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Abbreviations and Acronyms

AIC	Akaike Information Criterion
AOS	Apparently Occupied Sites
BDMPS	Biologically Defined Minimum Population Scale
CRM	Collision Risk Modelling
COWRIE	Collaborative Offshore Wind Research into the Environment
ESAS	European Seabirds at Sea
FAME	Future of the Atlantic Marine Environment
GPS	Global Positioning System
HRA	Habitats Regulations Appraisal
ICOL	Inch Cape Offshore Limited
MS-LOT	Marine Scotland Licensing Operations Team
RSPB	Royal Society for the Protection of Birds
SMP	Seabird Monitoring Programme
SNH	Scottish Natural Heritage
SPA	Special Protection Area
STAR	Seabird Tracking and Research

11A   Offshore Ornithology Baseline Survey Report

11A.1 Introduction

1   This report provides details of the methods used to collect data on the birds present within the Development Area and buffer. These data were then analysed to provide robust estimates of species abundance in the Development Area and buffer, for both birds in flight and birds on the water.

2   Following the Scoping Opinion of Marine Scotland Licensing Operations Team (MS-LOT), and the advice from Scottish Natural Heritage (SNH) and Royal Society for the Protection of Birds (RSPB) therein, this baseline report focuses on six key species identified for assessment:

- Gannet;

- Kittiwake;

- Herring gull;

- Guillemot;

- Razorbill; and,

- Puffin.

3   The background to the regional population scale for breeding and non-breeding seasons is provided, and an appropriate regional population size for each species is estimated from published information. This information provides a suitable baseline from which to compare predicted impacts on key seabird populations.

11A.2 Methodology

11A.2.1 Baseline Surveys

Survey approach

4   A boat-based survey methodology for seabirds at sea was deployed for the Development Area and a four kilometre buffer (subsequently referred to as the Survey Area). The survey programme was adapted from 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). Following the advice of the Scoping Opinion, the assessment focussed on the Development Area and two kilometre buffer[1].

5   Monthly seabird surveys in the Survey Area, began in September 2010, and continued for two consecutive years until September 2012. In their Scoping Opinion, MS-LOT agreed with the recommendations of SNH that these survey data remained suitable for this assessment.

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[1] Note that population sizes for the two kilometre buffer were derived by extrapolation from the estimated densities within the four kilometre buffer (as agreed with MS-LOT and SNH in letter of 17 October 2017 from MS-LOT to ICOL).

6   Two survey vessels were used throughout the survey programme: the Fleur de Lys from September 2010 to January 2011, and the Eileen May from February 2011 until the completion of the surveys in September 2012. Both vessels complied with the main requirements of Camphuysen *et al*. (2004), although the Eileen May was 17 m in length, slightly short of the 20 m minimum recommendation of Camphuysen *et al*. (2004). Prior to deploying this vessel, Inch Cape Offshore Limited (ICOL) agreed with SNH that the Eileen May was a sufficiently stable platform for carrying out boat-based surveys. This is the main purpose of the minimum 20 m vessel length recommend by Camphuysen *et al*. (2004).

7   Fourteen transects, with a total length of 219 km, were spaced at two kilometre intervals to minimise double-recording of mobile bird species. Transects were situated approximately perpendicular to the coast in an east-west orientation, parallel to the depth gradient. This design is consistent with Camphuysen *et al.* (2004) recommendations.

8   During each survey, the vessel's Global Positioning System (GPS) receiver continuously recorded the survey track. In addition, surveyors used a handheld GPS receiver to record the vessel's location every 60 seconds, i.e. approximately every 300 m at a speed of 10 knots.

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

10   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, and observers rotated through roles. This reduced fatigue and ensured visual acuity was maintained.

11   Seabird surveys were not undertaken in visibility of less than 300 m, which would have effectively reduced the transect strip width.

<u>Survey Effort</u>

12   A total of 24 surveys were undertaken between September 2010 and September 2012 (*Table 11A.1*). 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 of the baseline surveys were undertaken over consecutive days or in single days (during summer months). Thus, for the majority of surveys, bias in capturing the seasonal composition of highly mobile bird communities was minimal.

13   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.

14   Except for the very first survey, the subsequent 23 surveys fully covered the Survey Area each month. Slight differences in vessel tracks between months resulted in different

distances surveyed in relation to the theoretical transect layout (*Table 11A.1*), although essentially 100 per cent coverage was achieved during every survey.

15   ICOL undertook an additional survey in September 2012, to ensure that two complete, consecutive breeding seasons (2011 and 2012) were sampled.

Table 11A.1 Spatial and temporal coverage of boat-based surveys

Survey	Dates	Distance surveyed (km)	Percentage completed (%)
1	21 – 23 September 2010	90.2	41.19
2	13 – 15 October 2010	211.4	96.53
3	21, 30-31 December 2010	214.6	97.99
4	18 - 20 January 2011	211.7	96.67
5	22, 27 February 2011	219.3	100.14
6	4 – 5 March 2011	219.3	100.14
7	14 – 15 April 2011	218.2	99.63
8	3 June 2011	213.4	97.44
9	19 – 20 June 2011	215.7	98.49
10	10 – 11 July 2011	218.2	99.63
11	3, 5 August 2011	218.9	99.95
12	29 - 30 September 2011	218.3	99.68
13	12 -13 October 2011	218.6	99.82
14	5 – 6 November 2011	218.5	99.77
15	15 – 16, 19, 21 December 2011	216.7	98.95
16	13 – 15 January 2012	218.0	99.54
17	2 – 3 February 2012	218.6	99.82
18	11 – 13 March 2012	218.2	99.63
19	7 – 8 April 2012	218.4	99.72
20	6 May 2012	218.7	99.86
21	5 June 2012	218.3	99.68

Survey	Dates	Distance surveyed (km)	Percentage completed (%)
22	10 July 2012	218.5	99.77
23	7 – 8 August 2012	218.2	99.63

Sea State Conditions

16   Surveys in year one (September 2010 to August 2011) were carried out in predominantly good to excellent sea state conditions (*Figure 11A.1*). Nearly 85 per cent of all survey effort was undertaken in sea states 0-3, with 15 per cent undertaken in sea state four. Sea state five was only encountered briefly in October 2010 for a period of about 15 minutes.

17   Surveys in year two (September 2011 to September 2012) encountered very similar conditions, with 82 per cent of all survey effort undertaken in sea states 0-3 and about 18 per cent in sea state four. In December 2011 a total of 15 minutes of sea state five was experienced.

18   The observations made in sea state five were omitted from analysis, though there were few of these relative to the data collected in sea states of four or less.

Figure 11A.1 Proportional distribution of sea state conditions during boat-based surveys of the Survey Area in years one and two.
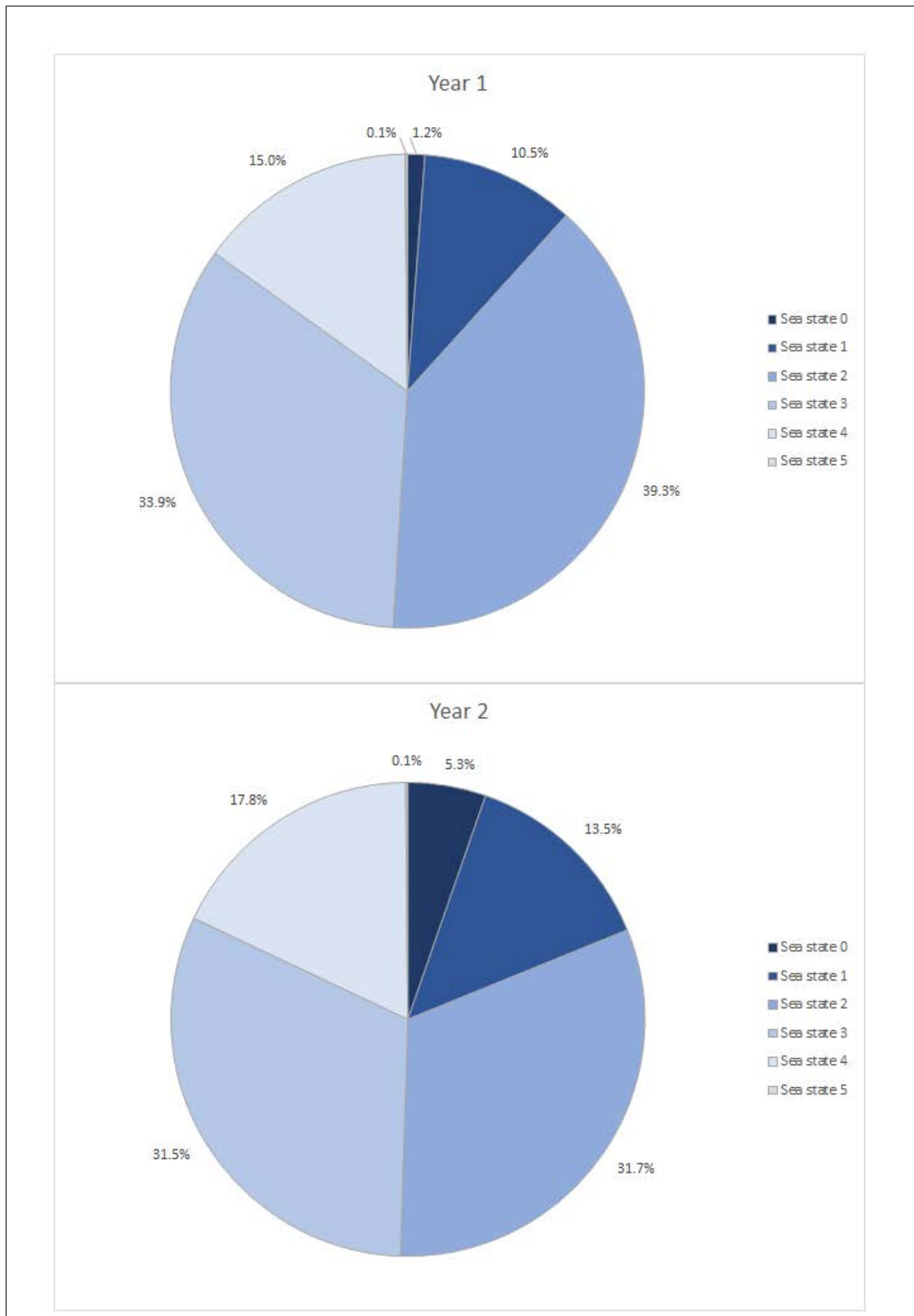
Distance Bands

19   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 also recorded, though with lower priority.

20   For distance sampling (Thomas *et al*. 2010) the recording zone for birds on the water was divided into five bands, with distances perpendicular to the transect line. Distance categories were divided into 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.

21   Data collected in sea states of five or more (Beaufort scale) were not used for distance sampling analysis.

22   Observations of note recorded on the 'off-effort' side of the vessel or on transect tails were also excluded from analysis.

Snapshots

23   Birds in flight were not allocated to distance bands. Instead, at the end of each recording interval (every 60 seconds, so approximately every 300 m), a 'snapshot' was taken of all birds seen in flight within a 300 x 300 m box on the relevant side of the boat. These data were used to estimate the aerial density of birds.

24   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.

25   Birds in flight which were clearly associated with the survey vessel were recorded but excluded from further analysis.

Flight Heights

26   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 five 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.

11A.2.2 Determination of the Zone of Influence

27   To establish the ornithological importance of the Development Area and two kilometre buffer and ultimately the potential impact magnitude of the Wind Farm on bird populations at a range of geographic scales was used:

- International: the bio-geographic population estimate for each species defined by BirdLife International (2004);

- National: the national (UK) population estimate for each species (breeding and non-breeding) from Musgrove *et al*. (2013). However, it should be noted, that these were the same as those in Baker *et al*. (2006), who provided more precise estimates which were rounded by Musgrove *et al*. (2013);

- Regional (breeding season): the regional population estimate for each species was from the Seabird Monitoring Programme (SMP) database and Mitchell *et al*. (2004). The regional spatial scale for each species was defined using the mean of the maximum foraging range (Thaxter *et al*. 2012);

- Regional (autumn and spring passage and non-breeding seasons): the Biologically Defined Minimum Population Scales (BDMPS) for the North Sea or the North Sea and English Channel, as listed in Furness (2015), with additional information from Skov *et al*. (1995) for context.

28   Following the Scoping Opinion of MS-LOT (which includes the scoping response of SNH), the regional population for each species was defined by the mean of the maximum foraging range from Thaxter *et al*. (2012). The RSPB stated in its scoping response that it could provide additional information on the foraging ranges of key species based on more recent tracking data, some of which has indicated longer foraging ranges than those reported by Thaxter *et al*. (2012). However, the data provided by RSPB were a subset of the full tracking data from UK colonies held by RSPB from the Future of the Atlantic Marine Environment (FAME) and Seabird Tracking and Research (STAR) projects. This subset was the data that were owned solely by RSPB. As such, it was considered that these data could not be assumed to be representative of the full dataset.

29   Further advice received from MS-LOT stated that it would be appropriate to determine colony connectivity (and hence the regional populations) on the basis of the Thaxter *et al.* (2012) foraging range data (unless the Marine Scotland Apportioning Tool became available in time for use in the assessment, which it did not). Had longer foraging ranges being used for the assessment of the regional population scale in the breeding season, the predicted impacts would have been compared with larger population sizes. Therefore, the approach taken here is more precautionary than would have been the case, had longer foraging ranges been used.

