) features for the Firth of Forth SPA.

The presence of grey phalarope, with a peak count of 21 birds (12 birds in the study area and nine birds just outside the study area) in November 2011 is an important one in the context of existing population estimates: Forrester *et al.* (2007) estimate 10 to 50 birds to occur on autumn passage each year, and a winter population of one to five birds. The grey phalarope numbers recorded in the Inch Cape study area are probably a result of low levels of historic winter survey effort in the area, rather than a genuine increase in wintering phalarope numbers.

15A.4 COLLISION RISK

15A.4.1 Species Selection

This section presents the parameter estimates for the Collision Risk Model (CRM) and the results of the modelling process. Data for this modelling were derived from the boat surveys in combination with published metrics (e.g. wingspan, flight speed) for each species as well as recent guidance on flight height distributions and avoidance rates (Cook *et al.* 2012).

Selection to determine which species warranted consideration for CRM was based on three aspects:

- the density of birds in flight within the Development Area each month;
- the proportion of birds recorded flying at potential collision height (PCH, see Section 15A.2.5.2); and,
- the sensitivity of a species to collision, based on flight manoeuvrability, altitude and proportion of time flying risk ratings in Furness and Wade (2012).

To avoid excluding species prematurely, data for all species were screened for sample size, flight height distribution and proportions at risk height prior to analysis.

Based on these criteria the following seven seabird species were included in collision risk modelling: gannet, Arctic skua, pomarine skua, great skua, kittiwake, great black-backed gull, and herring gull. Table 15A.26 below provides a summary of this screening process.

Sample size for calculation of herring gull, lesser and great black-backed gull flight densities in the Development Area in the breeding season is very small (in each case less than 10 observations), reflecting the very low densities at which these species occur in that time of year. No CRM was undertaken for these species during the breeding season as it is considered that with so few data points it is unlikely that collision risk can be estimated reliably.

All three skua species were selected for use in the migration model due to insufficient data for density estimation, largely due to their tendency of broad front migration in short migratory windows (Table 15A.26).

TABLE 15A.26: SAMPLE SIZE FOR ESTIMATION OF FLIGHT HEIGHT DISTRIBUTION AND FLIGHT DENSITIES

Species	Available data for calculation of proportion at PCH (Number of birds in flight in Study Area)		Available data for calculation of flight densities (Number of birds in flight in snap in Development Area; sample size in brackets)		Seasonal proportion of birds at PCH (%)	
	Breeding season	Non-breeding season	Breeding season	Non-breeding season	Breeding season	Non-breeding season
Fulmar	408	368	40 (38)	45 (41)	0	0
Manx shearwater	-	106	-	13 (6)	-	0
Sooty shearwater	-	59	-	4 (3)	-	0
Gannet	10,158	1,688	852 (354)	103 (63)	3.5%	1.5%
Shag	7	8	0	0	0	0
Arctic skua*	-	21	-	0	-	4.5%
Pomarine skua*	-	22	-	2 (2)	-	6.8%
Great skua*	-	33	-	2 (2)	-	8.9%

TABLE 15A.26: SAMPLE SIZE FOR ESTIMATION OF FLIGHT HEIGHT DISTRIBUTION AND FLIGHT DENSITIES						
Species	**Available data for calculation of proportion at PCH** (Number of birds in flight in Study Area)		**Available data for calculation of flight densities** (Number of birds in flight in snap in Development Area; sample size in brackets)		**Seasonal proportion of birds at PCH (%)**	
	Breeding season	**Non-breeding season**	**Breeding season**	**Non-breeding season**	**Breeding season**	**Non-breeding season**
Common gull	-	[20]	-	3 (3)	-	30%
Little gull	-	[26]	-	11 (5)	-	6.3%
Kittiwake	[1,508]	[873]	310 (109)	272 (133)	0.4%	9.2%
Great black-backed gull	5	254	2 (2)	20 (22)	-	28.1%
Lesser black-backed gull	43	-	4 (4)	-	10.5%	-
Herring gull	78	232	7 (5)	14 (14)	13.5%	17.1%
Common tern	[3]	[6]	0	0	0	0
Arctic tern	[17]	[108]	7 (3)	68 (5)	0	0
Guillemot	937	1,095	47 (26)	71 (51)	0	0
Razorbill	267	1,119	13 (8)	52 (27)	0	0
Puffin	974	87	71 (60)	1 (1)	0	0
Little auk	-	152	-	11 (6)	-	0

Note: Numbers between square brackets [..] refer to birds in snapshot only. These are used for small gulls and terns to avoid biasing flight height distribution calculations

* Species with an asterisk were selected for use in the migration model due to insufficient data for density estimation largely due to tendency of broad front migration in short migratory windows

15A.4.1.1 Species CRM Parameters

Species-specific morphological data used in the standard Band 2012 Model is provided in Table 15A.27. The model was used for gannet, kittiwake and the large gulls. Where a range of values for wing span and body length were available the mid-point was used.

TABLE 15A.27: BIRD METRICS USED FOR STANDARD BAND COLLISION RISK MODEL				
Species	**Flight speed (m/s)[1]**	**Wing span (m)[2]**	**Body length (m)[2]**	**Nocturnal activity**
Gannet	14.9	1.725	0.935	0%
Kittiwake	13.1	1.075	0.39	50%
Great black-backed gull	13.7	1.65	0.71	50%
Herring gull	12.8	1.44	0.61	50%

1: flight speeds from Alerstam *et al*. (2007), except gannet, sourced from Pennycuick (1997)
2: wing span and body length from BWP (Snow and Perrins, 1998)

Bird metrics and flight corridor information used in the SOSS migration model (Band 2012) are provided in Table 15A.28. This model was used for geese, skuas and waders recorded during boat-based surveys in Year 1 and 2. The migration model was also run for taiga bean goose (not recorded during surveys) as CRM for this species was specifically requested by SNH in its response to the Scoping Report for Inch Cape Offshore Wind farm (letter from Catriona Gall, SNH, to Fiona Thompson, Marine Scotland, dated 29 October 2010).

TABLE 15A.28: BIRD METRICS USED FOR BAND MIGRATION COLLISION RISK MODEL

Species	Flight speed (m/s)[1]	Wing span (m)[2]	Body length (m)[2]	Proportion at PCH[3]	Season / Population[4]		Flight corridor width [5]
					Spring	Autumn	
Taiga bean goose	17.3	1.585	0.750	75%	Mar (260)	Oct (260)	430 km: Shetland to Firth of Forth
Svalbard barnacle goose	21	1.385	0.645	75%	Apr-May (15,000)	Sep-Oct (15,000)	90 km: Firth of Forth to Farne Islands
Pink-footed goose	18	1.525	0.675	75%	Apr-May (100,000)	Sep-Oct (200,000)	150 km: Great Glen to Peterhead
Shelduck	15.4	1.215	0.625	15%	Feb (61,000)	Sep (61,000)	900 km: Orkney to Kent
Tufted duck	21.1	0.70	0.435	15%	Feb-Apr (110,000)	Sep-Oct (110,000)	700 km: Orkney to Norfolk
Long-tailed duck	22	0.76	0.435	15%	Mar (11,000)	Dec (11,000)	500 km: Shetland to Farne Islands
Common scoter	22.1	0.845	0.49	17%	Dec-Jan (30,000)	Apr (30,000)	300 km: Orkney to Scottish Borders
Goldeneye	20.3	0.725	0.46	15%	Mar (20,000)	Oct (20,000)	700 km: Orkney to Norfolk
Great skua	14.9	1.36	0.555	8.9%	n/a	Jun-Dec (19,628)	665 km: Fife Ness – west coast Denmark
Arctic skua	13.8	1.175	0.435	4.5%	n/a	Jul-Oct (4,272)	
Pomarine skua	15.2	1.315	0.485	6.8%	n/a	Oct-Dec (40,000)	
Ringed plover	19.5	0.525	0.19	25%	May (73,000)	Sep (73,000)	900 km: Orkney to Kent
Golden plover	17.9	0.715	0.275	25%	Apr (930,000)	Sep (930,000)	1,000 km: Shetland to SW Ireland
Oystercatcher	13	0.83	0.425	25%	Mar-Apr (200,000)	Aug-Sep (200,000)	900 km: Orkney to Kent
Dunlin	15.3	0.405	0.18	25%	Apr (350,000)	Sep (350,000)	500 km: Outer Hebrides to Orkney to Scottish Borders
Knot	20.1	0.59	0.24	25%	Apr-May (225,000)	Aug-Sep (225,000)	600 km: Fife Ness to southern Norway
Purple sandpiper	15.3	0.44	0.21	25%	Apr-May (13,000)	Aug-Sep (13,000)	500 km: Outer Hebrides to Orkney to Scottish Borders
Curlew	16.3	0.90	0.55	25%	Apr (85,700)	Sep (85,700)	500 km: Shetland to Farne Islands
Grey phalarope	12.4	0.42	0.21	25%	n/a	Sep (50)	300 km: Orkney to Scottish Borders

1: flight speeds from Alerstam *et al*. (2007), except for pink-footed goose (Patterson 2006), purple sandpiper (dunlin speed used)
2: wing span and body length from BWP
3: % at PCH taken from recommendations by Wright *et al.* (2012), except for skuas – based on flight data collected during boat-based surveys of the study area, common scoter (17%, Cook *et al*. (2012) and geese – based on upper range of recommended values (75%) in Wright *et al.* (2012)
4: flyway populations taken from information in Wright *et al.* (2012), Delany *et al.* (2009), Forrester *et al.* (2007), BirdLife International (2004), Mitchell *et al.* (2004)
5: flight corridors taken from interpretation of Wright *et al.* (2012), except Svalbard barnacle goose, based on sat-tagged birds, Griffin *et al.* 2011; also incorporated 81% of flights downwind for this species

15A.4.2 Explanation of Collision Estimates

Each species account below provides information on seasonality, the relevant background population size and annual adult mortality as well as the mean collision estimates and the change in adult mortality. For the breeding season the change in adult mortality is expressed as proportional change in adult mortality rate (AMR). For the post- and non-breeding seasons collision estimates reflect the proportion of the population affected.

Background populations range from national or regional levels in the breeding and post-breeding seasons to regional, passage or North Sea population levels in the non-breeding season. Where applicable collision estimates are provided for each of these seasons.

Where applicable, collision estimates for the breeding season have been corrected for age using the adult: immature ratio recorded during the baseline surveys in the breeding season to derive an estimate of the number of adult birds predicted to collide. These estimates of adult birds have been further corrected to account for the number of breeding adults. For most species this is in line with SNH and JNCC recommendations that 50 per cent of all birds in adult or summer plumage are assumed to be breeding birds. For gannet it is assumed that all adult plumage birds are breeding based on the PVA carried out by WWT Consulting (2012) which found no evidence for non-breeding among adult plumage birds. For kittiwake the PVA modelling has been used: a stable age distribution predicts that 74.4 per cent of all birds seen during the breeding season would be breeding adults (Appendix 15B, Table 15B.6; note this percentage has been calculated excluding juvenile birds, as at this time the young of the year will be in the nest).

Collision estimates for the post- and non-breeding seasons have not been corrected for age and as such these estimates include collisions by both adult and immature birds.

15A.4.2.1 Collision Risk Scenarios

The worst case turbine layout scenario for collisions is considered to be 213 “large” turbines, as this gave the greatest amount of rotor swept airspace. This scenario was therefore used here to generate the most conservative mortality estimates. The alternative turbines under consideration (medium and small) both generate lower mortality estimates. For all species the collision estimates for the small turbine scenario are provided as well, effectively providing a minimum – maximum range of collision estimates for the Development Area.

Avoidance of turbines by birds can occur across a range of distances. There are few data with which to empirically estimate avoidance for seabird species, thus a range of avoidance rates (from 0 to 99.5 per cent) have been used in this report. Current SNH guidance in relation to onshore wind farms (SNH 2010) recommends a precautionary avoidance rate of 98 per cent unless further information permits another rate to be used for a given bird species. Advice from SNH and JNCC advice during FTOWDG meetings recommends the use of a precautionary avoidance rate of 98 per cent unless further refinement permits another rate to be used, but also that analysis can include results for avoidance rates ranging from 95 to 99.5 per cent (Marine Scotland / SNH / JNCC advice in Niras 2012, Appendix 1).

A recent review of offshore wind farm bird studies suggests that avoidance rates are likely to exceed 99% for some seabird species (divers, gannet, sea ducks and auks); it recommends that 98% as recommended by SNH should be used as a precautionary avoidance rate but that estimates are also presented at rates of 95, 99 and 99.5%. Recent studies in the Netherlands and Belgium indicate that avoidance rates for gannet lie in the vicinity of 99.5 per cent, for large gulls at 98-98.5 per cent and for small gulls at 99 per cent (Krijgsveld *et al.* 2010, 2011; Everaert and Kuijken, 2007). It is understood that Marine Scotland has commissioned a review of avoidance rates for seabirds with a view to advising whether 99 % avoidance could be considered appropriate based on available studies and expert opinion. The outcome of this review is expected in late March 2013.

15A.4.3 Seabirds

15A.4.3.1 Breeding Season

Table 15A.29 provides an overview of collision risk estimates for key breeding bird species across a range of avoidance rates for the 'large turbines' scenario.

TABLE 15A.29: ESTIMATED BREEDING SEASON COLLISION MORTALITY FOR THE WORST CASE WIND FARM LAYOUT

Species	Population cohort	Avoidance rate (%)				
		0	95	98	99	99.5
Gannet	All birds	32,418	1,621	648	324	162
	Adult birds	31,511	1,576	630	315	158
Kittiwake	All birds	1,211	61	24	12	6
	Adult birds	901	45	18	9	5

Note: collision estimates for adult gannet are based on season-specific age proportions (average 97.2 per cent) as recorded during baseline boat surveys in 2010-2012. Age-correction for kittiwake (74.4 %of the population are breeding adults) is based on the stable age distribution as used in the species' PVA model in Appendix 15B. Collision estimates have been rounded to whole numbers.

Gannet

Large Turbines

The predicted breeding season collision mortality for adult gannets lies between 630 and 158 at 98 per cent and 99.5 per cent avoidance respectively (Table 15A.29). Assuming all adult plumage birds are in fact breeding birds, at 98 per cent avoidance rate this equates to an increase in adult mortality rate (AMR) at a regional level of 6.68 per cent and 1.78 per cent on a UK level (Table 15A.30).

Based on recent studies at Egmond aan Zee in The Netherlands, 99 per cent avoidance is likely to be more realistic for gannets. At that rate, collision estimates equates to an increase of 3.34 per cent AMR at a regional level.

In context, the recently published gannet population viability analysis (WWT, 2012) indicates a 'harvest' threshold of 2,000 gannets from Bass Rock before the population is predicted to decline.

Small Turbines

A turbine array consisting of small turbines has slightly lower collision estimates, largely due to a lower rotor blade surface area. Assuming all adult plumage birds are breeding, at 99 per cent avoidance collision estimates represent 2.66 per cent of the regional population.

TABLE 15A.30: COLLISION MORTALITY OF ADULT GANNETS AT INCH CAPE IN THE BREEDING SEASON RELATIVE TO BACKGROUND MORTALITY AT A RANGE OF POPULATION SCALES

Scenario	Parameters	Regional population	UK (breeding)	Europe (breeding)
Baseline	Estimated population (individuals)	116,538	437,092	620,000
	Annual adult mortality rate (AMR) (1)	9,440	35,404	50,220

TABLE 15A.30: COLLISION MORTALITY OF ADULT GANNETS AT INCH CAPE IN THE BREEDING SEASON RELATIVE TO BACKGROUND MORTALITY AT A RANGE OF POPULATION SCALES

Large turbines	% AMR increase (2)	98% avoidance (630 collisions)	**6.68%**	**1.78%**	**1.25%**
		99% avoidance (315 collisions)	**3.34%**	0.89%	0.63%
		99.5% avoidance (158 collisions)	**1.67%**	0.45%	0.31%
Small turbines	% AMR increase (2)	98% avoidance (501 collisions)	**5.32%**	**1.42%**	**1.00%**
		99% avoidance (251 collisions)	**2.66%**	0.71%	0.50%
		99.5% avoidance (125 collisions)	**1.33%**	0.35%	0.25%

1. based on an adult mortality rate of 8.1% (Wanless *et al.* 2006)

2. collision mortality estimate corrected for age (average 97.2% adults in study area in Year 1 and 2), assuming 100% of adult plumage birds are breeding birds

Collision estimates >1% of the AMR highlighted in **bold**

Kittiwake

Large Turbines

Collision estimates for adult kittiwakes in the breeding season amount to an increase in AMR of 0.14 per cent at 98 per cent avoidance at a regional population level (Table 15A.31). At a national or European scale, collision estimates fall below a tenth of a per cent AMR increase.

Small Turbines

Estimates for small turbines are lower still, with an estimated 0.09 per cent increase in AMR at 98 per cent avoidance at a regional level.

TABLE 15A.31: COLLISION MORTALITY OF ADULT KITTIWAKES AT INCH CAPE IN THE BREEDING SEASON RELATIVE TO BACKGROUND MORTALITY AT A RANGE OF POPULATION SCALES

Scenario	Parameters		Regional population	UK (breeding)	Europe (breeding)
Baseline	Estimated population (individuals)		110,080	759,784	6,000,000
	Annual adult mortality rate (AMR) (1)		13,210	91,174	720,000
Large turbines	% AMR increase (2)	98% avoidance (18 collisions)	0.14%	0.02%	<0.01%
		99% avoidance (9 collisions)	0.07%	<0.01%	<0.01%
		99.5% avoidance (5 collisions)	0.04%	<0.01%	<0.01%
Small turbines	% AMR increase (2)	98% avoidance (12 collisions)	0.09%	0.01%	<0.01%
		99% avoidance (6 collisions)	0.05%	<0.01%	<0.01%
		99.5% avoidance (3 collisions	0.02%	<0.01%	<0.01%

1. based on an adult mortality rate of 12% (Harris *et al.* 2000)

2. collision mortality estimate corrected for age (74.4% adults in study area as per the kittiwake PVA model, Appendix 15B)

15A.4.3.2 Non-breeding Season

Table 15A.32 provides an overview of the estimated collision risk during the non-breeding season for the large turbine scenario across a range of avoidance rates.

TABLE 15A.32: ESTIMATED NON-BREEDING SEASON COLLISION MORTALITY FOR THE WORST CASE WIND FARM LAYOUT

Species		Avoidance rate (%)				
		0	95	98	99	99.5
Gannet		1,332	67	27	13	7
Kittiwake	Post-breeding	18,229	911	365	182	91
	Non-breeding	7,894	395	158	79	39
Herring gull		2,675	134	54	27	13
Great black-backed gull		7,341	367	147	73	37
Arctic skua		34	2	1	1	1
Pomarine skua		11	1	1	1	1
Great skua		132	6	2	2	1

Collision estimates represent all birds, regardless of age class. Estimates have been rounded to whole numbers.

Gannet

Large Turbines

At 99 per cent avoidance gannet collision equates to 0.04 per cent of the non-breeding regional population (Table 15A.33). In the context of the entire North Sea population present during the non-breeding season, mortality from collision estimates represents 0.01 per cent of the population.

Small Turbines

At 99 per cent avoidance collision estimates for small turbines represent 0.03 per cent of the regional population and 0.01 per cent of the North Sea population during the non-breeding season (Table 15A.33).

TABLE 15A.33: COLLISION MORTALITY OF GANNETS AT INCH CAPE IN THE NON-BREEDING SEASON RELATIVE TO REGIONAL AND NORTH SEA POPULATIONS

Scenario	Parameters		Regional – Non-breeding population	North Sea – Non-breeding population
Baseline	Estimated population (individuals)		31,200	157,800
Large turbines	% mortality relative to population	98% avoidance (27 collisions)	0.09%	0.02%
		99% avoidance (13 collisions)	0.04%	0.01%
		99.5% avoidance (7 collisions)	0.02%	<0.01%
Small turbines	% mortality relative to population	98% avoidance (21 collisions)	0.07%	0.01%
		99% avoidance (10 collisions)	0.03%	0.01%
		99.5% avoidance (5 collisions)	0.02%	<0.01%

Collision estimates reflecting >1% of the background population highlighted in **bold;** estimates represent all birds, regardless of age class.

Skuas

Large turbines

At 98 per cent avoidance collision estimates for great, Arctic and pomarine skua in the non-breeding season represent very small proportions (<0.02 per cent for great and Arctic skua, 0.1 per cent for pomarine skua) of their background populations (Table 15A.32).

Kittiwake

Post-breeding Season - Large Turbines

At 98 per cent avoidance kittiwake collision estimates for the post-breeding season represent a proportion of 0.2 per cent of the regional population (Table 15A.34).

In the context of the entire UK breeding population (no estimate available for the North Sea area in this time of year) present during the post-breeding season, the collision estimate represents a proportion of 0.05 per cent.

Post-breeding Season - Small Turbines

At 98 per cent avoidance collision estimates for small turbines represent a proportion of 0.16 per cent at a regional level, and 0.04 per cent in the context of the UK breeding population (Table 15A.34).

TABLE 15A.34: COLLISION MORTALITY OF KITTIWAKES AT INCH CAPE IN THE POST-BREEDING SEASON RELATIVE TO REGIONAL AND UK POPULATION LEVELS

Scenario	Parameters		Post-breeding population	
			Regional	UK
Baseline	Estimated population (individuals)		181,832	759,784
Large turbines	% mortality relative to population	98% avoidance (365 collisions)	0.20%	0.05%
		99% avoidance (182 collisions)	0.10%	0.02%
		99.5% avoidance (91 collisions)	0.05%	0.01%
Small turbines	% mortality relative to population	98% avoidance (285 collisions)	0.16%	0.04%
		99% avoidance (143 collisions)	0.08%	0.02%
		99.5% avoidance (71 collisions)	0.04%	0.01%

Collision estimates >1% of the AMR highlighted in **bold**

Non-breeding Season - Large Turbines

Kittiwake collision estimates for the non-breeding season at 98% avoidance rate, are exceedingly low in relation to regional (0.19 per cent) or North Sea level (0.02 per cent) populations (Table 15A.35).

Non-breeding Season - Small Turbines

Collision estimates for small turbines do not exceed 0.15 per cent in a regional context at any avoidance rate, and represent approximately 0.01 per cent of the North Sea non-breeding population (Table 15A.35).

TABLE 15A.35: COLLISION MORTALITY OF KITTIWAKES AT INCH CAPE IN THE NON-BREEDING SEASON RELATIVE TO REGIONAL AND NORTH SEA POPULATIONS				
Scenario	**Parameters**		**Regional – Non-breeding population**	**North Sea – Non-breeding population**
Baseline	Estimated population (individuals)		84,000	1,032,690
Large turbines	% mortality relative to population	98% avoidance (158 collisions)	0.19%	0.02%
		99% avoidance (79 collisions)	0.09%	0.01%
		99.5% avoidance (39 collisions)	0.05%	<0.01%
Small turbines	% mortality relative to population	98% avoidance (126 collisions)	0.15%	0.01%
		99% avoidance (59 collisions)	0.07%	0.01%
		99.5% avoidance (34 collisions)	0.04%	<0.01%

Collision estimates reflecting >1% of the background population highlighted in **bold;** estimates represent all birds, regardless of age class.

Herring Gull

Large Turbines

At 98% avoidance up to 0.03 per cent of the regional herring gull population in the non-breeding season is estimated to collide with turbines on an annual basis (Table 15A.36). These estimates represent 0.03 and 0.01 per cent of the regional and North Sea populations.

Small Turbines

Collision estimates for small turbines are similarly low, with annual mortality not exceeding 0.02 per cent of regional and North Sea populations (Table 15A.36).

TABLE 15A.36: COLLISION MORTALITY OF HERRING GULLS AT INCH CAPE IN THE NON-BREEDING SEASON RELATIVE TO REGIONAL AND NORTH SEA POPULATIONS

Scenario	Parameters		Regional – Non-breeding population	North Sea – Non-breeding population
Baseline	Estimated population (individuals)		200,000	971,700
Large turbines	% mortality relative to population	98% avoidance (54 collisions)	0.03%	0.01%
		99% avoidance (27 collisions)	0.01%	<0.01%
		99.5% avoidance (13 collisions)	0.01%	<0.01%
Small turbines	% mortality relative to population	98% avoidance (41 collisions)	0.02%	<0.01%
		99% avoidance (21 collisions)	0.01%	<0.01%
		99.5% avoidance (10 collisions)	0.01%	<0.01%

Collision estimates reflecting >1% of the background population highlighted in **bold;** estimates represent all birds, regardless of age class.

Great Back-backed Gull

Large Turbines

At 98 per cent avoidance collision estimates for great black-backed gulls in the non-breeding season represent mortality of 0.68 per cent to 0.05 per cent of the regional and North Sea populations respectively (Table 15A.37).

Small Turbines

Estimates for small turbines are equally low, with 0.53 per cent mortality at a regional level at 98 per cent avoidance.

TABLE 15A.37: COLLISION MORTALITY OF GREAT BLACK-BACKED GULLS AT INCH CAPE IN THE NON-BREEDING SEASON RELATIVE TO REGIONAL AND NORTH SEA POPULATIONS

Scenario	Parameters		Regional – Non-breeding population	North Sea – Non-breeding population
Baseline	Estimated population (individuals)		21,600	299,900
Large turbines	% mortality relative to population	98% avoidance (147 collisions)	0.68%	0.05%
		99% avoidance (73 collisions)	0.34%	0.02%
		99.5% avoidance (37 collisions)	0.17%	0.01%
Small turbines	% mortality relative to population	98% avoidance (114 collisions)	0.53%	0.04%
		99% avoidance (57 collisions)	0.26%	0.02%
		99.5% avoidance (28 collisions)	0.13%	<0.01%

Collision estimates reflecting >1% of the background population highlighted in **bold;** estimates represent all birds, regardless of age class.

15A.4.4 Waterfowl and Waders

Table 15A.38 provides an overview of the estimated collision risk for waterfowl and wader species during the non-breeding season for the large turbine scenario across a range of avoidance rates. These estimates relate only to species recorded during boat-based surveys of the study area in 2010-2012. Appropriate avoidance rates for geese species are 99 per cent (SNH, 2010).

Annual collision estimates for all waterfowl and wader species are low to very low in comparison to their background populations (Table 15A.28), despite very precautionary assumptions in available guidance about the proportion of birds at collision risk height (Wright *et al.* (2012) (see Table 15A.28 above).

TABLE 15A.38: ESTIMATED ANNUAL COLLISION MORTALITY FOR WATERFOWL AND WADERS FOR THE WORST CASE WIND FARM LAYOUT

Species	Avoidance rate (%)				
	0	95	98	99	99.5
Taiga bean goose	1	<1	<1	<1	<1
Svalbard barnacle goose	657	33	13	7	3
Pink-footed goose	2,276	114	46	23	11
Shelduck	32	2	1	<1	<1
Tufted duck	62	3	1	1	<1
Long-tailed duck	9	<1	<1	<1	<1
Common scoter	46	2	1	<1	<1
Goldeneye	12	1	<1	<1	<1
Ringed plover	49	2	1	<1	<1
Golden plover	593	89	36	18	9
Oystercatcher	159	8	3	2	1
Dunlin	414	21	8	4	2
Knot	228	11	5	2	1
Purple sandpiper	16	1	<1	<1	<1
Curlew	124	6	2	1	1
Grey phalarope	<1	<1	<1	<1	<1

15A.5 DISPLACEMENT

15A.5.1 Introduction and Species Selection

The following section presents seasonal population estimates for seabirds within the Development Area and a 2 km buffer - an area of 278 km^2. These population estimates are used as the basis for the assessment of displacement in the Ornithology chapter (Table 15.11). The inclusion of the 2 km buffer reflects the available evidence from post construction monitoring that displacement effects are likely to extend beyond the turbine array of an offshore wind farm. Marine Scotland, SNH and JNCC have advised the use of a 2 km buffer around a wind farm footprint in relation to displacement (Niras 2012, Appendix 1). In Chapter 15 (Ornithology), a review of evidence for displacement for each species is presented and a realistic worst case scenario (in terms of the likely percentage displacement within the Development Area) is predicted.

Seabird species were selected for inclusion in displacement assessments based on one of the following criteria;

- likely presence of birds from regional breeding bird populations (including SPA colonies);
- regionally or nationally important populations present during any time of year;
- likely susceptibility to displacement (as per e.g. Langston 2010, Furness & Wade 2012);
- any species of inter(national) conservation concern; and,
- migratory seabird species which have the capacity to occasionally occur in (very) high numbers.

15A.5.2 Explanation of Displacement Population Estimates

Each species section below provides the relevant seasonal background population scale and size, the estimated number of birds displaced from the Development Area and a 2 km buffer, and the corresponding proportion of the background populations these estimates represent.

For some species where data was scarce (i.e. species recorded infrequently during boat surveys: Manx shearwater, sooty shearwater, shag, common gull, little gull, lesser black-backed gull, common tern), peak counts from the surveys were transformed into densities to provide an approximation of the possible magnitude of displacement. Thus, at times the number of ‘at risk’ birds might be higher than the number of birds actually recorded in the study area.

Background populations range from national or regional levels in the breeding season to regional, passage or North Sea population levels in the non-breeding season. These correspond with information given in the species accounts in Section 15A.3.

Where applicable population estimates for the breeding season have been corrected for age using the adult:immature ratio recorded during the baseline surveys in the breeding season. Following consultation recommendations from Marine Scotland (Niras 2012, Appendix 1), it has been assumed for some species that 50 per cent of birds in adult plumage or summer plumage are breeding birds. However, where additional evidence has been found in relation to the proportion of adult birds at sea which are likely to be breeding birds, this has been used in preference to the 50 per cent assumption. For kittiwake, guillemot, razorbill and puffin, stable age distributions calculated from population models (Appendix 15B, Table 15B.6) have been used to predict the number of breeding adult birds. For gannet, it is assumed that all adult plumage birds within the Development Area are breeding birds, based on the recent PVA (WWT consulting 2012) which reports no evidence for non-breeding among adult plumage birds.

Population estimates for the Development Area and a 2 km buffer during the non-breeding season have not been corrected for age as background populations include immature birds as well.

For non-seabird species which may pass through the Development Area on migration, there is the possibility that the wind farm represents a barrier to migratory flights, this is assessed qualitatively in the ornithology chapter (Chapter 15).

15A.5.2.1 Displacement Scenarios

Based on a review of available studies, displacement scenarios (i.e. displacement proportions) for each species scoped in for EIA are set out in Chapter 15 Ornithology. These scenarios are provided here for the relevant species to complement the Chapter. Supporting information is provided for species scoped out for EIA, with displacement estimates based on 100 per cent displacement to provide context to the assessment.

To present a complete overview of the displacement spectrum Annex 15A.5 provides an overview of displacement rates ranging from 10 to 100 per cent for all species for the Development Area and a 2 km buffer. This information is provided following a request from Marine Scotland to FTOWDG in August 2011 (Niras 2012, Appendix 1). This provides an overview of the numbers of birds potentially displaced at a range of displacement scenarios for each species.

For key breeding bird species (gannet, kittiwake, guillemot, razorbill and puffin) displacement estimates presented in the accounts below include a ‘Development Area utilisation only’ scenario as well. This assumes displacement of only those birds that were recorded utilising the sea surface through foraging, roosting or other behaviour. The proportion of on-site populations actually utilising the Development Area is an indication of the importance of the Development Area and surroundings for foraging purposes and is presented to provide context to the assessment.

15A.5.3 Results

Fulmar

Table 15A.39 provides fulmar displacement estimates for the Development Area and a 2 km buffer for the breeding season and non-breeding season. These estimates are compared with the regional / national or North Sea population for the equivalent season.

For the breeding season it has been assumed that 50 per cent of all fulmars recorded in the study area during the breeding season are breeding birds, based on advice from Marine Scotland and SNH (Niras 2012, Appendix 1). This is considered reasonable given the species’ population dynamics, with a very substantial proportion of non-breeding birds (Dunnet & Ollason 1978, Kerbiriou *et al.* 2012).

Assuming a 100 per cent displacement rate, up to 36 breeding birds are at risk of displacement from the Development Area and the 2 km buffer in the breeding season.
In the non-breeding season an average of 69 to 101 birds are predicted to be at displacement risk from the Development Area and the 2 km buffer.

None of these displacement estimates exceed 0.1 per cent of national / North Sea and regional breeding or non-breeding population sizes.

TABLE 15A.39: FULMAR - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 100% DISPLACEMENT						
Season	**Population**	**Population size (individuals)**	**Development Area**		**Development Area + 2 km buffer**	
			Estimated displaced number of birds (1)	**Proportion (%)**	**Estimated displaced number of birds (1)**	**Proportion (%)**
Breeding	National	1,009,512	18	<0.1	36	<0.1
	Regional	82,224		<0.1		<0.1
Non-breeding	North Sea	1,872,000	69	<0.1	101	<0.1
	Regional	400,000		<0.1		<0.1

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the breeding season relate to adult breeding birds in the study area – here assumed to be 50% of all birds recorded. Estimates for the non-breeding season are not age-corrected and thus reflect the whole ‘at sea’ population.

Manx Shearwater

It is considered that no regional breeding population exists as the nearest colony of note (St. Kilda) lies beyond the species’ mean maximum foraging range from the Development Area (see section 15A.3.2.2). Instead it is likely that all the birds recorded in the study area are passage birds heading to or from colonies in northwest Scotland, Iceland, and the Faeroe Islands, including early failed breeders as well as non-breeding birds. Table 15A.40 provides Manx shearwater displacement estimates for the Development Area and a 2 km buffer.
As no reliable regional population estimate is available for passage movements, the national breeding population estimate (lower range of estimate, Mitchell *et al.* 2004) is provided for context purposes.
Assuming 100 per cent displacement an average of 27 to 38 birds are predicted to be at displacement risk from the Development Area and the 2 km buffer in the breeding season, less than 0.1 per cent of the national breeding population.

TABLE 15A.40: MANX SHEARWATER - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 100% DISPLACEMENT						
Season	**Population**	**Population size (individuals)**	**Development Area**		**Development Area + 2 km buffer**	
			Estimated displaced number of birds (1)	**Proportion (%)**	**Estimated displaced number of birds (1)**	**Proportion (%)**
Non-Breeding/ passage	National	562,764	27	<0.1	38	<0.1

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the non-breeding season are not age-corrected and thus reflect the whole ‘at sea’ population

Sooty Shearwater

Sooty shearwaters occur in Scottish waters in the non-breeding season only (see section 15A.3.2.3). Table 15A.41 provides estimates of the number of sooty shearwaters displaced from the Development Area and a 2 km buffer during the non-breeding season.

Assuming 100 per cent displacement an average of 65 to 112 birds are predicted to be at displacement risk from the Development Area and the 2 km buffer, equating to up to 1.5 per cent of the Scottish passage population.

TABLE 15A.41: SOOTY SHEARWATER - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 100% DISPLACEMENT						
Season	Population	Population size (individuals)	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Non-breeding	North Sea	No data available	65	-	112	-
	Regional	7,500 (2)		0.9		1.5

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the non-breeding season are not age-corrected and thus reflect the whole 'at sea' population; 2: Based on peak Scotland estimate in Forrester *et al.* (2007)

Gannet

Table 15A.42 provides the estimated number of gannets displaced from the Development Area and a 2 km buffer during the breeding season and non-breeding season. The breeding season estimate of adult birds is based on an age-correction of 97.2 per cent (ie 97.2 per cent of birds recorded in the breeding season were in adult plumage). A recent population viability analysis for gannet (WWT consulting 2012) reports no evidence for non-breeding for gannets in adult plumage so it is assumed that 100 per cent of adult birds are breeding birds.

Assuming a 75 per cent displacement rate an average of 524 adult gannets are at risk of displacement from the Development Area in the breeding season, increasing to 973 birds when including the 2 km buffer. These estimates equate to 0.4 – 0.8 per cent of the regional breeding population.

In the non-breeding season an average of 67 gannets are predicted to be at displacement risk from the Development Area, increasing to 147 birds with inclusion of the 2 km buffer. These 'at risk' estimates are minimal in comparison to the North Sea population (up to 0.1 per cent) and represent up to 0.5 per cent of the regional non-breeding population.