11A.3 Analysis

11A.3.1 Baseline Surveys

30   Analysis of boat-based survey data to provide density and abundance estimates within the Survey Area (separately for the Development Area and buffer) was different for birds on the water and birds in flight.

Birds on the Water

31   Observations of birds on the water (within distance bands A to D) were analysed using Distance 6.0 (Buckland *et al*. 2001; Thomas *et al*. 2010). Herring gull had too few observations of birds on the water to estimate densities using distance; monthly peak count was used instead for this species.

32   Half-normal models with cosine adjustment terms were initially used for all key species, except herring gull, 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 (AIC). Sea state was incorporated into models as a covariate where this made an improvement (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.

33   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.

Allocation of Unknown Species Group Observations to Species

34   Following Maclean *et al*. (2009), to account for unidentified birds (i.e. unidentified guillemot/razorbill) in the distance sampling analysis, an attempt was made to assign unidentified birds to a species based on the relative abundances of identified species. This was only investigated for observations of unidentified auks (n=88) and unidentified guillemot/razorbills (n=228).

35   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. In addition, given the small proportion of observations involving such birds, it was considered that there was limited value in trying to incorporate these into detection models and the subsequent density and abundance estimates.

Birds in Flight

36   Boat-based data of birds in flight are not suitable for distance sampling as this method tends to overestimate the number of birds present (Maclean *et al*. 2009), therefore violating the assumptions of the model. Instead, 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 four kilometre buffer (separately for each of these two areas) to provide an abundance estimate of the number of flying birds.

37   These estimates are provided in conjunction with the density and population estimates as derived through distance sampling for birds on the water, in order to provide total densities and population estimates for key species within the Development Area and within the four kilometre buffer.

38   Subsequent to these analyses, the Scoping Opinion from MS-LOT advised that the assessment should be based upon consideration of densities and population estimates using a two kilometre buffer around the Development Area. Therefore, densities for the two kilometre buffer were extrapolated from the estimates for the four kilometre buffer (based upon the difference in areas)[1].

39   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.

11A.4 Results

40   A total of 65,879 individual birds were recorded across all boat-based surveys undertaken between September 2010 and September 2012. Observations were distributed over 54 species and seven unidentified species groups. All count data relating to the six species that are the focus of this report (and of the assessment) collected during the baseline surveys are provided in *Annex 11A.2: Boat-Based Survey Data*. Thus, the raw count data from the surveys for each of these six species are presented for the Development Area and four kilometre buffer separately in *Tables 11A.2.1* and *11A.2.2*, whilst the resulting population estimates for the Development Area and the four kilometre buffer are presented for each individual survey in *Tables 11A.2.3* to *11A.2.8*.

41   SNH advice prior to the commencement of boat-based surveys was to undertake surveys in the Development Area and a four kilometre buffer. However, the Scoping Opinion from MS-LOT stated that the impact assessment should be based on a two kilometre buffer, in line with current SNH advice. The distribution of the records for each species in the Development Area, two kilometre and four kilometre buffers are shown in *Annex 11A.1*.

11A.5 Species Accounts

42   Accounts for each species provide information on baseline populations, including regional breeding and non-breeding populations. An overview of population estimates in the Development Area and a two kilometre buffer is illustrated with graphs and maps. Where

available, detail is provided on age distribution, flight direction and flight height patterns and foraging behaviour.

43   The key species, as determined in the Scoping Opinion of MS-LOT were:

- Gannet;

- Kittiwake;

- Guillemot;

- Razorbill; and,

- Puffin.

44   Plus, as an additional species, if collision risk modelling (CRM) shows important potential impacts:

- Herring gull.

11A.5.1 Gannet

45   The UK breeding population of gannets (218,546 pairs; Baker *et al*. 2006), totals more than half of the global breeding population, which has been estimated at 390,000 pairs (Mitchell *et al*. 2004). Gannet is listed as "Amber" conservation concern within the UK, as its population is of international importance and 50 per cent of the population occurs at fewer than 10 sites (Eaton *et al*. 2015).

46   Gannets can return to breeding colonies as early as January with levels of attendance generally increasing until April, when the first eggs are laid (Snow & Perrins 1998). The breeding season in the Forth and Tay region was recommended as mid-March to September (based on the Scoping Opinion from MS-LOT dated 10 August 2017).

Regional Population Size and Trends

47   The regional population of gannets in the breeding season is dominated by the colony on the Bass Rock (part of the Forth Islands Special Protection Area (SPA)). An aerial survey of the Bass Rock in 2014 counted a mean total of 75,259 apparently occupied sites (AOS) (Murray *et al.* 2014), making this colony the largest in the world for this species. The population has increased from 21,589 pairs in 1985 with an average annual growth rate of 1.045 (*Figure 11A.2*).

48   This is a higher growth rate than for the UK as a whole (1.023) or all of Scotland (1.022). It is likely that the population size of breeding gannets on the Bass Rock is reaching saturation, and further growth is unlikely due to a lack of space for further nesting sites. The recent colonisation of St Abb's Head suggests that saturation at the Bass Rock may have already occurred. It is also notable that another new colony formed in 2007 on Berneray, suggesting that saturation may be occurring in other colonies in Scotland. Overall, it is clear that the UK, Scottish and local gannet populations are very healthy and increasing.

Figure 11A.2 Change in gannet population size at Bass Rock between 1985 and 2014.
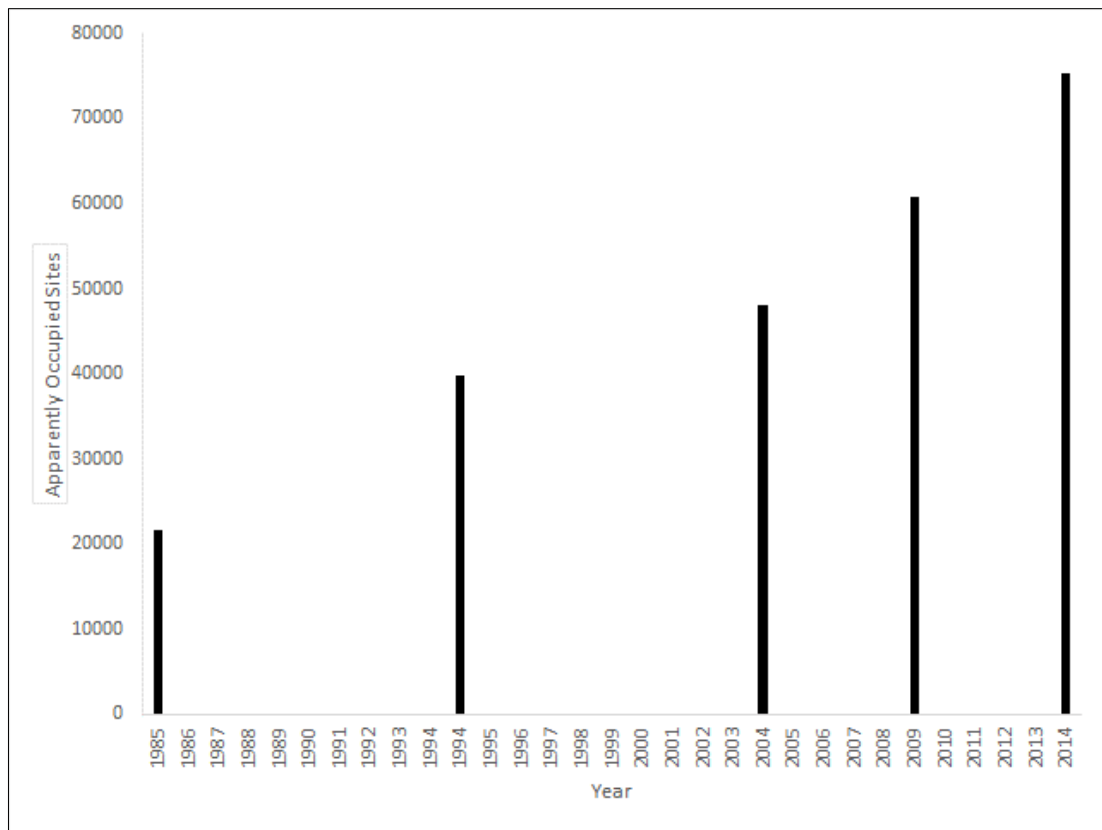
49   In addition to the colony on the Bass Rock, the gannet colony at Troup Head may also contribute to the regional population of gannets in the breeding season, as this has not been sampled using GPS tracking. However, Wakefield *et al*. (2013) showed little overlap in foraging areas used by birds from colonies that were sampled using tracking, so connectivity between the Development Area and this colony is unlikely, or at least will be very limited. The Troup Head colony has also shown sustained growth since it was colonised in 1988 (*Figure 11A.3*). It should be noted that the colony count in 2014 was an aerial survey (Murray *et al.* 2014), and is likely to be more accurate than land based counts undertaken in 2013 and 2016. The population size is therefore likely to be larger now than the count in 2014 of 6,456 AOS.

Figure 11A.3 Change in gannet population size at Troup Head between 1986 and 2016.
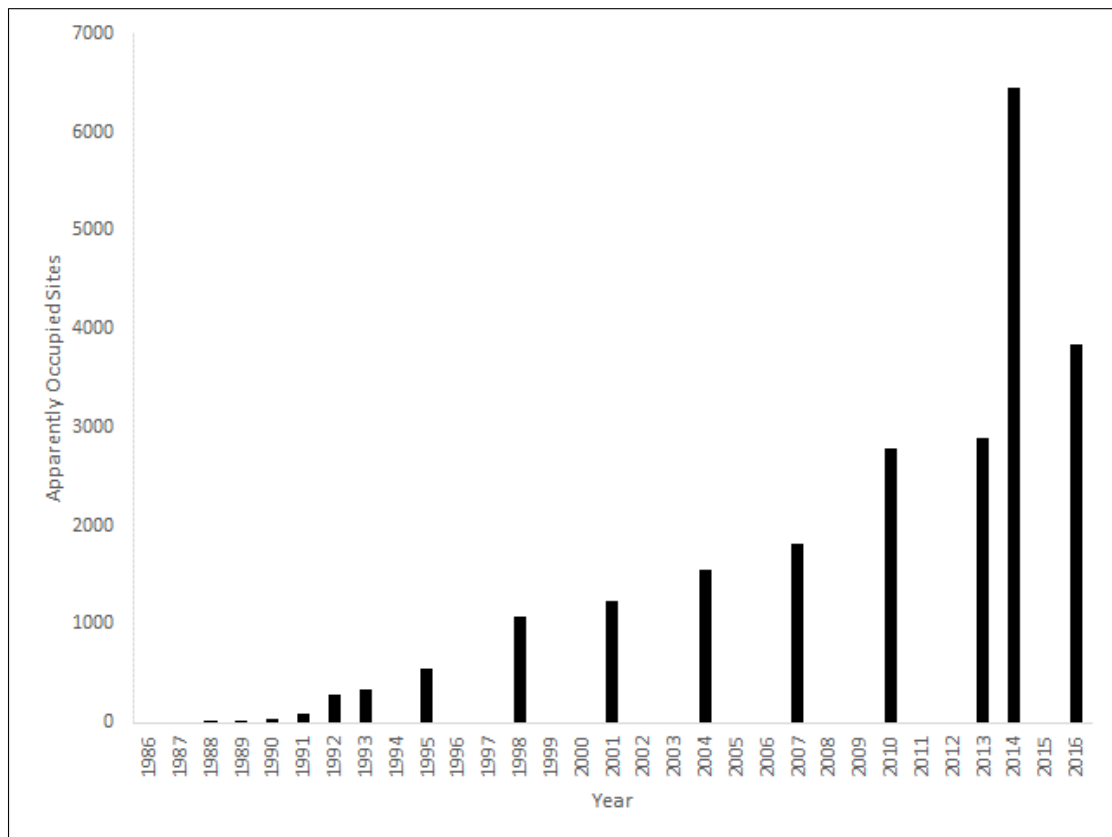
50   In their Scoping Opinion MS-LOT advised that the non-breeding season assessment for gannet should include collision estimates for all UK North Sea and Channel wind farms. In their Scoping Opinion, MS-LOT recommended using the BDMPS to determine the regional populations (Furness, 2015). The temporal scale of the BDMPS for gannet is divided between an autumn period (September to November), and a spring period (December to March). The spatial scale of the BDMPS is the UK North Sea and English Channel. Furness (2015) estimates the autumn population to be 395,934 individuals, and the spring population to be 199,601individuals, both with a "low" level of uncertainty.

Development Area and Buffer Population Size

51   Boat-based survey data were used to estimate the total population size of birds within the Development Area and a two kilometre buffer (see *Section 11A.2.1*). These data clearly show that the population size was larger in both the Development Area and buffer in the breeding season (*Figure 11A.4)*. Abundance was slightly higher in the first breeding season, compared to the second breeding season. There was little difference in the pattern of abundance between the first non-breeding seasons and the second. Abundance was higher in the autumn passage phase of the non-breeding season than the spring passage phase. It is important to note that advice received from SNH for surveys was to undertake monthly surveys, while the subsequent scoping advice from SNH on seasons split March in to two. Both surveys occurred in the first half of March and were therefore during the spring passage period of the non-breeding season.