TABLE 15A.42: GANNET – DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 75% DISPLACEMENT						
Season	Population	Population size	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Breeding	National	437,092	524	0.1	973	0.2
	Regional	116,538		0.4		0.8
Non-breeding	North Sea	157,800	67	<0.1	147	0.1
	Regional	31,200		0.2		0.5

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the breeding season relate to adult breeding birds – here considered to be 97.2 per cent of the total number of birds of all age classes, all of which are assumed to be breeding. Estimates for the non-breeding season are not age-corrected and thus reflect the whole 'at sea' population.

Foraging Breeding Birds

During the breeding season an average of 12 and 15 per cent of gannets were recorded foraging in the Development Area and the buffer zone respectively. At 75 per cent displacement estimates range from 63 birds for the Development Area to 130 birds when including the 2 km buffer. These estimates represent very low proportions on both national (<0.1 per cent), and regional (up to 0.1 per cent) scales (Table 15A.43 below).

TABLE 15A.43: GANNET - DISPLACEMENT ESTIMATES OF FORAGING BREEDING BIRDS IN THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 75% DISPLACEMENT						
Season	**Population**	**Population size (individuals)**	**Development Area**		**Development Area + 2 km buffer**	
			Estimated displaced number of birds (1)	**Proportion (%)**	**Estimated displaced number of birds (1)**	**Proportion (%)**
Breeding	National	437,092	63	<0.1	130	<0.1
	Regional	116,538		0.1		0.1

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion and the proportion of foraging birds. Estimates for the breeding season relate to adult breeding birds – here considered to be 97.2 per cent of the total number of birds of all age classes, all of which are assumed to be breeding.

Shag

Table 15A.44 provides the estimated number of shags displaced from the Development Area and 2 km buffer during the breeding season and non-breeding season. Estimates in the breeding season are age-corrected (86 per cent adults) and it is assumed that 50% birds in adult plumage were breeding birds. Very few shags were in fact recorded during boat surveys in the breeding and non-breeding season – none were recorded within the Development Area.

Assuming a 100 per cent displacement rate less than one bird and two birds are estimated to be displaced from the 2 km buffer in the breeding and non-breeding season respectively. For the breeding season this equates to 3.1 per cent of the (very small) regional population. This relatively high proportion is a result of the small size of the breeding population within mean maximum range, where even displacing one bird has a disproportionally large (theoretical) effect.

TABLE 15A.44: SHAG – DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 100% DISPLACEMENT						
Season	**Population**	**Population size (individuals)**	**Development Area**		**Development Area + 2 km buffer**	
			Estimated displaced number of birds (1)	**Proportion (%)**	**Estimated displaced number of birds (1)**	**Proportion (%)**
Breeding	National	54,954	0	n/a	(<)1	<0.1
	Regional	32		n/a		3.1
Non-breeding	North Sea	29,115	0	n/a	2	<0.1
	Regional	7,855		n/a		<0.1

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the breeding season relate to adult breeding birds – here considered to be 86 per cent of the total number of birds of all age classes, 50 per cent of which are assumed to be breeding. Estimates for the non-breeding season are not age-corrected and thus reflect the whole 'at sea' population.

Common Gull

Very few common gulls were recorded in boat surveys during the breeding season (raw counts of <5 birds per month, see section 15A.3.2.8). The Development Area is not considered to provide an important foraging area for common gulls at this time as it lies towards the maximum limit of the potential foraging range (50 km, Thaxter *et al.* 2012). Table 15A.45 provides the estimated displaced number of common gulls during the non-breeding season.

Assuming a 30 per cent displacement rate, an average of 11 common gulls are estimated to be displaced in the Development Area alone, increasing to 16 birds if displacement were to occur up to 2 km distance. These estimates equate to 0.4 to 0.5 per cent of the regional population and less than 0.1 per cent of the North Sea population in the non-breeding season.

TABLE 15A.45: COMMON GULL - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 30% DISPLACEMENT						
Season	**Population**	**Population size (individuals)**	**Development Area**		**Development Area + 2 km buffer**	
			Estimated displaced number of birds (1)	**Proportion (%)**	**Estimated displaced number of birds (1)**	**Proportion (%)**
Non-breeding	North Sea	175,530	11	<0.1	16	<0.1
	Regional	3,000		0.4		0.5

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion

Little Gull

Little gulls do not breed in Scotland or elsewhere in the UK and there are no breeding populations within foraging range. Table 15A.46 provides the estimated displaced number of little gulls for the Development Area and a 2 km buffer during autumn passage and the non-breeding (winter) season.

Assuming a 30 per cent displacement rate, an average of six little gulls is estimated to be displaced in the Development Area during autumn passage, increasing to 11 gulls if displacement were to occur up to 2 km distance. These estimates equate to 0.1 per cent of the North Sea population and up to 0.2 per cent of the regional population.

Displacement estimates for the Development Area and the 2 km buffer in winter amount to up to 14 gulls. In comparison to the midpoint of the regional estimate (20-400 birds) this represents up to 6.7 per cent of the winter population.

TABLE 15A.46: LITTLE GULL - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2KM BUFFER AT 30% DISPLACEMENT						
Season	**Population**	**Population size (individuals)**	**Development Area**		**Development Area + 2 km buffer**	
			Estimated displaced number of birds (1)	**Proportion (%)**	**Estimated displaced number of birds (1)**	**Proportion (%)**
Non-breeding (autumn passage)	North Sea	9,000	6	0.1	11	0.1
	Regional	3,000		0.2		0.4
Non-breeding (wintering)	North Sea	5,370	10	0.2	14	0.3
	Regional	20-400		4.8*		6.7*

1: estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion
*Assuming mid-point of winter population estimate of 20-400 birds (Forrester *et al.* 2007)

Kittiwake

Table 15A.47 presents the estimated number of kittiwakes displaced from the Development Area and a 2 km buffer during the breeding, post-breeding and non-breeding season. For the breeding season, population viability analysis (Appendix 15B) has been used to estimate the proportion of breeding adults. The stable age distribution estimated from this analysis predicted that 74.4 per cent of these birds would be breeding adults (Appendix 15B, Table 15B.6; note this percentage has been calculated excluding juvenile birds, as at this time the young of the year will be in the nest). For the post-breeding season this proportion is predicted to be 60.6 per cent.

At a 30 per cent displacement rate, an average of 259 kittiwakes is estimated to be displaced in the Development Area during the breeding season, increasing to 502 gulls if displacement were to occur up to 2 km distance. These estimates equate to 0.2-0.5 per cent of the regional population and up to 0.1 per cent of the national population.

In the post-breeding season up to 202 kittiwakes (of which 123 are predicted to be adults) are estimated to be displaced from the Development Area, increasing to 407 birds (of which 246 are predicted to be adults) when including the buffer zone. These estimates equate to 0.2-0.4 per cent of the regional population and up to 0.1 per cent of the national population.

Displacement estimates for the Development Area and the buffer in the non-breeding season amount to up to 275 kittiwakes. In comparison to the regional and national populations these estimates represent up to 0.3 and <0.1 per cent of the regional and national populations respectively.

TABLE 15A.47: KITTIWAKE - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 30% DISPLACEMENT

Season	Population	Population size (individuals)	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Breeding	National	759,784	259	<0.1	502	0.1
	Regional	110,080		0.2		0.5
Post-breeding	National	759,784	202(123)	<0.1	407 (246)	0.1
	Regional	110,080		0.2		0.4
Non-breeding	North Sea	1,032,690	97	<0.1	275	<0.1
	Regional	84,000		0.1		0.3

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the breeding season relate to adult breeding birds – here assumed to be 74.4% of the total number of birds of all age classes, all of which are assumed to be breeding. Estimates for the post-breeding season show all birds as well as (between brackets) the proportion adult birds (based on a 60.6% adult proportion) while those for the non-breeding season are not age-corrected and thus reflect the whole 'at sea' population. Numbers presented here have been rounded for data presentation purposes – actual calculations are based on the detailed data available in Annex 15A.5.

Displacement – Foraging Breeding Birds

Of the kittiwakes recorded during the surveys, an average of 60 per cent of kittiwakes were foraging in the Development Area and 56 per cent in the buffer during the breeding season. Displacement estimates range from 155 birds for the Development Area to 291 birds when including the 2 km buffer. These estimates represent a very low proportion of the national population (<0.1 per cent), and in a regional context amount to 0.1 to 0.3 per cent of the regional breeding population (Table 15A.48).

TABLE 15A.48: KITTIWAKE - DISPLACEMENT ESTIMATES OF FORAGING BREEDING BIRDS IN THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 30% DISPLACEMENT

Season	Population	Population size (individuals)	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Breeding	National	759,784	155	<0.1	291	<0.1
	Regional	110,080		0.1		0.3

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion and the proportion of foraging birds. Estimates for the breeding season relate to adult breeding birds – here assumed to be 74.4% of the total number of birds of all age classes, all of which are assumed to be breeding.

Herring Gull

Table 15A.49 provides the estimated number of herring gulls displaced from the Development Area and a 2 km buffer during the breeding and non-breeding seasons. Breeding season estimates are age-corrected (80.5 per cent of all aged birds during boat surveys were adults) and assume that 50% of gulls in adult plumage are breeding birds.

At 30% displacement up to one gull is estimated to be displaced from the Development Area during the breeding season. Including the 2 km buffer increases the estimate to two gulls. These estimates amount to <0.1 per cent of the national and regional breeding populations.

Displacement estimates for the non-breeding season amount to up to 16 herring gulls from the Development Area and 2 km buffer, representing less than <0.1 per cent of the North Sea and regional populations during this time of year.

TABLE 15A.49: HERRING GULL - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 30% DISPLACEMENT

Season	Population	Population size (individuals)	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Breeding	National	278,078	1	<0.1	2	<0.1
	Regional	39,482		<0.1		<0.1
Non-breeding	North Sea	971,700	5	<0.1	16	<0.1
	Regional	200,000		<0.1		<0.1

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the breeding season relate to adult breeding birds – here considered to be 80.5% of all birds in adult plumage of which 50 per cent are assumed to be breeding. Estimates for the non-breeding season are not age-corrected and thus reflect the whole 'at sea' population.

Great Back-backed Gull

Table 15A.50 provides the estimated number of displaced great black-backed gulls for the Development Area and a 2 km buffer during the breeding and non-breeding season.

During the breeding season up to one gull is estimated to be displaced from the Development Area and 2 km buffer, equating up to 0.9 per cent of the (very small) regional population.

At a displacement rate of 30 per cent up to eight birds are estimated to be displaced from the Development Area in the non-breeding season. Including the 2 km buffer increases this to 14 gulls. These estimates amount to <0.1 and up to 0.1 per cent of the North Sea and regional winter populations respectively.

TABLE 15A.50: GREAT BLACK-BACKED GULL - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 30% DISPLACEMENT

Season	Population	Population size	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Breeding	National	34,320	(<)1	<0.1	(<)1	<0.1
	Regional	110		0.9		0.9
Non-breeding	North Sea	299,900	8	<0.1	14	<0.1
	Regional	21,600		<0.1		0.1

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the breeding season relate to adult breeding birds – here considered to be 53.8% of all birds in adult plumage of which 50 per cent are assumed to be breeding. Estimates for the non-breeding season are not age-corrected and thus reflect the whole 'at sea' population.

Lesser Black-backed Gull

Table 15A.51 provides the estimated displaced number of lesser black-backed gulls for the Development Area and a 2 km buffer during the breeding season. Estimates are based on an age-correction of 85.9 per cent and the assumption that 50% of birds in adult plumage are in fact breeding birds. The species is migratory and was not recorded in the study area during the non-breeding period (September to March).

Using a 30 per cent displacement rate, an estimated two birds will be displaced from the Development Area during the breeding season. Including the 2 km buffer increases the estimate to five gulls. These estimates amount to <0.1 per cent in comparison to national and regional breeding populations respectively.

TABLE 15A.51: LESSER BLACK-BACKED GULL - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 30% DISPLACEMENT

Season	Population	Population size (individuals)	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Breeding	National	224,148	2	<0.1	5	<0.1
	Regional	17,834		<0.1		<0.1

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the breeding season relate to adult breeding birds – here considered to be 85.9 per cent of all birds in adult plumage of which 50 per cent are assumed to be breeding.

Great Skua

Great skuas were recorded within the boat based survey area during the non-breeding season (autumn passage / non-breeding) only (15A.3.2.12). Table 15A.52 provides displacement estimates based on the peak number of great skuas (the peak raw count) recorded for the Development Area and a 2 km buffer during the non-breeding season.

At a displacement rate of 100 per cent up to 12 skuas are estimated to be displaced from the Development Area and the 2 km buffer. These estimates equate to up to <0.1 per cent of North Sea population and 0.1 for the regional non-breeding population.

TABLE 15A.52: GREAT SKUA - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 100% DISPLACEMENT

Season	Population	Population size (individuals)	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Autumn passage / non-breeding	North Sea	12,200	4	<0.1	12	<0.1
	Regional	10,750		<0.1		0.1

Arctic Skua

Arctic skuas were recorded within the boat based survey area on autumn passage only (15A.3.2.13). Table 15A.53 provides displacement estimates based on the peak number (the peak raw count) of Arctic skuas recorded for the Development Area and a 2 km buffer during autumn passage.

At a displacement rate of 100 per cent up to six skuas are estimated to be displaced from the Development Area and the 2 km buffer. These estimates amount to 0.6 per cent of the lower estimate for the regional autumn passage population of 1,000 – 10,000 birds (Forrester *et al.*

2007) and to less than 0.1 per cent of the North Sea passage population - assumed to comprise of breeding populations originating from Norway, Sweden, Finland, the Faeroe Isles and the UK.

TABLE 15A.53: ARCTIC SKUA - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 100% DISPLACEMENT

Season	Population	Population size	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Non-breeding (autumn passage)	North Sea (1)	25,900	1	<0.1	6	<0.1
	Regional (2)	1,000		0.1		0.6

(1) North Sea estimate based on assumption that breeding populations from Norway, Sweden, Finland, the Faeroes Isles and the UK move through or into the North Sea during autumn passage.
(2) Regional population considered to be at least 1,000 birds, based on lower range of Scottish autumn passage estimate (Forrester *et al.* 2007)

Pomarine Skua

Table 15A.54 provides displacement estimates based on the peak number of pomarine skuas recorded for the Development Area and a 2 km buffer during autumn passage. The Scottish passage population is estimated at 100 – 2,000 birds (Forrester *et al.* 2007), reflecting the large variation in numbers between years.

At a displacement rate of 100 per cent up to eight birds are estimated to be displaced from the Development Area and the 2 km buffer. These estimates amount to 0.8 per cent in comparison to the 1,000 birds (mid-point of available population estimate) estimated to pass the Scottish east coast during an average autumn.

TABLE 15A.54: POMARINE SKUA - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 100% DISPLACEMENT

Season	Population	Population size	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Non-breeding (autumn passage)	Scottish East coast passage population (1)	1,000	4	0.4	8	0.8

(1) Regional population considered to be at least 1,000 birds, based on historic counts at Hound Point (Forrester *et al.* 2007)

Arctic Tern

Table 15A.55 provides the estimated number of Arctic terns displaced from the Development Area and a 2 km buffer during the breeding and post-breeding (dispersal movements and autumn passage) season. Estimates for the breeding season are age-corrected (78 per cent adults) for which it is assumed that 50% of birds in adult plumage are breeding birds.

At 30% displacement up to one adult Arctic tern is estimated to be at risk of displacement from the Development Area in the breeding season, increasing to four birds when including the 2 km buffer. These estimates represent a fraction of the national population (<0.1 per cent). Displacement from the Development Area alone amounts to 0.2 per cent of the regional breeding population, and up to 0.5 per cent when considering the buffer zone as well.

During the post-breeding period up to 90 terns are estimated to be displaced from the Development Area and the 2 km buffer, representing up to 0.2 per cent of the regional post-breeding population.

TABLE 15A.55: ARCTIC TERN - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 30% DISPLACEMENT						
Season	**Population**	**Population size (individuals)**	**Development Area**		**Development Area + 2 km buffer**	
			Estimated displaced number of birds (1)	**Proportion (%)**	**Estimated displaced number of birds (1)**	**Proportion (%)**
Breeding	National	106,776	1	<0.1	3	<0.1
	Regional	586		0.2		0.5
Post-breeding (autumn passage)	North Sea	Unknown	72	-	90	-
	Regional	43,615		0.2		0.2

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the breeding season relate to adult breeding birds – here considered to be 78 per cent of all birds in adult plumage of which 50 per cent are assumed to be breeding. Estimates for the post-breeding season are not age-corrected and thus reflect the whole 'at sea' population.

Common Tern

Table 15A.56 provides the estimated number of displaced common terns for the Development Area and a 2 km buffer during the breeding season and autumn passage. For the breeding season it was assumed that 50 per cent of adult birds were breeding (all birds recorded during surveys in the breeding season were in adult plumage).

There is no displacement estimate for the Development Area during either season as no birds were recorded there at any time of year. At 30 per cent displacement the single bird estimated to be displaced from the buffer zone equates to 0.4 per cent of the regional breeding population.

Up to eight terns are estimated to be displaced from the 2 km buffer in the post-breeding season, which equates to 0.1 per cent of the regional background population.

TABLE 15A.56: COMMON TERN - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 30% DISPLACEMENT						
Season	**Population**	**Population size (individuals)**	**Development Area**		**Development Area + 2 km buffer**	
			Estimated displaced number of birds (1)	**Proportion (%)**	**Estimated displaced number of birds (1)**	**Proportion (%)**
Breeding	National	23,676	0	n/a	(<)1	<0.1
	Regional	228		n/a		0.4
Post-breeding (autumn passage)	North Sea	7,500	0	n/a	8	0.1
	Regional	7,286		n/a		0.1

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the breeding season relate to adult breeding birds – here considered to be 100 per cent of all birds in adult plumage of which 50 per cent are assumed to be breeding. Estimates for the post-breeding season are not age-corrected and thus reflect the whole 'at sea' population.

Guillemot

Table 15A.57 provides guillemot displacement estimates for the Development Area and a 2 km buffer during the breeding, post-breeding and non-breeding season. For the breeding season, population viability analysis (Appendix 15B) has been used to estimate the proportion of birds that were breeding adults. A stable age distribution estimated from population viability analysis predicted that 83.6 per cent of all birds would be breeding adults (Appendix 15B, Table 15B.6; note this percentage has been calculated excluding juvenile birds, as at this time the young of the year will be in the nest).

At 50 per cent displacement an estimated 893 guillemots could be displaced from the Development Area in the breeding season, increasing to 1,827 birds when including the 2 km buffer. These estimates represent 0.5 – 1.0 per cent of the regional population for the Development Area and the Development Area combined with the 2 km buffer respectively.

During the post-breeding period up to 1,588 guillemots are considered at risk of displacement from the Development Area and the buffer zone together, representing up to 0.8 per cent of the regional post-breeding population.

In the non-breeding season an average of 415 guillemots are at displacement risk from the Development Area, increasing to 880 birds with inclusion of the 2 km buffer. These displacement estimates are very low in comparison to the North Sea population which consists of over 1.5 million birds and represent up to 0.2 per cent of the regional winter population.

TABLE 15A.57: GUILLEMOT - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 50% DISPLACEMENT

Season	Population	Population size (individuals)	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Breeding	National	1,420,900	893	0.1	1,827	0.1
	Regional	188,210		0.5		1.0
Post-breeding	North Sea	1,420,900	697	<0.1	1,588	0.1
	Regional	188,210		0.4		0.8
Non-breeding	North Sea	1,562,400	415	<0.1	880	0.1
	Regional	521,000		0.1		0.2

1:. Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the breeding season relate to adult breeding birds – here assumed to be 83.6 per cent of the total number of birds of all age classes, all of which are assumed to be breeding. Estimates for the post- and non-breeding season are not age-corrected and thus reflect the whole 'at sea' population.

Displacement – Foraging Breeding Birds

Of all guillemots recorded during the breeding season an average of 81 per cent (Development Area) and 75 per cent (buffer) were seen to be foraging. At 50 per cent displacement, estimates for individuals physically utilising the sea surface in the breeding season range from 723 birds for the Development Area to 1,424 birds when including the 2 km buffer. These estimates represent 0.1 per cent of the national population, and up to 0.8 per cent of the regional breeding population (Table 15A.58).

TABLE 15A.58: GUILLEMOT - DISPLACEMENT ESTIMATES OF FORAGING BREEDING BIRDS FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 50% DISPLACEMENT

Season	Population	Population size (individuals)	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Breeding	National	1,420,900	723	0.1	1,424	0.1
	Regional	188,210		0.4		0.8

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion and the proportion of foraging birds. Estimates for the breeding season relate to adult breeding birds – here assumed to be 83.6% of the total number of birds of all age classes, all of which are assumed to be breeding.

Razorbill

Table 15A.59 provides razorbill displacement estimates for the Development Area and a 2 km buffer during the breeding, post-breeding and non-breeding season. For the breeding season, population viability analysis (Appendix 15B) has been used to estimate the proportion of birds that were breeding adults. A stable age distribution estimated from population viability analysis predicted that 87.7 per cent of all birds would be breeding adults (Appendix 15B, Table 15B.6; note this percentage has been calculated excluding juvenile birds, as at this time the young of the year will be in the nest).

At 50 per cent displacement an estimated 368 razorbills would be displaced from the Development Area in the breeding season, increasing to 718 birds when including the 2 km buffer. These estimates represent up to 0.4 per cent relative to the national population and up to 3.6 per cent of the regional breeding population.

During the post-breeding period as many as 650 – 1,435 razorbills are considered at risk of displacement from the Development Area and the buffer zone, representing up to 7.1 per cent of the regional post-breeding population.

In the non-breeding season a peak mean of 187 razorbills are estimated to be displaced from the Development Area, increasing to 326 birds with inclusion of the 2 km buffer. These estimates are low in comparison to the North Sea population (0.1 per cent) which consists of over 300,000 birds but represent 1.3 – 2.3 per cent of the regional winter population.

TABLE 15A.59: RAZORBILL - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 50% DISPLACEMENT

Season	Population	Population size (individuals)	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Breeding	National	188,576	368	0.2	718	0.4
	Regional	20,181		1.8		3.6
Post-breeding	National	188,576	650	0.3	1,435	0.8
	Regional	20,181		3.2		7.1
Non-breeding	North Sea	324,000	187	0.1	326	0.1
	Regional	14,400		1.3		2.3

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the breeding season relate to adult breeding birds – here assumed to be 87.7% of the total number of birds of all age classes, all of which are assumed to be breeding. Estimates for the post- and non-breeding season are not age-corrected and thus reflect the whole 'at sea' population.

Displacement – Foraging Breeding Birds

Of all razorbills recorded during the breeding season an average of 81 per cent (Development Area) to 63 per cent (buffer zone) were foraging. An estimated 298 birds could be displaced from the Development Area in the breeding season, increasing to 518 birds when including the 2 km buffer. These estimates represent up to 0.3 per cent of the national population. In a regional context a peak mean of between 1.5 and 2.6 per cent of the breeding population is estimated to be displaced (Table 15A.60).

TABLE 15A.60: RAZORBILL - DISPLACEMENT ESTIMATES OF FORAGING BREEDING BIRDS AT 50% DISPLACEMENT						
Season	**Population**	**Population size (individuals)**	**Development Area**		**Development Area + 2 km buffer**	
			Estimated displaced number of birds (1)	**Proportion (%)**	**Estimated displaced number of birds (1)**	**Proportion (%)**
Breeding	National	188,576	298	0.2	518	0.3
	Regional	20,181		1.5		2.6

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion and the proportion of foraging birds. Estimates for the breeding season relate to adult breeding birds – here assumed to be 87.7% of the total number of birds of all age classes, all of which are assumed to be breeding.

Puffin

Table 15A.61 provides estimated displaced number of puffins for the Development Area and a 2 km buffer during the breeding, post-breeding and non-breeding season. For the breeding season, population viability analysis (Appendix 15B) has been used to estimate the proportion of birds that were breeding adults. A stable age distribution estimated from population viability analysis predicted that 82.1 per cent of all birds would be breeding adults (Appendix 15B, Table 15B.6; note this percentage has been calculated excluding juvenile birds, as at this time the young of the year will be in the nest).

At 50 per cent displacement an estimated 816 puffins could be displaced from the Development Area in the breeding season, increasing to 1,478 birds when including the 2 km buffer. These estimates represent up to 0.1 per cent relative to the national population and up to 0.6 per cent of the regional breeding population.

During the post-breeding period as many as 697 – 1,344 puffins are estimated to be displaced from the Development Area and the buffer zone, representing up to 0.6 per cent of the regional post-breeding population.

In the non-breeding season 116 puffins are estimated to be displaced from the Development Area, increasing to 190 birds with inclusion of the 2 km buffer. These estimates represent up to 0.3 and 0.5 per cent of the North Sea and regional winter population respectively.

TABLE 15A.61: PUFFIN - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 50% DISPLACEMENT						
Season	**Population**	**Population size (individuals)**	**Development Area**		**Development Area + 2 km buffer**	
			Estimated displaced number of birds (1)	**Proportion (%)**	**Estimated displaced number of birds (1)**	**Proportion (%)**
Breeding	National	1,161,598	816	0.1	1,478	0.1
	Regional	229,284		0.4		0.6
Post-breeding	National	1,161,598	697	0.1	1,344	0.1
	Regional	229,284		0.3		0.6
Non-breeding	North Sea	74,600	116	0.2	190	0.3
	Regional	37,400		0.3		0.5

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the breeding season relate to adult breeding birds – here assumed to be 82.1% of the total number of birds of all age classes, all of which are assumed to be breeding. Estimates for the post- and non-breeding season are not age-corrected and thus reflect the whole 'at sea' population.

Displacement – Foraging Breeding Birds

Of all puffins recorded during the breeding season an average of 76 per cent (Development Area) and 71 per cent (buffer) were seen foraging. Displacement estimates of foraging puffins are estimated at 620 birds for the Development Area, increasing to 1,090 individuals when including the 2 km buffer. These estimates are very low compared to the national population (0.1 per cent), and equate to 0.3 to 0.5 per cent of the regional breeding population (Table 15A.62).

TABLE 15A.62: PUFFIN - DISPLACEMENT ESTIMATES OF FORAGING BREEDING BIRDS AT 50% DISPLACEMENT

Season	Population	Population size (individuals)	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Breeding	National	1,161,598	620	0.1	1,090	0.1
	Regional	229,284		0.3		0.5

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion and the proportion of foraging birds. Estimates for the breeding season relate to adult breeding birds – here assumed to be 82.1% of the total number of birds of all age classes, all of which are assumed to be breeding.

Little Auk

Table 15A.63 provides displacement estimates for little auks for the Development Area and a 2 km buffer during the non-breeding season. The species was not present during the breeding season.

At 100 per cent displacement up to 1,190 little auks are estimated to be displaced from the Development Area, increasing to 2,319 birds when including the 2 km buffer. At 0.1 to 0.3 per cent respectively, these estimates represent a fraction of the North Sea population. Comparison with a regional population is not considered possible due to the nature of the species' presence in Scottish waters which is largely ruled by offshore weather patterns and characterised by large scale bird movements with a very high turnover. As such a meaningful regional population would be very difficult to define.

TABLE 15A.63: LITTLE AUK - DISPLACEMENT ESTIMATES FOR THE DEVELOPMENT AREA AND A 2 KM BUFFER AT 100% DISPLACEMENT

Season	Population	Population size (individuals)	Development Area		Development Area + 2 km buffer	
			Estimated displaced number of birds (1)	Proportion (%)	Estimated displaced number of birds (1)	Proportion (%)
Non-breeding	North Sea	852,690	1,190	0.1	2,319	0.3

1: Estimates for displaced bird numbers are derived by multiplying peak mean population estimates with the predicted displacement proportion. Estimates for the non-breeding season are not age-corrected and thus reflect the whole 'at sea' population.

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ANNEX 15A.1: MAPS

List of Figures:

Figure 15A.1.1: Inch Cape Boat-based Survey Area

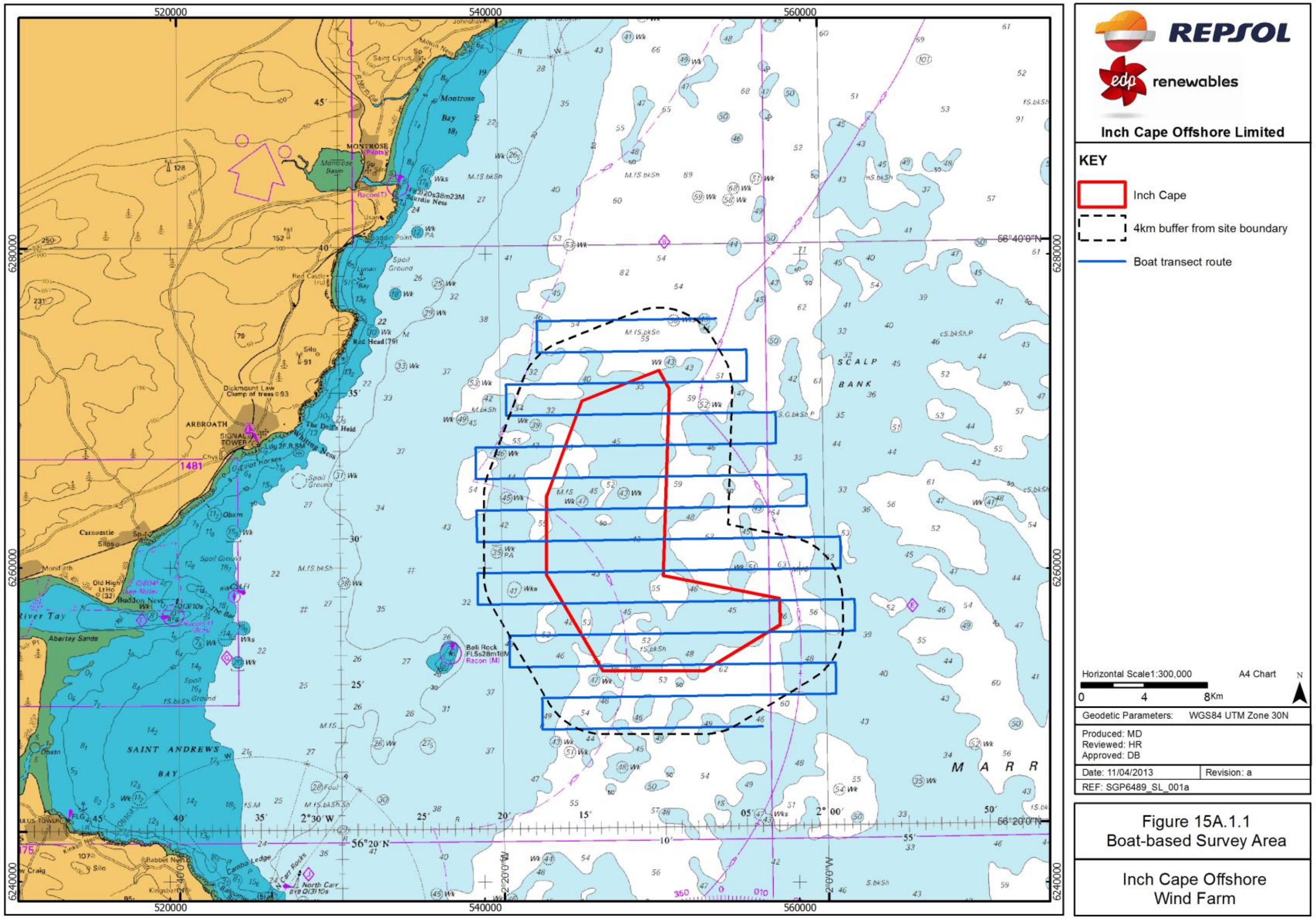


Figure 15A.1.2: Fulmar Colonies and Foraging Ranges

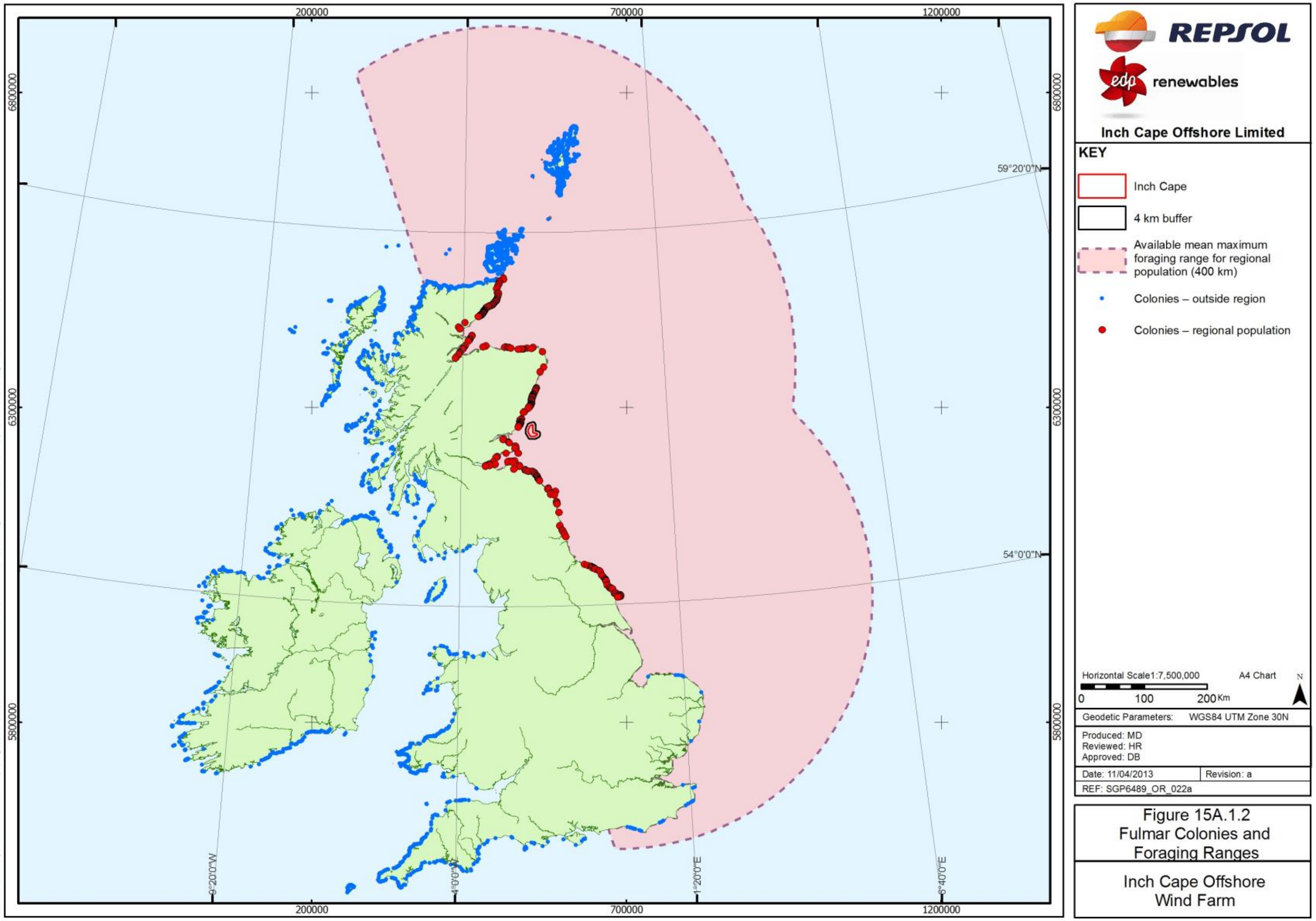


Figure 15A.1.3: Fulmar Seasonal Distribution Year 1

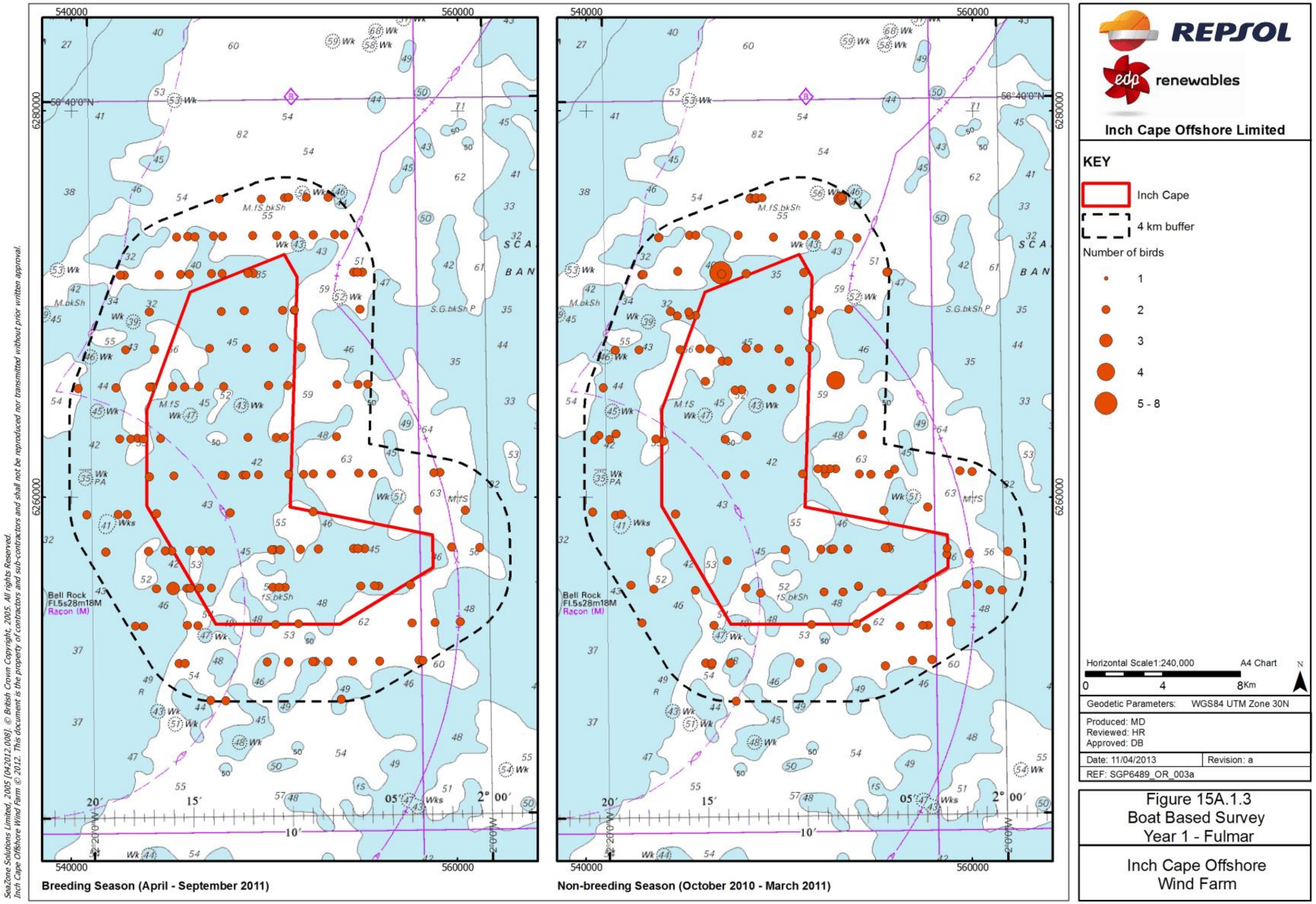


Figure 15A.1.4: Fulmar Seasonal Distribution Year 2

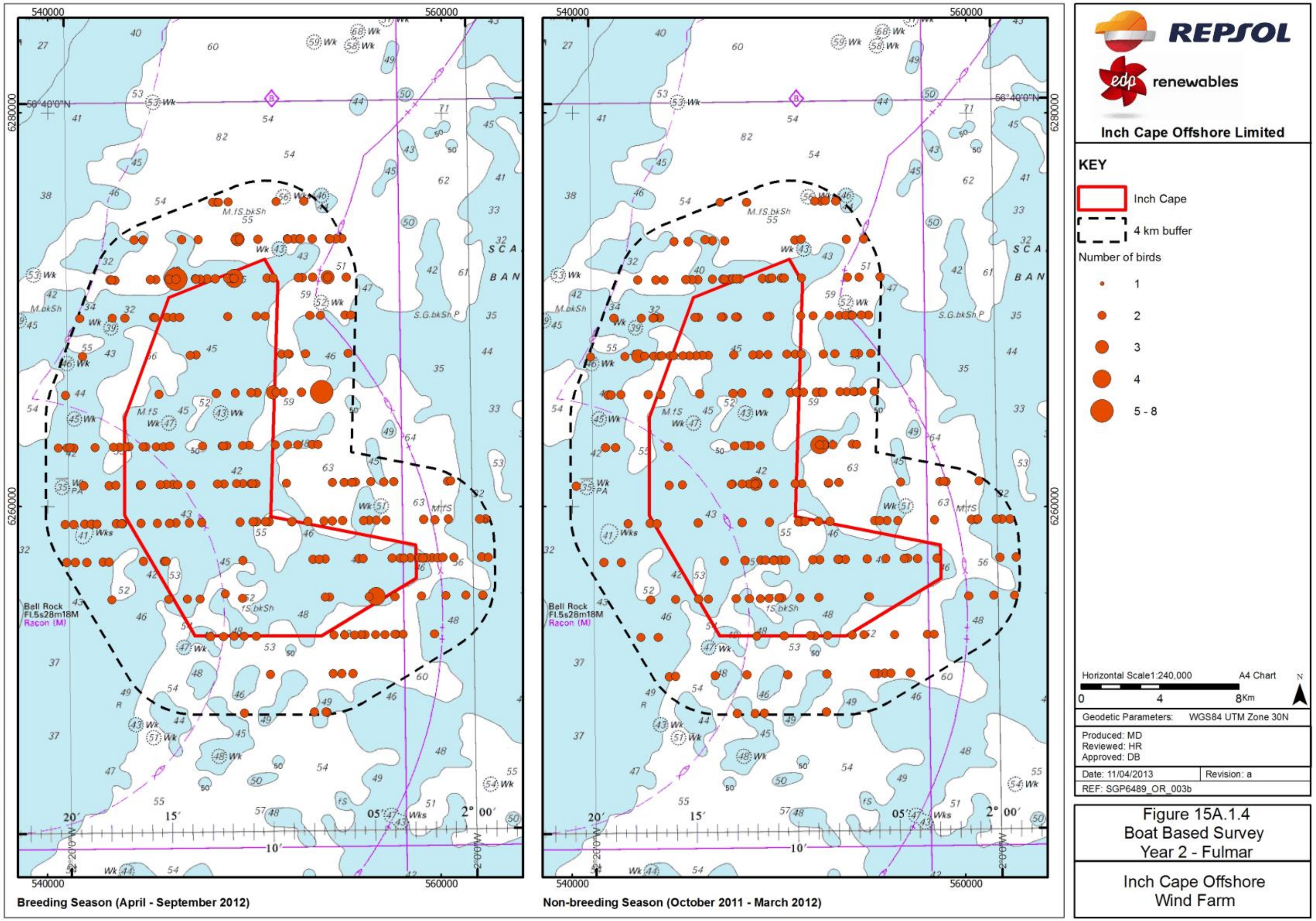


Figure 15A.1.5: Gannet Colonies and Foraging Ranges

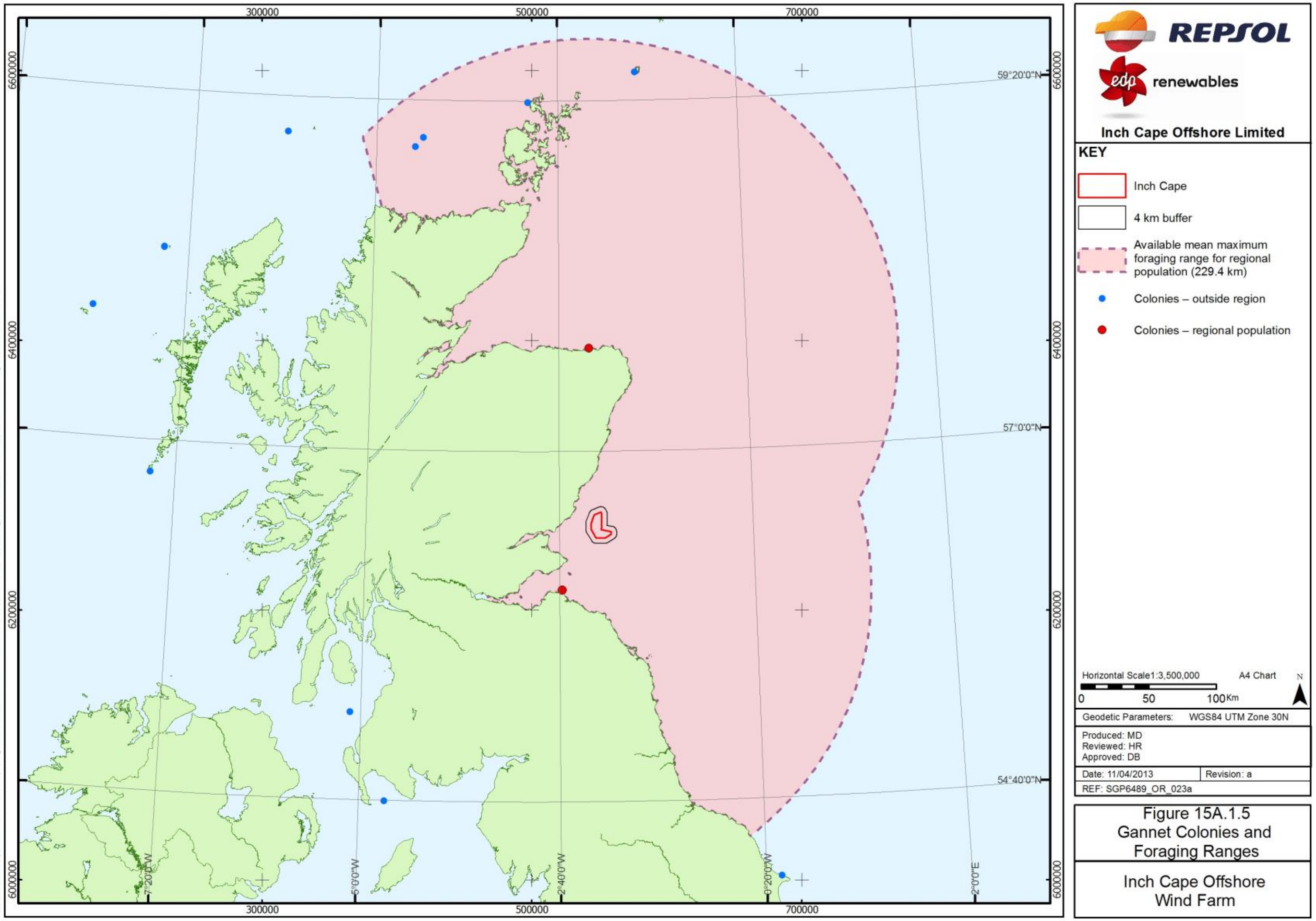


Figure 15A.1.6: Gannet Seasonal Distribution Year 1

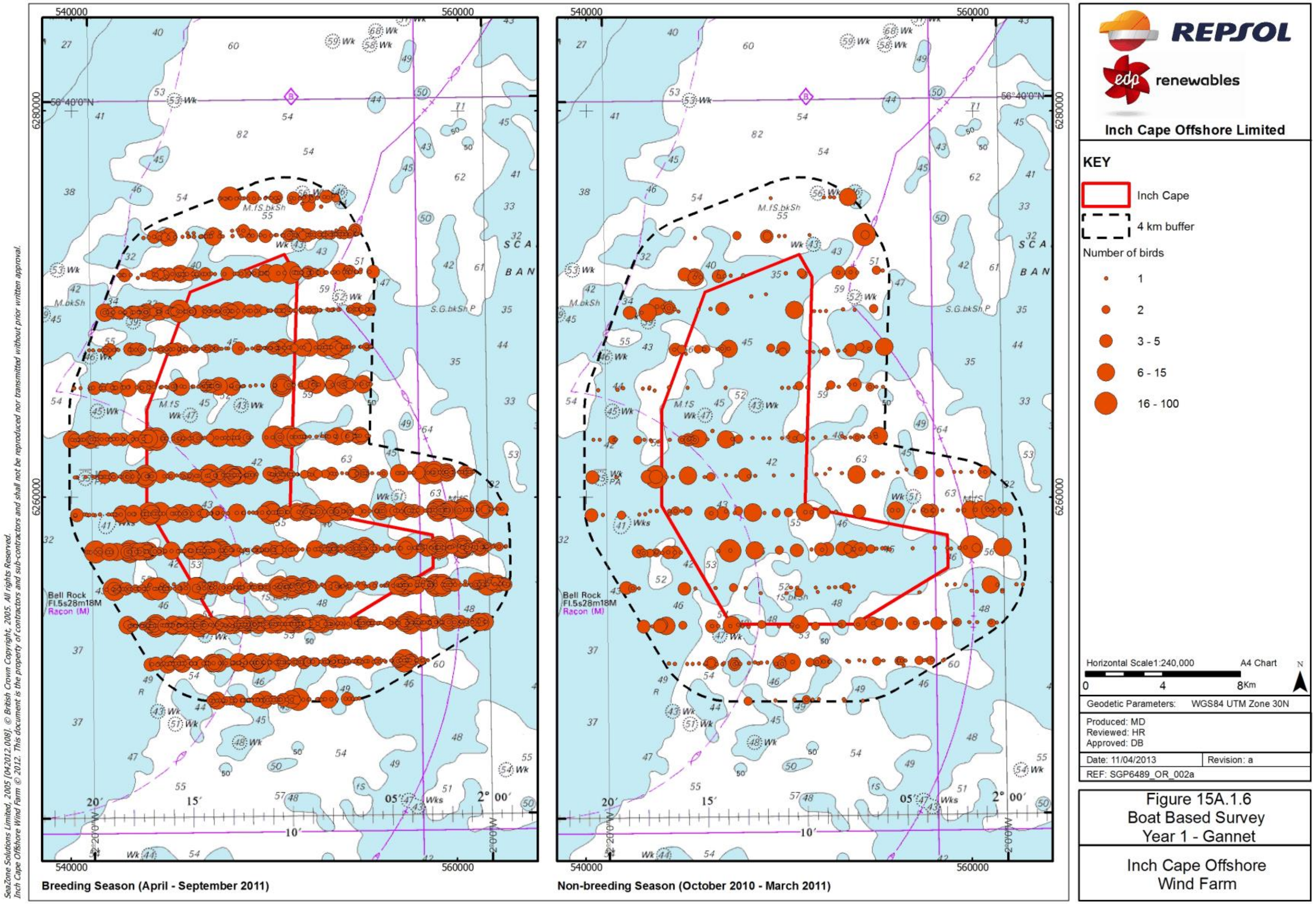


Figure 15A.1.7: Gannet Seasonal Distribution Year 2

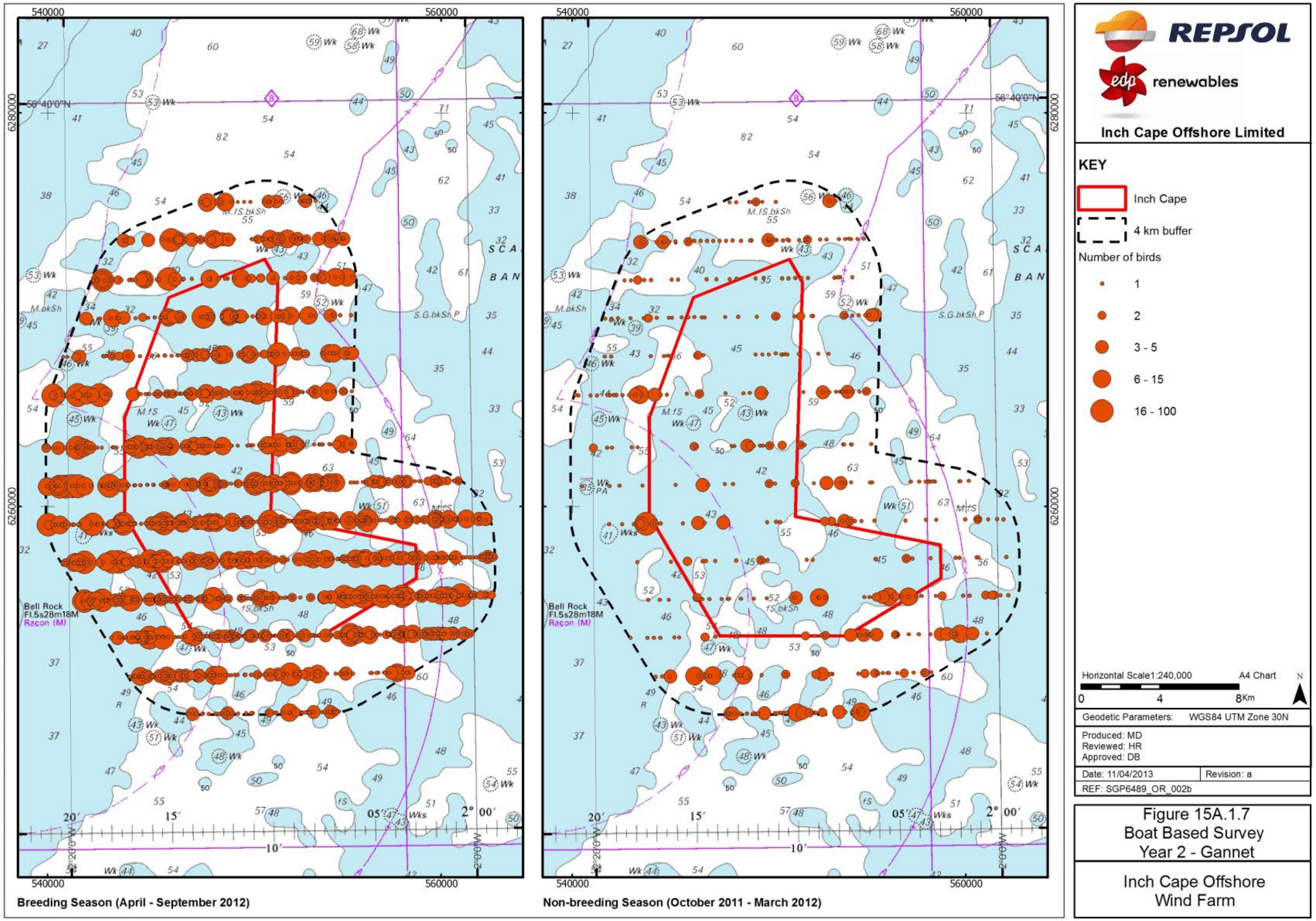


Figure 15A.1.8: Shag Colonies and Foraging Ranges

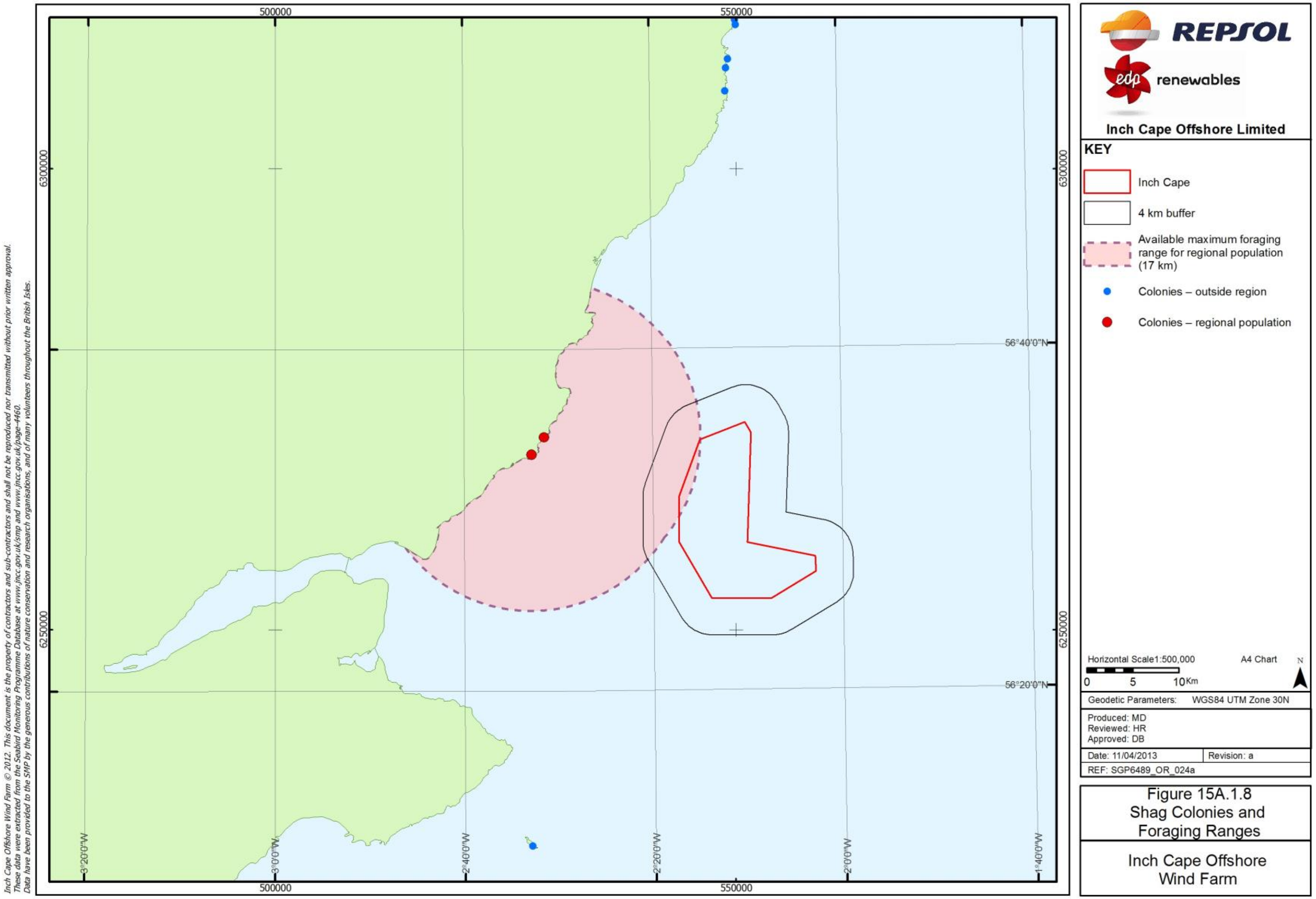


Figure 15A.1.9: Kittiwake Colonies and Foraging Ranges

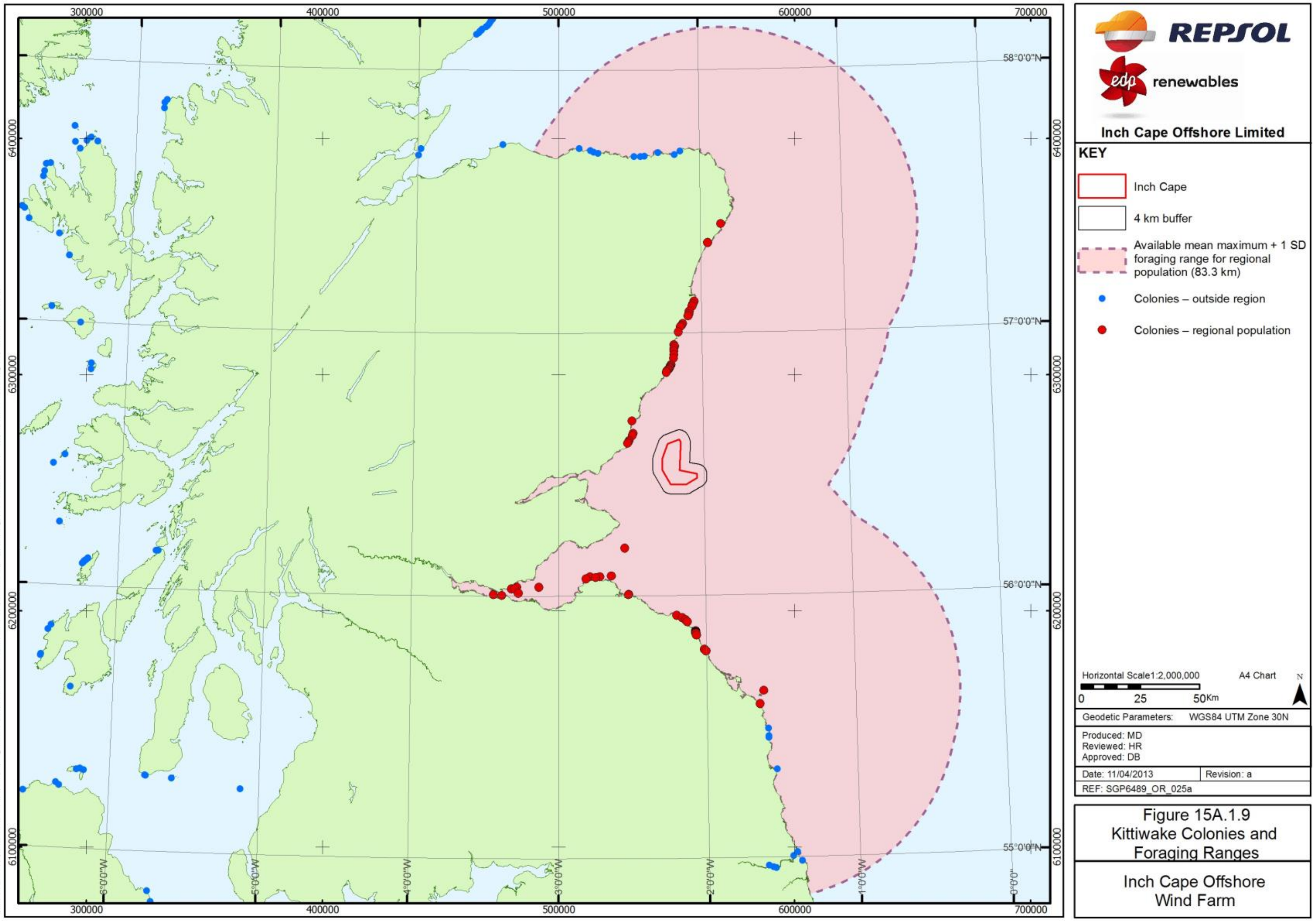


Figure 15A.1.10: Kittiwake Seasonal Distribution Year 1

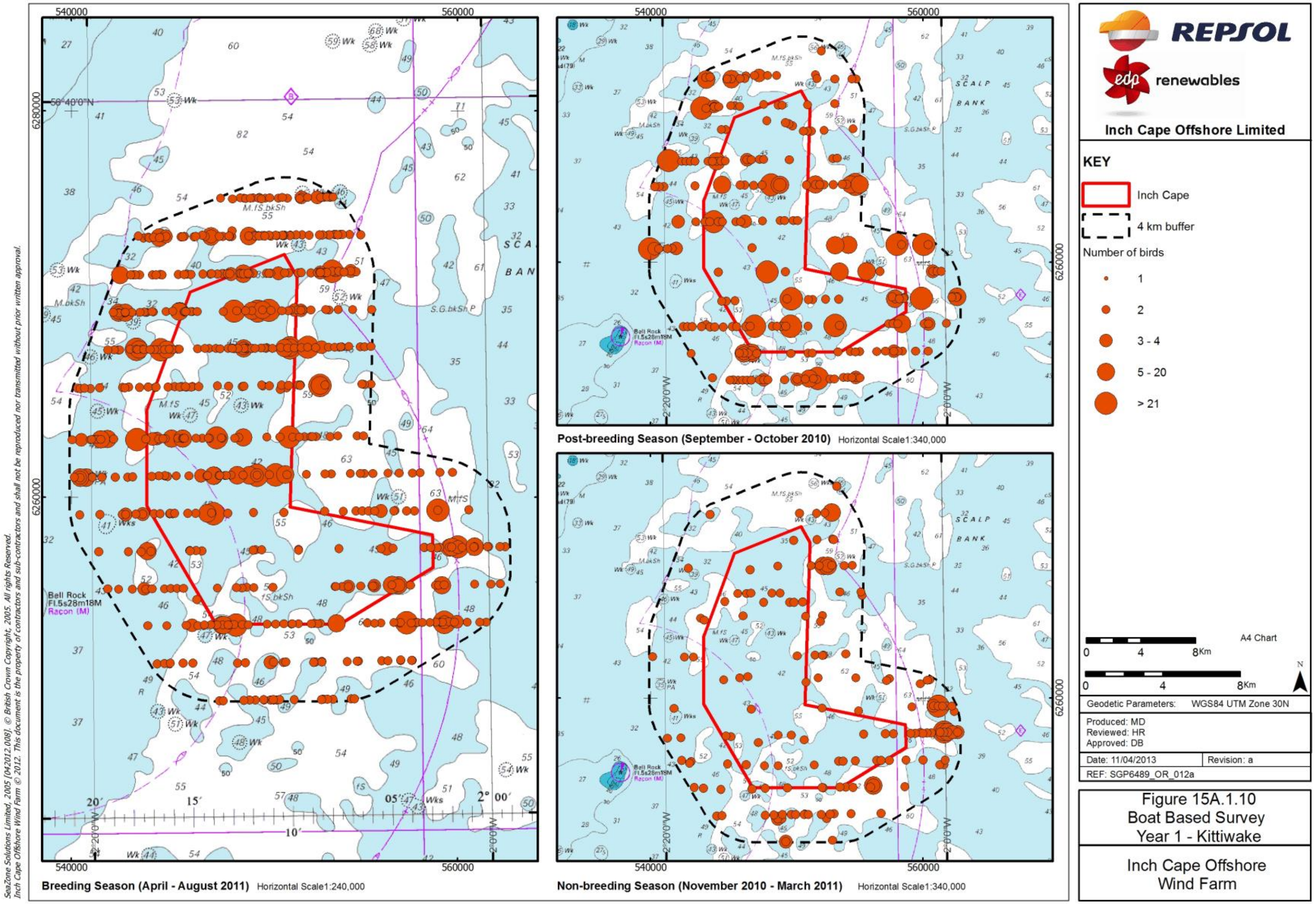


Figure 15A.1.11: Kittiwake Seasonal Distribution Year 2

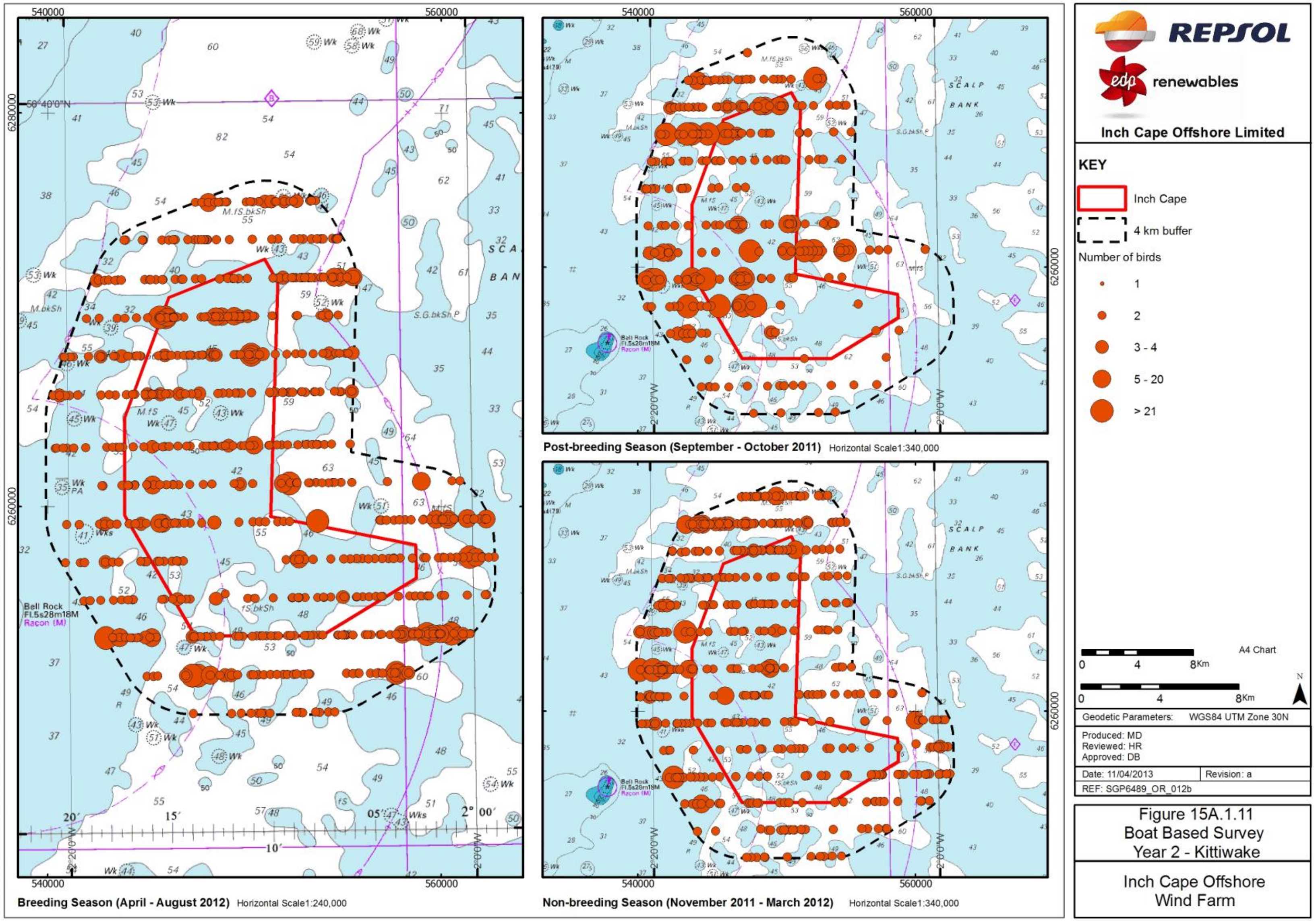


Figure 15A.1.12: Lesser Black-backed Gull Colonies and Foraging Ranges

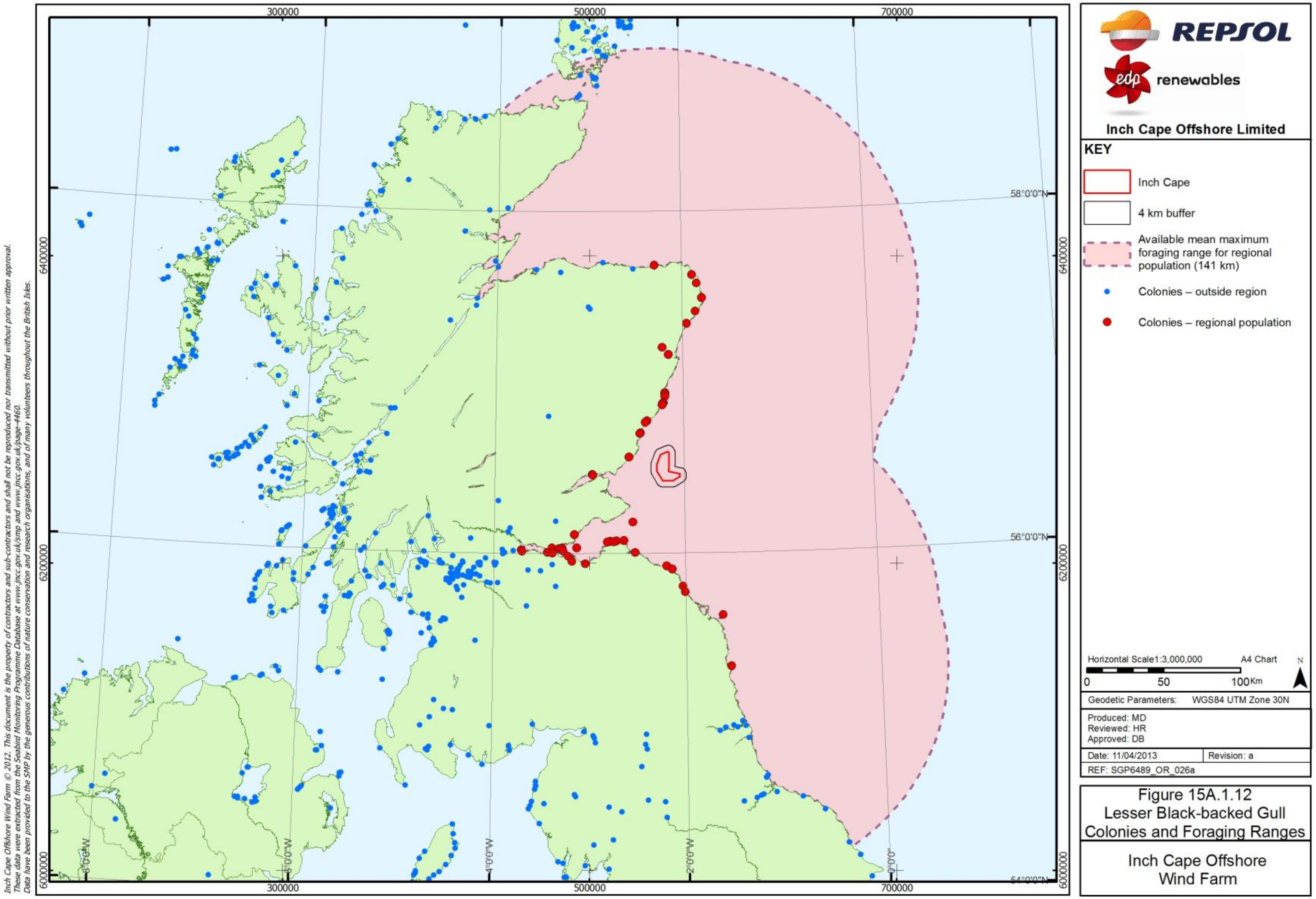


Figure 15A.1.13: Lesser Black-backed Gull Seasonal Distribution Year 1 & 2

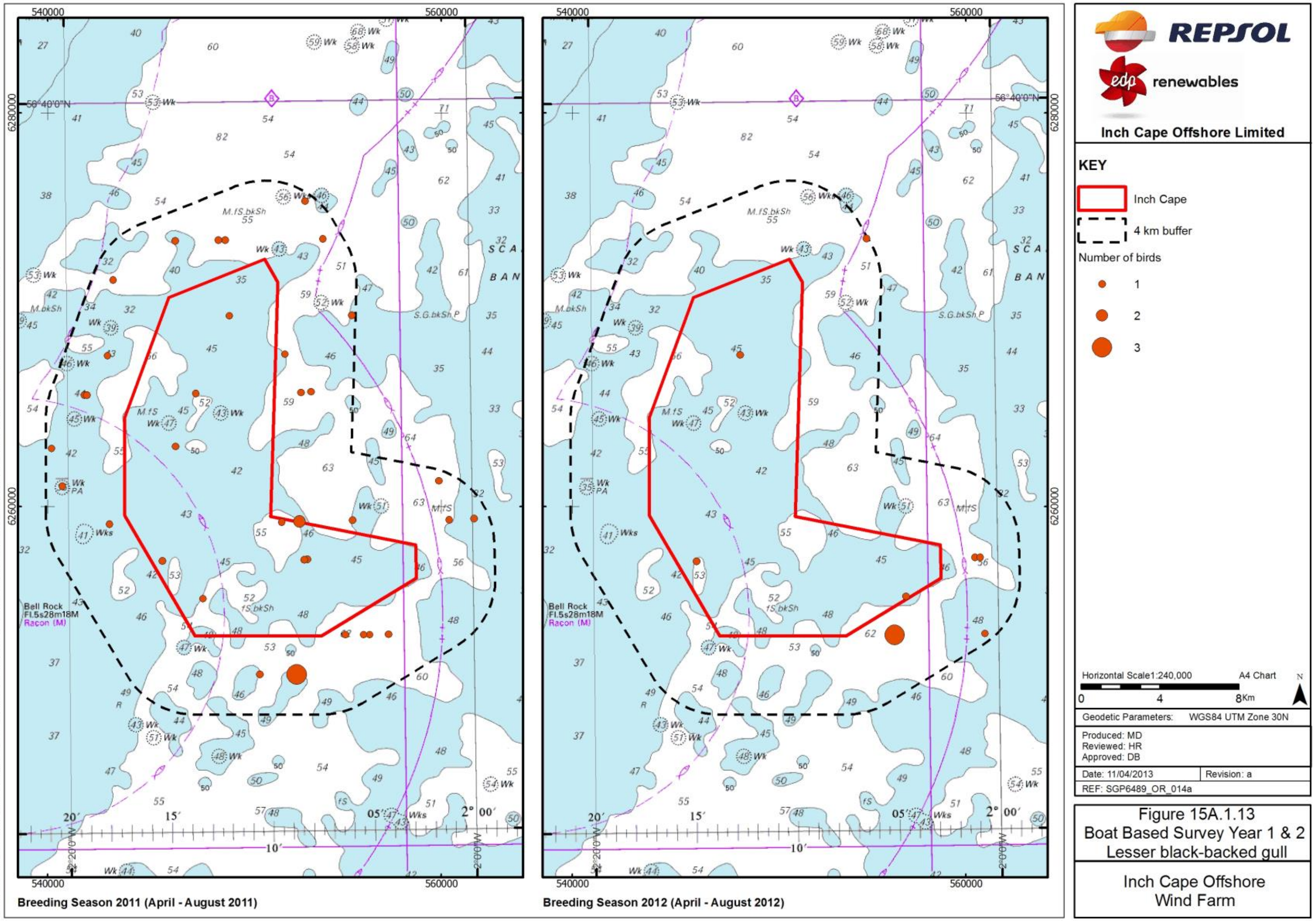


Figure 15A.1.14: Herring Gull Colonies and Foraging Ranges

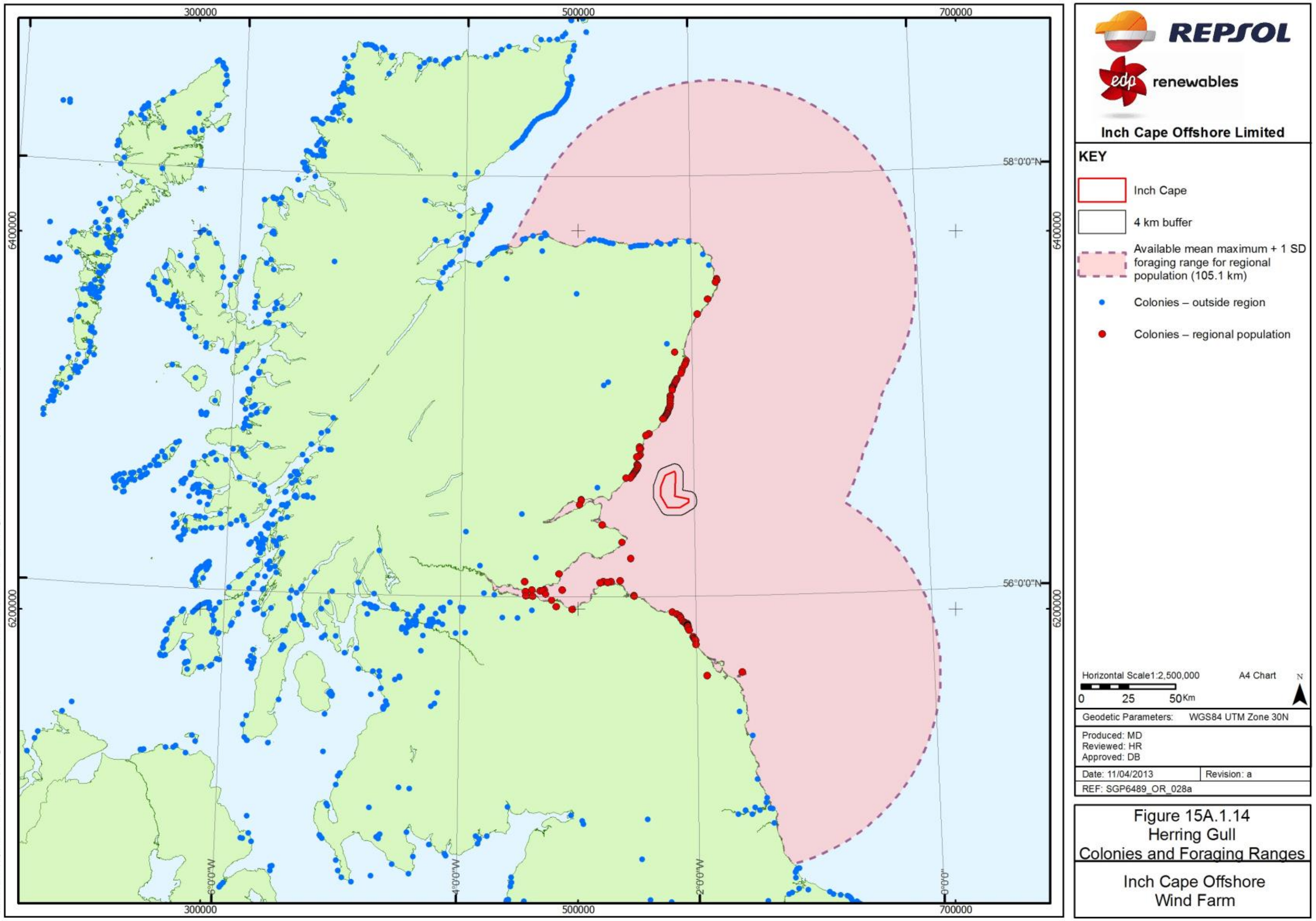


Figure 15A.1.15: Herring Gull Seasonal Distribution Year 1

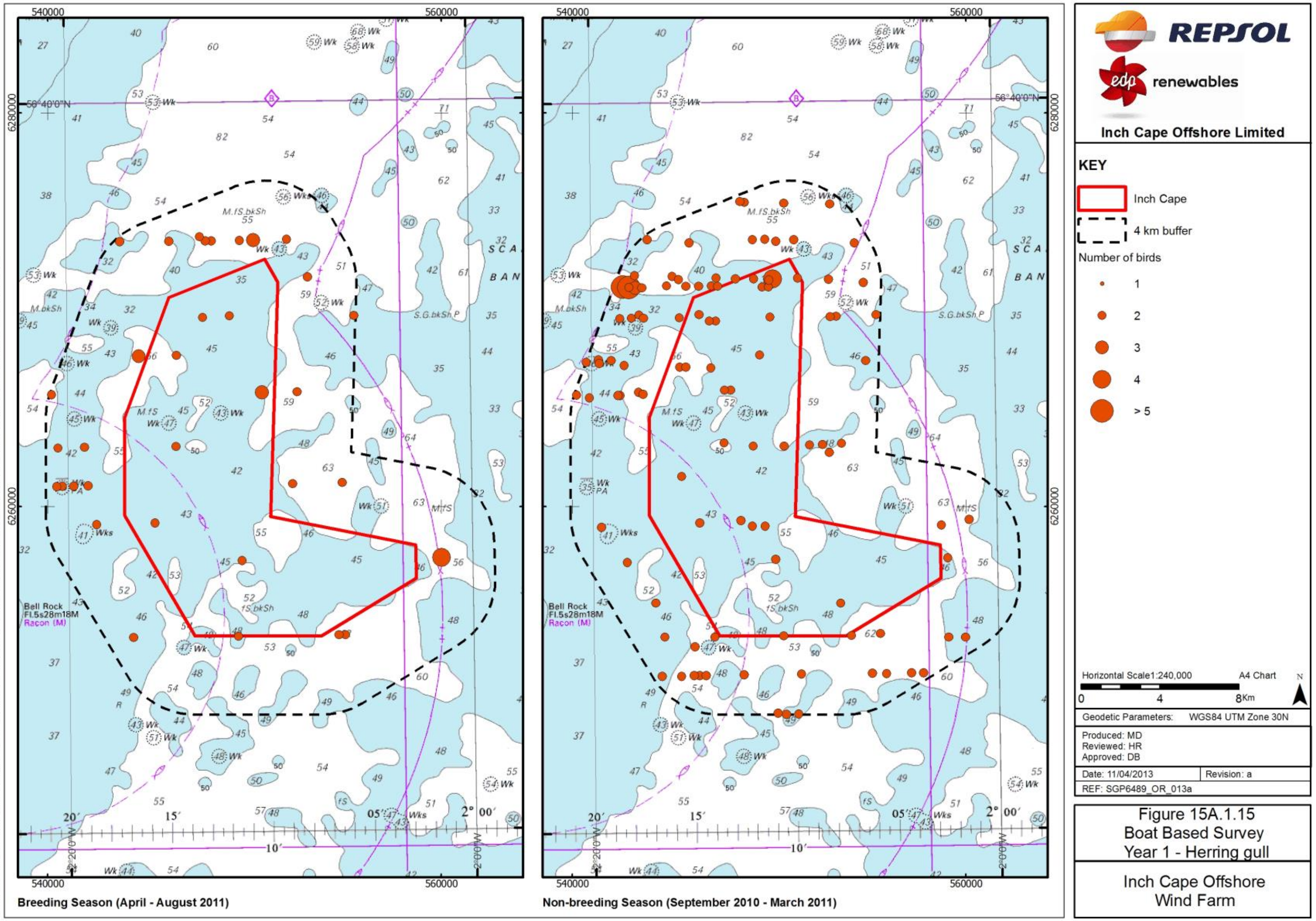


Figure 15A.1.16: Herring Gull Seasonal Distribution Year 2

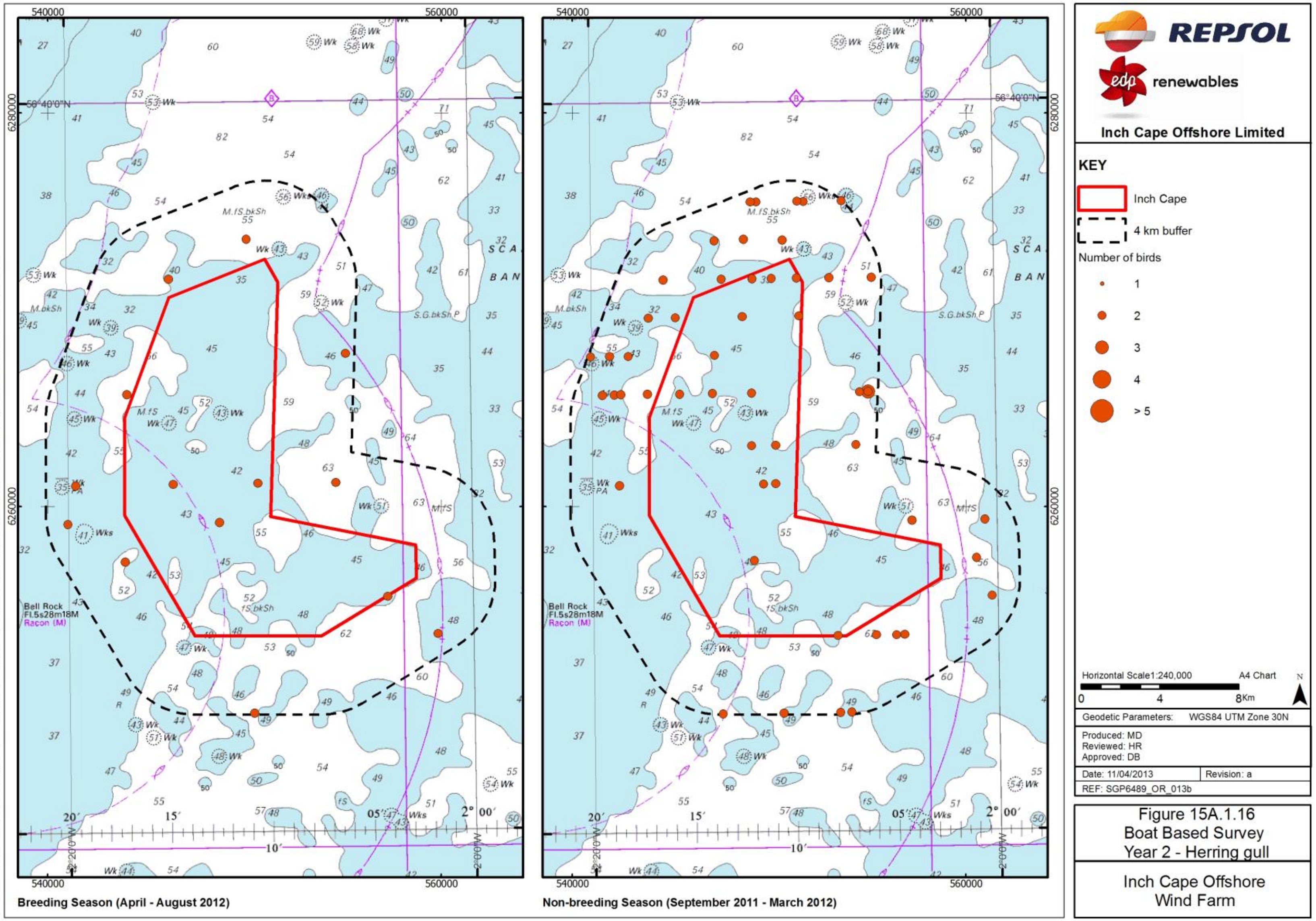


Figure 15A.1.17: Great Black-backed Gull Colonies and Foraging Ranges

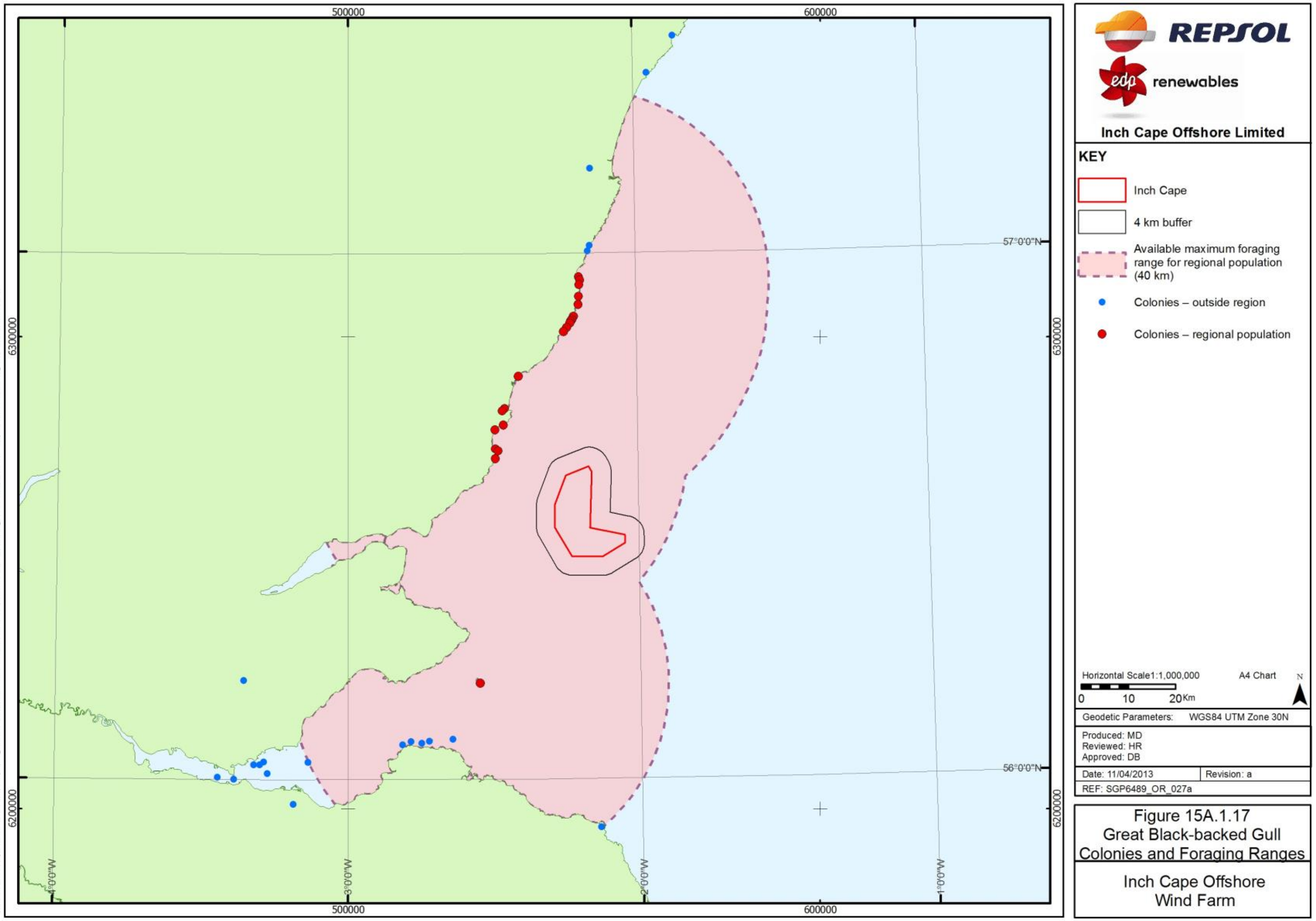


Figure 15A.1.18: Great Black-backed Gull Seasonal Distribution Year 1

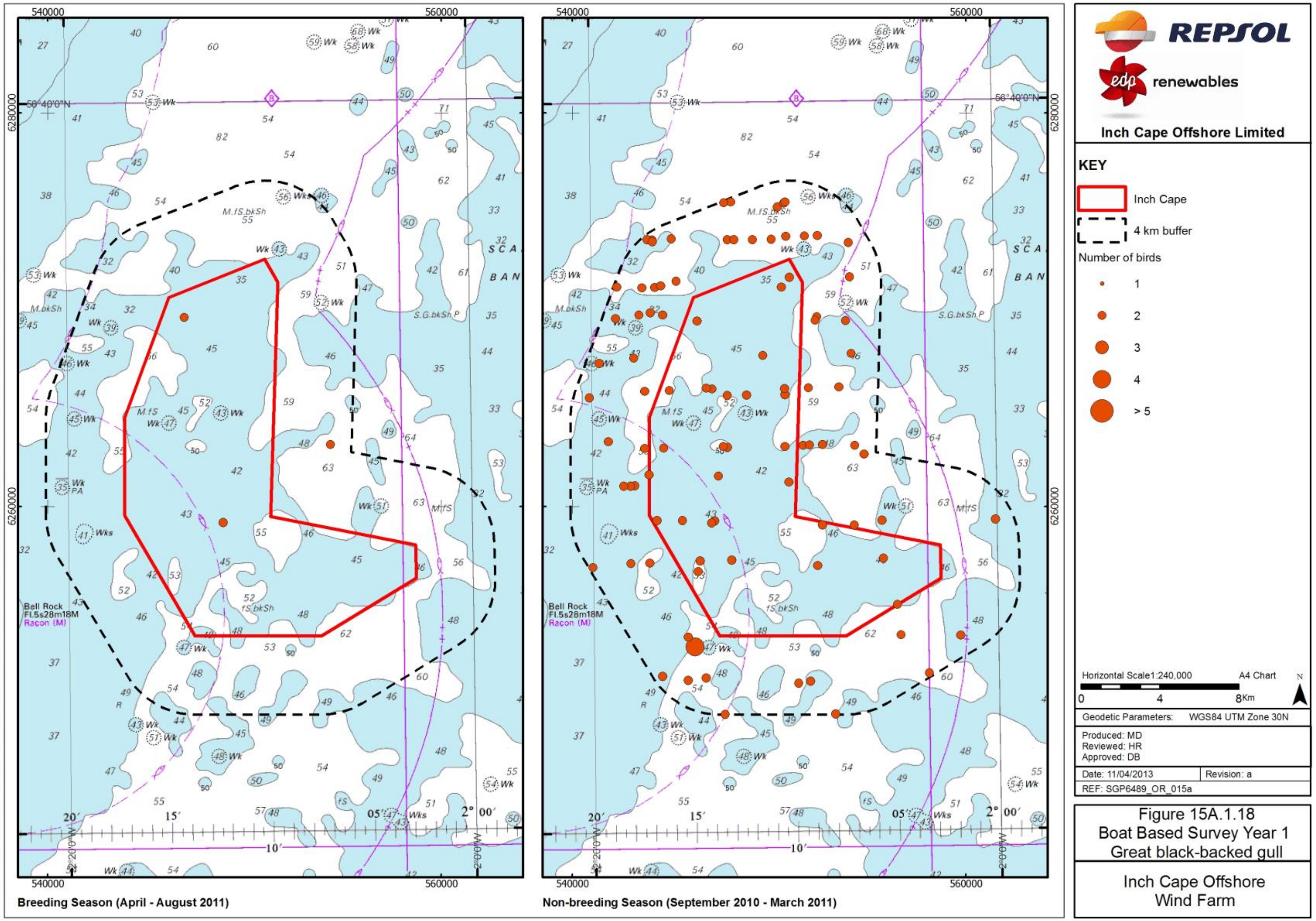


Figure 15A.1.19: Great Back-backed Gull Seasonal Distribution Year 2

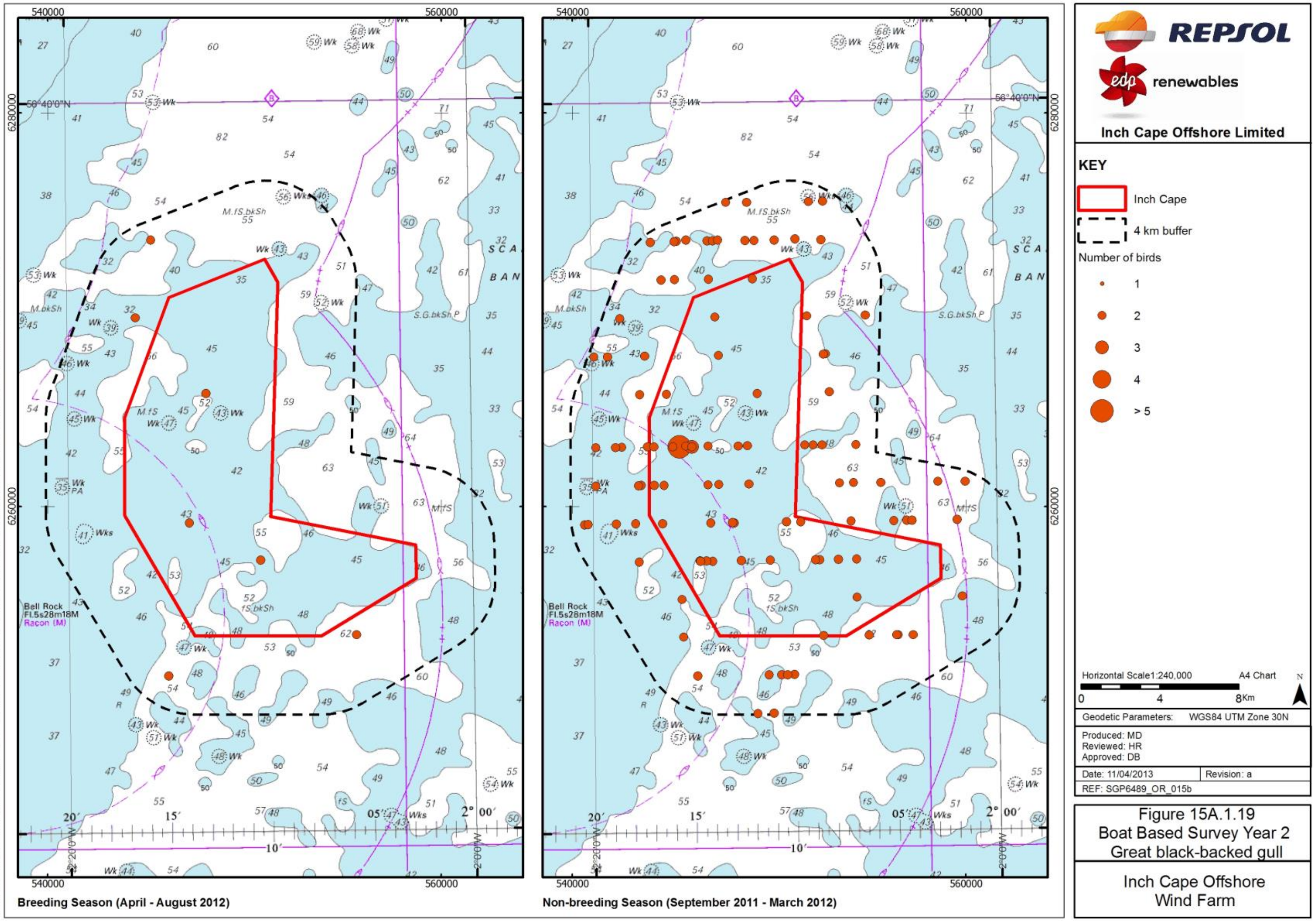


Figure 15A.1.20: Arctic Tern Colonies and Foraging Ranges

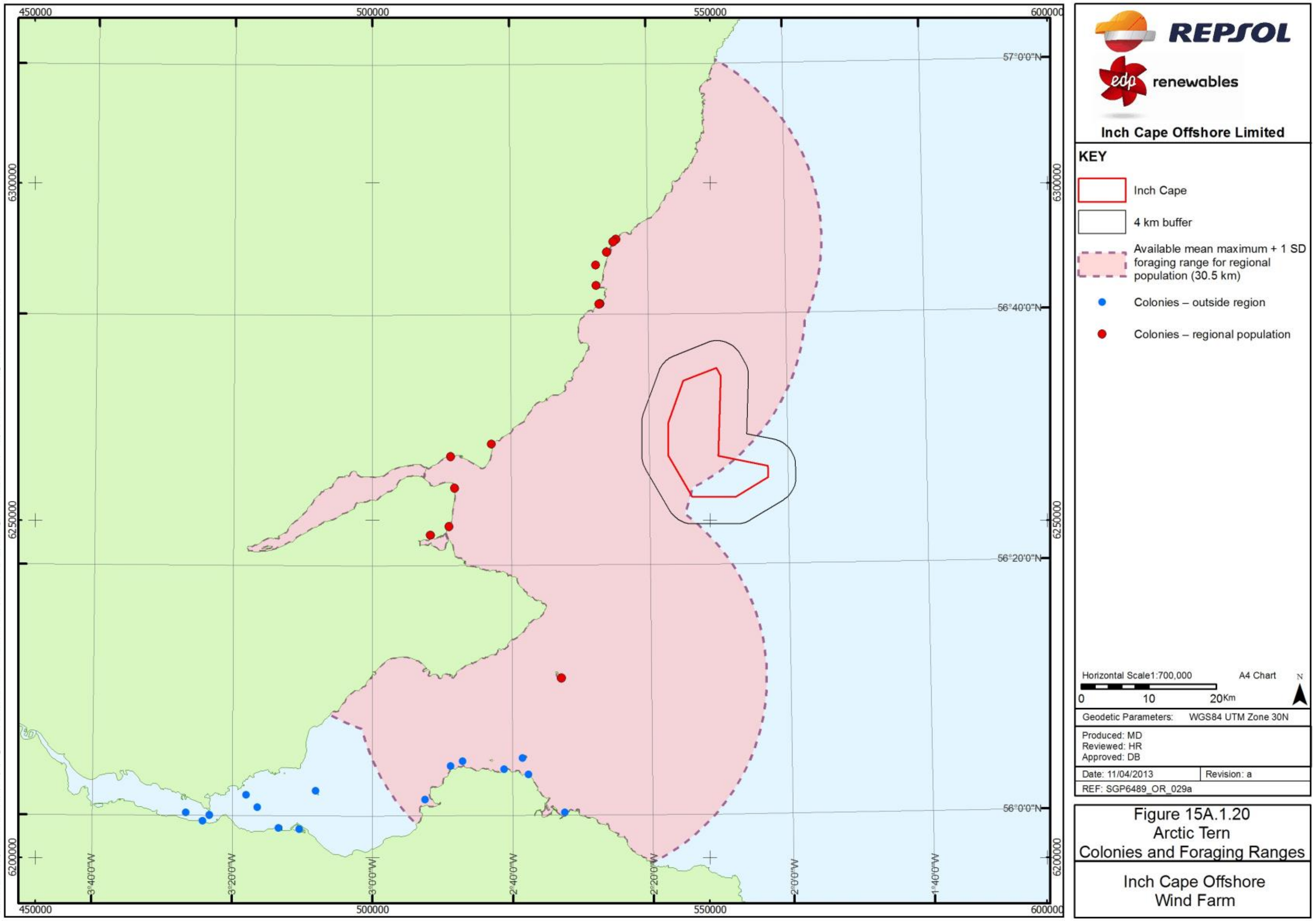


Figure 15A.1.21: Common Tern Colonies and Foraging Ranges

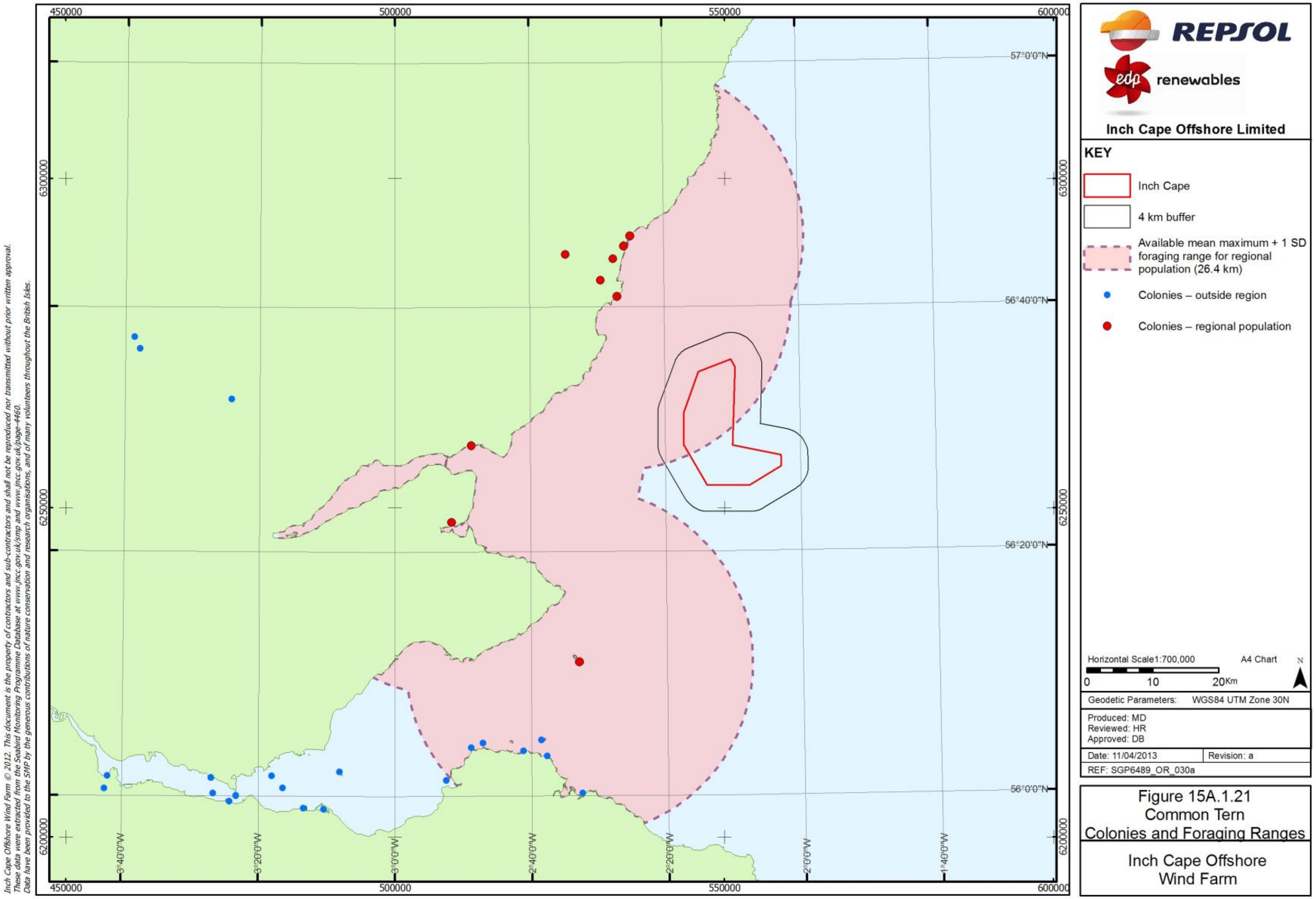


Figure 15A.1.22: Guillemot Colonies and Foraging Ranges

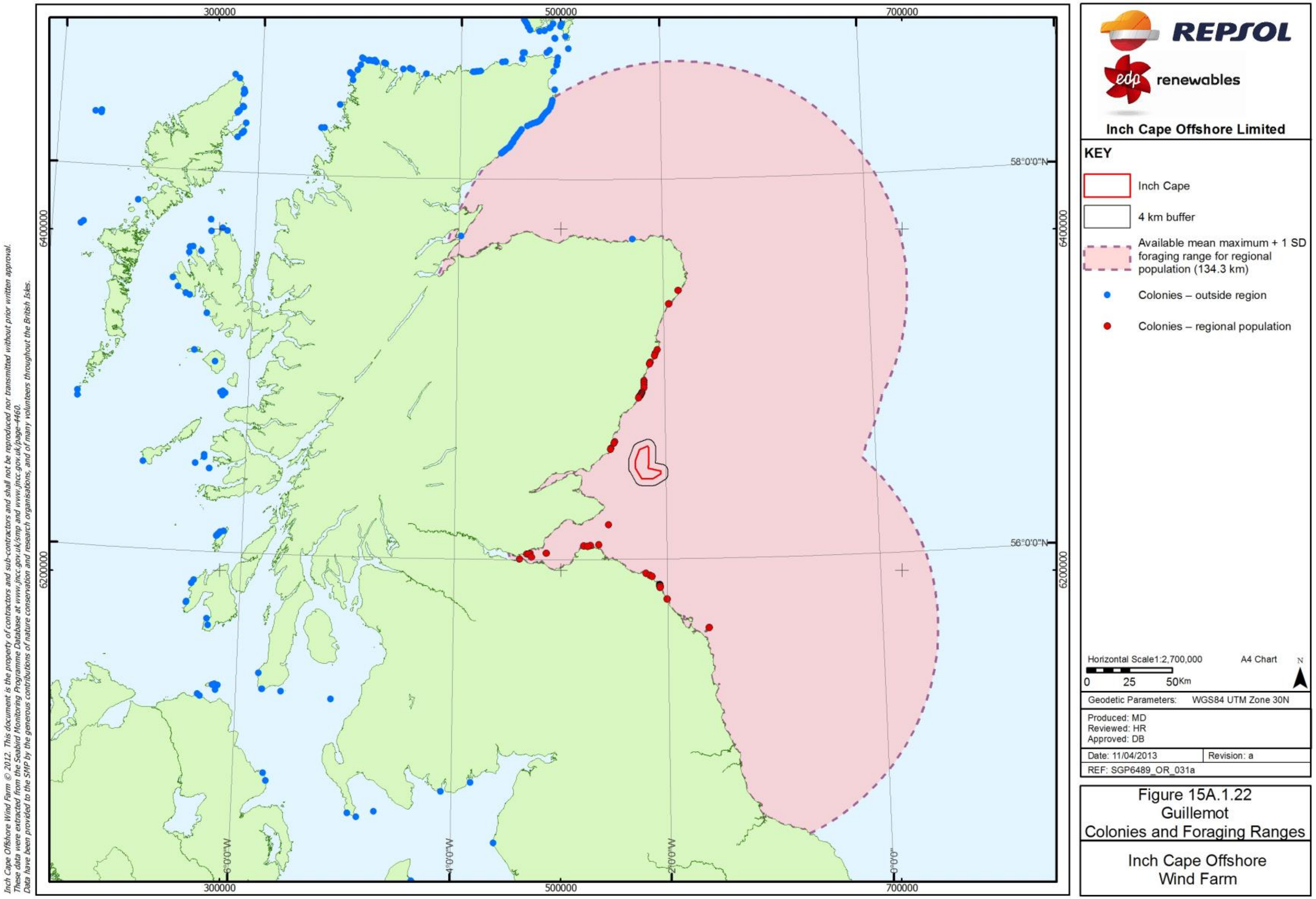


Figure 15A.1.23: Guillemot Seasonal Distribution Year 1

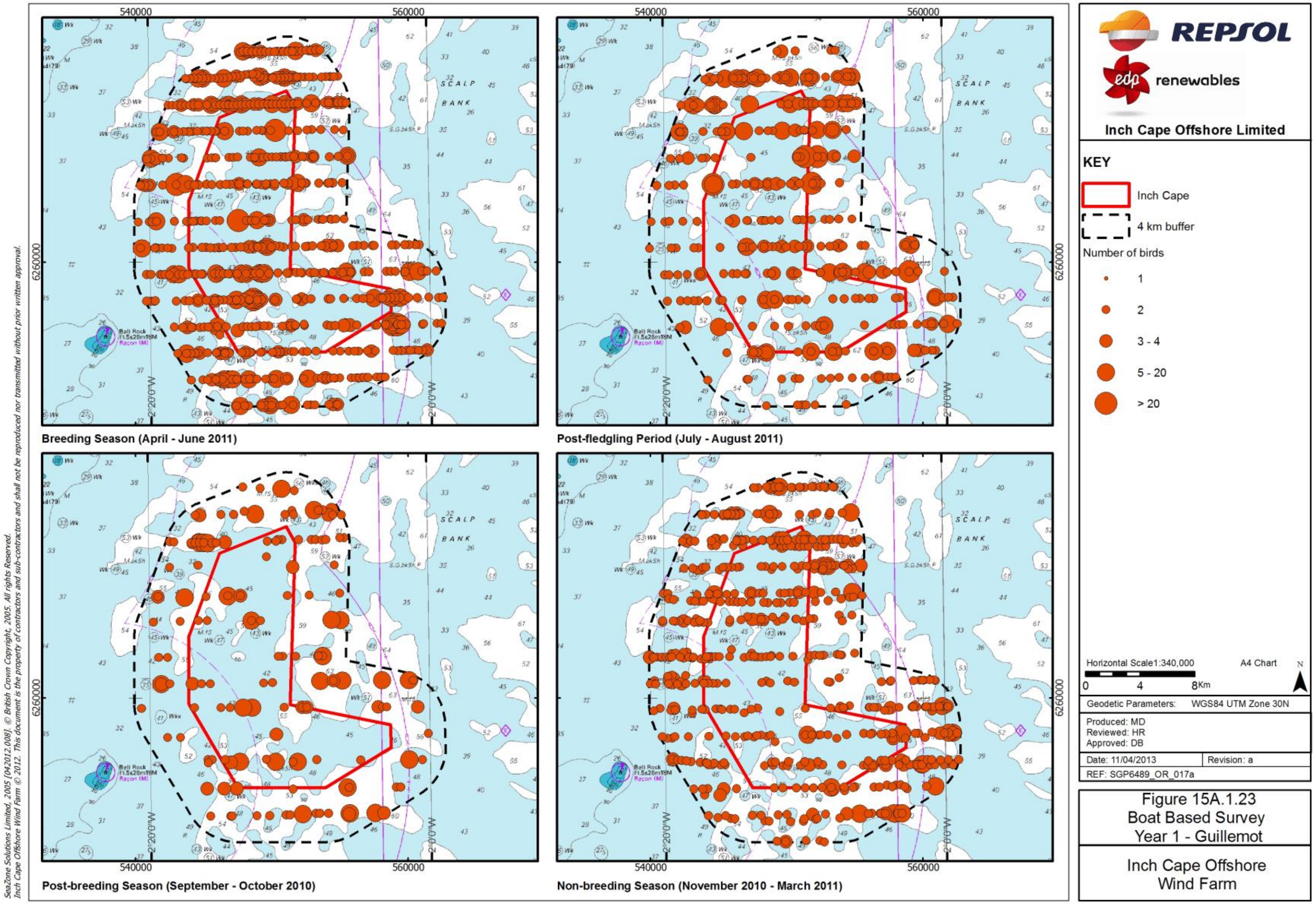


Figure 15A.1.24: Guillemot Seasonal Distribution Year 2