52   In the breeding season, spatial abundance was largely even across the Development Area, including the two kilometre and four kilometre buffers, with little difference apparent between them in both survey years (*Figure 11A.1.1* and *Figure 11A.1.2)*. During the autumn passage period, spatial abundance was patchy compared to the breeding season (but abundance was much lower). There was little notable difference in the abundance of birds between the two kilometre and four kilometre buffers. There was a greater difference between years during the spring passage period than for the other seasons. In year one, abundance was fairly uniform, with perhaps slightly higher numbers of birds in the southern half of the Survey Area. However, in year two, abundance was clearly higher in the southern half of the Survey Area than in the northern half. Again, there was little difference in the density between the two kilometre and four kilometre buffers.

Figure 11A.4 Population estimates of all gannets in the Development Area (amber columns) and two kilometre buffer (green columns) by survey number. Green shading indicates the breeding season, amber shading indicates spring passage and peach shading indicates autumn passage
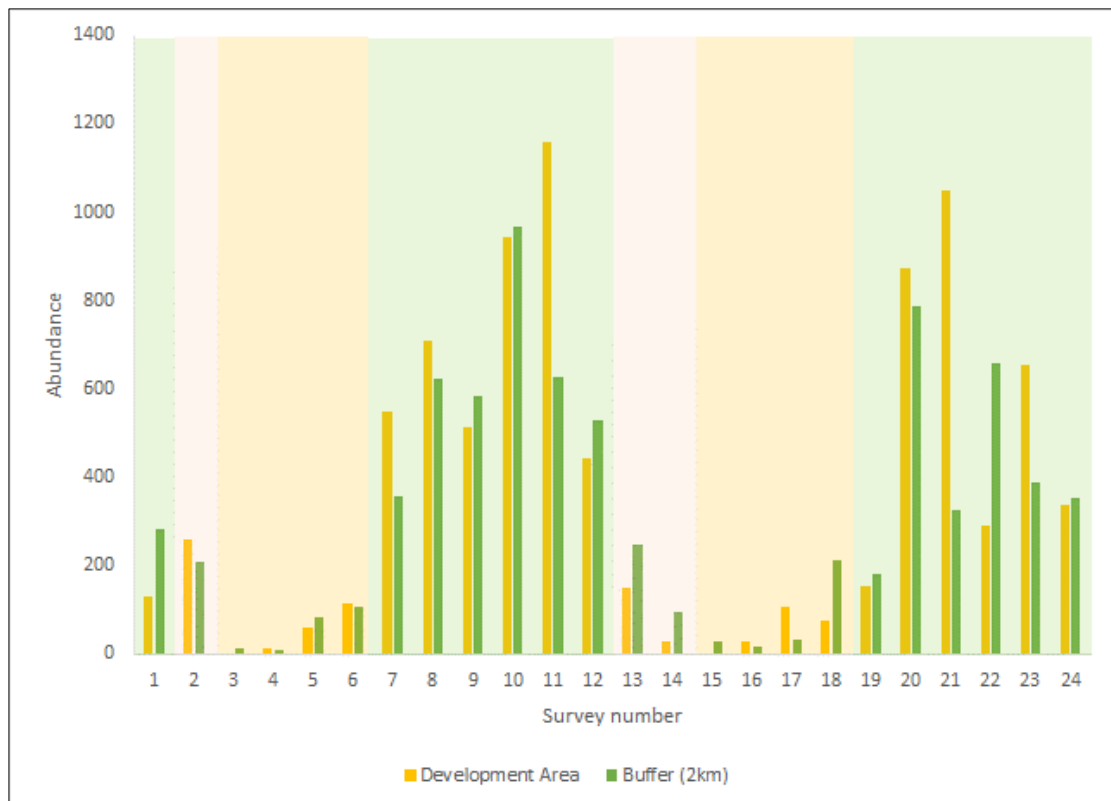
Flight Behaviour

53   Gannets are a relatively fast flying species, on average, (14.9 ms^{-1}; Pennycuick 1987). Flight heights have been shown to be bimodal and, based on a small sample of tracked birds, commuting flights (between the breeding colony and foraging areas) were found to be at relatively low heights (median = 11.5 m) whilst foraging birds occurred at greater heights (median 26.5 m) (Cleasby *et al*. 2015). Foraging birds gain altitude in order to plunge dive below the water surface to catch prey.

54   Analysis of flight directions recorded from boat-based surveys using wind roses shows that birds in the breeding and non-breeding seasons were moving predominantly along a south-west and north-east axis (*Figure 11A.5*).

Figure 11A.5 Distribution of gannet flight direction from boat-based survey data in the breeding season(red), autumn passage (blue) and spring passage (green) phases of the non-breeding season.
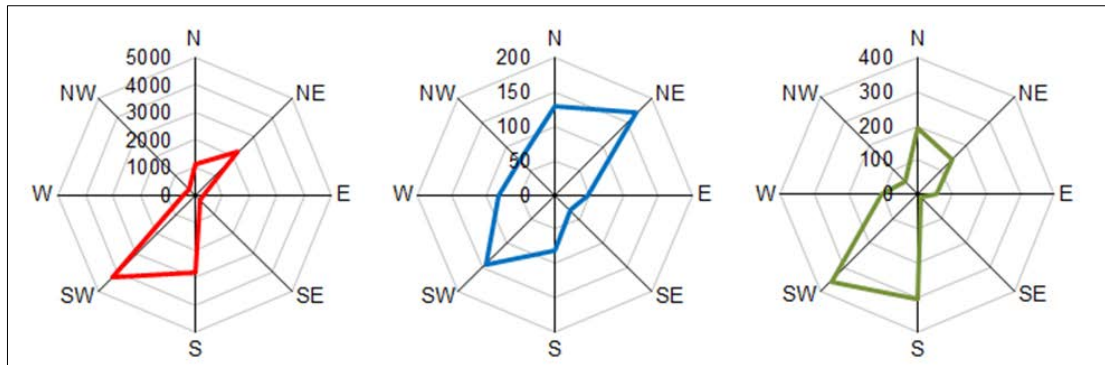
55   Flight height information from the Survey Area was collected during boat-based surveys. These data showed that flight heights of gannets within the Survey Area were similar across seasons (*Figure 11A.6*). The modal height band for the breeding season, autumn passage and spring passage periods was the 0 - 5 m height band. In order to provide context to these bands, they were compared with the flight height data from Johnston *et al*. (2014), the source of "generic" flight height data used for Option 2 and 3 in CRM (*Appendix 11C: Estimation of the Development Alone and Cumulative Collision Risk*).

56   The difference in the flight heights from the Survey Area and the generic data has relatively strong statistical support (based on comparisons of the respective 95 per cent confidence intervals – *Appendix 11C*), and is not particularly surprising, given that the analyses of the generic flight height data for gannet suggest high between-site variability and a low confidence in the applicability of the estimated flight heights to new sites (Johnston *et al.* 2014a, b). Furthermore, a high proportion of the sites which contribute to the generic flight heights are in more southerly locations than the Development Area and relatively far from major gannet breeding colonies. Therefore, the generic flight heights for gannet may be biased towards passage or wintering birds. The flight heights of gannets on the Survey Area, combined with the flight direction information above, suggests that birds are mostly passing through the Development Area, rather than foraging within it and therefore are flying lower.

Figure 11A.6 Flight height distribution of gannets from boat-based survey data. Green columns are breeding season, amber columns are spring passage, orange columns are autumn passage, and blue columns are generic data from Johnston *et al*. (2014)
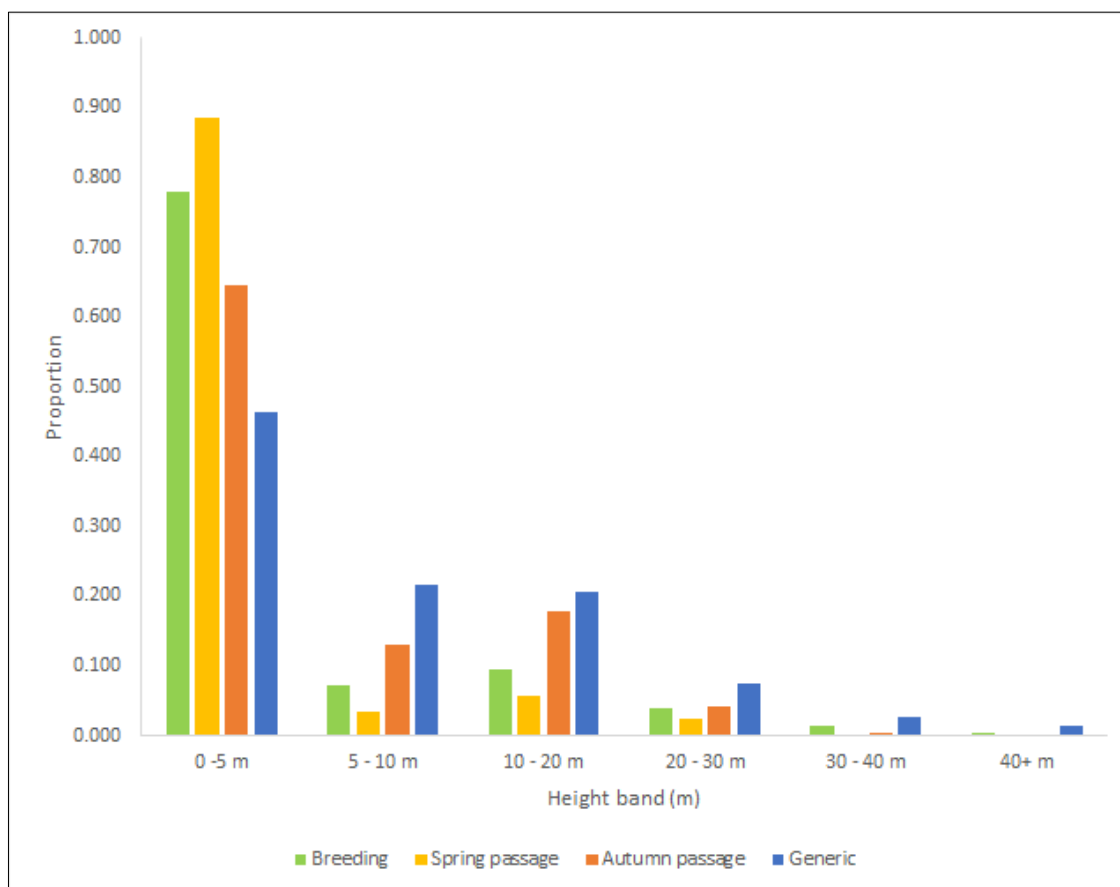
Foraging Behaviour

57   Gannets are an aerial foraging species, undertaking dives from heights of a few metres to 30 m or more (Cleasby *et al*. 2015). They forage over large areas of sea, with little or no overlap between foraging areas of different colonies (Wakefield *et al*. 2013). Gannets from the Bass Rock have been tracked flying as far as the Norwegian coast to forage (Hamer *et al*. 2000), though most foraging trips are closer than this.

58   A relatively small proportion of gannets recorded in the Development Area and two kilometre buffer during the breeding season 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 (12 to 15 per cent; Development Area and buffer zone respectively). Group size in foraging gannets ranged from one to 100 and between one and 30 for birds on the water. Associations with fishing vessels were only recorded on a few occasions in October 2010.

Age Classes

59   Gannets are relatively easily aged by plumage characteristics. Boat-based surveys recorded the age of 11,975 birds across both breeding seasons, 847 birds during both autumn passage seasons and 1,226 across both spring passage seasons.

60   In the breeding season, a total of 97.1 per cent of birds that were aged during surveys were adults (taking the mean across the two breeding seasons). There was slight variation between years of surveys with 97.7 per cent and 96.4 per cent aged as adults in year one and year two respectively. The remaining small percentage of birds consisted of immature or juvenile gannets (2.2 per cent and 0.7 per cent respectively).

61   During autumn passage, the percentage of adults was very similar; 94.0 per cent adults from 847 birds that were aged. During spring passage, the percentage of adults was slightly higher; 98.3 per cent adults from 1,226 birds that were aged.

62   The age distribution of gannets from the population model run for the Forth Islands SPA predicts that the stable age structure of the population would be made up of 60.4 per cent adult birds and 39.6 per cent of younger age classes (one to four years). Given that the majority of birds occurring within the Development Area will be from the Bass Rock colony, this is likely a good representation of the overall population age structure. This result highlights the high proportion of birds in the Development Area that have been aged as adults, presumably due to the large concentration of breeding adult birds from the Bass Rock.

63   Overall, the information collected from boat-based surveys suggested that most gannets recorded during the breeding season were adult birds commuting through the Development Area when moving between the breeding colony on the Bass Rock and foraging locations further to the north-east.

11A.5.2 Kittiwake

64   The UK population of kittiwakes is about 379,892 pairs (Baker *et al*. 2006). The species conservation status in the UK has been classified as "Red" (Eaton *et al*. 2015). Recently, some breeding colonies bordering the North Sea have experienced large declines in reproductive success (Mavor *et al*. 2004, 2006), though the closely monitored colony on the Isle of May, in the outer Forth, has generally been growing with good to high productivity over the last four years[2]. It is apparent that during some years some individuals take sabbatical years (e.g. in 2016)[2].