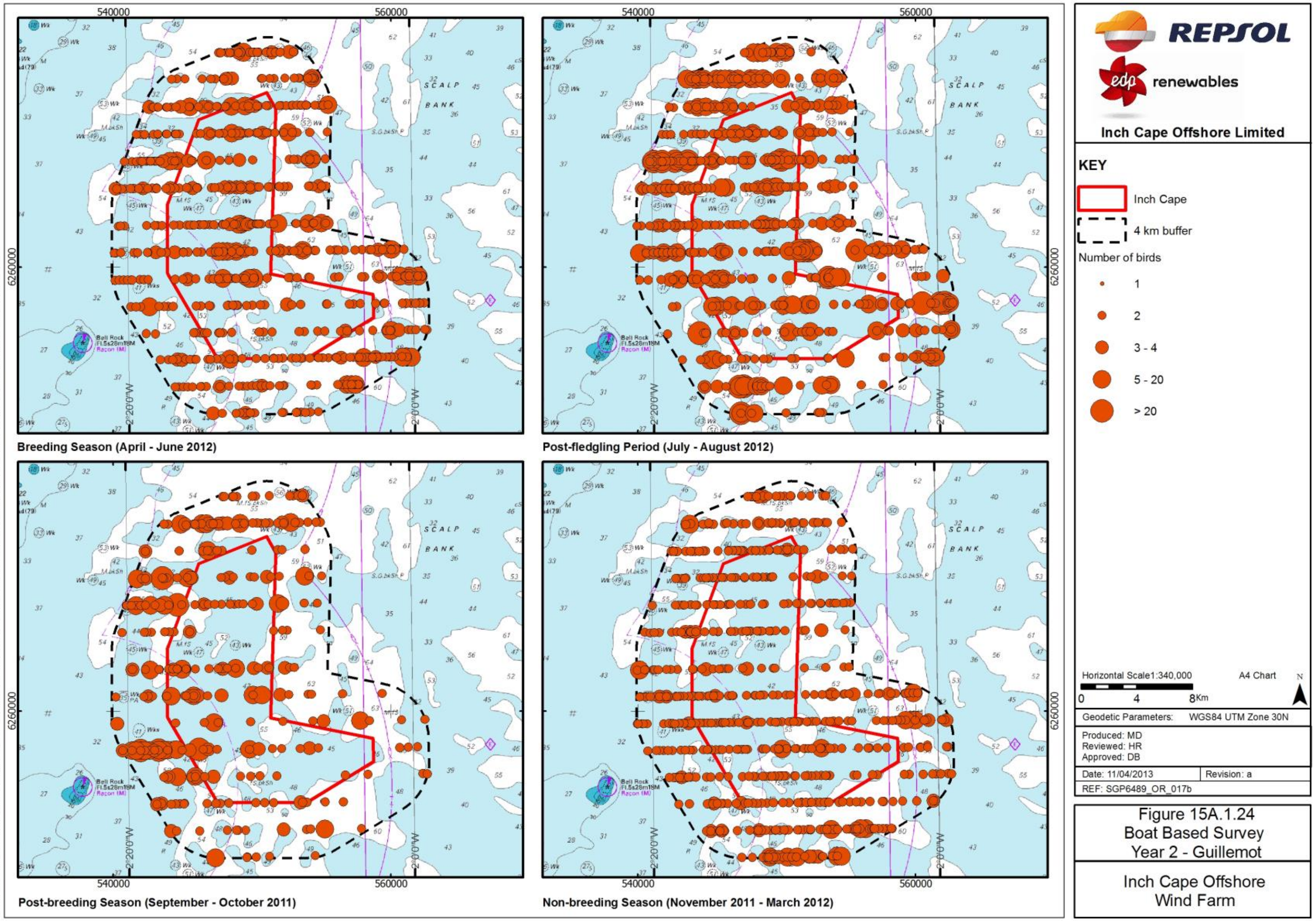


Figure 15A.1.25: Razorbill Colonies and Foraging Ranges

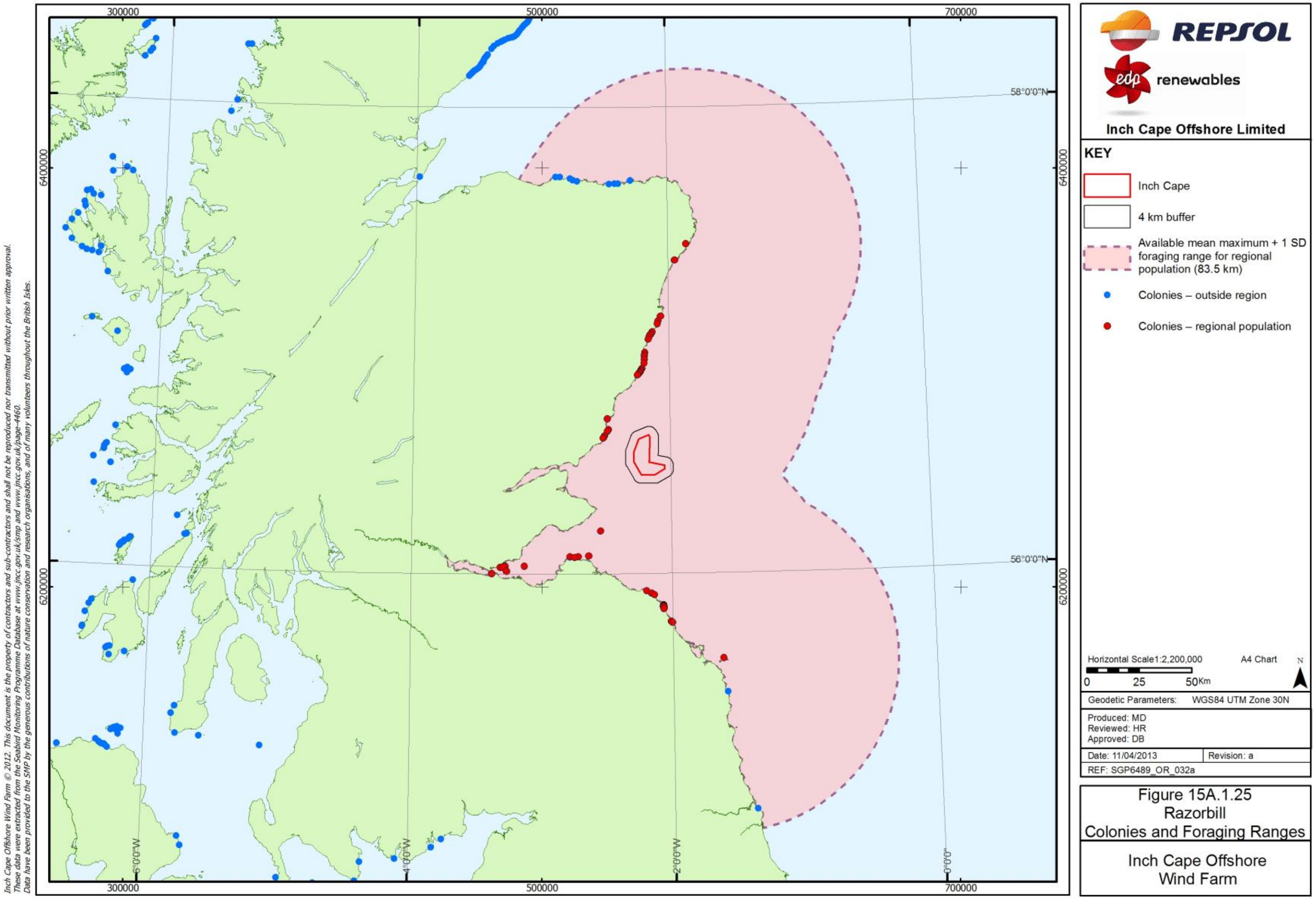


Figure 15A.1.26: Razorbill Seasonal Distribution Year 1

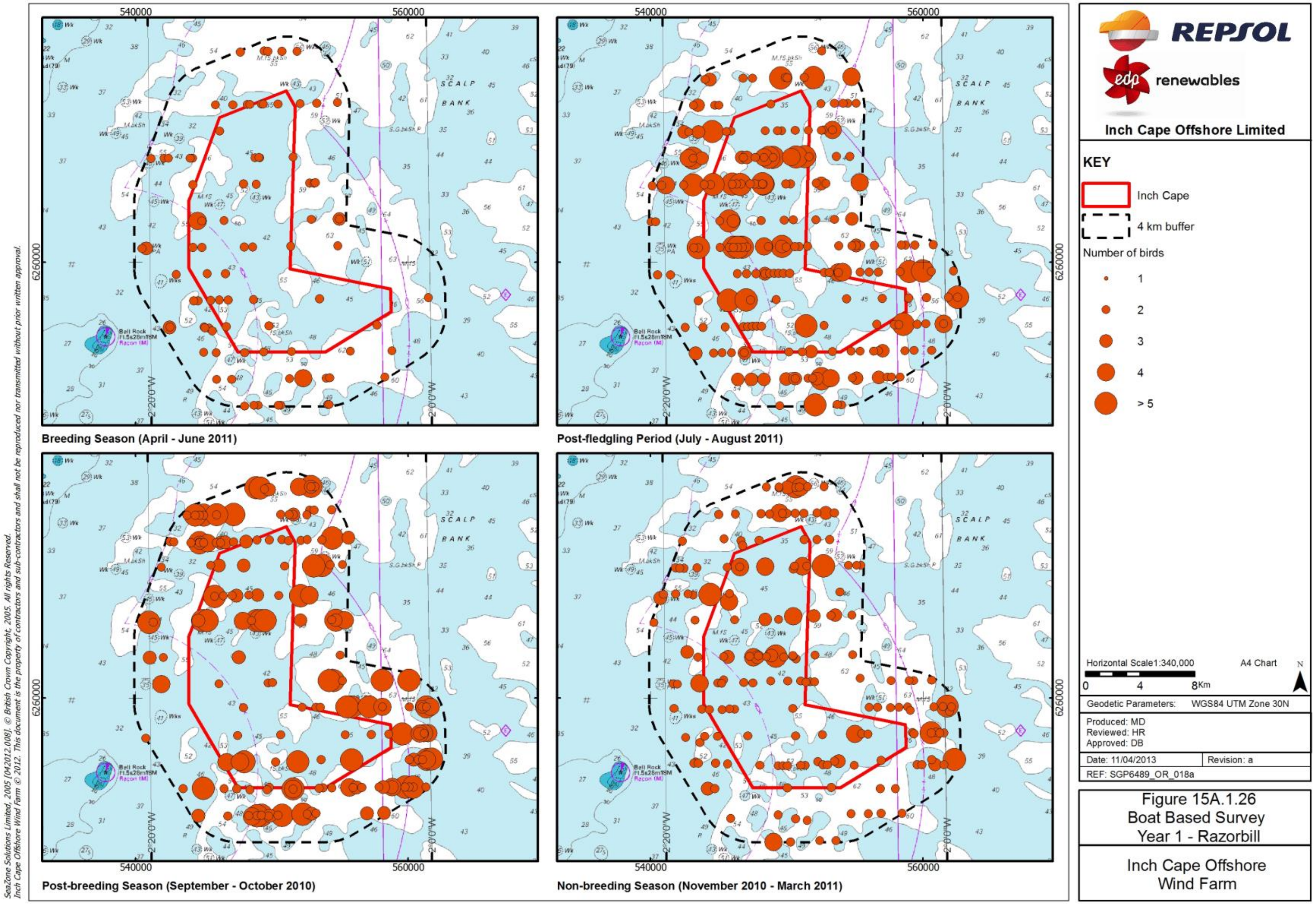


Figure 15A.1.27: Razorbill Seasonal Distribution Year 2

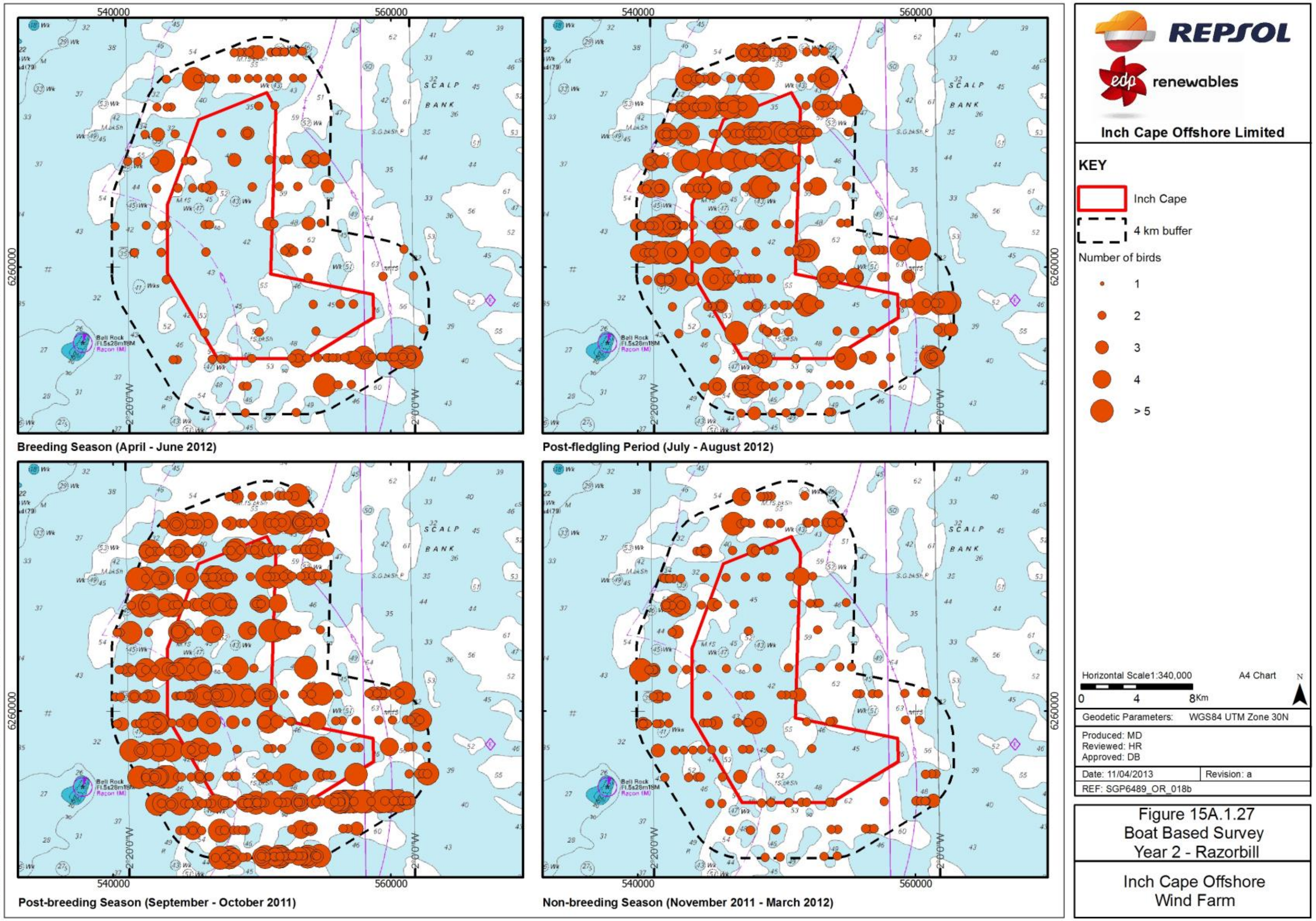


Figure 15A.1.28: Puffin Colonies and Foraging Ranges

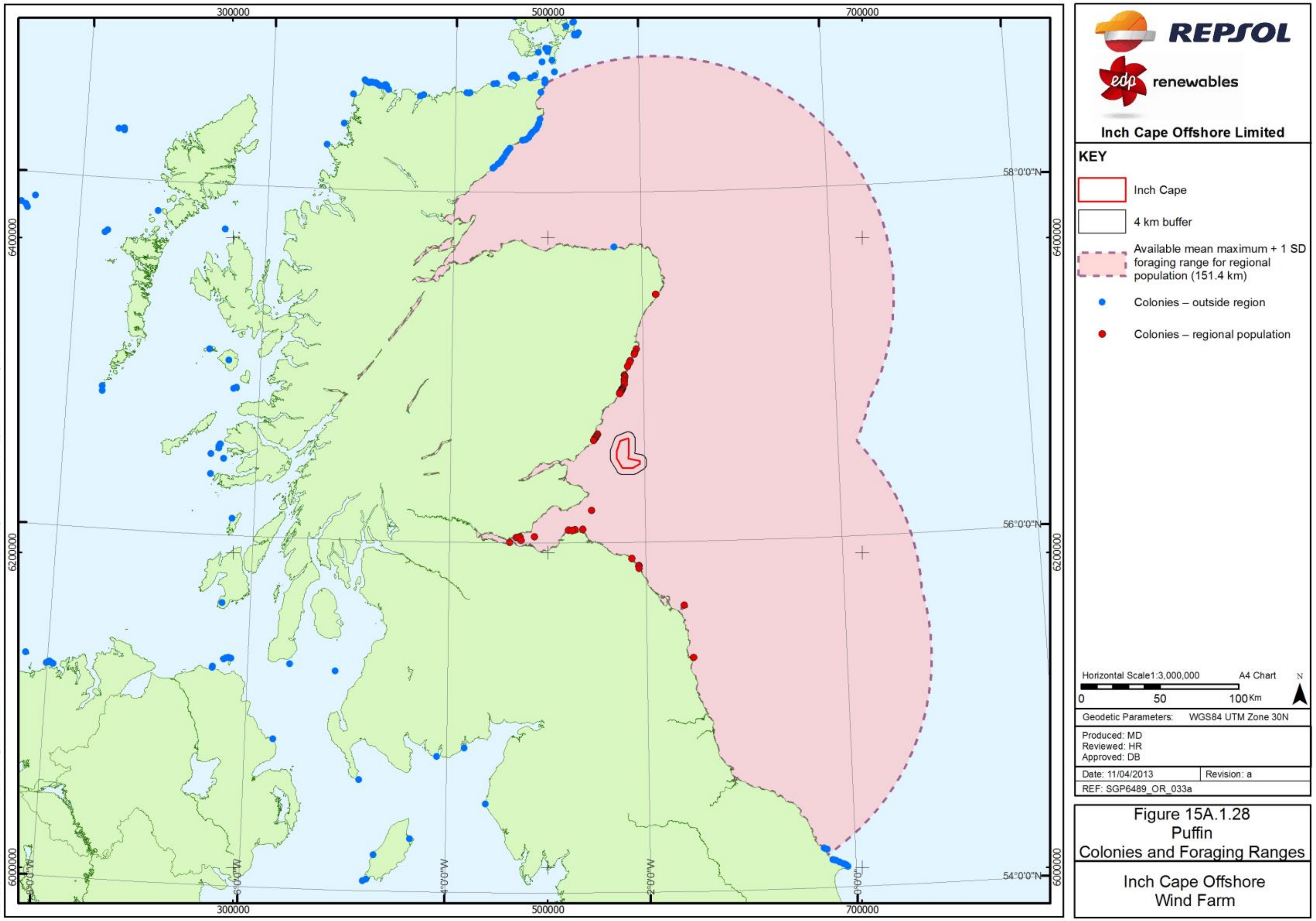


Figure 15A.1.29: Puffin Seasonal Distribution Year 1

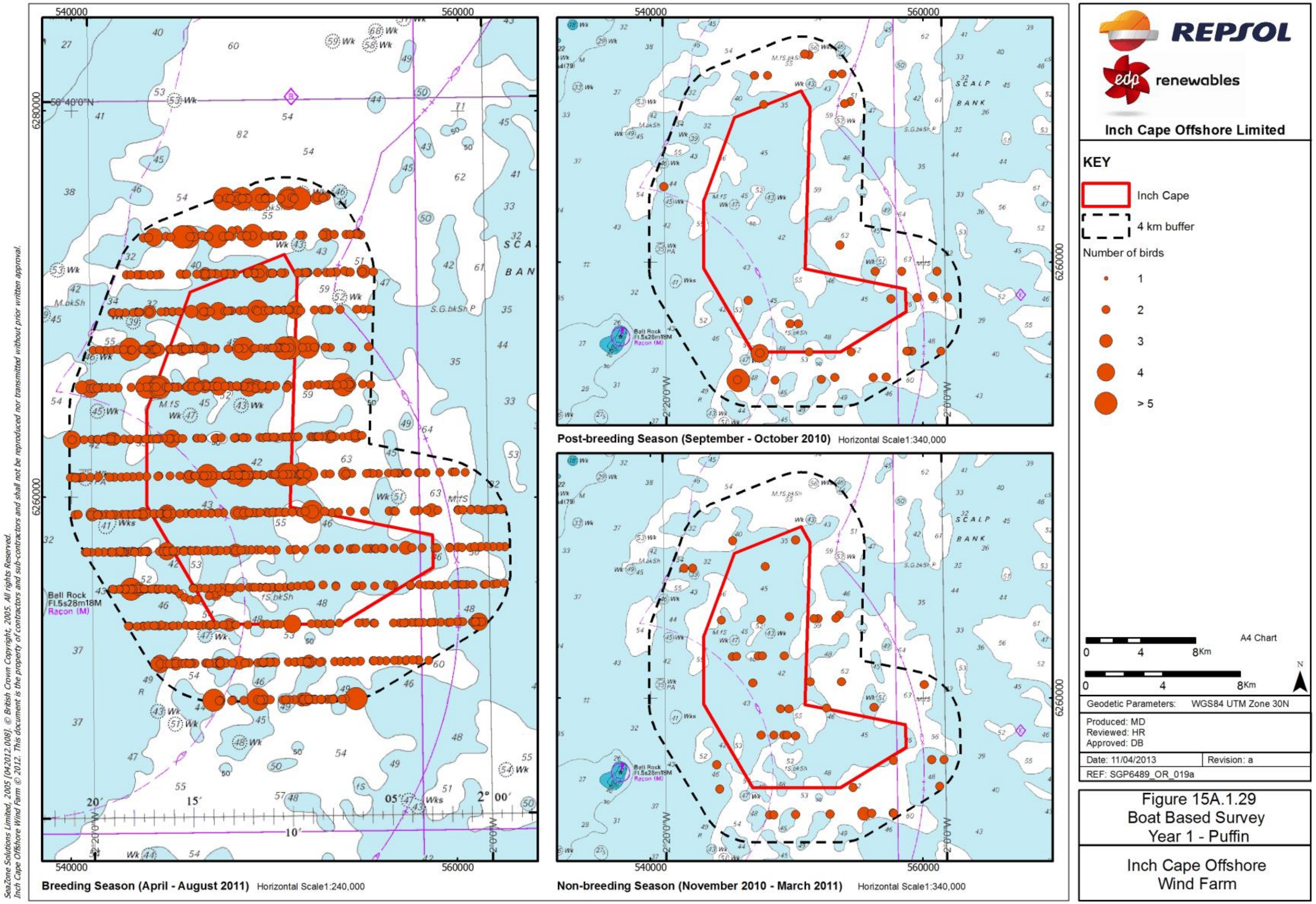


Figure 15A.1.30: Puffin Seasonal Distribution Year 2

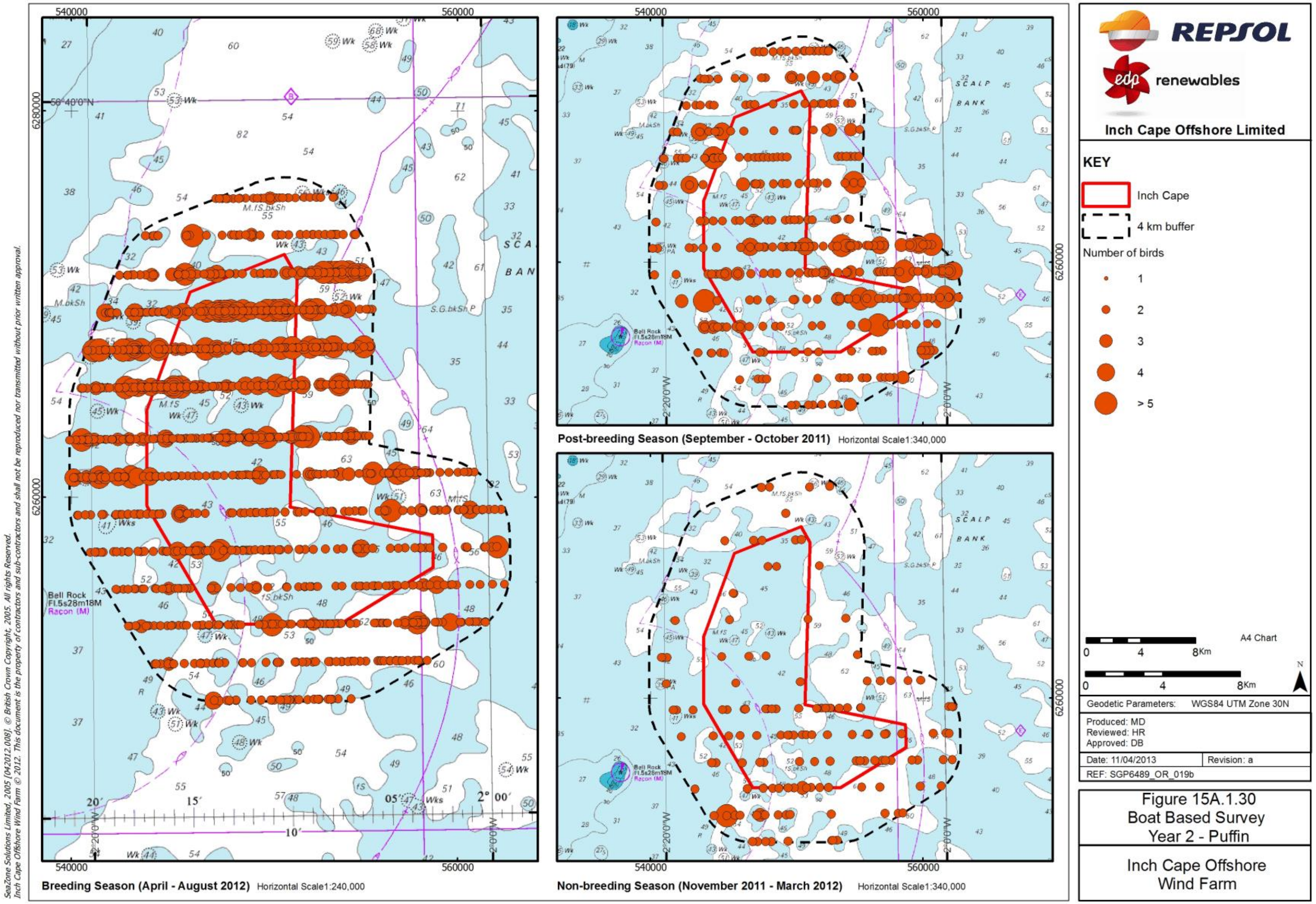
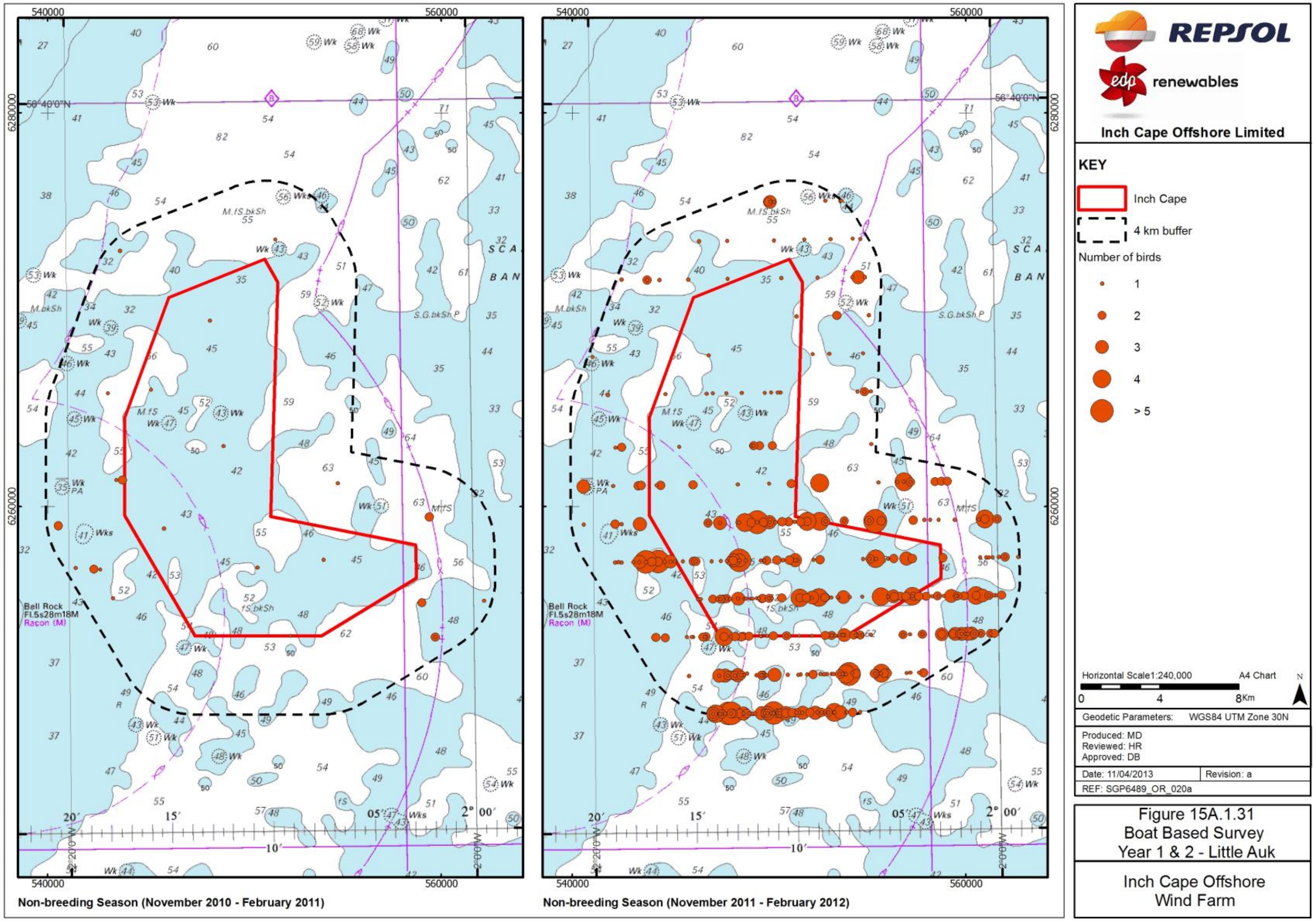


Figure 15A.1.31: Little Auk Seasonal Distribution Year 1 & 2



ANNEX 15A.2: BOAT-BASED SURVEY DATA

Table 15A.2.1 provides an overview of the raw count data collected in the Development Area and the 4 km buffer in Year 1 (September 2010 to August 2011). Note: data includes all observations, regardless of distance from vessel, snapshot status or on/off effort and may at times differ from numbers used in species account text where such considerations have been used to filter the data.

Table 15A.2.1: Monthly Survey Counts for the Inch Cape Development Area and 4 km Buffer for Year 1

Year	2010						2011																
Month	September		October		December		January		February		March		April		May		June		July		August		
Species (BTO code)	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	Total
RH							1																1
MX		8	3	5				1							40	18	2	5	14	7	2	2	107
OT	1	11	29	28																	2	5	76
F.	2	6		2	6	39	16	27	10	17	12	27	6	14	9	10	11	25	3	8	22	29	301
GX	33	268	107	236	1	6	6	35	97	254	113	192	245	509	334	551	238	764	543	800	447	688	6,467
SA										11		6				1							18
BY			14	57																			71
PG					8																		8
SU												1											1
LN						2																	2
E.														3									3
OC																					17	3	20
CU																		3					3
PL			1	1																			2
AC		2	1	4																3			10
NX		2																1		2	1		6
PK			3																				3
KI	2	96	537	746	6	11	15	365	2	14	25	82	24	75	263	159	121	447	400	1,025	258	116	4,789
LU		9	1					5						1					6	14	10	1	47
CM			5	6	15	20	4	3	3	3	2	1			1	2				1		2	68

Table 15A.2.1: Monthly Survey Counts for the Inch Cape Development Area and 4 km Buffer for Year 1																							
Year	**2010**						**2011**																**Total**
Month	**September**		**October**		**December**		**January**		**February**		**March**		**April**		**May**		**June**		**July**		**August**		
Species (BTO code)	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	
HG			4	6	15	32	16	70	2	18	1	12		10		2	9	26					223
LB													1	2	4	10	2	17		1	1	2	40
GB	1	9	12	23	10	25	3	19	3	6	2	4	1			1			1				120
lgu		2	1	101		3		1					1	1									110
gul						1		2															3
AE																1			3	23	156	93	276
CN		9																		3			12
com																						8	8
GU	7	62	115	265	28	126	100	167	20	80	159	320	11	40	186	199	499	1,243	226	790	171	176	4,990
RA	5	64	169	675	20	50	27	34	6	42	62	107	6	27	13	31	18	27	244	364	51	25	2,067
PU	3	25	2	21	1	3			1	2	17	29	19	151	231	358	126	195	114	173	241	296	2,008
LK					3	20	2	4	1	1													31
G/R		15	69	209	1	19	22	85	5	34	25	54		3	3	10		1	204	178	8	16	961
auk				3	5	16	1			1	4	5			6	2	5	94	1	4	1	4	152
FP																	1						1
SI																				1		1	2
SL																						1	1
HM																1							1
MP			2	8									3	2									15
PW				1																			1
C.													1										1
pas										1													1
Total	54	588	1,075	2,397	119	373	213	818	150	484	422	840	318	838	1,090	1,356	1,032	2,848	1,759	3,397	1,388	1,468	23,027

DA: Development Area; BF: 4 km buffer; Species as per BTO code, except: lgu (large gull), gul (unidentified gull), com (common / Arctic tern), G/R (guillemot / razorbill), auk (unidentified auk) and pas (unidentified passerine)

Table 15A.2.2 provides an overview of the raw count data collected in the Development Area and the 4 km buffer in Year 2 (September 2011 to September 2012). Data includes all observations, regardless of distance from vessel, snapshot status or on/off effort.

Table 15A.2.2: Monthly Survey Counts for the Inch Cape Development Area and 4 km Buffer for Year 2

Year	2011								2012																		
Month	September		October		November		December		January		February		March		April		May		June		July		August		September		
Species (BTO Code)	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	Total
RH						2																				3	5
ND						1			1																		2
TM			1	5															1			1				1	9
MX	3	7		2														1		1	2	1	2	2	10	12	43
OT	1	5	2	8																				1	1	3	21
F.	4	12	36	35			9	16	29	55	23	29	21	32	20	45	19	51	11	32	8	13	14	31	22	25	592
GX	205	425	79	184	14	123	6	15	7	19	37	35	33	195	64	136	405	748	440	505	204	896	449	611	177	324	6,336
H.																									1		1
SA								1		2		3				1											7
BY																		3									3
PG									6					70													76
LN														1													1
E.					2																						2
CX										2												1					3
PE																										1	1
GP						2																					2
RP				1									1														2
KN																					3						3
PS						1																					1
DN																							4	1			5
PL		3		1	7	5																					16
AC	1	5	1	1		1																2				1	12
NX	3		4	8	2	4	2	1														1	3	1	1	2	32
PK			4	6	1	9	1																				21
sku				2																							2

Table 15A.2.2: Monthly Survey Counts for the Inch Cape Development Area and 4 km Buffer for Year 2

Year	2011								2012																		
Month	September		October		November		December		January		February		March		April		May		June		July		August		September		
Species (BTO Code)	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	Total
KI	862	976	205	295	46	763	54	113	28	87	3	41	49	90	103	565	125	199	134	191	135	506	26	52	47	93	5,788
LU														1								2	25	15		85	128
CM					1	1	1				1	3	4	2				1		1				1		1	17
HG			1	5	3	4	4	7	2	6	4	7	4	15			2	5		2		6	1	1			79
LB																1		2	1	4	1		1			1	11
GB	9	12	4	6	4	11	18	18	5	16	2	4	6	9		3	2	1			1				1	14	146
lgu								2		1	1	3								1			1				9
gul				1									1	5													7
TE																		1									1
AE																	4	6					2	73		1	86
CN																				1							1
GU	284	743	25	60	57	220	74	108	77	134	26	73	66	190	55	237	112	307	273	349	451	1,399	247	808	28	103	6,506
RA	294	876	189	339	28	46	13	55	10	44	5	21	11	42	22	168	17	60	14	28	237	533	287	350	159	183	4,031
PU	73	229	125	233	29	35	10	26	9	9	1	3	17	33	35	152	250	286	130	216	87	165	476	859	129	172	3,789
TY										1																	1
LK					86	230	117	195	41	99	1	9															778
G/R	289	583	17	65	11	43	26	35	20	27		18	26	121	17	33	6	67	4	17	5	116	18	257	3	2	1,826
auk	57	163	4	14	8	24	1	8	4	5		3	1	41	2		1	2	40		1	6	2	1	2	12	402
WP				1																							1
S.																										1	1
SL	10																										10
MP	51	46																							5		102
FF			8	73																							81
RE			4	1																							5
ST		1	6	1																							8
SG				1	5																						6
pas	3			1																							4

Table 15A.2.2: Monthly Survey Counts for the Inch Cape Development Area and 4 km Buffer for Year 2																											
Year	**2011**								**2012**																		
Month	**September**		**October**		**November**		**December**		**January**		**February**		**March**		**April**		**May**		**June**		**July**		**August**		**September**		
Species (BTO Code)	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**DA**	**BF**	**Total**
Total	2,149	4,086	715	1,349	304	1,525	336	600	239	507	104	252	240	847	318	1,341	943	1,740	1,048	1,348	1,135	3,648	1,558	3,064	586	1,040	31,022

DA: Development Area; BF: 4 km buffer; Species as per BTO code, except: sku (unidentified skua), lgu (large gull), gul (unidentified gull), G/R (guillemot / razorbill), auk (unidentified auk) and pas (unidentified passerine)

Table 15A.2.3 provides an overview of the weather data collected in the Development Area and the 4 km buffer in Year 1 and 2. Data includes observations on wind direction and force, sea state, swell height, glare and precipitation, summarised by survey day (in the field such information was recorded every 15 minutes along a survey transect).

Table 15A.2.3: Summarised Weather Data per Survey Day for the Inch Cape Development Area and 4 km Buffer in Year 1 and 2							
Date	**Wind direction**	**Force (Beaufort)**	**Sea State**	**Swell height (m)**	**Visibility**	**Glare**	**Precipitation**
21/09/2010	SE	3	3-4	1-1.5	4	0	N
22/09/2010	S	4	4	1-1.5	4	0-1	N
23/09/2010	SE	1-4	2-4	1	4	0	N-R
13/10/2010	N	1-2	1-2	1	4	0	N
14/10/2010	NW	1-4	1-3	0-1.5	3-4	0-1	N
15/10/2010	NW	0-3	1-5	0-1	4	0	N
21/12/2010	NE-NW	1-3	2-3	1-1.5	4	0	N
30/12/2010	SE-SW	1	1-2	1	4	0	N-LR
31/12/2010	SW	3	2-3	1	4	0	N
18/01/2011	SW	2-4	3-4	1	4	0-1	N
19/01/2011	SW	2-3	3	1	4	0	N
20/01/2011	W	2	2-3	1	4	0	N
22/02/2011	SW	2-3	2-3	2	4	0	N
27/02/2011	W	2-4	2-4	1	3-4	0	N-LR
04/03/2011	W-none	0-2	0-2	0	4	0	N

Table 15A.2.3: Summarised Weather Data per Survey Day for the Inch Cape Development Area and 4 km Buffer in Year 1 and 2							
Date	Wind direction	Force (Beaufort)	Sea State	Swell height (m)	Visibility	Glare	Precipitation
05/03/2011	NE	2-4	2-4	1	4	0-1	N
14/04/2011	S	2	2-3	1	4	0-1	N
15/04/2011	SW-SE	1-3	1-3	0-1	4	0-1	N
03/06/2011	S-SE	1-4	1-4	0-1	4	0-3	N
19/06/2011	NE-SW	1-4	1-4	1-2	4	0	N-R
20/06/2011	S	1	1	N	3-4	0	L-N
10/07/2011	SW-NE	1-3	1-3	1	4	0-2	N-R
11/07/2011	NE	2-3	2-3	1	4	0	N-R
03/08/2011	None	0	0-1	0.5	2	0	N
05/08/2011	SW	2-4	2-4	0.5-1	4	0-3	N
29/09/2011	S	2-4	2-4	1	4	0-1	N
30/09/2011	S	1-4	1-4	0	4	0-1	N
12/10/2011	NE-E	1-3	1-3	1	4	0	N-R
13/10/2011	SE	3-4	3-4	1	4	0	N
05/11/2011	N-SW	1-3	2-4	1-1.5	4	0	N
06/11/2011	S-SW	2-3	2-4	1	4	0	N
15/12/2011	SW	3-4	3-4	1	4	0	N
16/12/2011	NE	3-5	3-5	1	4	0	LR-N
19/12/2011	S-SW	3-5	3-4	1-1.5	3-4	0	N-LR
21/12/2011	S	3-4	3-4	1	3	0	LR-N
13/01/2012	NW-S	1-3	2-4	1-3	4	0	N
14/01/2012	SW-S	2	2-3	1-3	4	0	N
15/01/2012	S	1	2	1	4	0	N
02/02/2012	SW	3-4	3-4	0.5	4	0	N
03/02/2012	SW	3-4	3-4	0.5-1	4	0	N
11/03/2012	S	4	4	1	4	0	N
12/03/2012	SW	1-3	1-3	0-0.5	4	0	N
13/03/2012	SW	2-3	2-3	0-0.5	4	0	N
07/04/2012	N-SW	2-3	1-3	1	4	0	N-LR
08/04/2012	SW	2-3	2-3	0.5	4	0-2	N

Table 15A.2.3: Summarised Weather Data per Survey Day for the Inch Cape Development Area and 4 km Buffer in Year 1 and 2							
Date	**Wind direction**	**Force (Beaufort)**	**Sea State**	**Swell height (m)**	**Visibility**	**Glare**	**Precipitation**
06/05/2012	NE-SE	1-4	0-4	1	4	0-2	LR-N
05/06/2012	E-SE	1-4	1-4	0.5-1	4	0-3	N-R
10/07/2012	N	1-3	1-3	1-2	4	0	N-R
07/08/2012	None - SW	0-2	0-2	0-0.5	3-4	0-1	N-LR
08/08/2012	NE	2	2-3	1	4	0-1	N
20/09/2012	SW	1-3	0-3	0.5	4	0	N-R
Wind direction recorded in 8 ordinal directions; wind force recorded in Beaufort; sea state recorded as per ESAS notation; visibility coded from 1 (poor or < 1km) to 4 (excellent, clear to the horizon) as per ESAS notation; glare coded from 0 (no glare) to 3 (heavy glare); precipitation (N: no rain, LR: light rain, R: rain)							

ANNEX 15A.3: SEABIRD POPULATION ESTIMATES

Population Estimates

Tables 15A.3.1 to 15A.3.11 contain population estimates derived through distance sampling (fulmar, gannet, kittiwake, guillemot, razorbill, puffin, little auk) and extrapolation (Manx shearwater, herring gull, great black-backed gull, Arctic tern). Estimates (labelled N) are provided for birds on the sea surface and in flight separately. Confidence intervals (LCI - lower, UCI - upper) for birds on the water are shown for those species analysed with Distance software. Abbreviations DA and BF stand for Development Area (DA) and 4 km buffer zone (BF) respectively.

Table 15A.3.1 Fulmar Population Estimates for the Inch Cape Development Area and 4 km Buffer zone

Survey month	Area	Birds on sea surface			Birds in flight	Total
		N	LCI	UCI	N	
Sep-10	DA	0	-	-	0	0
	BF	0	-	-	0	0
Oct-10	DA	0	-	-	0	0
	BF	0	-	-	0	0
Dec-10	DA	0	-	-	15	15
	BF	100	50	200	66	166
Jan-11	DA	0	-	-	60	60
	BF	11	2	64	36	47
Feb-11	DA	11	2	66	7	18
	BF	11	2	64	27	38
Mar-11	DA	22	5	86	0	22
	BF	22	6	84	20	42
Apr-11	DA	0	-	-	8	8
	BF	0	-	-	22	22
May-11	DA	22	6	78	23	45
	BF	0	-	-	15	15
Jun-11	DA	0	-	-	44	44
	BF	11	2	67	21	32
Jul-11	DA	0	-	-	15	15
	BF	11	2	69	21	32
Aug-11	DA	11	2	64	44	55
	BF	33	11	98	27	60
Sep-11	DA	11	2	73	15	26
	BF	44	19	106	7	51
Oct-11	DA	33	7	143	53	86
	BF	33	12	90	63	96
Nov-11	DA	0	-	-	0	0
	BF	0	-	-	0	0
Dec-11	DA	0	-	-	37	37
	BF	11	2	64	21	32
Jan-12	DA	65	12	351	106	171
	BF	111	38	324	97	208
Feb-12	DA	22	5	90	36	58
	BF	0	-	-	27	27
Mar-12	DA	43	20	93	22	65
	BF	11	2	69	41	52
Apr-12	DA	0	-	-	43	43
	BF	22	6	83	81	103
May-12	DA	11	2	73	15	26
	BF	44	13	148	69	113
Jun-12	DA	11	2	75	22	33
	BF	0	-	-	41	41
Jul-12	DA	0	-	-	14	14
	BF	11	2	67	7	18

Table 15A.3.1 Fulmar Population Estimates for the Inch Cape Development Area and 4 km Buffer zone						
Survey month	Area	Birds on sea surface			Birds in flight	Total
		N	LCI	UCI	N	
Aug-12	DA	33	10	104	29	62
	BF	67	28	159	54	121
Sep-12	DA	11	2	72	22	33
	BF	11	2	64	76	87

Table 15A.3.2 Gannet Population Estimates for the Inch Cape Development Area and 4 km Buffer zone						
Survey month	Area	Birds on sea surface			Birds in flight	Total
		N	LCI	UCI	N	
Sep-10	DA	0	-	-	132	132
	BF	104	26	414	517	621
Oct-10	DA	78	20	303	182	260
	BF	180	83	393	272	452
Dec-10	DA	0	-	-	0	0
	BF	10	2	61	20	30
Jan-11	DA	0	-	-	15	15
	BF	0	-	-	22	22
Feb-11	DA	0	-	-	58	58
	BF	0	-	-	183	183
Mar-11	DA	10	1	65	106	116
	BF	10	2	60	222	232
Apr-11	DA	39	12	123	508	547
	BF	150	70	323	630	780
May-11	DA	196	64	600	512	708
	BF	240	142	407	1,126	1,366
Jun-11	DA	59	31	113	453	512
	BF	431	254	730	847	1,278
Jul-11	DA	137	66	283	807	944
	BF	200	108	372	1,919	2,119
Aug-11	DA	137	55	344	1,023	1,160
	BF	340	207	561	1,032	1,372
Sep-11	DA	117	62	222	326	443
	BF	290	169	499	864	1,154
Oct-11	DA	20	5	80	129	149
	BF	190	80	451	355	545
Nov-11	DA	0	-	-	29	29
	BF	70	31	160	142	212
Dec-11	DA	0	-	-	0	0
	BF	10	2	60	49	59
Jan-12	DA	0	-	-	30	30
	BF	10	2	58	28	38
Feb-12	DA	0	-	-	108	108
	BF	20	5	74	54	74
Mar-12	DA	10	2	60	67	77
	BF	10	2	62	456	466
Apr-12	DA	10	2	57	144	154
	BF	50	15	171	346	396
May-12	DA	88	38	202	785	873
	BF	170	78	371	1,551	1,721
Jun-12	DA	372	158	877	679	1,051
	BF	110	57	214	601	711
Jul-12	DA	10	1	66	281	291
	BF	80	41	156	1,362	1,442
Aug-12	DA	137	54	345	516	653
	BF	170	90	322	684	854
Sep-12	DA	117	46	302	222	339
	BF	150	63	358	620	770

Table 15A.3.3 Kittiwake Population Estimates for the Inch Cape Development Area and 4 km Buffer Zone						
Survey month	Area	Birds on sea surface			Birds in flight	Total
		N	LCI	UCI	N	
Sep-10	DA	0	-	-	26	26
	BF	441	106	1,842	109	550
Oct-10	DA	912	481	1,729	235	1,147
	BF	2,121	1,205	3,731	307	2,428
Dec-10	DA	0	-	-	15	15
	BF	170	47	615	13	183
Jan-11	DA	166	24	1,129	30	196
	BF	679	182	2,536	181	860
Feb-11	DA	83	14	507	0	83
	BF	170	45	646	20	190
Mar-11	DA	83	14	487	21	104
	BF	170	44	648	141	311
Apr-11	DA	249	37	1,694	47	296
	BF	594	198	1,782	116	710
May-11	DA	1,078	426	2,727	75	1,153
	BF	848	311	2,314	552	1,400
Jun-11	DA	995	317	3,128	446	1,441
	BF	2,205	1,254	3,880	1,323	3,528
Jul-11	DA	1,493	826	2,696	851	2,344
	BF	1,696	831	3,462	4,213	5,909
Aug-11	DA	459	165	1,277	102	561
	BF	254	85	758	94	348
Sep-11	DA	166	41	676	940	1,106
	BF	509	195	1,330	1,485	1,994
Oct-11	DA	0	0	0	242	242
	BF	254	63	1,024	411	665
Nov-11	DA	166	40	687	94	260
	BF	339	131	880	2,607	2,946
Dec-11	DA	249	56	1,113	90	339
	BF	339	140	821	319	658
Jan-12	DA	249	37	1,661	30	279
	BF	1,272	376	4,310	97	1,369
Feb-12	DA	0	0	0	14	14
	BF	679	130	3,541	54	733
Mar-12	DA	580	186	1,815	149	729
	BF	679	188	2,443	95	774
Apr-12	DA	0	-	-	136	136
	BF	1,527	560	4,164	964	2,491
May-12	DA	1,327	562	3,131	176	1,503
	BF	1,103	620	1,960	317	1,420
Jun-12	DA	1,741	650	4,663	153	1,894
	BF	1,527	741	3,146	212	1,739
Jul-12	DA	249	54	1,140	252	501
	BF	2,121	1,008	4,460	526	2,647
Aug-12	DA	415	150	1,143	44	459
	BF	933	453	1,923	74	1,007
Sep-12	DA	83	12	554	155	238
	BF	594	228	1,543	62	656

Table 15A.3.4 Guillemot Population Estimates for the Inch Cape Development Area and 4 km Buffer Zone						
Survey month	**Area**	**Birds on sea surface**			**Birds in flight**	**Total**
		N	**LCI**	**UCI**	**N**	
Sep-10	DA	421	55	3,220	0	421
	BF	1,168	539	2,532	27	1,195
Oct-10	DA	827	461	1,482	8	835
	BF	2,303	1,569	3,382	140	2,443
Dec-10	DA	275	108	701	7	282
	BF	1,573	969	2,552	86	1,659
Jan-11	DA	796	398	1,592	90	886
	BF	1,966	1,047	3,693	173	2,139
Feb-11	DA	329	173	627	15	344
	BF	1,264	726	2,202	47	1,311
Mar-11	DA	1,730	1,040	2,876	78	1,808
	BF	2,753	1,707	4,439	276	3,029
Apr-11	DA	137	37	513	0	137
	BF	506	324	790	36	542
May-11	DA	1,428	1,003	2,033	38	1,466
	BF	2,612	1,855	3,678	36	2,648
Jun-11	DA	4,421	2,824	6,919	124	4,545
	BF	11,657	7,390	18,388	140	11,797
Jul-11	DA	2,306	1,310	4,060	90	2,396
	BF	4,410	3,512	5,537	156	4,566
Aug-11	DA	769	469	1,261	0	769
	BF	843	436	1,627	0	843
Sep-11	DA	2,210	1,364	3,581	0	2,210
	BF	5,281	3,317	8,406	21	5,302
Oct-11	DA	165	53	514	15	180
	BF	655	416	1,031	28	683
Nov-11	DA	741	373	1,474	36	777
	BF	2,275	1,702	3,042	108	2,383
Dec-11	DA	412	196	863	194	606
	BF	1,689	1,255	2,275	28	1,717
Jan-12	DA	933	476	1,828	53	986
	BF	1,629	1,025	2,588	104	1,733
Feb-12	DA	412	184	924	7	419
	BF	786	590	1,048	41	827
Mar-12	DA	796	494	1,283	22	818
	BF	1,124	649	1,944	95	1,219
Apr-12	DA	467	147	1,479	65	532
	BF	1,433	929	2,210	156	1,589
May-12	DA	1,263	673	2,369	7	1,270
	BF	2,921	1,878	4,544	124	3,045
Jun-12	DA	2,828	1,626	4,918	15	2,843
	BF	4,747	3,659	6,158	82	4,829
Jul-12	DA	3,542	2,416	5,194	7	3,549
	BF	6,292	4,779	8,284	20	6,312
Aug-12	DA	2,883	1,522	5,461	0	2,883
	BF	7,191	4,178	12,377	0	7,191
Sep-12	DA	467	136	1,607	0	467
	BF	2,050	998	4,215	7	2,057

Table 15A.3.5 Razorbill Population Estimates for the Inch Cape Development Area and 4 km Buffer Zone

Survey month	Area	Birds on sea surface			Birds in flight	Total
		N	LCI	UCI	N	
Sep-10	DA	321	23	4,423	0	321
	BF	975	360	2,643	95	1,070
Oct-10	DA	1,137	575	2,251	8	1,145
	BF	3,528	2,553	4,877	133	3,661
Dec-10	DA	183	36	925	15	198
	BF	821	463	1,458	0	821
Jan-11	DA	491	144	1,676	37	528
	BF	240	94	614	51	291
Feb-11	DA	37	5	245	7	44
	BF	245	86	699	34	279
Mar-11	DA	734	422	1,276	28	762
	BF	938	438	2,009	94	1,032
Apr-11	DA	110	32	384	0	110
	BF	225	112	454	7	232
May-11	DA	183	83	405	15	198
	BF	338	128	889	15	353
Jun-11	DA	367	173	778	0	367
	BF	526	234	1,182	14	540
Jul-11	DA	2,679	1,560	4,600	7	2,686
	BF	4,129	3,273	5,209	64	4,193
Aug-11	DA	294	101	850	7	301
	BF	450	206	987	0	450
Sep-11	DA	3,119	1,957	4,970	44	3,163
	BF	8,070	5,430	11,995	314	8,384
Oct-11	DA	347	125	960	91	438
	BF	1,051	661	1,671	411	1,462
Nov-11	DA	294	178	485	87	381
	BF	450	237	857	20	470
Dec-11	DA	73	18	307	30	103
	BF	563	281	1,127	21	584
Jan-12	DA	110	25	481	8	118
	BF	300	123	730	42	342
Feb-12	DA	73	11	499	0	73
	BF	307	150	629	20	327
Mar-12	DA	89	13	609	7	96
	BF	413	170	1,001	20	433
Apr-12	DA	257	97	682	36	293
	BF	879	314	2,464	197	1,076
May-12	DA	330	135	810	15	345
	BF	601	320	1,126	41	642
Jun-12	DA	183	80	419	22	205
	BF	326	182	583	7	333
Jul-12	DA	2,495	1,371	4,543	0	2,495
	BF	4,880	3,832	6,214	34	4,914
Aug-12	DA	2,053	753	5,597	0	2,053
	BF	4,091	2,351	7,119	0	4,091
Sep-12	DA	1,798	802	4,032	15	1,813
	BF	2,440	1,571	3,789	14	2,454

Table 15A.3.6 Puffin Population Estimates for the Inch Cape Development Area and 4 km Buffer Zone						
Survey month	**Area**	**Birds on sea surface**			**Birds in flight**	**Total**
		N	**LCI**	**UCI**	**N**	
Sep-10	DA	138	23	832	0	138
	BF	710	398	1,264	0	710
Oct-10	DA	42	7	247	0	42
	BF	280	150	523	35	315
Dec-10	DA	21	3	142	0	21
	BF	65	22	188	0	65
Jan-11	DA	0	-	-	0	0
	BF	0	-	-	0	0
Feb-11	DA	0	-	-	0	0
	BF	0	-	-	0	0
Mar-11	DA	295	145	600	0	295
	BF	216	104	447	20	236
Apr-11	DA	147	87	249	8	155
	BF	690	463	1,029	145	835
May-11	DA	1,854	1,386	2,480	196	2,050
	BF	2,694	1,828	3,972	356	3,050
Jun-11	DA	1,180	705	1,975	44	1,224
	BF	2,242	1,631	3,082	84	2,326
Jul-11	DA	1,349	704	2,585	15	1,364
	BF	2,285	1,628	3,207	71	2,356
Aug-11	DA	1,138	603	2,146	58	1,196
	BF	1,530	969	2,418	154	1,684
Sep-11	DA	843	530	1,340	7	850
	BF	2,738	1,896	3,952	21	2,759
Oct-11	DA	1,939	1,194	3,148	0	1,939
	BF	2,888	2,145	3,890	14	2,902
Nov-11	DA	548	279	1,074	0	548
	BF	690	413	1,152	0	690
Dec-11	DA	169	71	401	0	169
	BF	517	249	1,074	0	517
Jan-12	DA	147	51	423	0	147
	BF	129	54	311	0	129
Feb-12	DA	21	3	145	0	21
	BF	43	11	174	0	43
Mar-12	DA	274	107	701	0	274
	BF	237	101	558	14	251
Apr-12	DA	400	195	821	7	407
	BF	1,574	947	2,614	61	1,635
May-12	DA	2,760	1,640	4,646	44	2,804
	BF	3,514	2,199	5,613	69	3,583
Jun-12	DA	1,285	686	2,409	73	1,358
	BF	1,918	1,219	3,018	157	2,075
Jul-12	DA	1,159	835	1,608	58	1,217
	BF	2,048	1,489	2,817	54	2,102
Aug-12	DA	4,130	2,057	8,292	22	4,152
	BF	8,170	5,273	12,657	61	8,231
Sep-12	DA	1,749	1,080	2,833	0	1,749
	BF	2,673	1,739	4,109	0	2,673

Table 15A.3.7 Little Auk Population Estimates for the Inch Cape Development Area and 4 km Buffer Zone						
Survey month	Area	Birds on sea surface			Birds in flight	Total
		N	LCI	UCI	N	
Sep-10	DA	0	-	-	0	0
	BF	0	-	-	0	0
Oct-10	DA	0	-	-	0	0
	BF	0	-	-	0	0
Dec-10	DA	42	6	298	7	49
	BF	264	103	674	13	277
Jan-11	DA	91	25	330	0	91
	BF	118	42	333	0	118
Feb-11	DA	38	6	256	0	38
	BF	0	-	-	0	0
Mar-11	DA	0	-	-	0	0
	BF	0	-	-	0	0
Apr-11	DA	0	-	-	0	0
	BF	0	-	-	0	0
May-11	DA	0	-	-	0	0
	BF	0	-	-	0	0
Jun-11	DA	0	-	-	0	0
	BF	0	-	-	0	0
Jul-11	DA	0	-	-	0	0
	BF	0	-	-	0	0
Aug-11	DA	0	-	-	0	0
	BF	0	-	-	0	0
Sep-11	DA	0	-	-	0	0
	BF	0	-	-	0	0
Oct-11	DA	0	-	-	0	0
	BF	0	-	-	0	0
Nov-11	DA	1,572	633	3,906	14	1,586
	BF	4,354	2,658	7,133	47	4,401
Dec-11	DA	1,994	723	5,501	60	2,054
	BF	4,040	1,962	8,321	28	4,068
Jan-12	DA	1,072	423	2,720	8	1,080
	BF	1,086	476	2,474	83	1,169
Feb-12	DA	38	6	258	0	38
	BF	235	78	709	7	242
Mar-12	DA	0	-	-	0	0
	BF	0	-	-	0	0
Apr-12	DA	0	-	-	0	0
	BF	0	-	-	0	0
May-12	DA	0	-	-	0	0
	BF	0	-	-	0	0
Jun-12	DA	0	-	-	0	0
	BF	0	-	-	0	0
Jul-12	DA	0	-	-	0	0
	BF	0	-	-	0	0
Aug-12	DA	0	-	-	0	0
	BF	0	-	-	0	0
Sep-12	DA	0	-	-	0	0
	BF	0	-	-	0	0

Table 15A.3.8 Manx Shearwater Extrapolated Population Estimates for the Inch Cape Development Area and 4 km Buffer Zone									
Survey month	Area	Birds on sea surface	Birds in flight	Total	Survey month	Area	Birds on sea surface	Birds in flight	Total
Sep-10	DA	0	0	0	Oct-11	DA	0	0	0
	BF	0	14	14		BF	8	0	8
Oct-10	DA	27	0	27	Nov-11	DA	0	0	0
	BF	9	14	23		BF	0	0	0
Dec-10	DA	0	0	0	Dec-11	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Jan-11	DA	0	0	0	Jan-12	DA	0	0	0
	BF	0	7	7		BF	0	0	0
Feb-11	DA	0	0	0	Feb-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Mar-11	DA	0	0	0	Mar-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Apr-11	DA	0	0	0	Apr-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0
May-11	DA	89	0	89	May-12	DA	0	0	0
	BF	69	0	69		BF	0	0	0
Jun-11	DA	0	7	7	Jun-12	DA	0	0	0
	BF	0	21	21		BF	0	0	0
Jul-11	DA	44	22	66	Jul-12	DA	0	7	7
	BF	25	0	25		BF	0	7	7
Aug-11	DA	18	0	18	Aug-12	DA	0	0	0
	BF	8	7	15		BF	0	7	7
Sep-11	DA	9	0	9	Sep-12	DA	0	59	59
	BF	17	14	31		BF	24	7	31

Table 15A.3.9 Herring Gull Extrapolated Population Estimates for the Inch Cape Development Area and 4 km Buffer Zone									
Survey month	Area	Birds on sea surface	Birds in flight	Total	Survey month	Area	Birds on sea surface	Birds in flight	Total
Sep-10	DA	0	0	0	Oct-11	DA	0	8	8
	BF	0	0	0		BF	0	21	21
Oct-10	DA	3	0	3	Nov-11	DA	0	7	7
	BF	1	21	22		BF	0	14	14
Dec-10	DA	0	29	29	Dec-11	DA	0	15	15
	BF	0	46	46		BF	1	28	29
Jan-11	DA	2	15	17	Jan-12	DA	0	15	15
	BF	7	260	267		BF	1	7	8
Feb-11	DA	0	7	7	Feb-12	DA	0	7	7
	BF	1	20	21		BF	1	7	8
Mar-11	DA	0	0	0	Mar-12	DA	0	0	0
	BF	1	40	41		BF	0	14	14
Apr-11	DA	0	0	0	Apr-12	DA	0	0	0
	BF	0	43	43		BF	0	0	0
May-11	DA	0	0	0	May-12	DA	0	7	7
	BF	0	7	7		BF	0	7	7
Jun-11	DA	0	37	37	Jun-12	DA	0	0	0
	BF	5	49	54		BF	0	7	7
Jul-11	DA	0	0	0	Jul-12	DA	0	0	0
	BF	0	0	0		BF	0	20	20
Aug-11	DA	0	0	0	Aug-12	DA	0	7	7
	BF	0	0	0		BF	0	0	0
Sep-11	DA	0	0	0	Sep-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0

Table 15A.3.10 Great Black-backed Gull Extrapolated Population Estimates for the Inch Cape Development Area and 4 km Buffer Zone									
Survey month	**Area**	**Birds on sea surface**	**Birds in flight**	**Total**	**Survey month**	**Area**	**Birds on sea surface**	**Birds in flight**	**Total**
Sep-10	DA	0	0	0	Oct-11	DA	0	15	15
	BF	0	14	14		BF	0	14	14
Oct-10	DA	59	30	89	Nov-11	DA	0	14	14
	BF	93	14	107		BF	0	34	34
Dec-10	DA	10	22	32	Dec-11	DA	19	22	42
	BF	45	46	92		BF	36	49	85
Jan-11	DA	10	7	17	Jan-12	DA	10	15	25
	BF	28	7	35		BF	27	14	41
Feb-11	DA	0	7	7	Feb-12	DA	0	7	7
	BF	9	14	22		BF	0	7	7
Mar-11	DA	10	0	10	Mar-12	DA	19	7	27
	BF	0	13	13		BF	18	27	45
Apr-11	DA	0	8	8	Apr-12	DA	0	0	0
	BF	0	0	0		BF	0	7	7
May-11	DA	0	0	0	May-12	DA	0	7	7
	BF	0	0	0		BF	0	0	0
Jun-11	DA	0	0	0	Jun-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Jul-11	DA	0	0	0	Jul-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Aug-11	DA	0	0	0	Aug-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Sep-11	DA	0	0	0	Sep-12	DA	0	0	0
	BF	18	7	25		BF	72	21	93

Table 15A.3.11 Arctic Tern Extrapolated Population Estimates for the Inch Cape Development Area and 4 km Buffer Zone									
Survey month	**Area**	**Birds on sea surface**	**Birds in flight**	**Total**	**Survey month**	**Area**	**Birds on sea surface**	**Birds in flight**	**Total**
Sep-10	DA	0	0	0	Oct-11	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Oct-10	DA	0	0	0	Nov-11	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Dec-10	DA	0	0	0	Dec-11	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Jan-11	DA	0	0	0	Jan-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Feb-11	DA	0	0	0	Feb-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Mar-11	DA	0	0	0	Mar-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Apr-11	DA	0	0	0	Apr-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0
May-11	DA	0	0	0	May-12	DA	0	29	29
	BF	0	0	0		BF	0	0	0
Jun-11	DA	0	0	0	Jun-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0
Jul-11	DA	0	22	22	Jul-12	DA	0	0	0
	BF	11	71	82		BF	0	0	0
Aug-11	DA	20	489	509	Aug-12	DA	0	7	7
	BF	29	60	89		BF	1	210	211

Table 15A.3.11 Arctic Tern Extrapolated Population Estimates for the Inch Cape Development Area and 4 km Buffer Zone									
Survey month	**Area**	**Birds on sea surface**	**Birds in flight**	**Total**	**Survey month**	**Area**	**Birds on sea surface**	**Birds in flight**	**Total**
Sep-11	DA	0	0	0	Sep-12	DA	0	0	0
	BF	0	0	0		BF	0	0	0

ANNEX 15A.4: COLLISION RISK RESULTS

Tables 15A.4.1 to 15A.4.15 provide collision risk estimates for gannet, kittiwake, herring gull, great black-backed gull and lesser black-backed gull for all birds, regardless of age class or breeding status. Estimates for each species are shown in three separate tables, representing Large, Medium and Small turbine scenarios respectively. Information is provided on a month by month basis, with bird flight density, proportion at PCH, the Band collision probability, available day and night time hours and the maximum estimated number of transits (flight) per month. Estimated collisions are provided for a range of avoidance rates. Collision estimates for the missed November 2010 survey are an average of those calculated for the previous month and the following month. All estimates are rounded to one decimal.