Regional Population Size and Trends

65   The regional breeding kittiwake population was estimated from the mean of the maximum foraging range from Thaxter *et al*. (2012). Based on this spatial scale, from Girdleness in the north to Burnmouth in the south, the data from Seabird 2000 (Mitchell *et al.* 2004)

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[2]https://www.ceh.ac.uk/news-and-media/blogs/isle-may-breeding-success [Assessed 16/05/18]

suggested a regional population of about 59,876 breeding pairs. While these data represent the last time all the colonies were counted in systematic way over the same approximate period, they are now quite old. More recent count data (2015 – 2017) were available for SPA colonies (as provided in the SNH scoping advice), which results in a regional population of 36,709 breeding pairs, when the recent SPA colony counts are combined with Seabird 2000 counts for the non-SPA colonies. This was a 56 per cent decline in the breeding population of kittiwakes in the SPA population. It is likely that declines also occurred in other kittiwake colonies in the region. Applying the decline experienced in the SPAs to the remaining colonies would result in a regional population of 25,893 breeding pairs. No breeding season connectivity is assumed with colonies in the Moray Firth as these lie substantially beyond the mean maximum foraging range.

66   The entire North Sea winter population present between October to March was estimated as 1,032,690 birds by Skov *et al.* (1995). In their Scoping Opinion, MS-LOT recommended using the BDMPS to determine the regional population (Furness 2015). The temporal scale of the BDMPS for kittiwake is divided between an autumn period (August to December) and a spring period (January to April). The spatial scale of the BDMPS is the UK North Sea. Furness (2015) estimates the autumn population to be 829,937 individuals, and the spring population to be 627,816 individuals, both with a "high" level of uncertainty.

67   The breeding season in the Forth and Tay region was recommended as mid-April to August, whilst the autumn and spring passage periods were advised as September to December and January to mid-April, respectively (based on the Scoping Opinion from MS-LOT and associated advice from SNH).

Development Area and Buffer Population Size

68   Boat-based survey data were used to estimate the total population size of birds within the Development Area and a two kilometre buffer. These data clearly show that the population size was larger in both the Development Area and buffer in the breeding season (*Figure 11.7*). Abundance was higher in the first breeding season, compared to the second breeding season. The abundance in the first non-breeding season was lower (average abundance of 606 birds) than in the second (average abundance of 1,021 birds). Abundance was higher during autumn passage than spring passage. It is important to note that advice received from SNH for surveys was to undertake monthly surveys, while subsequent advice on the seasonal periods for kittiwake split April in to two. The first April survey occurred on the 14th and 15th of the month, so has been included in the breeding season in the data presentations below, while the second April survey occurred on the 7th and 8th of the month, so has been included in the spring passage period of the non-breeding season in the data presentations below.

69   In the breeding season, spatial abundance appeared lower in the southern part of the Development Area in year one. In year two, the spatial abundance was patchier, although abundance was generally lower overall (*Figure 11A.1.3* and *Figure 11A.1.4*). There appeared to be little difference between the two kilometre and four kilometre buffers in both years. During autumn passage spatial abundance was fairly even across the Survey Area in year

one. However, in year two there was clearly a lower abundance in the south-east of the Survey Area than in the rest of the Survey Area. There was little notable difference in the abundance of birds between the two kilometre and four kilometre buffers in both years. During spring passage in year one, there was greater abundance in the four kilometre buffer than the Development Area, though this was only true in April (*Figure 11A.7*). In year two, abundance was lower in the south-west of the Survey Area than elsewhere. Again, there was little difference in the density between the two kilometre and four kilometre buffers.

Figure 11A.7 Population estimates of all kittiwakes in the Development Area (amber columns) and two kilometre buffer (green columns) by survey number. Green shading indicates the breeding season, amber shading indicates spring passage and peach shading indicates autumn passage.
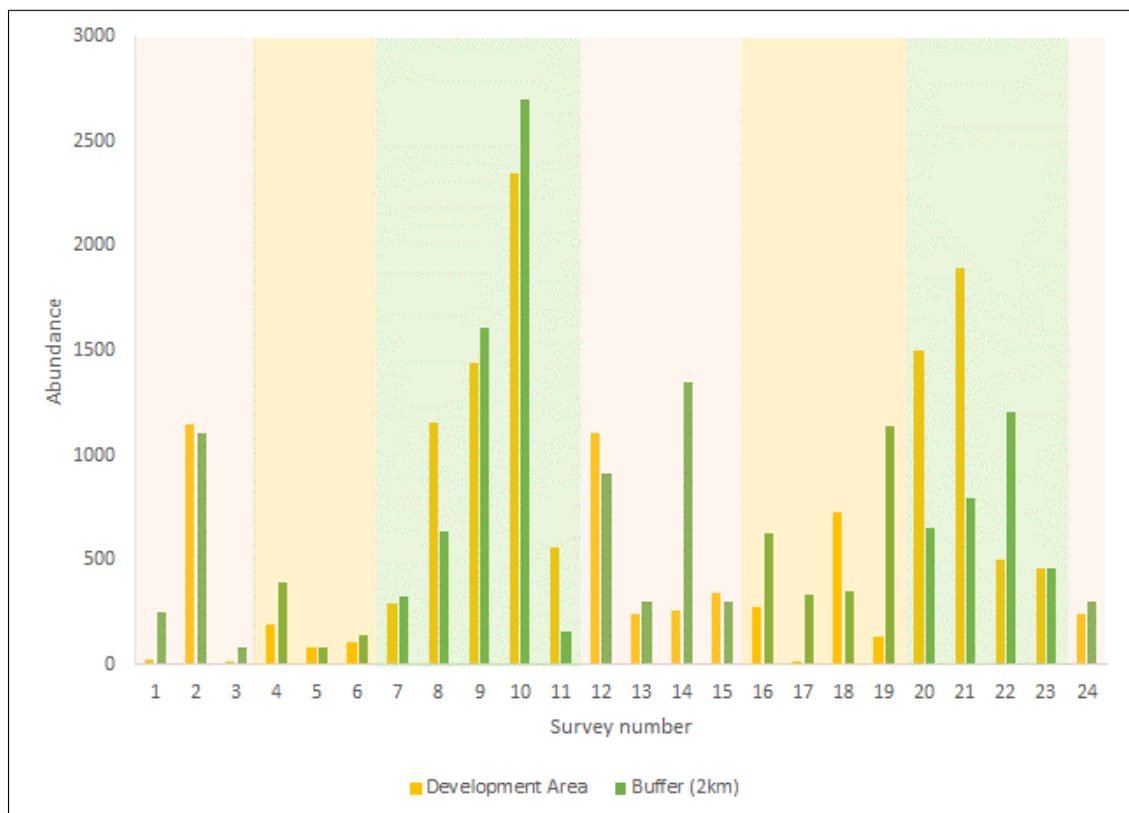
Flight Behaviour

70   Kittiwakes are not a particularly fast flying species (13.1 ms[-1,] Alerstam *et al*. 2007). Analyses of survey data showed that the majority of birds fly close to the water (Johnston *et al*. 2014).

71   Analysis of flight directions recorded from boat-based surveys using wind roses showed that birds in the breeding season were moving predominantly along a south/north axis (*Figure 11A.8*). During autumn passage, flight directions were still broadly north/south in orientation, but with more westerly and south-westerly components in the movement. Spring passage was quite different, with north-westerly and northerly movements predominating.

Figure 11A.8 Distribution of kittiwake flight direction from boat-based survey data in the breeding season (red), autumn passage (blue) and spring passage (green) phases of the non-breeding seasons.
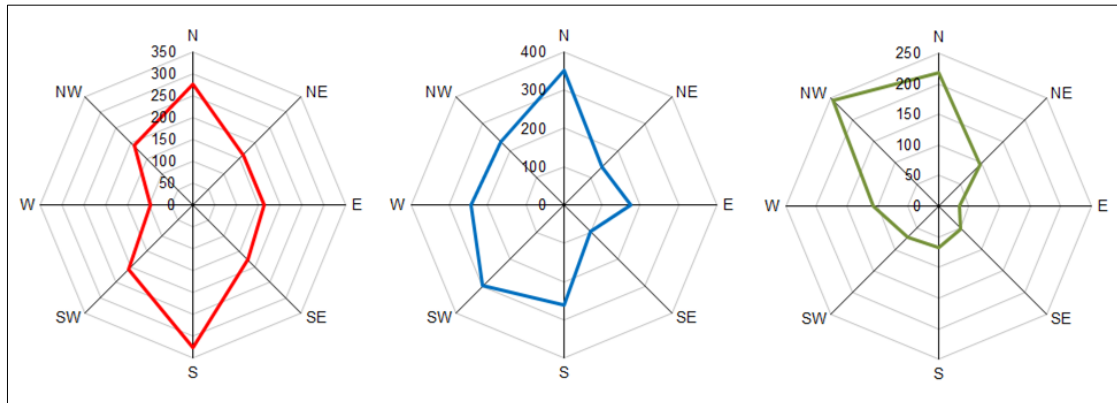
72   Flight height estimates from the Survey Area were collected during boat-based surveys. These data showed that the modal flight heights of kittiwakes within the Survey Area were in the lowest height band (0 – 5m) in the breeding season (*Figure 11A.9*). During the spring passage, the modal flight height was slightly higher in the 5 – 10 m band, and during the autumn passage slightly higher again in the 10 – 20 m band. In order to provide context to these bands, they were compared with the flight height data from Johnston *et al.* (2014), the source of "generic" flight height data used for Options 2 and 3 in CRM (*Appendix 11C*)). It is apparent from this comparison that the kittiwakes flying through the Survey Area in the breeding season are occurring in the lowest height band (0 – 5 m) more frequently than predicted by the generic data. In the spring passage periods, the boat-based data showed a higher flight height distribution than in the breeding season. When compared to the generic data, the spring passage flight height data from the Survey Area showed birds occurred in lower frequencies in the 0 – 5 m, 10 – 20 m, 30 – 40 m and greater than 40 m height bands, but in greater frequencies in the 5 – 10 m height band, and very similar frequencies in the 20 – 30 m height band. Overall, this indicated lower frequencies of flights in the collision risk heights from the site based data than from the generic data (*Appendix 11C*). When compared to the generic data, the autumn passage flight height data from the Survey Area showed lower frequencies in the 0 – 5 m and 5 – 10 m height bands, but higher frequencies in the 10 – 20 and 20 – 30 m height bands. However, frequencies were much lower in the 30 – 40 m and greater than 40 m height bands.

73   As for gannet, the difference in the flight heights from the Survey Area and the generic data has relatively strong statistical support (based on comparisons of the respective 95 per cent confidence intervals – *Appendix 11C*), and is not particularly surprising, given that the analyses of the generic flight height data for kittiwake suggest high between-site variability and a low confidence in the applicability of the estimated flight heights to new sites (Johnston *et al.* 2014a, b). Furthermore, a high proportion of the sites which contribute to the generic flight heights are in more southerly locations than the Development Area and relatively far from major kittiwake breeding colonies. Therefore, the generic flight heights for kittiwake may be biased towards passage or wintering birds.

Figure 11A.9 Flight height distribution of flying kittiwakes from boat-based survey data. Green columns are breeding season, amber columns spring passage, orange columns are autumn passage, and blue columns are generic data from Johnston *et al*. (2014).
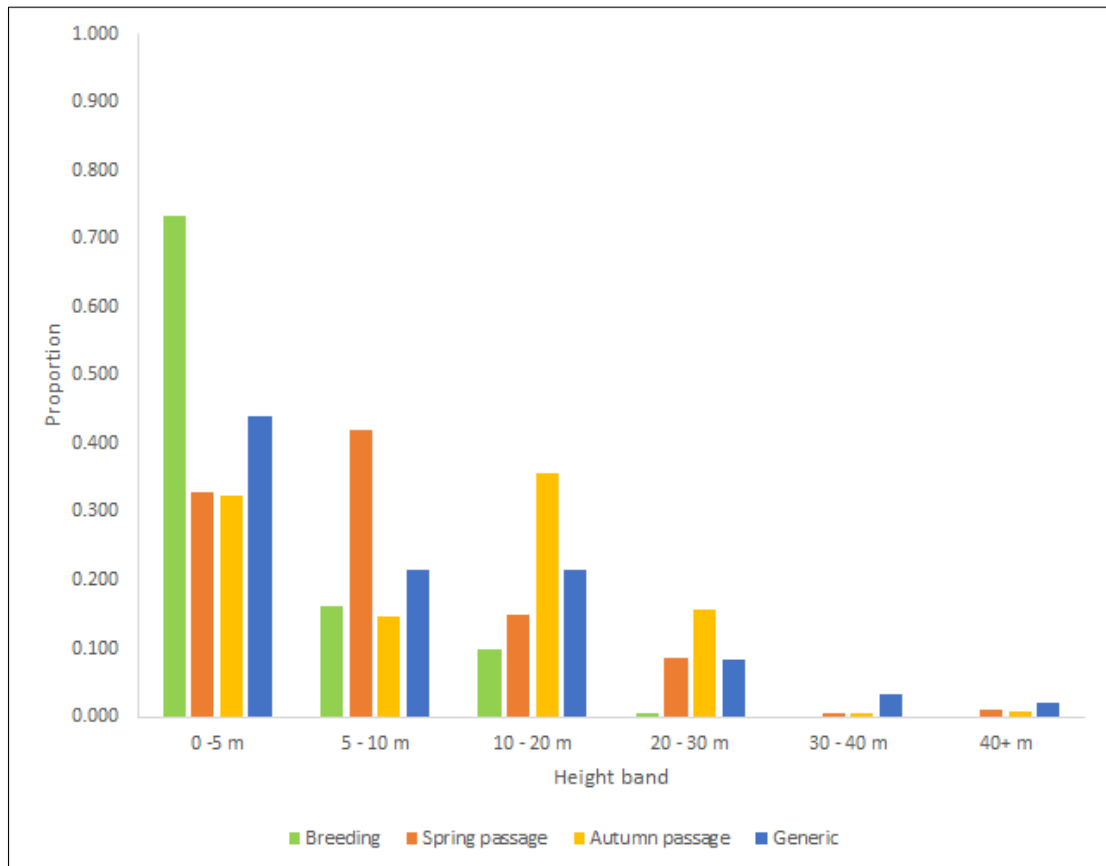
Foraging Behaviour

74   Kittiwakes are mainly an aerial foraging species, where they forage only in the very top layer of the water surface. They are a highly pelagic species, not spending much time in coastal or terrestrial habitats. They forage up to 120 km from their breeding colony, but the mean of the maximum foraging range is much shorter; 60 km (Thaxter *et al*. 2012). As part of the study of potential impacts of the Development, tracking studies of kittiwakes were undertaken from the colonies at Fowlsheugh in Aberdeenshire and the Isle of May in the outer Forth (CEH 2010, 2011). These showed the birds from both of these colonies occurred within the Development Area.