Table 15A.4.1 Gannet Collision Risk Estimates for Large Turbines

Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
1	2010	9	0.882	0.035	0.0679	385.16	334.84	18510.85	1140.01	57.0	22.8	11.4	5.7
2	2010	10	1.212	0.015	0.0709	324.17	419.83	9288.38	603.80	30.2	12.1	6.0	3.0
No survey	2010	11	-	-	0.0729	-	-	-	301.9	15.1	6.05	3.0	1.5
3	2010	12	0	0.015	0.0735	216.02	527.98	0	0	0	0	0	0
4	2011	1	0.100	0.015	0.0741	234.72	509.28	552.91	38.00	1.9	0.8	0.4	0.2
5	2011	2	0.390	0.015	0.0721	265.50	406.50	2446.81	163.55	8.2	3.3	1.6	0.8
6	2011	3	0.709	0.015	0.0718	365.40	378.61	6125.87	403.49	20.2	8.1	4.0	2.0
7	2011	4	3.391	0.035	0.0678	425.75	294.25	78676.27	4835.82	241.8	96.7	48.4	24.2
8	2011	5	3.419	0.035	0.0658	507.50	236.50	94559.81	5578.84	278.9	111.6	55.8	27.9
9	2011	6	3.021	0.035	0.0645	528.73	191.27	87065.71	5092.72	254.6	101.9	50.9	25.5
10	2011	7	5.381	0.035	0.0636	529.62	214.38	155322.31	8757.43	437.9	175.1	87.6	43.8
11	2011	8	6.823	0.035	0.0646	470.04	273.96	174776.73	10128.65	506.4	202.6	101.3	50.6
12	2011	9	2.173	0.035	0.0679	385.16	334.84	45610.72	2808.99	140.5	56.2	28.1	14.0
13	2011	10	0.859	0.015	0.0709	324.17	419.83	6579.27	427.69	21.4	8.6	4.3	2.1
14	2011	11	0.193	0.015	0.0729	247.59	472.41	1130.96	76.48	3.8	1.5	0.8	0.4
15	2011	12	0	0.015	0.0735	216.02	527.98	0.00	0.00	0.0	0.0	0.0	0.0
16	2012	1	0.201	0.015	0.0741	234.72	509.28	1115.83	76.70	3.8	1.5	0.8	0.4
17	2012	2	0.722	0.015	0.0721	276.10	419.91	4708.90	314.76	15.7	6.3	3.1	1.6
18	2012	3	0.448	0.015	0.0718	367.86	376.14	3899.42	256.84	12.8	5.1	2.6	1.3
19	2012	4	0.958	0.035	0.0678	428.07	291.93	22346.34	1373.51	68.7	27.5	13.7	6.9
20	2012	5	5.237	0.035	0.0658	509.41	234.60	145403.25	8578.49	428.9	171.6	85.8	42.9

Table 15A.4.1 Gannet Collision Risk Estimates for Large Turbines													
Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
21	2012	6	4.532	0.035	0.0645	529.12	190.88	130693.79	7644.64	382.2	152.9	76.4	38.2
22	2012	7	1.876	0.035	0.0636	528.18	215.82	53999.27	3044.61	152.2	60.9	30.4	15.2
23	2012	8	3.445	0.035	0.0646	467.79	276.22	87825.80	5089.68	254.5	101.8	50.9	25.4
24	2012	9	1.481	0.035	0.0679	382.82	337.18	30908.99	1903.57	95.2	38.1	19.0	9.5

Table 15A.4.2 Gannet Collision Risk Estimates for Medium Turbines													
Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
1	2010	9	0.882	0.035	0.0626	385.16	334.84	16573.66	941.39	47.1	18.8	9.4	4.7
2	2010	10	1.212	0.015	0.0654	324.17	419.83	8316.34	499.00	25.0	10.0	5.0	2.5
No survey	2010	11	-	-	0.0674	-	-	-	249.5	12.5	5.0	2.5	1.25
3	2010	12	0	0.015	0.0679	216.02	527.98	0	0	0	0	0	0
4	2011	1	0.100	0.015	0.0685	234.72	509.28	495.05	31.43	1.6	0.6	0.3	0.2
5	2011	2	0.390	0.015	0.0665	265.50	406.50	2190.75	135.13	6.8	2.7	1.4	0.7
6	2011	3	0.709	0.015	0.0663	365.40	378.61	5484.79	333.45	16.7	6.7	3.3	1.7
7	2011	4	3.391	0.035	0.0625	425.75	294.25	70442.71	3992.30	199.6	79.8	39.9	20.0
8	2011	5	3.419	0.035	0.0606	507.50	236.50	84664.02	4604.01	230.2	92.1	46.0	23.0
9	2011	6	3.021	0.035	0.0594	528.73	191.27	77954.19	4202.17	210.1	84.0	42.0	21.0
10	2011	7	5.381	0.035	0.0586	529.62	214.38	139067.65	7224.85	361.2	144.5	72.2	36.1
11	2011	8	6.823	0.035	0.0595	470.04	273.96	156486.14	8357.67	417.9	167.2	83.6	41.8
12	2011	9	2.173	0.035	0.0626	385.16	334.84	40837.51	2319.58	116.0	46.4	23.2	11.6
13	2011	10	0.859	0.015	0.0654	324.17	419.83	5890.74	353.46	17.7	7.1	3.5	1.8
14	2011	11	0.193	0.015	0.0674	247.59	472.41	1012.60	63.23	3.2	1.3	0.6	0.3
15	2011	12	0	0.015	0.0679	216.02	527.98	0	0	0	0	0	0
16	2012	1	0.201	0.015	0.0685	234.72	509.28	999.06	63.42	3.2	1.3	0.6	0.3
17	2012	2	0.722	0.015	0.0665	276.10	419.91	4216.11	260.06	13.0	5.2	2.6	1.3
18	2012	3	0.448	0.015	0.0663	367.86	376.14	3491.34	212.26	10.6	4.2	2.1	1.1
19	2012	4	0.958	0.035	0.0625	428.07	291.93	20007.77	1133.93	56.7	22.7	11.3	5.7

Table 15A.4.2 Gannet Collision Risk Estimates for Medium Turbines													
Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
20	2012	5	5.237	0.035	0.0606	509.41	234.60	130186.63	7079.52	354.0	141.6	70.8	35.4
21	2012	6	4.532	0.035	0.0594	529.12	190.88	117016.53	6307.85	315.4	126.2	63.1	31.5
22	2012	7	1.876	0.035	0.0586	528.18	215.82	48348.19	2511.79	125.6	50.2	25.1	12.6
23	2012	8	3.445	0.035	0.0595	467.79	276.22	78634.73	4199.75	210.0	84.0	42.0	21.0
24	2012	9	1.481	0.035	0.0626	382.82	337.18	27674.33	1571.91	78.6	31.4	15.7	7.9

Table 15A.4.3 Gannet Collision Risk Estimates for Small Turbines													
Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
1	2010	9	0.882	0.035	0.0763	385.16	334.84	12914.54	893.48	44.7	17.9	8.9	4.5
2	2010	10	1.212	0.015	0.0787	324.17	419.83	6480.26	467.44	23.4	9.3	4.7	2.3
No survey	2010	11	-	-	0.0803	-	-	-	233.72	11.7	4.65	2.35	1.15
3	2010	12	0	0.015	0.0808	216.02	527.98	0	0	0	0	0	0
4	2011	1	0.100	0.015	0.0813	234.72	509.28	385.75	29.07	1.5	0.6	0.3	0.1
5	2011	2	0.390	0.015	0.0796	265.50	406.50	1707.07	125.92	6.3	2.5	1.3	0.6
6	2011	3	0.709	0.015	0.0794	365.40	378.61	4273.86	311.12	15.6	6.2	3.1	1.6
7	2011	4	3.391	0.035	0.0761	425.75	294.25	54890.42	3791.04	189.6	75.8	37.9	19.0
8	2011	5	3.419	0.035	0.0747	507.50	236.50	65971.96	4417.98	220.9	88.4	44.2	22.1
9	2011	6	3.021	0.035	0.0738	528.73	191.27	60743.52	4064.05	203.2	81.3	40.6	20.3
10	2011	7	5.381	0.035	0.0732	529.62	214.38	108364.40	7032.02	351.6	140.6	70.3	35.2
11	2011	8	6.823	0.035	0.0738	470.04	273.96	121937.26	8076.75	403.8	161.5	80.8	40.4
12	2011	9	2.173	0.035	0.0763	385.16	334.84	31821.44	2201.53	110.1	44.0	22.0	11.0
13	2011	10	0.859	0.015	0.0787	324.17	419.83	4590.19	331.10	16.6	6.6	3.3	1.7
14	2011	11	0.193	0.015	0.0803	247.59	472.41	789.04	58.74	2.9	1.2	0.6	0.3
15	2011	12	0	0.015	0.0808	216.02	527.98	0	0	0	0	0	0
16	2012	1	0.201	0.015	0.0813	234.72	509.28	778.49	58.66	2.9	1.2	0.6	0.3
17	2012	2	0.722	0.015	0.0796	276.10	419.91	3285.28	242.34	12.1	4.8	2.4	1.2
18	2012	3	0.448	0.015	0.0794	367.86	376.14	2720.52	198.04	9.9	4.0	2.0	1.0

Table 15A.4.3 Gannet Collision Risk Estimates for Small Turbines													
Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
19	2012	4	0.958	0.035	0.0761	428.07	291.93	15590.47	1076.76	53.8	21.5	10.8	5.4
20	2012	5	5.237	0.035	0.0747	509.41	234.60	101444.13	6793.46	339.7	135.9	67.9	34.0
21	2012	6	4.532	0.035	0.0738	529.12	190.88	91181.71	6100.52	305.0	122.0	61.0	30.5
22	2012	7	1.876	0.035	0.0732	528.18	215.82	37673.91	2444.75	122.2	48.9	24.4	12.2
23	2012	8	3.445	0.035	0.0738	467.79	276.22	61273.82	4058.59	202.9	81.2	40.6	20.3
24	2012	9	1.481	0.035	0.0763	382.82	337.18	21564.41	1491.91	74.6	29.8	14.9	7.5

Table 15A.4.4 Kittiwake Collision Risk Estimates for Large Turbines													
Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
1	2010	9	0.176	0.092	0.0558	385.16	334.84	12116.79	613.36	30.7	12.3	6.1	3.1
2	2010	10	1.566	0.092	0.057	324.17	419.83	103963.45	5436.02	271.8	108.7	54.4	27.2
No survey	2010	11	-	-	0.0579	-	-	-	2874.84	143.8	57.5	28.8	14.4
3	2010	12	0.097	0.092	0.0582	216.02	527.98	5816.69	313.66	15.7	6.3	3.1	1.6
4	2011	1	0.199	0.092	0.0585	234.72	509.28	12125.94	657.39	32.9	13.1	6.6	3.3
5	2011	2	0	0.092	0.0575	265.50	406.50	0	0	0	0	0	0
6	2011	3	0.142	0.092	0.0574	365.40	378.61	9782.32	515.10	25.8	10.3	5.2	2.6
7	2011	4	0.313	0.004	0.0558	425.75	294.25	933.02	47.19	2.4	0.9	0.5	0.2
8	2011	5	0.503	0.004	0.055	507.50	236.50	1637.08	80.77	4.0	1.6	0.8	0.4
9	2011	6	2.973	0.004	0.0546	528.73	191.27	9658.18	478.00	23.9	9.6	4.8	2.4
10	2011	7	5.680	0.004	0.0543	529.62	214.38	18822.14	906.25	45.3	18.1	9.1	4.5
11	2011	8	0.682	0.004	0.0546	470.04	273.96	2155.05	105.55	5.3	2.1	1.1	0.5
12	2011	9	6.272	0.092	0.0558	385.16	334.84	430873.20	21810.93	1090.5	436.2	218.1	109.1
13	2011	10	1.616	0.092	0.057	324.17	419.83	107317.11	5611.38	280.6	112.2	56.1	28.1
14	2011	11	0.628	0.092	0.0579	247.59	472.41	37775.41	2027.87	101.4	40.6	20.3	10.1
15	2011	12	0.598	0.092	0.0582	216.02	527.98	35682.64	1924.16	96.2	38.5	19.2	9.6
16	2012	1	0.201	0.092	0.0585	234.72	509.28	12235.68	663.34	33.2	13.3	6.6	3.3
17	2012	2	0.096	0.092	0.0575	276.10	419.91	5813.38	310.09	15.5	6.2	3.1	1.6

Table 15A.4.4 Kittiwake Collision Risk Estimates for Large Turbines													
Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
18	2012	3	0.997	0.092	0.0574	367.86	376.14	68877.41	3626.80	181.3	72.5	36.3	18.1
19	2012	4	0.910	0.004	0.0558	428.07	291.93	2718.08	137.46	6.9	2.7	1.4	0.7
20	2012	5	1.175	0.004	0.055	509.41	234.60	3830.95	189.02	9.5	3.8	1.9	0.9
21	2012	6	1.023	0.004	0.0546	529.12	190.88	3325.97	164.61	8.2	3.3	1.6	0.8
22	2012	7	1.684	0.004	0.0543	528.18	215.82	5572.31	268.30	13.4	5.4	2.7	1.3
23	2012	8	0.291	0.004	0.0546	467.79	276.22	917.85	44.96	2.2	0.9	0.5	0.2
24	2012	9	1.037	0.092	0.0558	382.82	337.18	71095.66	3598.88	179.9	72.0	36.0	18.0

Table 15A.4.5 Kittiwake Collision risk Estimates for Medium Turbines													
Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
1	2010	9	0.176	0.092	0.05	385.16	334.84	10848.76	491.83	24.6	9.8	4.9	2.5
2	2010	10	1.566	0.092	0.0511	324.17	419.83	93083.56	4360.66	218.0	87.2	43.6	21.8
No survey	2010	11	-	-	0.0519	-	-	-	2306.1	115.3	46.1	23.1	11.6
3	2010	12	0.097	0.092	0.0521	216.02	527.98	5207.96	251.53	12.6	5.0	2.5	1.3
4	2011	1	0.199	0.092	0.0524	234.72	509.28	10856.95	526.90	26.3	10.5	5.3	2.6
5	2011	2	0	0.092	0.0515	265.50	406.50	0	0	0	0	0	0
6	2011	3	0.142	0.092	0.0514	365.40	378.61	8758.59	413.16	20.7	8.3	4.1	2.1
7	2011	4	0.313	0.004	0.0499	425.75	294.25	835.38	37.83	1.9	0.8	0.4	0.2
8	2011	5	0.503	0.004	0.0493	507.50	236.50	1465.76	64.77	3.2	1.3	0.6	0.3
9	2011	6	2.973	0.004	0.0489	528.73	191.27	8647.44	383.45	19.2	7.7	3.8	1.9
10	2011	7	5.680	0.004	0.0487	529.62	214.38	16852.38	727.28	36.4	14.5	7.3	3.6
11	2011	8	0.682	0.004	0.0489	470.04	273.96	1929.52	84.67	4.2	1.7	0.8	0.4
12	2011	9	6.272	0.092	0.05	385.16	334.84	385781.82	17489.53	874.5	349.8	174.9	87.4
13	2011	10	1.616	0.092	0.0511	324.17	419.83	96086.25	4501.32	225.1	90.0	45.0	22.5
14	2011	11	0.628	0.092	0.0519	247.59	472.41	33822.17	1626.46	81.3	32.5	16.3	8.1
15	2011	12	0.598	0.092	0.0521	216.02	527.98	31948.41	1542.99	77.1	30.9	15.4	7.7
16	2012	1	0.201	0.092	0.0524	234.72	509.28	10955.20	531.67	26.6	10.6	5.3	2.7

Table 15A.4.5 Kittiwake Collision risk Estimates for Medium Turbines													
Survey	**Year**	**Month**	**Density (km2)**	**Proportion at PCH**	**Collision probability**	**Daytime hours**	**Night time hours**	**Number of Transits**	**Estimated number of collisions per avoidance rate**				
									0	**95%**	**98%**	**99%**	**99.5%**
17	2012	2	0.096	0.092	0.0515	276.10	419.91	5205.01	248.68	12.4	5.0	2.5	1.2
18	2012	3	0.997	0.092	0.0514	367.86	376.14	61669.31	2909.08	145.5	58.2	29.1	14.5
19	2012	4	0.910	0.004	0.0499	428.07	291.93	2433.63	110.22	5.5	2.2	1.1	0.6
20	2012	5	1.175	0.004	0.0493	509.41	234.60	3430.04	151.57	7.6	3.0	1.5	0.8
21	2012	6	1.023	0.004	0.0489	529.12	190.88	2977.91	132.05	6.6	2.6	1.3	0.7
22	2012	7	1.684	0.004	0.0487	528.18	215.82	4989.16	215.31	10.8	4.3	2.2	1.1
23	2012	8	0.291	0.004	0.0489	467.79	276.22	821.80	36.06	1.8	0.7	0.4	0.2
24	2012	9	1.037	0.092	0.05	382.82	337.18	63655.42	2885.84	144.3	57.7	28.9	14.4

Table 15A.4.6 Kittiwake Collision Risk Estimates for Small Turbines													
Survey	**Year**	**Month**	**Density (km2)**	**Proportion at PCH**	**Collision probability**	**Daytime hours**	**Night time hours**	**Number of Transits**	**Estimated number of collisions per avoidance rate**				
									0	**95%**	**98%**	**99%**	**99.5%**
1	2010	9	0.176	0.092	0.0627	385.16	334.84	8453.58	481.07	24.1	9.6	4.8	2.4
2	2010	10	1.566	0.092	0.0635	324.17	419.83	72532.64	4225.18	211.3	84.5	42.3	21.1
No survey	2010	11	-	-	0.0641	-	-	-	2233.5	223.4	44.7	22.6	11.1
3	2010	12	0.097	0.092	0.0643	216.02	527.98	4058.15	241.87	12.1	4.8	2.4	1.2
4	2011	1	0.199	0.092	0.0645	234.72	509.28	8459.96	505.79	25.3	10.1	5.1	2.5
5	2011	2	0	0.092	0.0638	265.50	406.50	0	0	0	0	0	0
6	2011	3	0.142	0.092	0.0638	365.40	378.61	6824.88	399.16	20.0	8.0	4.0	2.0
7	2011	4	0.313	0.004	0.0627	425.75	294.25	650.95	37.02	1.9	0.7	0.4	0.2
8	2011	5	0.503	0.004	0.0623	507.50	236.50	1142.15	63.85	3.2	1.3	0.6	0.3
9	2011	6	2.973	0.004	0.0622	528.73	191.27	6738.26	379.97	19.0	7.6	3.8	1.9
10	2011	7	5.680	0.004	0.0621	529.62	214.38	13131.73	723.79	36.2	14.5	7.2	3.6
11	2011	8	0.682	0.004	0.0622	470.04	273.96	1503.52	83.86	4.2	1.7	0.8	0.4
12	2011	9	6.272	0.092	0.0627	385.16	334.84	300609.21	17106.79	855.3	342.1	171.1	85.5
13	2011	10	1.616	0.092	0.0635	324.17	419.83	74872.40	4361.47	218.1	87.2	43.6	21.8
14	2011	11	0.628	0.092	0.0641	247.59	472.41	26354.94	1566.64	78.3	31.3	15.7	7.8
15	2011	12	0.598	0.092	0.0643	216.02	527.98	24894.86	1483.77	74.2	29.7	14.8	7.4

Table 15A.4.6 Kittiwake Collision Risk Estimates for Small Turbines

Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
16	2012	1	0.201	0.092	0.0645	234.72	509.28	8536.52	510.36	25.5	10.2	5.1	2.6
17	2012	2	0.096	0.092	0.0638	276.10	419.91	4055.85	240.06	12.0	4.8	2.4	1.2
18	2012	3	0.997	0.092	0.0638	367.86	376.14	48054.00	2810.5	140.5	56.2	28.1	14.1
19	2012	4	0.910	0.004	0.0627	428.07	291.93	1896.34	107.9	5.4	2.2	1.1	0.5
20	2012	5	1.175	0.004	0.0623	509.41	234.60	2672.76	149.4	7.5	3.0	1.5	0.7
21	2012	6	1.023	0.004	0.0622	529.12	190.88	2320.45	130.9	6.5	2.6	1.3	0.7
22	2012	7	1.684	0.004	0.0621	528.18	215.82	3887.66	214.3	10.7	4.3	2.1	1.1
23	2012	8	0.291	0.004	0.0622	467.79	276.22	640.36	35.7	1.8	0.7	0.4	0.2
24	2012	9	1.037	0.092	0.0627	382.82	337.18	49601.62	2822.7	141.1	56.5	28.2	14.1

Table 15A.4.7 Herring Gull Collision Risk Estimates for Large Turbines

Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
1	2010	9	0	0.171	0.0624	385.16	334.84	0	0	0	0	0	0
2	2010	10	0	0.171	0.0645	324.17	419.83	0	0	0	0	0	0
No survey	2010	11	-	-	0.0661	-	-	-	656.2	32.8	13.1	6.6	3.3
3	2010	12	0.195	0.171	0.0665	216.02	527.98	21275.2	1312.4	65.6	26.2	13.1	6.6
4	2011	1	0.100	0.171	0.0671	234.72	509.28	11088.0	689.2	34.5	13.8	6.9	3.4
5	2011	2	0.049	0.171	0.0654	265.50	406.50	5194.0	315.1	15.8	6.3	3.2	1.6
6	2011	3	0	0.171	0.0652	365.40	378.61	0	0	0	0	0	0
12	2011	9	0	0.171	0.0624	385.16	334.84	0	0	0	0	0	0
13	2011	10	0.051	0.171	0.0645	324.17	419.83	6133.2	363.0	18.1	7.3	3.6	1.8
14	2011	11	0.048	0.171	0.0661	247.59	472.41	5314.1	325.6	16.3	6.5	3.3	1.6
15	2011	12	0.100	0.171	0.0665	216.02	527.98	10876.1	670.9	33.5	13.4	6.7	3.4
16	2012	1	0.101	0.171	0.0671	234.72	509.28	11188.3	695.5	34.8	13.9	7.0	3.5
17	2012	2	0.048	0.171	0.0654	276.10	419.91	5315.8	322.5	16.1	6.5	3.2	1.6
18	2012	3	0	0.171	0.0652	367.86	376.14	0	0	0	0	0	0
24	2012	9	0	0.171	0.0624	382.82	337.18	0	0	0	0	0	0

Note: collision estimates presented here represent the non-breeding season (September to March) only

Table 15A.4.8 Herring Gull Collision Risk Estimates for Medium Turbines

Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
1	2010	9	0	0.171	0.0568	385.16	334.84	0	0	0	0	0	0
2	2010	10	0	0.171	0.0589	324.17	419.83	0	0	0	0	0	0
No survey	2010	11	-	-	0.0603	-	-	9524.3	535.5	26.8	10.7	5.4	2.7
3	2010	12	0.195	0.171	0.0607	216.02	527.98	19048.69	1070.99	53.5	21.4	10.7	5.4
4	2011	1	0.100	0.171	0.0611	234.72	509.28	9927.61	562.21	28.1	11.2	5.6	2.8
5	2011	2	0.049	0.171	0.0597	265.50	406.50	4650.48	257.27	12.9	5.1	2.6	1.3
6	2011	3	0	0.171	0.0595	365.40	378.61	0	0	0	0	0	0
12	2011	9	0	0.171	0.0568	385.16	334.84	0	0	0	0	0	0
13	2011	10	0.051	0.171	0.0589	324.17	419.83	5491.34	296.39	14.8	5.9	3.0	1.5
14	2011	11	0.048	0.171	0.0603	247.59	472.41	4758.01	265.84	13.3	5.3	2.7	1.3
15	2011	12	0.100	0.171	0.0607	216.02	527.98	9737.89	547.50	27.4	11.0	5.5	2.7
16	2012	1	0.101	0.171	0.0611	234.72	509.28	10017.45	567.30	28.4	11.3	5.7	2.8
17	2012	2	0.048	0.171	0.0597	276.10	419.91	4759.47	263.30	13.2	5.3	2.6	1.3
18	2012	3	0	0.171	0.0595	367.86	376.14	0	0	0	0	0	0
24	2012	9	0	0.171	0.0568	382.82	337.18	0	0	0	0	0	0

Note: collision estimates presented here represent the non-breeding season (September to March) only

Table 15A.4.9 Herring Gull Collision Risk Estimates for Small Turbines

Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
1	2010	9	0	0.171	0.0701	385.16	334.84	0	0	0	0	0	0
2	2010	10	0	0.171	0.0717	324.17	419.83	0	0	0	0	0	0
-	2010	11	-	-	0.0729	-	-	7421.6	503.75	25.2	10.1	5.1	2.5
3	2010	12	0.195	0.171	0.0732	216.02	527.98	14843.1	1007.5	50.4	20.2	10.1	5.0
4	2011	1	0.100	0.171	0.0736	234.72	509.28	7735.8	527.8	26.4	10.6	5.3	2.6
5	2011	2	0.049	0.171	0.0724	265.50	406.50	3623.7	243.1	12.2	4.9	2.4	1.2
6	2011	3	0	0.171	0.0722	365.40	378.61	0	0	0	0	0	0
12	2011	9	0	0.171	0.0701	385.16	334.84	0	0	0	0	0	0

Table 15A.4.9 Herring Gull Collision Risk Estimates for Small Turbines													
Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
13	2011	10	0.051	0.171	0.0717	324.17	419.83	4279.0	281.5	14.1	5.6	2.8	1.4
14	2011	11	0.048	0.171	0.0729	247.59	472.41	3707.5	250.6	12.5	5.0	2.5	1.3
15	2011	12	0.100	0.171	0.0732	216.02	527.98	7588.0	515.1	25.8	10.3	5.2	2.6
16	2012	1	0.101	0.171	0.0736	234.72	509.28	7805.8	532.5	26.6	10.7	5.3	2.7
17	2012	2	0.048	0.171	0.0724	276.10	419.91	3708.7	248.8	12.4	5.0	2.5	1.2
18	2012	3	Less0	0.171	0.0722	367.86	376.14	0	0	0	0	0	0
24	2012	9	0	0.171	0.0701	382.82	337.18	0	0	0	0	0	0
Note: collision estimates presented here represent the non-breeding season (September to March) only													

Table 15A.4.10 Great Black-Backed Gull Collision Risk Estimates for Large Turbines													
Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
1	2010	9	0.000	0.281	0.0646	385.16	334.84	0	0	0	0	0	0
2	2010	10	0.202	0.281	0.0669	324.17	419.83	42969.4	2634.5	131.7	52.7	26.3	13.2
No survey	2010	11	-	-	0.0685	-	-	-	2210	110.5	44.2	22.1	11.1
3	2010	12	0.146	0.281	0.0689	216.02	527.98	27947.8	1785.5	89.3	35.7	17.9	8.9
4	2011	1	0.050	0.281	0.0694	234.72	509.28	9710.4	625.1	31.3	12.5	6.3	3.1
5	2011	2	0.049	0.281	0.0678	265.50	406.50	9097.4	571.9	28.6	11.4	5.7	2.9
6	2011	3	0.000	0.281	0.0676	365.40	378.61	0	0	0	0	0	0
12	2011	9	0.000	0.281	0.0646	385.16	334.84	0	0	0	0	0	0
13	2011	10	0.101	0.281	0.0669	324.17	419.83	21484.7	1317.2	65.9	26.3	13.2	6.6
14	2011	11	0.097	0.281	0.0685	247.59	472.41	18615.6	1181.6	59.1	23.6	11.8	5.9
15	2011	12	0.149	0.281	0.0689	216.02	527.98	28574.4	1825.5	91.3	36.5	18.3	9.1
16	2012	1	0.101	0.281	0.0694	234.72	509.28	19596.5	1261.5	63.1	25.2	12.6	6.3
17	2012	2	0.048	0.281	0.0678	276.10	419.91	9310.6	585.3	29.3	11.7	5.9	2.9
18	2012	3	0.050	0.281	0.0676	367.86	376.14	11031.3	683.8	34.2	13.7	6.8	3.4
24	2012	9	0.000	0.281	0.0646	382.82	337.18	0	0	0	0	0	0
Note: collision estimates presented here represent the non-breeding season (September to March) only													

Table 15A.4.11 Great Black-Backed Gull Collision Risk Estimates for Medium Turbines													
Survey	**Year**	**Month**	**Density (km2)**	**Proportion at PCH**	**Collision probability**	**Daytime hours**	**Night time hours**	**Number of Transits**	**Estimated number of collisions per avoidance rate**				
									0	**95%**	**98%**	**99%**	**99.5%**
1	2010	9	0.000	0.281	0.0592	385.16	334.84	0	0	0	0	0	0
2	2010	10	0.202	0.281	0.0614	324.17	419.83	38472.6	2165.3	108.3	43.3	21.7	10.8
No survey	2010	11	-	-	0.0629	-	-	-	1816.5	90.9	36.4	18.2	9.1
3	2010	12	0.146	0.281	0.0633	216.02	527.98	25023.0	1467.7	73.4	29.4	14.7	7.3
4	2011	1	0.050	0.281	0.0637	234.72	509.28	8694.2	513.7	25.7	10.3	5.1	2.6
5	2011	2	0.049	0.281	0.0622	265.50	406.50	8145.4	469.8	23.5	9.4	4.7	2.3
6	2011	3	0.000	0.281	0.062	365.40	378.61	0	0	0	0	0	0
12	2011	9	0.000	0.281	0.0592	385.16	334.84	0	0	0	0	0	0
13	2011	10	0.101	0.281	0.0614	324.17	419.83	19236.3	1082.7	54.1	21.7	10.8	5.4
14	2011	11	0.097	0.281	0.0629	247.59	472.41	16667.4	971.3	48.6	19.4	9.7	4.9
15	2011	12	0.149	0.281	0.0633	216.02	527.98	25584.1	1500.7	75.0	30.0	15.0	7.5
16	2012	1	0.101	0.281	0.0637	234.72	509.28	17545.7	1036.7	51.8	20.7	10.4	5.2
17	2012	2	0.048	0.281	0.0622	276.10	419.91	8336.3	480.8	24.0	9.6	4.8	2.4
18	2012	3	0.050	0.281	0.062	367.86	376.14	9876.9	561.9	28.1	11.2	5.6	2.8
24	2012	9	0.000	0.281	0.0592	382.82	337.18	0	0	0	0	0	0
Note: collision estimates presented here represent the non-breeding season (September to March) only													

Table 15A.4.12 Great Black-Backed Gull Collision Risk Estimates for Small Turbines													
Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
1	2010	9	0.000	0.281	0.0731	385.16	334.84	0	0	0	0	0	0
2	2010	10	0.202	0.281	0.0748	324.17	419.83	29978.6	2055.3	102.8	41.1	20.6	10.3
No survey	2010	11	-	-	0.076	-	-	-	1717.4	85.9	34.4	17.2	8.6
3	2010	12	0.146	0.281	0.0763	216.02	527.98	19498.4	1379.5	69.0	27.6	13.8	6.9
4	2011	1	0.050	0.281	0.0767	234.72	509.28	6774.7	481.8	24.1	9.6	4.8	2.4
5	2011	2	0.049	0.281	0.0754	265.50	406.50	6347.0	443.9	22.2	8.9	4.4	2.2
6	2011	3	0.000	0.281	0.0753	365.40	378.61	0	0	0	0	0	0
12	2011	9	0.000	0.281	0.0731	385.16	334.84	0	0	0	0	0	0

Table 15A.4.12 Great Black-Backed Gull Collision Risk Estimates for Small Turbines													
Survey	Year	Month	Density (km2)	Proportion at PCH	Collision probability	Daytime hours	Night time hours	Number of Transits	Estimated number of collisions per avoidance rate				
									0	95%	98%	99%	99.5%
13	2011	10	0.101	0.281	0.0748	324.17	419.83	14989.3	1027.7	51.4	20.6	10.3	5.1
14	2011	11	0.097	0.281	0.076	247.59	472.41	12987.6	914.7	45.7	18.3	9.1	4.6
15	2011	12	0.149	0.281	0.0763	216.02	527.98	19935.6	1410.5	70.5	28.2	14.1	7.1
16	2012	1	0.101	0.281	0.0767	234.72	509.28	13672.0	972.4	48.6	19.4	9.7	4.9
17	2012	2	0.048	0.281	0.0754	276.10	419.91	6495.8	454.3	22.7	9.1	4.5	2.3
18	2012	3	0.050	0.281	0.0753	367.86	376.14	7696.3	531.5	26.6	10.6	5.3	2.7
24	2012	9	0.000	0.281	0.0731	382.82	337.18	0	0	0	0	0	0
Note: collision estimates presented here represent the non-breeding season (September to March) only													

ANNEX 15A.5: DISPLACEMENT SCENARIOS

Tables 15A.5.1 to 15A.5.17 provide season-specific displacement scenarios for the Development Area and a 2 km buffer zone separately. These scenarios are based on a request from Marine Scotland, SNH and JNCC to FTOWDG in August 2011 and are presented for information. The assessment of displacement in the ornithology chapter (Chapter 15) reviews the available evidence for displacement of each species in relation to offshore wind farms and considers a realistic worst case scenario.

In the tables below, a range of displacement rates from 10 – 100 per cent is shown for all relevant species. Where applicable a peak mean estimate (the season with the highest mean between Year 1 and 2) is provided. To provide some context for these estimates a 2 year mean (the mean of mean seasonal estimates for both Year 1 and Year 2) is presented as well.

For the breeding season, displacement estimates are provided for all birds, adult or summer plumage birds (based on age class proportions for species where adult birds can be distinguished in the field, based on plumage, from immatures / juveniles – information on this is provided in the species accounts) and the total number of breeding adults which could potentially be displaced. For some species the numbers of breeding adults are calculated based on an assumption that 50 per cent of adults are breeding birds, based on advice from Marine Scotland (Niras 2012, Appendix 1). For kittiwake (breeding and post-breeding), guillemot, razorbill and puffin the proportion of adult birds at sea which are likely to be breeding birds has been determined using PVA models (Appendix 15B). Proportions thus derived have been used in preference to the 50 per cent assumption. For gannet it has been assumed that all birds in adult plumage are in fact breeding birds as there is no evidence to the contrary (WWT 2012).

As outlined in the Methodology section, population estimates for species with sufficient observations were derived through distance sampling or extrapolation. These formed the basis for calculation of potentially displaced birds. Species for which too few observations were made, were presented in terms of raw counts in the baseline. As several of these are SPA species or otherwise of conservation concern, a precautionary approach was used: raw counts were turned into impromptu densities based on the area surveyed and subsequently extrapolated to the surface areas of the Development Area and the 2 km buffer. As a result these population estimates are at times higher than the raw counts presented in the baseline species accounts. This was done for Manx shearwater, sooty shearwater, shag, little gull, common gull, lesser black-backed gull and common tern). Although it is acknowledged that there is a high degree of uncertainty in deriving densities in this manner, in doing so species of conservation concern with few observations are at least not prematurely omitted from consideration. A range of displacement estimates for the three skua species are not provided, as population estimates are exceedingly low and unlikely to be accurate due to the very short period of time these species' occur in the study area annually and the high turnover involved in migrating populations.

All displacement estimates are rounded to two decimals.