75   Active feeding behaviour in the breeding season was recorded for 3,325 individuals (61 per cent of records). Feeding behaviours included active searching, plunge diving, dip feeding and surface pecking. Flight direction for an additional 627 (12 per cent) of birds was recorded as "variable" or "circling", indicating some form of foraging behaviour. Another 1,025 birds (19 per cent) were recorded on the sea surface.

76   During the breeding season, and particularly during post-breeding, flocks of several hundred birds were recorded foraging in the Development Area and two kilometre buffer. In July 2011, a flock of 500 birds was recorded as part of a large multi-species feeding association.

Age Classes

77   Kittiwakes in their first two years are relatively easily aged by plumage characteristics. However, kittiwakes typically don't breed until their fourth year. Thus, the estimated proportion of adult birds recorded from the Development Area and buffer has assumed that all adult plumaged birds are breeding, even though some will be too young to start breeding. Consequently, there is some added precaution on the assessment of impacts on adults. Boat-based surveys recorded 6,140 kittiwakes with an age.

78   In the breeding season, a total of 93.8 per cent of birds that were aged during surveys were adults (using the average value across the two breeding seasons of surveys). There was slight variation between years of surveys with 91.3 per cent and 95.6 per cent aged as adults in year one and year two respectively. The remaining small percentage of birds comprised first or second year birds (2.5 per cent and 3.7 per cent respectively).

79   During autumn passage, a total of 59.4 per cent of aged birds were adults, with some variation between years (52.4 per cent in years one, and 66.5 per cent in year two). Most of the remaining proportion of birds were aged as juveniles (40.4 per cent across both years), which is as expected as juvenile birds fledge and head out to sea. During spring passage the proportion of adults was more similar to the breeding season, with a total of 83.4 per cent adults across both years.

80   There was a noticeable difference between years one and two, with a higher proportion of adults aged (91.1 per cent) in year two compared with year one (75.7 per cent). There was also a predictable shift in the relative proportion of juvenile aged birds to immature aged birds, with their relative proportions being quite similar (6.9 per cent and 6.6 per cent respectively).

81   The age distribution of kittiwakes from the population models run for the SPA populations assessed in the Habitats Regulations Appraisal (HRA) predicted that the stable age structure of the population would be made up of 55.8 per cent adult birds and 44.3 per cent of younger age classes. This highlights the high proportion of birds in the Development Area that have been aged as adults compared to the overall population.

11A.5.3 Herring Gull

82   The UK breeding population of herring gull is about 139,309 pairs, with 71,659 pairs estimated in Scotland (Mitchell *et al*. 2004, Baker *et al*. 2006). The species is of "Red" conservation concern in Britain, due to long term declines in both breeding and non-breeding populations (Eaton *et al*. 2015).

Regional Population Size and Trends

83   The regional breeding population of herring gull was estimated from the mean of the maximum foraging range from Thaxter *et al*. (2012). Based on this spatial scale, from Aberdeen in the north, to Kirkcaldy in the west, and Burnmouth in the south the data from Seabird 2000 (Mitchell *et al.* 2004) suggested a regional population of about 13,054 breeding

pairs. While these data represent the last time all of the colonies were counted in a systematic way over the same approximate time period, they are now quite old. More recent count data (2014 – 2017) were available for SPA colonies (as provided in the SNH scoping advice), which resulted in a regional population of 12,515 breeding pairs, when the recent SPA colony counts are combined with Seabird 2000 counts for the non-SPA colonies. This represents a seven per cent decline in the breeding population of herring gulls in the SPA populations. It is possible that declines also occurred in other herring gull colonies in the region. Applying the decline experienced in the SPAs to the remaining colonies would result in a regional population of 12,124 breeding pairs. Since this regional population is only made up of coastal breeding colonies it is likely that there are urban breeding colonies within the mean of the maximum foraging range of herring gull, so the true regional population is likely to be larger than estimated here.

84   The North Sea winter population present between November and February is estimated at 971,700 birds (Skov *et al.* 1995). The population in the non-breeding season was estimated by Furness (2015) as 466,511 individuals for the North Sea and English Channel (September to February). In their Scoping Opinion, MS-LOT (following the scoping advice of SNH) recommended using the regional population size estimate for the non-breeding season (September to March).

Development Area and Buffer Population Size

85   Boat-based survey data were used to estimate the total population size of birds within the Development Area and a two kilometre buffer. These data clearly show that the population size was generally low in all seasons (*Figure 11.19*). The only exception was a total abundance of 139 birds in January 2011, 122 of which were in the buffer. Abundance was higher, on average, in the first breeding season (average of total abundance = 17), compared to the first breeding season (average of total abundance = 6). Abundance was higher in the first non-breeding season than the second, though note that although a large peak occurred in the first breeding season abundance was still higher, on average, in the first breeding season.

86   In the breeding season, spatial abundance was low and patchy (*Figure 11A.1.5* and *Figure 11A.1.6*). Since the only impact source of concern for herring gull is collision risk, abundance within the buffers is of less relevance to the assessment than it is for other species. Abundance was higher in the two kilometre buffer, than the four kilometre buffer in both breeding seasons. The opposite was true in the non-breeding seasons, though it is important to note that densities were generally very low. The higher peak abundance in the buffer in January of year one compared with other non-breeding season months (*Figure 11A.10*) was due to the occurrence of birds at the edge of the four kilometre buffer.

Figure 11A.10 Population estimates of all herring gulls in the Development Area (amber columns) and two kilometre buffer (green columns) by survey number. Amber shading indicates the non-breeding season and green shading indicates the breeding season.
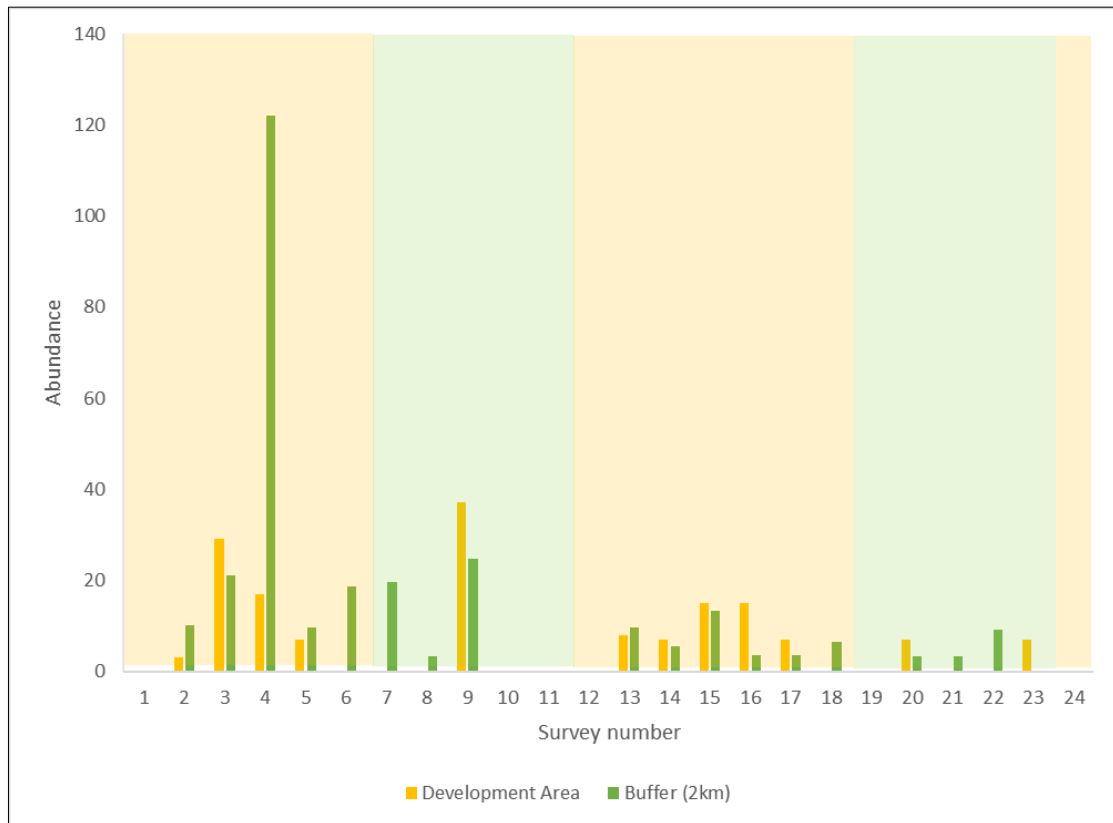
Flight Behaviour

87   Herring gulls are not a particularly fast flying species (12.8 ms^{-1}, Alerstam *et al*. 2007). Analyses of generic boat-based survey data showed that, while the majority of birds fly close to the water, a relatively high proportion (about 20 per cent) could fly at potential collision height (Johnston *et al*. 2014).

88   Analysis of flight directions recorded from the Inch Cape boat-based surveys using wind roses showed that herring gulls in the breeding season were not strongly moving in any particular direction. This is likely due to their foraging behaviour. In the non-breeding season flights were predominantly in a north-westerly and westerly direction, towards the Angus coast (*Figure 11A.11*).

Figure 11A.11 Distribution of herring gull flight directions from boat-based survey data in the breeding (left) and non-breeding (right) seasons.
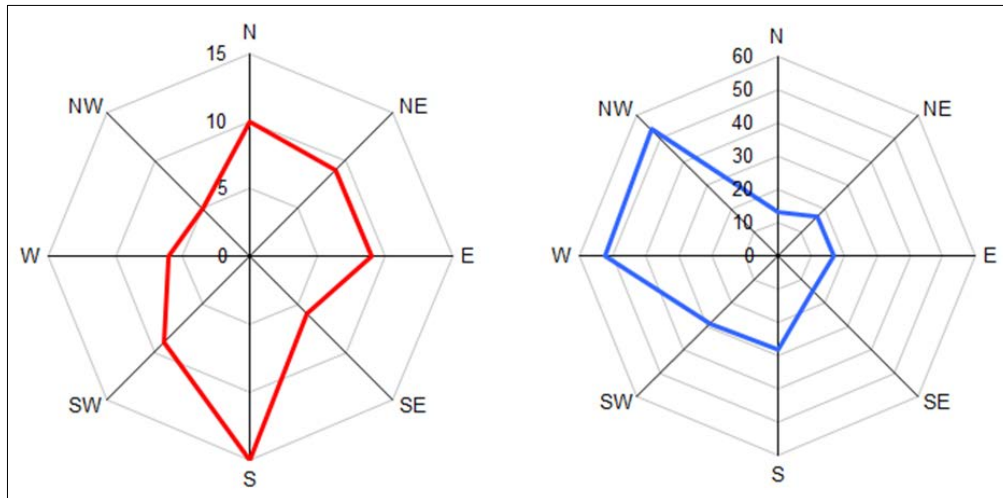
89   Flight height information from the Development Area and buffer was collected during boat-based surveys. These data showed that the modal flight heights of herring gulls within the Survey Area were in the lowest height band (0 – 5 m), in the breeding and non-breeding seasons (*Figure 11A.12*). In order to provide context to these bands, they were compared with the flight height data from Johnston *et al*. (2014), the source of "generic" flight height data used for Options 2 and 3 in CRM (*Appendix 11C*). It is apparent from this comparison that herring gulls in the breeding and non-breeding seasons were flying through the Survey Area with a similar flight height distribution to the generic data.

Figure 11A.12 Flight height distribution of flying herring gulls from boat-based survey data. Green columns are breeding season, amber columns are non-breeding season, and blue columns are generic data from Johnston *et al*. (2014).
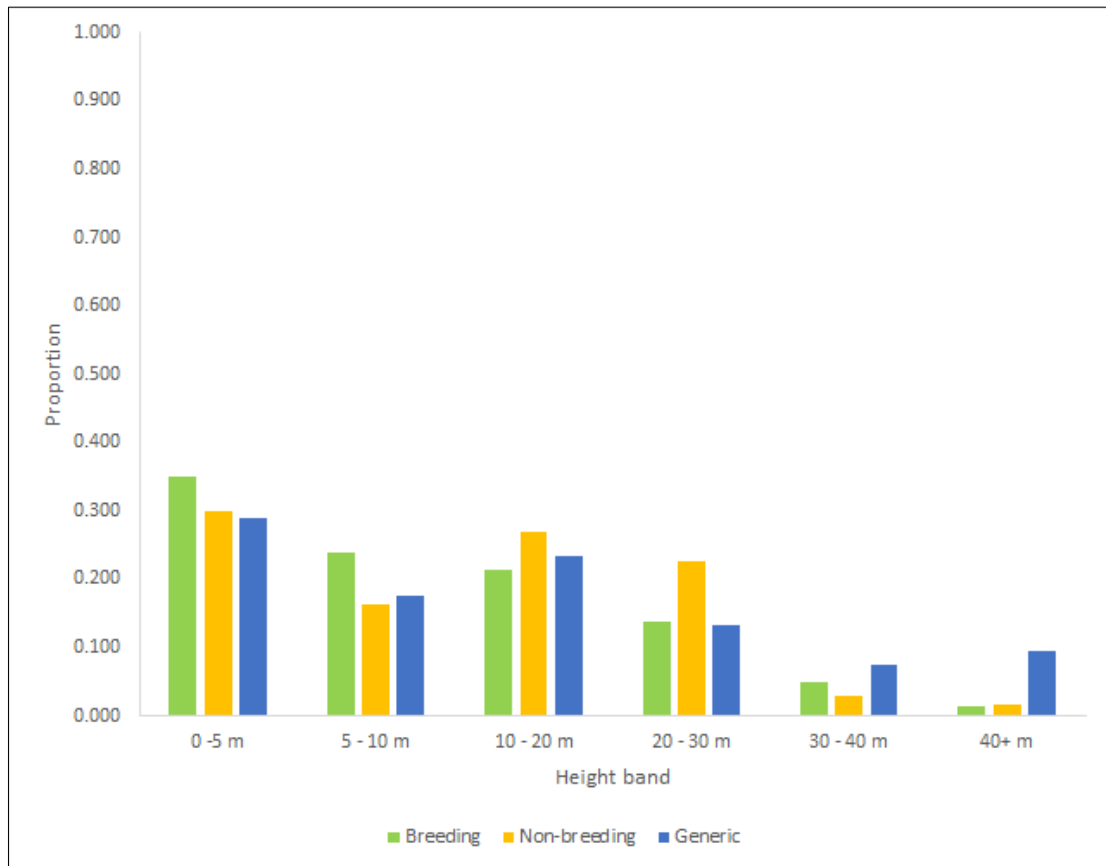
Foraging Behaviour

90   Herring gulls are a highly adaptable species, with a broad diet (Snow & Perrins 1998). They forage on the water surface, scavenge natural and human food sources (especially from fishing boats) and kleptoparasitise other species of seabird. They also regularly forage in coastal and inland habitats on a wide range of prey, including foraging at rubbish dumps and agricultural habitats. They forage up to 92 km from their breeding colony, but the mean of the maximum foraging range is much shorter; 61 km (Thaxter *et al*. 2012).

91   Herring gulls were recorded engaging in active foraging behaviour on only seven occasions during boat-based surveys (involving a total of 10 birds), predominantly during the breeding season. This behaviour was not recorded in the Development Area, although this is likely due to the relatively low number of observations.

Age Classes

92   Herring gulls are relatively easily aged by plumage characteristics until they reach breeding age. Boat-based surveys recorded 77 herring gulls with an age during the breeding season, of which 78.6 per cent were aged as adult birds (based on the average value from the two breeding seasons of surveys). The remaining 21.4 per cent of aged birds were all in an immature age class, with no juvenile birds observed. However, in the non-breeding season,

from a larger sample of 230 aged birds, 17.0 per cent of birds were juveniles, 27.6 per cent were immature birds, and 55.3 per cent were adults. Differences in age classes between years were relatively small, with the adult proportion in the breeding season dropping from 83.3 per cent to 73.9 per cent, and in the non-breeding season they were very similar (53.0 per cent in year one and 57.6 per cent in year two).

93   The age distribution of herring gulls from the population model run for the Forth Islands SPA population predicted that the stable age structure of the population would be made up of 39.9 per cent adult birds and 60.0 per cent of younger age classes. The proportion of adult birds predicted from the population model is lower than the observations from the Development Area and buffer.

11A.5.4 Guillemot

94   The UK breeding population of guillemots is about 1,420,900 individuals (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*. 2015).

Regional Population Size and Trends

95   The regional breeding population of guillemots was estimated from the mean of the maximum foraging range from Thaxter *et al*. (2012). Based on this spatial scale, from Girdleness in the north, Inchkeith in the west and Burnmouth in the south, Seabird 2000 (Mitchell *et al.* 2004) suggested a regional population of about 188,185 breeding individuals. This population estimate was based on the number of individuals, rather than breeding pairs, as it is usually not possible to count AOS for guillemot in the field. Counts of individual birds in the breeding colony may include off-duty adults away from a breeding site, non-breeders, immature birds and breeding birds. Consequently, a recommended correction factor of 0.67 is applied to estimate the number of breeding pairs (based on studies where counts of AON have been made, Mitchell *et al*. 2004). Thus 188,185 individuals are equivalent to 126,084 pairs. While these data represent the last time all of the colonies were counted in systematic way over the same approximate time period, they are now quite old. More recent count data (2015 – 2017) were available for SPA colonies (as provided in the SNH scoping advice), which resulted in a regional population of 110,091 breeding pairs, when the recent SPA colony counts are combined with Seabird 2000 counts for the non-SPA colonies. This was a 13 per cent decline in the breeding population of guillemots in the SPA populations. It is possible that declines also occurred in other guillemot colonies in the region. Applying the decline experienced in the SPAs to the remaining colonies would result in a regional population of 109,176 breeding pairs.

96   The North Sea population in the non-breeding season (mid-August to March) was estimated by Skov *et al*. (1995) as 1,562,400 individuals, and by Furness (2015) as 1,617,306 for the North Sea and English Channel. In their Scoping Opinion, MS-LOT (following the scoping advice of SNH) recommended using the same regional scale for the non-breeding season as

the breeding season, rather than BDMPS to determine the regional populations (Furness 2015).

Development Area and Buffer Population Size

97   Boat-based survey data were used to estimate the total population size of birds within the Development Area and a two kilometre buffer. These data clearly show that the population size was larger in both the Development Area and buffer in the breeding season (*Figure 11A.13). Abundance was slightly higher, on average, in the second breeding season (4,314), c*ompared to the first breeding season (3,726), though the peak abundance was higher in the first breeding season. There was little difference in the pattern of abundance between the first non-breeding season and the second. Based on the SNH scoping advice, the breeding season is from April to mid-August. Boat-based surveys in August both occurred in the first half of the month, and therefore occurred in the period defined as the breeding season.

98   In the breeding season, spatial abundance was largely even across the Survey Area, including the two kilometre and four kilometre buffers, with little difference apparent between them in both survey years (*Figure 11A.1.7*and *Figure 11A.1.8*). During the non-breeding season, spatial abundance was patchier than the breeding season, but abundance was lower. There was little notable difference in the abundance of birds between the two kilometre and four kilometre buffers.

Figure 11A.13 Population estimates of all guillemots in the Development Area (amber columns) and two kilometre buffer (green columns) by survey number. Amber shading indicates the non-breeding season and green shading indicates the breeding season.
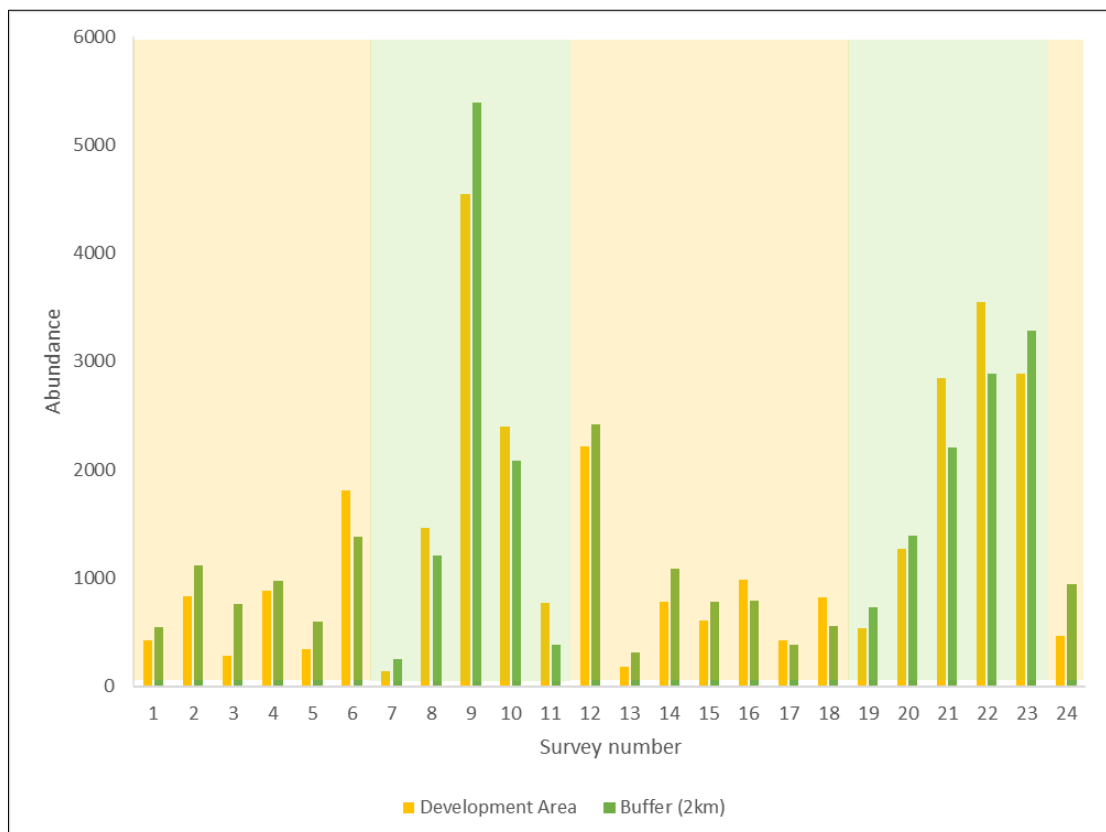
Flight Behaviour

99   Guillemots are fast flying species (19.1 ms^{-1}, Pennycuick 1987). Analyses of generic survey data showed that the majority of birds fly close to the water (Johnston *et al*. 2014), typically below five metres (Johnston & Cook 2016).

100   Analysis of flight directions recorded from boat-based surveys using wind roses showed that birds in the breeding season were moving predominantly along a northerly axis and a northerly and north-westerly axis in the non-breeding season (*Figure 11A.14*).

Figure 11A.14 Distribution of guillemot flight directions from boat-based survey data in the breeding (left) and non-breeding (right) seasons.
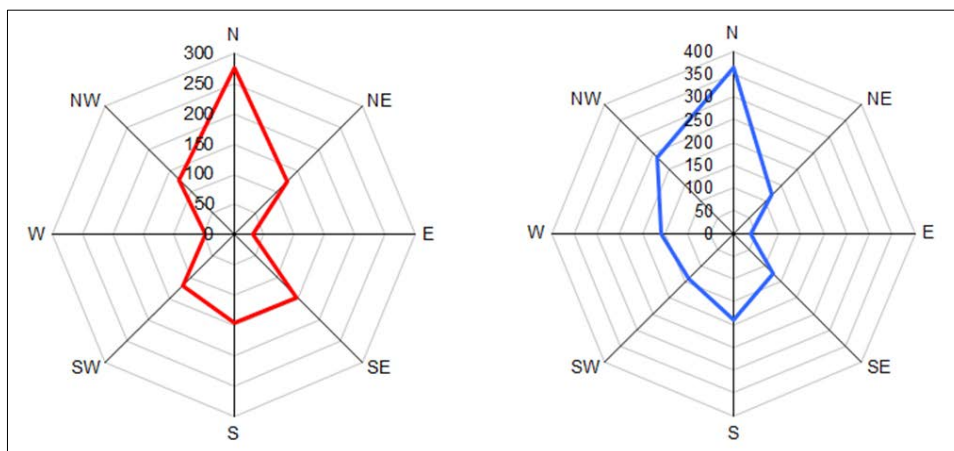
101   Flight height information from the Development Area and buffer was collected during boat-based surveys. These data showed that the modal flight heights of guillemots within the Survey Area were in the lowest height band (0 – 5 m) in the breeding and non-breeding seasons (*Figure 11A.15*). In order to provide context to these bands, they were compared with the flight height data from Johnston *et al*. (2014), the source of "generic" flight height data used for Option 2 and 3 in CRM (*Appendix 11C*). It is apparent from this comparison that the guillemots, in the breeding and non-breeding seasons, flying through the Development Area and buffer are occurring in the lowest height band (0 – 5 m) more frequently than predicted by the generic data.