Table 15A.5.1A Fulmar Displacement – Breeding Season, Development Area											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	3.51	7.01	10.52	14.03	17.54	21.04	24.55	28.06	31.57	35.07
	50% of birds breeding (1)	1.75	3.51	5.26	7.01	8.77	10.52	12.28	14.03	15.78	17.54
2 year mean	All birds	3.35	6.69	10.04	13.39	16.74	20.08	23.43	26.78	30.12	33.47
	50% of birds breeding (1)	1.67	3.35	5.02	6.69	8.37	10.04	11.71	13.39	15.06	16.74
(1) adult fulmars cannot be distinguished from immature birds in the field. The assumption is therefore that 50% of all birds estimated to be within the Development Area or the buffer zone are breeding birds.											

Table 15A.5.1B Fulmar Displacement – Breeding Season, 2 km Buffer											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	3.69	7.38	11.07	14.76	18.45	22.14	25.83	29.52	33.21	36.90
	50% of birds breeding (1)	1.84	3.69	5.53	7.38	9.22	11.07	12.91	14.76	16.60	18.45
2 year mean	All birds	2.65	5.31	7.96	10.62	13.27	15.93	18.58	21.23	23.89	26.54
	50% of birds breeding (1)	1.33	2.65	3.98	5.31	6.64	7.96	9.29	10.62	11.94	13.27
(1) adult fulmars cannot be distinguished from immature birds in the field. The assumption is therefore that 50% of all birds estimated to be within the Development Area or the buffer zone are breeding birds.											

Table 15A.5.1C Fulmar Displacement – Non-breeding Season, Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	6.95	13.90	20.85	27.80	34.75	41.69	48.64	55.59	62.54	69.49
2 year mean All birds	4.62	9.23	13.85	18.47	23.08	27.70	32.32	36.93	41.55	46.17

Table 15A.5.1D Fulmar Displacement – Non-breeding Season, 2 km Buffer										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	3.17	6.33	9.50	12.67	15.84	19.00	22.17	25.34	28.50	31.67
2 year mean All birds	3.17	6.33	9.50	12.67	15.84	19.00	22.17	25.34	28.50	31.67

Table 15A.5.2A Manx Shearwater Displacement – Non-breeding Season, Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	2.71	5.42	8.13	10.84	13.55	16.26	18.97	21.68	24.39	27.10
2 year mean All birds	1.91	3.82	5.73	7.63	9.54	11.45	13.36	15.27	17.18	19.09

Table 15A.5.2B Manx Shearwater Displacement – Non-breeding Season, 2 km Buffer										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	1.11	2.22	3.33	4.44	5.54	6.65	7.76	8.87	9.98	11.09
2 year mean All birds	0.73	1.46	2.19	2.91	3.64	4.37	5.10	5.83	6.56	7.28

Table 15A.5.3A Sooty Shearwater Displacement – Non-breeding season, Development Area										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	6.54	13.08	19.61	26.15	32.69	39.23	45.76	52.30	58.84	65.38
2 year mean All birds	3.42	6.84	10.25	13.67	17.09	20.51	23.93	27.35	30.76	34.18

Table 15A.5.3B Sooty Shearwater Displacement – Non-breeding Season, 2 km Buffer										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	4.63	9.26	13.89	18.53	23.16	27.79	32.42	37.05	41.68	46.32
2 year mean All birds	2.85	5.71	8.56	11.42	14.27	17.13	19.98	22.84	25.69	28.54

Table 15A.5.4A Gannet Displacement – Breeding Season, Development Area											
Population		**Proportion displacement**									
		10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean	All birds	71.90	143.79	215.69	287.58	359.48	431.38	503.27	575.17	647.06	718.96
	Adult birds (1)	69.88	139.77	209.65	279.53	349.42	419.30	489.18	559.06	628.95	698.83
	100% adults breeding (2)	69.88	139.77	209.65	279.53	349.42	419.30	489.18	559.06	628.95	698.83
2 year mean	All birds	63.96	127.92	191.89	255.85	319.81	383.77	447.74	511.70	575.66	639.62
	Adult birds (1)	62.17	124.34	186.51	248.68	310.86	373.03	435.20	497.37	559.54	621.71
	100% adults breeding (2)	62.17	124.34	186.51	248.68	310.86	373.03	435.20	497.37	559.54	621.71

(1) Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 97.2 per cent) as recorded during boat surveys in Year 1 and 2; (2) there is no evidence that a proportion of adult gannets do not breed on an annual basis (WWT 2012), and therefore it is assumed that 100% of birds in adult plumage are part of the breeding population.

Table 15A.5.4B Gannet Displacement – Breeding season, 2 km Buffer											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	61.61	123.23	184.84	246.45	308.07	369.68	431.29	492.91	554.52	616.13
	Adult birds (1)	59.89	119.78	179.66	239.55	299.44	359.33	419.22	479.11	538.99	598.88
	100% adults breeding (2)	59.89	119.78	179.66	239.55	299.44	359.33	419.22	479.11	538.99	598.88
2 year mean	All birds	53.32	106.63	159.95	213.27	266.58	319.90	373.22	426.53	479.85	533.17
	Adult birds (1)	51.82	103.65	155.47	207.30	259.12	310.94	362.77	414.59	466.42	518.24
	100% adults breeding (2)	51.82	103.65	155.47	207.30	259.12	310.94	362.77	414.59	466.42	518.24
(1) Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 97.2 per cent) as recorded during boat surveys in Year 1 and 2; (2) there is no evidence that a proportion of adult gannets do not breed on an annual basis (WWT 2012), and therefore it is assumed that 100% of birds in adult plumage are part of the breeding population.											

Table 15A.5.4C Gannet Displacement – Non-breeding season, Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	8.99	17.98	26.97	35.96	44.95	53.94	62.93	71.91	80.90	89.89
2 year mean All birds	7.77	15.53	23.30	31.06	38.83	46.60	54.36	62.13	69.89	77.66

Table 15A.5.4D Gannet Displacement – Non-breeding Season, 2 km Buffer										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	10.65	21.29	31.94	42.58	53.23	63.87	74.52	85.16	95.81	106.45
2 year mean All birds	9.53	19.07	28.60	38.13	47.67	57.20	66.73	76.26	85.80	95.33

Table 15A.5.5A Shag Displacement – Breeding Season, Development Area											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Adult birds (1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	50% adults breeding (2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 year mean	All birds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Adult birds (1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	50% adults breeding (2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(1): Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 86 per cent) as recorded during boat surveys in Year 1 and 2; (2) 50% of adult birds are assumed to be breeding											

Table 15A.5.5B Shag Displacement – Breeding Season, 2 km Buffer											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	0.07	0.14	0.21	0.28	0.35	0.42	0.49	0.56	0.63	0.70
	Adult birds (1)	0.06	0.12	0.18	0.24	0.30	0.36	0.42	0.48	0.54	0.60
	50% breeding (2)	0.03	0.06	0.09	0.12	0.15	0.18	0.21	0.24	0.27	0.30
2 year mean	All birds	0.04	0.07	0.11	0.14	0.18	0.21	0.25	0.28	0.32	0.35
	Adult birds (1)	0.03	0.06	0.09	0.12	0.15	0.18	0.21	0.24	0.27	0.30
	50% breeding (2)	0.02	0.03	0.05	0.06	0.08	0.09	0.11	0.12	0.14	0.15
(1): Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 86 per cent) as recorded during boat surveys in Year 1 and 2; (2) 50% of adult birds are assumed to be breeding											

Table 15A.5.5C Shag Displacement – Non-breeding Season, Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	0.02	0.03	0.05	0.07	0.09	0.10	0.12	0.14	0.16	0.17
2 year mean All birds	0.01	0.03	0.04	0.06	0.07	0.09	0.10	0.12	0.13	0.15

Table 15A.5.5D Shag Displacement – Non-breeding Season, 2 km Buffer										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	0.17	0.33	0.50	0.67	0.83	1.00	1.17	1.33	1.50	1.67
2 year mean All birds	0.12	0.24	0.36	0.48	0.60	0.73	0.85	0.97	1.09	1.21

Table 15A.5.6A Kittiwake Displacement – Breeding Season, Development Area											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	115.89	231.77	347.66	463.55	579.43	695.32	811.21	927.09	1042.98	1158.87
	Adult birds (1)	86.22	172.44	258.66	344.88	431.10	517.32	603.54	689.76	775.98	862.20
	100% adults breeding (2)	86.22	172.44	258.66	344.88	431.10	517.32	603.54	689.76	775.98	862.20
2 year mean	All birds	102.87	205.74	308.61	411.49	514.36	617.23	720.10	822.97	925.84	1028.72
	Adult birds (1)	76.54	153.07	229.61	306.15	382.68	459.22	535.75	612.29	688.83	765.36
	100% adults breeding (2)	76.54	153.07	229.61	306.15	382.68	459.22	535.75	612.29	688.83	765.36
(1) Estimates for adult birds are based on the stable age distribution calculated for the kittiwake PVA (Appendix 15B), and considered to be 74.4% of the total number of birds all age classes (excluding young in the nest as these have not fledged yet during this time of year); (2) 100% of adult birds are assumed to be breeding.											

Table 15A.5.6B Kittiwake Displacement – Breeding Season, 2 km Buffer											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	108.93	217.86	326.79	435.72	544.65	653.58	762.51	871.44	980.37	1089.3
	Adult birds (1)	81.04	162.09	243.13	324.17	405.22	486.26	567.31	648.35	729.39	810.44
	100% adults breeding (2)	81.04	162.09	243.13	324.17	405.22	486.26	567.31	648.35	729.39	810.44
2 year mean	All birds	96.78	193.57	290.35	387.13	483.92	580.70	677.48	774.27	871.05	967.84
	Adult birds (1)	72.01	144.01	216.02	288.03	360.03	432.04	504.05	576.06	648.06	720.07
	100% adults breeding (2)	72.01	144.01	216.02	288.03	360.03	432.04	504.05	576.06	648.06	720.07

(1) Estimates for adult birds are based on the stable age distribution calculated for the kittiwake PVA (Appendix 15B), and considered to be 74.4% of the total number of birds all age classes (excluding young in the nest as these have not fledged yet during this time of year); (2) 100% of adult birds are assumed to be breeding.

Table 15A.5.6C Kittiwake Displacement – Post-breeding Season, Development Area											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	67.41	134.82	202.23	269.64	337.05	404.46	471.87	539.28	606.69	674.10
	Adult birds (1)	40.85	81.70	122.55	163.40	204.25	245.10	285.95	326.80	367.65	408.50
2 year mean	All birds	63.03	126.07	189.10	252.13	315.17	378.20	441.23	504.27	567.30	630.33
	Adult birds (1)	38.20	76.40	114.59	152.79	190.99	229.19	267.39	305.59	343.78	381.98

(1) Estimates for adult birds are based on the stable age distribution calculated for the kittiwake PVA (Appendix 15B), and considered to be 60.6% of the total number of birds all age classes (including young as these have already fledged yet during this time of year and form part of the ‘at sea’ population).

Table 15A.5.6D Kittiwake Displacement – Post-breeding Season, 2 km Buffer											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	68.11	136.22	204.32	272.43	340.54	408.65	476.75	544.86	612.97	681.08
	Adult birds (1)	41.27	82.55	123.82	165.09	206.37	247.64	288.91	330.19	371.46	412.73
2 year mean	All birds	64.50	129.00	193.51	258.01	322.51	387.01	451.52	516.02	580.52	645.02
	Adult birds (1)	39.09	78.18	117.26	156.35	195.44	234.53	273.62	312.71	351.79	390.88

(1) Estimates for adult birds are based on the stable age distribution calculated for the kittiwake PVA (Appendix 15B), and considered to be 60.6% of the total number of birds all age classes (including young as these have already fledged yet during this time of year and form part of the ‘at sea’ population).

Table 15A.5.6E Kittiwake Displacement – Non-breeding Season, Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	32.43	64.85	97.28	129.71	162.14	194.56	226.99	259.42	291.84	324.27
2 year mean All birds	21.18	42.36	63.54	84.72	105.90	127.09	148.27	169.45	190.63	211.81

Table 15A.5.6F Kittiwake Displacement – Non-breeding Season, 2 km Buffer										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	59.34	118.69	178.03	237.37	296.72	356.06	415.40	474.74	534.09	593.43
2 year mean All birds	38.50	76.99	115.49	153.99	192.49	230.98	269.48	307.98	346.48	384.97

Table 15A.5.7A Little gull Displacement – Non-breeding Season (Autumn Passage), Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	1.89	3.78	5.66	7.55	9.44	11.33	13.22	15.11	16.99	18.88
2 year mean All birds	1.59	3.18	4.77	6.36	7.95	9.54	11.13	12.72	14.31	15.90

Table 15A.5.7B Little gull Displacement – Non-breeding Season (Autumn Passage), 2 km Buffer										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	1.75	3.49	5.24	6.99	8.74	10.48	12.23	13.98	15.73	17.47
2 year mean All birds	1.64	3.28	4.92	6.56	8.19	9.83	11.47	13.11	14.75	16.39

Table 15A.5.7C Little Gull Displacement – Non-breeding Season (winter), Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	3.21	6.42	9.64	12.85	16.06	19.27	22.48	25.70	28.91	32.12
2 year mean All birds	2.05	4.10	6.15	8.21	10.26	12.31	14.36	16.41	18.46	20.52

Table 15A.5.7D Little Gull Displacement – Non-breeding Season (winter), 2 km Buffer										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	1.54	3.08	4.62	6.16	7.70	9.24	10.78	12.32	13.86	15.40
2 year mean All birds	1.16	2.31	3.47	4.63	5.79	6.94	8.10	9.26	10.41	11.57

Table 15A.5.8A Common Gull Displacement – Non-breeding Season, Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	3.70	7.41	11.11	14.82	18.52	22.23	25.93	29.64	33.34	37.05
2 year mean All birds	2.22	4.44	6.67	8.89	11.11	13.33	15.56	17.78	20.00	22.22

Table 15A.5.8B Common Gull Displacement – Non-breeding season, 2 km Buffer										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	1.74	3.48	5.23	6.97	8.71	10.45	12.20	13.94	15.68	17.42
2 year mean All birds	1.00	2.01	3.01	4.02	5.02	6.03	7.03	8.04	9.04	10.04

Table 15A.5.9A Herring Gull Displacement – Breeding Season, Development Area											
Population		**Proportion displacement**									
		10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean	All birds	0.73	1.46	2.19	2.92	3.65	4.38	5.11	5.84	6.57	7.31
	Adult birds (1)	0.59	1.18	1.76	2.35	2.94	3.53	4.12	4.70	5.29	5.88
	50% adults breeding (2)	0.29	0.59	0.88	1.18	1.47	1.76	2.06	2.35	2.65	2.94
2 year mean	All birds	0.51	1.02	1.53	2.05	2.56	3.07	3.58	4.09	4.60	5.11
	Adult birds (1)	0.41	0.82	1.23	1.65	2.06	2.47	2.88	3.29	3.70	4.12
	50% adults breeding (2)	0.41	0.82	1.23	1.65	2.06	2.47	2.88	3.29	3.70	4.12
(1) Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 80.5 per cent) as recorded during boat surveys in Year 1 and 2; (2) 50% of which are assumed to be breeding											

Table 15A.5.9B Herring Gull Displacement – Breeding Season, 2 km Buffer											
Population		**Proportion displacement**									
		10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean	All birds	1.34	2.67	4.01	5.35	6.68	8.02	9.35	10.69	12.03	13.36
	Adult birds (1)	1.08	2.15	3.23	4.30	5.38	6.45	7.53	8.61	9.68	10.76
	50% adults breeding (2)	0.54	1.08	1.61	2.15	2.69	3.23	3.76	4.30	4.84	5.38
2 year mean	All birds	0.82	1.65	2.47	3.30	4.12	4.94	5.77	6.59	7.41	8.24
	Adult birds (1)	0.66	1.33	1.99	2.65	3.32	3.98	4.64	5.30	5.97	6.63
	50% adults breeding (2)	0.33	0.66	0.99	1.33	1.66	1.99	2.32	2.65	2.98	3.32
(1) Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 80.5 per cent) as recorded during boat surveys in Year 1 and 2; (2) 50% of which are assumed to be breeding											

Table 15A.5.9C Herring Gull Displacement – Non-breeding Season, Development Area										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	1.67	3.34	5.01	6.69	8.36	10.03	11.70	13.37	15.04	16.72
2 year mean All birds	1.21	2.41	3.62	4.83	6.04	7.24	8.45	9.66	10.87	12.07

Table 15A.5.9D Herring Gull Displacement – Non-breeding Season, 2 km buffer										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	3.68	7.35	11.03	14.71	18.38	22.06	25.74	29.41	33.09	36.76
2 year mean All birds	2.22	4.44	6.66	8.88	11.10	13.32	15.54	17.76	19.98	22.20

Table 15A.5.10A Great black-backed Gull Displacement – Breeding season, Development Area											
Population		**Proportion displacement**									
		10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean	All birds	0.16	0.31	0.47	0.63	0.78	0.94	1.09	1.25	1.41	1.56
	Adult birds (1)	0.08	0.17	0.25	0.34	0.42	0.50	0.59	0.67	0.76	0.84
	50% adults breeding (2)	0.04	0.08	0.13	0.17	0.21	0.25	0.29	0.34	0.38	0.42
2 year mean	All birds	0.15	0.30	0.45	0.61	0.76	0.91	1.06	1.21	1.36	1.52
	Adult birds (1)	0.08	0.16	0.24	0.33	0.41	0.49	0.57	0.65	0.73	0.82
	50% adults breeding (2)	0.04	0.08	0.12	0.16	0.20	0.24	0.29	0.33	0.37	0.41
(1) Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 53.8 per cent) as recorded during boat surveys in Year 1 and 2; (2) 50% of which are assumed to be breeding											

Table 15A.5.10B Great Black-backed Gull Displacement – Breeding Season, 2 km Buffer											
Population		**Proportion displacement**									
		10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean	All birds	0.06	0.12	0.19	0.25	0.31	0.37	0.44	0.50	0.56	0.62
	Adult birds (1)	0.03	0.07	0.10	0.13	0.17	0.20	0.23	0.27	0.30	0.33
	50% adults breeding (2)	0.02	0.03	0.05	0.07	0.08	0.10	0.12	0.13	0.15	0.17
2 year mean	All birds	0.03	0.06	0.09	0.12	0.16	0.19	0.22	0.25	0.28	0.31
	Adult birds (1)	0.02	0.03	0.05	0.07	0.08	0.10	0.12	0.13	0.15	0.17
	50% adults breeding (2)	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.08
(1) Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 53.8 per cent) as recorded during boat surveys in Year 1 and 2; (2) 50% of which are assumed to be breeding											

Table 15A.5.10C Great Black-backed Gull Displacement – Non-breeding Season, Development Area										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	2.59	5.17	7.76	10.35	12.94	15.52	18.11	20.70	23.29	25.87
2 year mean All birds	2.22	4.45	6.67	8.89	11.11	13.34	15.56	17.78	20.00	22.23

Table 15A.5.10D Great black-backed Gull Displacement – Non-breeding Season, 2 km Buffer										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	2.17	4.34	6.51	8.68	10.85	13.01	15.18	17.35	19.52	21.69
2 year mean All birds	1.90	3.81	5.71	7.62	9.52	11.43	13.33	15.23	17.14	19.04

Table 15A.5.11A Lesser black-backed Gull Displacement – Breeding Season, Development Area											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	1.58	3.16	4.74	6.31	7.89	9.47	11.05	12.63	14.21	15.79
	Adult birds (1)	1.36	2.71	4.07	5.42	6.78	8.14	9.49	10.85	12.20	13.56
	50% adults breeding (2)	0.68	1.36	2.03	2.71	3.39	4.07	4.75	5.42	6.10	6.78
2 year mean	All birds	1.10	2.21	3.31	4.41	5.52	6.62	7.72	8.83	9.93	11.03
	Adult birds (1)	0.95	1.90	2.84	3.79	4.74	5.69	6.63	7.58	8.53	9.48
	50% adults breeding (2)	0.47	0.95	1.42	1.90	2.37	2.84	3.32	3.79	4.26	4.74
(1) Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 85.9 per cent) as recorded during boat surveys in Year 1 and 2; (2) 50% of which are assumed to be breeding											

Table 15A.5.11B Lesser Black-backed Gull Displacement – Breeding Season, 2 km Buffer											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	2.12	4.23	6.35	8.47	10.58	12.70	14.81	16.93	19.05	21.16
	Adult birds (1)	1.82	3.64	5.45	7.27	9.09	10.91	12.73	14.54	16.36	18.18
	50% adults breeding (2)	0.91	1.82	2.73	3.64	4.54	5.45	6.36	7.27	8.18	9.09
2 year mean	All birds	1.29	2.57	3.86	5.15	6.44	7.72	9.01	10.30	11.58	12.87
	Adult birds (1)	1.11	2.21	3.32	4.42	5.53	6.63	7.74	8.85	9.95	11.06
	50% adults breeding (2)	0.55	1.11	1.66	2.21	2.76	3.32	3.87	4.42	4.98	5.53
(1) Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 85.9 per cent) as recorded during boat surveys in Year 1 and 2; (2) 50% of which are assumed to be breeding											

Table 15A.5.12A Arctic Tern Displacement – Breeding Season, Development Area											
Population		**Proportion displacement**									
		10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean	All birds	0.73	1.47	2.20	2.93	3.67	4.40	5.14	5.87	6.60	7.34
	Adult birds (1)	0.57	1.14	1.72	2.29	2.86	3.43	4.01	4.58	5.15	5.72
	50% adults breeding (2)	0.29	0.57	0.86	1.14	1.43	1.72	2.00	2.29	2.58	2.86
2 year mean	All birds	0.65	1.29	1.94	2.59	3.23	3.88	4.53	5.18	5.82	6.47
	Adult birds (1)	0.50	1.01	1.51	2.02	2.52	3.03	3.53	4.04	4.54	5.05
	50% adults breeding (2)	0.25	0.50	0.76	1.01	1.26	1.51	1.77	2.02	2.27	2.52
(1) Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 78 per cent) as recorded during boat surveys in Year 1 and 2; (2) 50% of which are assumed to be breeding											

Table 15A.5.12B Arctic Tern Displacement – Breeding Season, 2 km buffer											
Population		**Proportion displacement**									
		10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean	All birds	2.19	4.38	6.57	8.76	10.95	13.14	15.33	17.52	19.71	21.90
	Adult birds (1)	1.71	3.42	5.13	6.83	8.54	10.25	11.96	13.67	15.38	17.08
	50% adults breeding (2)	0.85	1.71	2.56	3.42	4.27	5.13	5.98	6.83	7.69	8.54
2 year mean	All birds	1.10	2.19	3.29	4.38	5.48	6.57	7.67	8.76	9.86	10.95
	Adult birds (1)	0.85	1.71	2.56	3.42	4.27	5.13	5.98	6.83	7.69	8.54
	50% adults breeding (2)	0.43	0.85	1.28	1.71	2.14	2.56	2.99	3.42	3.84	4.27
(1) Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 78 per cent) as recorded during boat surveys in Year 1 and 2; (2) 50% of which are assumed to be breeding											

Table 15A.5.12C Arctic Tern Displacement – Post-breeding Season, Development Area										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	24.12	48.25	72.37	96.50	120.62	144.75	168.87	193.00	217.12	241.25
2 year mean All birds	12.18	24.37	36.55	48.73	60.92	73.10	85.29	97.47	109.65	121.84

Table 15A.5.12D Arctic Tern Displacement – Post-breeding Season, 2 km Buffer										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	5.73	11.46	17.19	22.92	28.64	34.37	40.10	45.83	51.56	57.29
2 year mean All birds	4.55	9.10	13.65	18.21	22.76	27.31	31.86	36.41	40.96	45.51

Table 15A.5.13A Common Tern Displacement – Breeding Season, Development Area											
Population		**Proportion displacement**									
		10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean	All birds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Adult birds (1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	50% adults breeding (2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 year mean	All birds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Adult birds (1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	50% adults breeding (2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(1) Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 100 per cent) as recorded during boat surveys in Year 1 and 2; (2) 50% of which are assumed to be breeding											

Table 15A.5.13B Common Tern Displacement – Breeding Season, 2 km Buffer											
Population		**Proportion displacement**									
		10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean	All birds	0.19	0.39	0.58	0.78	0.97	1.17	1.36	1.56	1.75	1.95
	Adult birds (1)	0.19	0.39	0.58	0.78	0.97	1.17	1.36	1.56	1.75	1.95
	50% adults breeding (2)	0.10	0.19	0.29	0.39	0.49	0.58	0.68	0.78	0.88	0.97
2 year mean	All birds	0.13	0.26	0.39	0.51	0.64	0.77	0.90	1.03	1.16	1.29
	Adult birds (1)	0.13	0.26	0.39	0.51	0.64	0.77	0.90	1.03	1.16	1.29
	50% adults breeding (2)	0.06	0.13	0.19	0.26	0.32	0.39	0.45	0.51	0.58	0.64
(1) Estimates for adult birds are based on the average proportion of adults present in the breeding season (average: 100 per cent) as recorded during boat surveys in Year 1 and 2; (2) 50% of which are assumed to be breeding											

Table 15A.5.13C Common Tern Displacement – Post-breeding Season, Development Area										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 year mean All birds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 15A.5.13D Common Tern Displacement – Post-breeding season, 2 km Buffer										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	2.81	5.61	8.42	11.22	14.03	16.83	19.64	22.45	25.25	28.06
2 year mean All birds	1.40	2.81	4.21	5.61	7.01	8.42	9.82	11.22	12.63	14.03

Table 15A.5.14A Guillemot Displacement – Breeding Season, Development Area											
Population		**Proportion displacement**									
		10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean	All birds	213.57	427.14	640.71	854.29	1067.86	1281.43	1495.00	1708.57	1922.14	2135.72
	Adult birds (1)	178.55	357.09	535.64	714.18	892.73	1071.27	1249.82	1428.37	1606.91	1785.46
	100% adults breeding (2)	178.55	357.09	535.64	714.18	892.73	1071.27	1249.82	1428.37	1606.91	1785.46
2 year mean	All birds	209.20	418.40	627.59	836.79	1045.99	1255.19	1464.38	1673.58	1882.78	2091.98
	Adult birds (1)	174.89	406.68	610.02	813.36	1016.70	1220.04	1423.38	1626.72	1830.06	2033.40
	100% adults breeding (2)	174.89	406.68	610.02	813.36	1016.70	1220.04	1423.38	1626.72	1830.06	2033.40
(1) Estimates for adult birds are based on the stable age distribution calculated for the guillemot PVA (Appendix 15B), and considered to be 83.6 per cent of the total number of birds all age classes (excluding young in the nest as these have not fledged yet during this time of year); (2)											

Table 15A.5.14B Guillemot Displacement – Breeding Season, 2 km Buffer											
Population		**Proportion displacement**									
		10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean	All birds	223.56	447.12	670.68	894.24	1117.80	1341.36	1564.92	1788.48	2012.04	2235.61
	Adult birds (1)	186.90	373.79	560.69	747.59	934.48	1121.38	1308.28	1495.17	1682.07	1868.97
	100% adults breeding (2)	186.90	373.79	560.69	747.59	934.48	1121.38	1308.28	1495.17	1682.07	1868.97
2 year mean	All birds	201.96	403.92	605.88	807.85	1009.81	1211.77	1413.73	1615.69	1817.65	2019.62
	Adult birds (1)	168.84	337.68	506.52	675.36	844.20	1013.04	1181.88	1350.72	1519.56	1688.40
	100% adults breeding (2)	168.84	337.68	506.52	675.36	844.20	1013.04	1181.88	1350.72	1519.56	1688.40
(1) Estimates for adult birds are based on the stable age distribution calculated for the guillemot PVA (Appendix 15B), and considered to be 83.6 per cent of the total number of birds all age classes (excluding young in the nest as these have not fledged yet during this time of year); (2)											

Table 15A.5.14C Guillemot Displacement – Post-breeding Season, Development Area										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	139.45	278.91	418.36	557.81	697.27	836.72	976.17	1115.63	1255.08	1394.53
2 year mean All birds	122.37	244.75	367.12	489.50	611.87	734.25	856.62	979.00	1101.37	1223.75

Table 15A.5.14D Guillemot Displacement – Post-breeding Season, 2 km Buffer										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	178.22	356.45	534.67	712.89	891.11	1069.34	1247.56	1425.78	1604.01	1782.23
2 year mean	141.15	282.30	423.45	564.60	705.74	846.89	988.04	1129.19	1270.34	1411.49

Table 15A.5.14E Guillemot Displacement – Non-breeding Season, Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	82.98	165.96	248.94	331.91	414.89	497.87	580.85	663.83	746.81	829.79
2 year mean All birds	77.55	155.11	232.66	310.21	387.77	465.32	542.87	620.43	697.98	775.53

Table 15A.5.14F Guillemot Displacement – Non-breeding Season, 2 km Buffer										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	93.07	186.13	279.20	372.26	465.33	558.39	651.46	744.52	837.59	930.65
2 year mean All birds	82.57	165.14	247.71	330.29	412.86	495.43	578.00	660.57	743.14	825.72

Table 15A.5.15A Razorbill Displacement – Breeding Season, Development Area											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	84.03	168.06	252.09	336.12	420.15	504.18	588.21	672.24	756.27	840.30
	Adult birds (1)	73.69	147.39	221.08	294.78	368.47	442.17	515.86	589.56	663.25	736.95
	100% adults breeding (2)	73.69	147.39	221.08	294.78	368.47	442.17	515.86	589.56	663.25	736.95
2 year mean	All birds	83.74	167.48	251.22	334.96	418.69	502.43	586.17	669.91	753.65	837.39
	Adult birds (1)	73.44	146.88	220.32	293.76	367.19	440.63	514.07	587.51	660.95	734.39
	100% adults breeding (2)	73.44	146.88	220.32	293.76	367.19	440.63	514.07	587.51	660.95	734.39
(1) Estimates for adult birds are based on the stable age distribution calculated for the razorbill PVA (Appendix 15B), and considered to be 87.7 per cent of the total number of birds all age classes (excluding young in the nest as these have not fledged yet during this time											

Table 15A.5.15B Razorbill Displacement – Breeding Season, 2 km Buffer											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	79.62	159.25	238.87	318.49	398.12	477.74	557.36	636.99	716.61	796.23
	Adult birds (1)	69.83	139.66	209.49	279.32	349.15	418.98	488.81	558.64	628.47	698.30
	100% adults breeding (2)	69.83	139.66	209.49	279.32	349.15	418.98	488.81	558.64	628.47	698.30
2 year mean	All birds	70.21	140.42	210.63	280.83	351.04	421.25	491.46	561.67	631.88	702.08
	Adult birds (1)	61.57	123.15	184.72	246.29	307.86	369.44	431.01	492.58	554.15	615.73
	100% adults breeding (2)	61.57	123.15	184.72	246.29	307.86	369.44	431.01	492.58	554.15	615.73
(1) Estimates for adult birds are based on the stable age distribution calculated for the razorbill PVA (Appendix 15B), and considered to be 87.7 per cent of the total number of birds all age classes (excluding young in the nest as these have not fledged yet during this time											

Table 15A.5.15C Razorbill Displacement – Post-breeding Season, Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	130.04	260.09	390.13	520.18	650.22	780.27	910.31	1040.35	1170.40	1300.44
2 year mean All birds	101.67	203.34	305.02	406.69	508.36	610.03	711.71	813.38	915.05	1016.72

Table 15A.5.15D Razorbill Displacement – Post-breeding Season, 2 km Buffer										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	156.99	313.97	470.96	627.95	784.94	941.92	1098.91	1255.90	1412.89	1569.87
2 year mean All birds	132.60	265.19	397.79	530.39	662.99	795.58	928.18	1060.78	1193.38	1325.97

Table 15A.5.15E Razorbill Displacement – Non-breeding Season, Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	37.39	74.78	112.17	149.56	186.95	224.34	261.73	299.12	336.51	373.90
2 year mean All birds	26.41	52.82	79.23	105.63	132.04	158.45	184.86	211.27	237.68	264.09

Table 15A.5.15F Razorbill Displacement – Non-breeding Season, 2 km Buffer										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	27.71	55.42	83.14	110.85	138.56	166.27	193.99	221.70	249.41	277.12
2 year mean All birds	23.72	47.45	71.17	94.89	118.62	142.34	166.06	189.78	213.51	237.23

Table 15A.5.16A Puffin Displacement – Breeding Season, Development Area											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	198.75	397.50	596.25	795.00	993.75	1192.49	1391.24	1589.99	1788.74	1987.49
	Adult birds (1)	163.17	326.35	489.52	652.69	815.86	979.04	1142.21	1305.38	1468.56	1631.73
	100% adults breeding (2)	163.17	326.35	489.52	652.69	815.86	979.04	1142.21	1305.38	1468.56	1631.73
2 year mean	All birds	159.26	318.52	477.78	637.04	796.30	955.56	1114.82	1274.08	1433.34	1592.60
	Adult birds (1)	130.75	261.51	392.26	523.01	653.76	784.52	915.27	1046.02	1176.77	1307.53
	100% adults breeding (2)	130.75	261.51	392.26	523.01	653.76	784.52	915.27	1046.02	1176.77	1307.53
(1) Estimates for adult birds are based on the stable age distribution calculated for the puffin PVA (Appendix 15B), and considered to be 82.1 per cent of the total number of birds all age classes (excluding young in the nest as these have not fledged yet during this time of year); (2)											

Table 15A.5.16B Puffin Displacement – Breeding Season, 2 km Buffer											
Population		Proportion displacement									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean	All birds	161.21	322.42	483.64	644.85	806.06	967.27	1128.49	1289.70	1450.91	1612.12
	Adult birds (1)	132.36	264.71	397.07	529.42	661.78	794.13	926.49	1058.84	1191.20	1323.55
	100% adults breeding (2)	132.36	264.71	397.07	529.42	661.78	794.13	926.49	1058.84	1191.20	1323.55
2 year mean	All birds	127.49	254.99	382.48	509.98	637.47	764.96	892.46	1019.95	1147.45	1274.94
	Adult birds (1)	104.67	209.34	314.02	418.69	523.36	628.03	732.71	837.38	942.05	1046.72
	100% adults breeding (2)	104.67	209.34	314.02	418.69	523.36	628.03	732.71	837.38	942.05	1046.72
(1) Estimates for adult birds are based on the stable age distribution calculated for the puffin PVA (Appendix 15B), and considered to be 82.1 per cent of the total number of birds all age classes (excluding young in the nest as these have not fledged yet during this time of year); (2)											

Table 15A.5.16C Puffin Displacement – Post-breeding Season, Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	139.43	278.85	418.28	557.70	697.13	836.55	975.98	1115.40	1254.83	1394.26
2 year mean All birds	74.22	148.45	222.67	296.89	371.12	445.34	519.56	593.79	668.01	742.23

Table 15A.5.16D Puffin Displacement – Post-Breeding season, 2 km Buffer										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	129.44	258.89	388.33	517.78	647.22	776.67	906.11	1035.56	1165.00	1294.44
2 year mean All birds	76.44	152.88	229.32	305.75	382.19	458.63	535.07	611.51	687.95	764.38

Table 15A.5.16E Puffin Displacement – Non-Breeding Season, Development Area										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	23.18	46.35	69.53	92.70	115.88	139.05	162.23	185.41	208.58	231.76
2 year mean All birds	15.54	31.08	46.61	62.15	77.69	93.23	108.77	124.31	139.84	155.38

Table 15A.5.16F Puffin Displacement – Non-breeding Season, 2 km Buffer										
Population	Proportion displacement									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Peak mean All birds	14.91	29.82	44.73	59.65	74.56	89.47	104.38	119.29	134.20	149.11
2 year mean All birds	9.17	18.35	27.52	36.69	45.87	55.04	64.21	73.39	82.56	91.73

Table 15A.5.17A Little Auk Displacement – Non-breeding Season, Development Area										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	118.95	237.91	356.86	475.81	594.77	713.72	832.67	951.62	1070.58	1189.53
2 year mean All birds	62.46	124.91	187.37	249.82	312.28	374.73	437.19	499.64	562.10	624.55

Table 15A.5.17B Little auk Displacement – Non-Breeding Season, 2 km Buffer										
Population	**Proportion displacement**									
	10%	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Peak mean All birds	112.97	225.94	338.91	451.88	564.85	677.82	790.79	903.76	1016.73	1129.70
2 year mean All birds	59.49	118.99	178.48	237.98	297.47	356.96	416.46	475.95	535.44	594.94