Figure 11A.15 Flight height distribution of flying guillemots from boat-based survey data. Green columns are breeding season, amber columns are non-breeding season, and blue columns are generic data from Johnston *et al*. (2014).
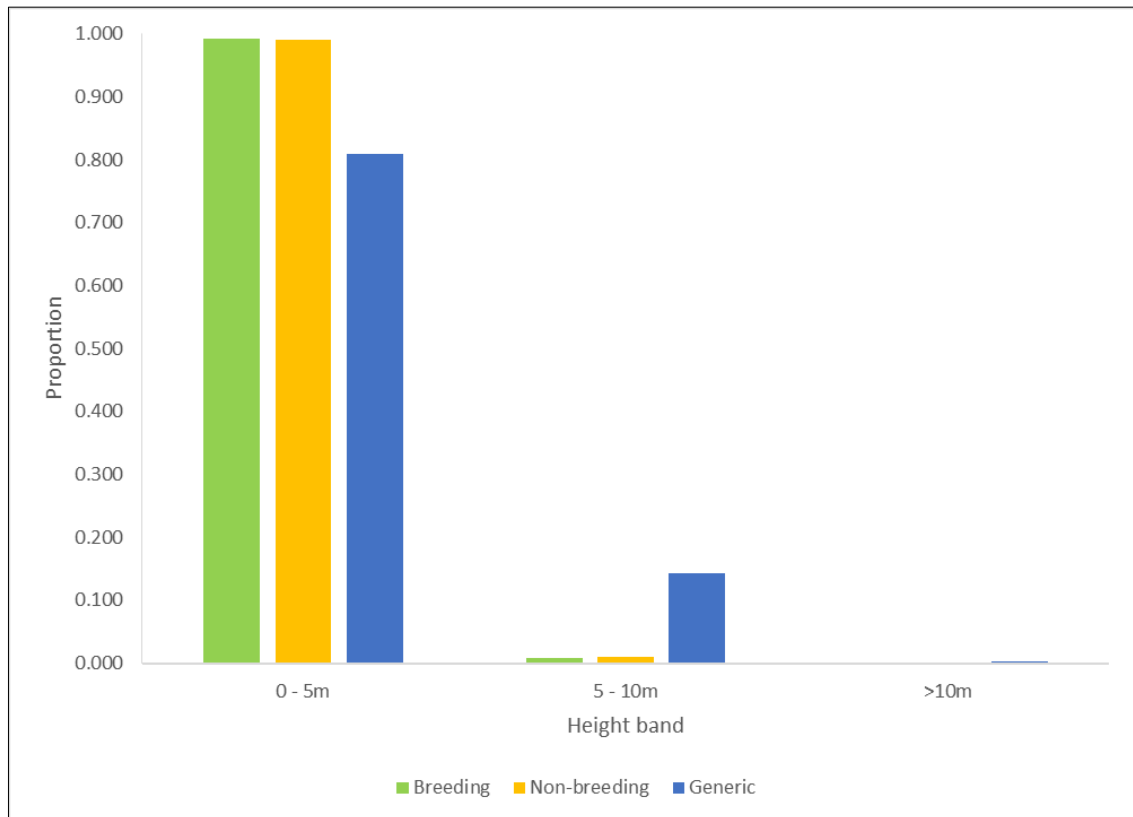
Foraging Behaviour

102   Guillemots are a surface foraging species, diving through the water column to forage on pelagic and demersal fish, particularly sandeels in the North Sea (Snow & Perrins 1998). They forage up to 135 km from their breeding colony, but the mean of the maximum foraging range is much shorter; 84 km (Thaxter *et al*. 2012).

103   It seems reasonable to assume that all guillemots recorded on the sea surface are present for foraging purposes. This is more likely to be the case in the breeding season than non-breeding season. This is a precautionary assumption, as resting birds will also spend time on the sea surface. Large proportions of the birds recorded from boat-based surveys of the Development Area and buffer in the breeding season were on the water surface: 81 per cent and 75 per cent respectively.

Age Classes

104   Immature guillemots cannot be distinguished from breeding age adult guillemots from observations at sea. It was therefore necessary to use the age structure from a stable population model to determine the proportions of adults and immature birds in the population of birds at sea.

105   The age distribution of guillemots from the population models run for the SPA populations assessed in the HRA predicted that the stable age structure of the population would be made up of 43.8 per cent adult birds and 56.3 per cent of younger age classes. Guillemots cannot be aged from 'at-sea' survey data and therefore the Scoping Opinion advised that the age structure as determined from a population model should be used in the assessment.

11A.5.5 Razorbill

106   The UK breeding population of razorbills is about 188,576 individuals (Mitchell *et al*. 2004, Baker *et al*. 2006). The species is of "Amber" conservation concern in Britain (Eaton *et al*. 2015).

Regional Population Size and Trends

107   The regional breeding population of razorbills was estimated from the mean of the maximum foraging range from Thaxter *et al*. (2012). Based on this spatial scale, from Burn of Daff (Portlethen) in the north to the Forth Islands in the south, Seabird 2000 (Mitchell *et al*. 2004) suggested a regional population of about 14,764 breeding individuals. The population estimate is based on the number of individuals rather than breeding pairs, as it is usually not possible to count AOS in the field. Counts of individual birds in the breeding colony may include off-duty adults away from their breeding site, non-breeders, immature birds and breeding birds. Consequently, a recommended correction factor of 0.67 is applied to estimate the number of breeding pairs (based on studies where counts of individuals have been made, Mitchell *et al*. 2004). Thus 14,764 individuals are equivalent to 9,982 pairs. While these data represent the last time all of the colonies were counted in systematic way over the same approximate time period, they are now quite old. More recent count data (2015 – 2017) were available for SPA colonies (as provided in the SNH scoping advice), which resulted in a regional population of 11,367 breeding pairs, when the recent SPA colony counts are combined with Seabird 2000 counts for the non-SPA colonies. This was a 20 per cent increase in the breeding population of razorbills in the SPA populations. It is possible that increases also occurred in other razorbill colonies in the region. Applying the increase experienced in the SPAs to the remaining colonies would result in a regional population of 11,864 breeding pairs.

108   The North Sea population in the non-breeding season (mid-August to March) was estimated by Skov *et al*. (1995) as 324,000 individuals, and by Furness (2015) as 218,622 for the North Sea in winter (November to December). In their Scoping Opinion, MS-LOT (following the scoping advice of SNH) recommended using the same regional scale as the breeding season, rather than BDMPS to determine the regional populations (Furness 2015).

Development Area and Buffer Population Size

109   Boat-based survey data were used to estimate the total population size of birds within the Development Area and a two kilometre buffer. These data show that the population size was usually larger in both the Development Area and buffer in the breeding season (*Figure 11A.16*). Abundance was slightly higher, on average, in the second breeding season (average of total abundance = 2,088), compared to the first breeding season (average of total

abundance = 1,259). There was little difference in the pattern of average abundance between the first non-breeding season and the second, but a much higher peak in the second breeding season. Based on SNH scoping advice, the breeding season ends in mid-August. Boat-based surveys in August both occurred in the first half of the month, and therefore occurred in the period defined as the breeding season.

110   In the breeding season, spatial abundance was patchy across the Survey Area, though with little apparent pattern to this, including the two kilometre and four kilometre buffers, with little difference apparent between them in both survey years (*Figure 11A.1.9* and *Figure 11A.1.10*). The pattern was similar during the non-breeding season. There was little notable difference in the abundance of birds between the two kilometre and four kilometre buffers.

Figure 11A.16 Population estimates of all razorbills in the Development Area (amber columns) and two kilometre buffer (green columns) by survey number. Amber shading indicates the non-breeding season and green shading indicates the breeding season.
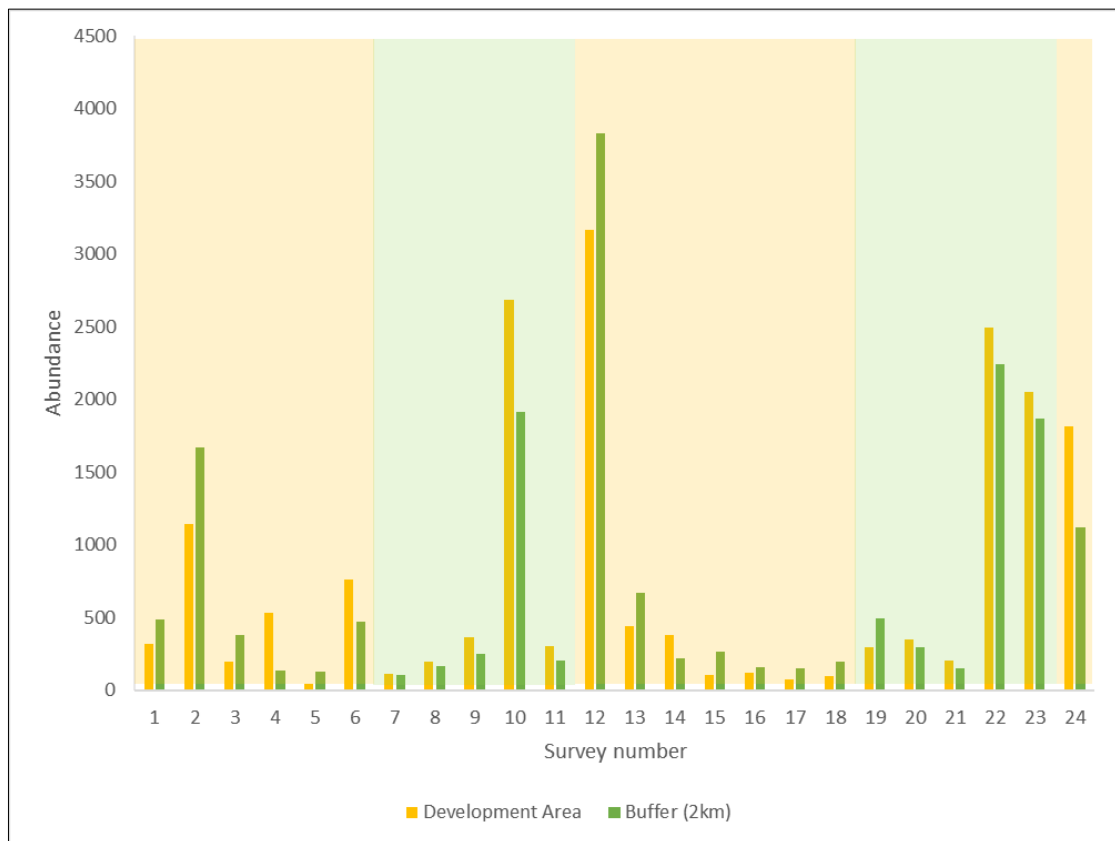
Flight Behaviour

111   Razorbills, like guillemots, are a fast flying species (16 ms^{-1}, Pennycuick 1987). Analyses of generic survey data showed that the majority of birds fly close to the water (Johnston *et al.* 2014), typically below five metres (Johnston & Cook 2016).

112   Analysis of flight directions recorded from boat-based surveys using wind roses showed that birds in the breeding season were moving predominantly along a northerly and north-

westerly axis and a northerly and north-westerly axis in the non-breeding season (*Figure 11A.17*).

Figure 11A.17 Distribution of razorbill flight directions from boat-based survey data in the breeding (left) and non-breeding (right) seasons.
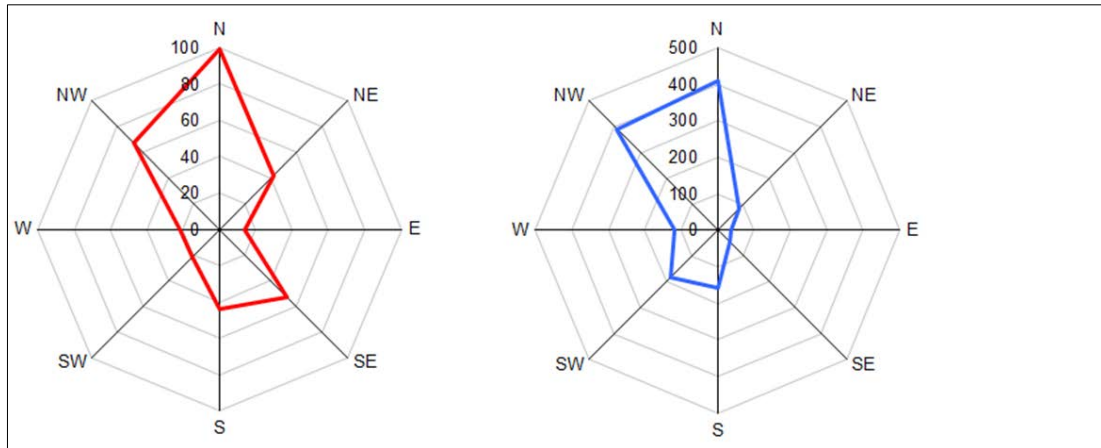
113   Flight height information from the Development Area and buffer was collected during boat-based surveys. These data showed that the modal flight heights of razorbills within the Survey Area were in the lowest height band (0 – 5 m), in the breeding and non-breeding seasons (*Figure 11A.18*). In order to provide context to these bands, they were compared with the flight height data from Johnston *et al*. (2014), the source of "generic" flight height data used for Option 2 and 3 in CRM (*Appendix*). It is apparent from this comparison that the razorbills, in the breeding and non-breeding seasons, flying through the Development Area and buffer are occurring in the lowest height band (0 – 5 m) more frequently than predicted by the generic data.

Figure 11A.18 Flight height distribution of flying razorbills from boat-based survey data. Green columns are breeding season, amber columns and non-breeding season, blue columns are generic data from Johnston *et al*. (2014).
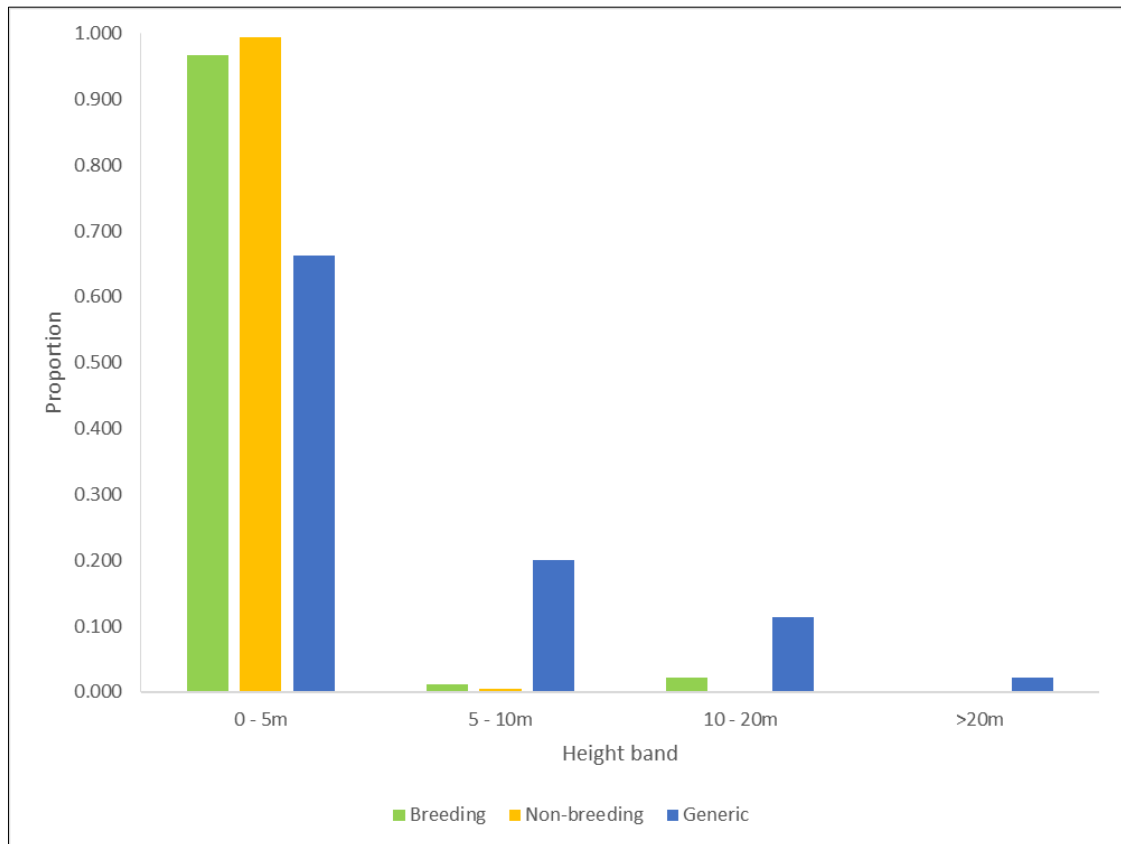
Foraging Behaviour

114   Razorbills are mainly a surface foraging species, where they dive though the water column to forage on pelagic and demersal fish, particularly sandeels in the North Sea (Snow & Perrins 1998). They forage up to 95 km from their breeding colony, but the mean of the maximum foraging range is much shorter; 48.5 km (Thaxter *et al*. 2012). Razorbills appear to undertake shorter foraging trips than guillemots.

115   It seems reasonable to assume that all razorbills recorded on the sea surface are present for foraging purposes. This is more likely to be the case in the breeding season than non-breeding season. This is a precautionary assumption, as resting birds will also spend time on the sea surface. Large proportions of the birds recorded from boat-based surveys of the Development Area and buffer in the breeding season were on the water surface: 81 per cent and 63 per cent respectively.

Age Classes

116   Immature razorbills cannot be distinguished from breeding age adult razorbills from observations at sea. It was therefore necessary to use the age structure from a stable

population model to determine the proportions of adults and immature birds in the population of birds at sea.

117   The age distribution of razorbills from the population models run for the SPA populations assessed in the HRA predicted that the stable age structure of the population would be made up of 49.3 per cent adult birds and 51.0 per cent of younger age classes. As for guillemot, razorbills cannot be aged from 'at-sea' survey data and therefore the Scoping Opinion advised that the age structure as determined from a population model should be used in the assessment.

11A.5.6 Puffin

118   The UK breeding population of puffin is about 580,799 pairs; about 9.6 per cent of the global population (Mitchell *et al*. 2004, Baker *et al*. 2006). Scotland is particularly important for this species, with a breeding population of about 493,042 pairs. The species is of "Red" conservation concern in Britain, due to localised populations and population declines (Eaton *et al*. 2015).

Regional Population Size and Trends

119   The regional breeding population of puffins was estimated from the mean of the maximum foraging range from Thaxter *et al*. (2012). Based on this spatial scale, from Buchan Ness in the north, to the Farne Islands in the south, Seabird 2000 (Mitchell *et al.* 2004) suggested a regional population of about 130,085 breeding pairs. While these data represent the last time all of the colonies were counted in systematic way over the same approximate time period, they are now quite old. More recent count data were available for SPA colonies (2009 – 2017), which results in a regional population of 88,944 breeding pairs, when the recent SPA colony counts are combined with Seabird 2000 counts for the non-SPA colonies. This was a 33 per cent decline in the breeding population of puffins in the SPA population. It is possible that declines also occurred in other puffin colonies in the region. Applying the decline experienced in the SPAs to the remaining colonies would result in a regional population of 87,647 breeding pairs.

120   The puffin population in the non-breeding season was estimated by Furness (2015) as 231,957 individuals for the North Sea and English Channel (mid-August to March). In their Scoping Opinion, MS-LOT (following the scoping advice of SNH) recommended that the breeding season period should be April to mid-August and that no assessment for the non-breeding season is required.

Development Area and Buffer Population Size

121   Boat-based survey data were used to estimate the total population size of birds within the Development Area and a two kilometre buffer. These data clearly show that the population size was larger in both the Development Area and buffer in the breeding season (*Figure 11A.19*). Abundance was higher, on average, in the second breeding season (average of total abundance = 3,598), compared to the first breeding season (average of total abundance = 2,134). Abundance was higher in the second non-breeding season than the first, when

abundance was very low. Based on the SNH scoping advice, the breeding season is from April to mid-August. Boat-based surveys in August both occurred in the first half of the month, and therefore occurred in the period defined as the breeding season.

122   In the breeding season, spatial abundance was even across the Survey Area in both years, including the two kilometre and four kilometre buffers, with little difference apparent between them in both survey years *(Figure 11A.1.11* and *Figure 11A.1.12*). In the non-breeding season, there was low abundance and patchy distribution in year one, which was in contrast to year two, where abundance was higher and more even. In year one, there appears to be a higher abundance in the four kilometre buffer than the two kilometre buffer, but with absolute abundance being so low, this difference is small and unlikely to be important. In year two, there was little clear difference between the two kilometre and four kilometre buffer.

Figure 11A.19 Population estimates of all puffins in the Development Area (amber columns) and two kilometre buffer (green columns) by survey number. Amber shading indicates the non-breeding season and green shading indicates the breeding season.
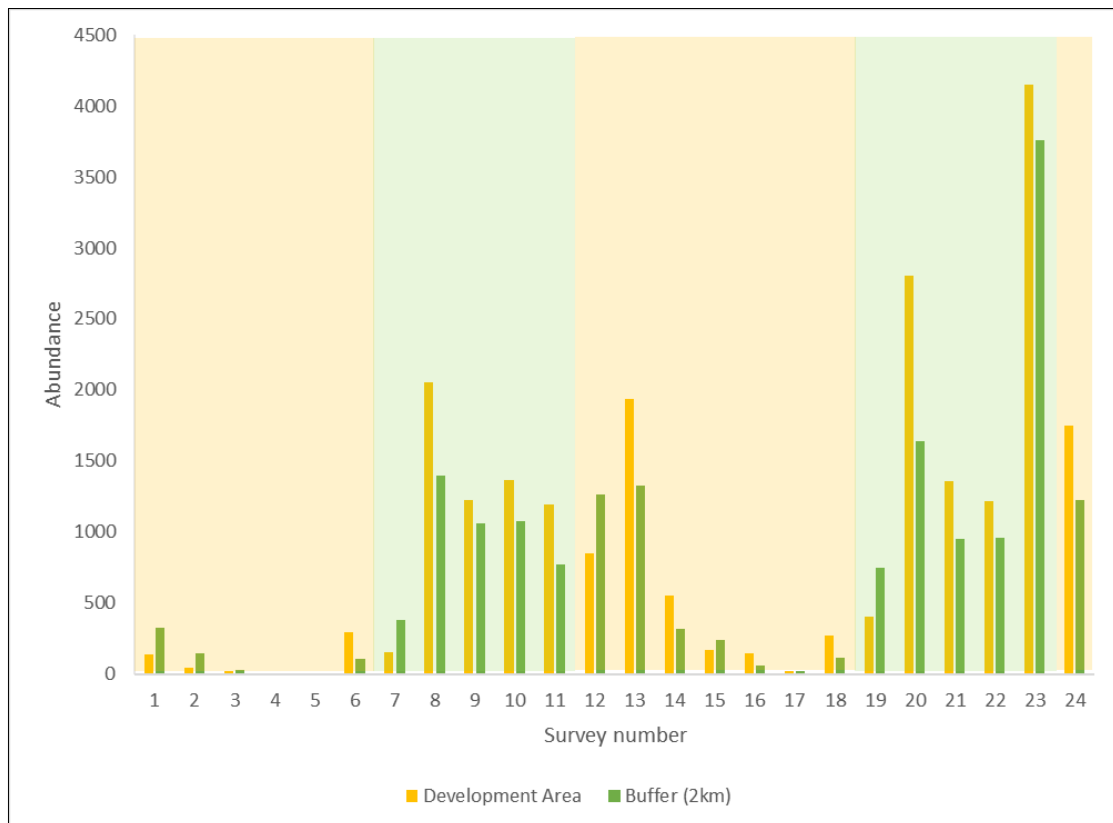
Flight Behaviour

123   Puffins, like the other auks, are a fast flying species (17.6 ms^{-1}, Pennycuick 1987). Analyses of generic survey data shows that the majority of birds fly close to the water (Johnston *et al.* 2014), typically below five metres (Johnston & Cook 2016).

124   Analysis of flight directions recorded from boat-based surveys using wind roses showed that birds in the breeding season were moving predominantly along a north-easterly and south-westerly axis. This is along the axis of the nearby Angus coastline, and heading the direction towards/ away from the large breeding colony on the Isle of May. In the non-breeding season flights were predominantly in the northerly and south-westerly direction (*Figure 11A.20*).

Figure 11A.20 Distribution of puffin flight direction from boat-based survey data in the breeding (left) and non-breeding (right) seasons.
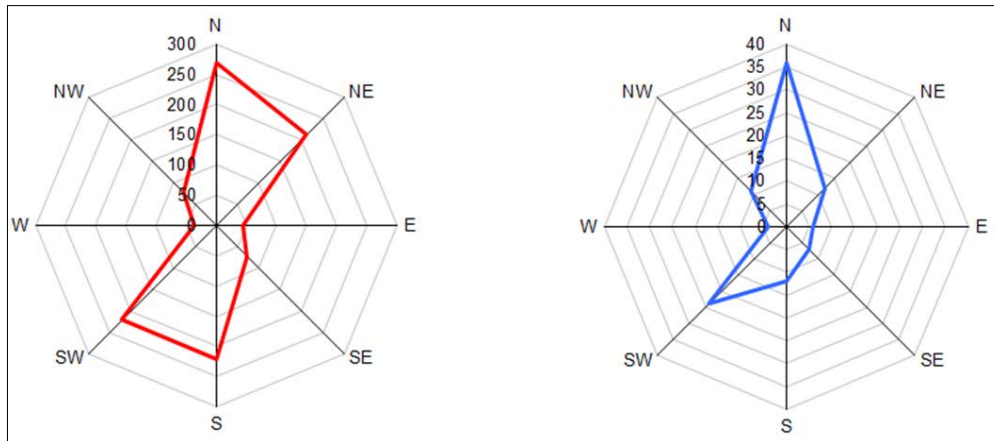
125   Flight height information from the Development Area, and buffer, was collected during boat-based surveys. These data showed that the modal flight heights of puffins within the Survey Area were in the lowest height band (0 – 5 m), in the breeding and non-breeding seasons (*Figure 11A.21*). In order to provide context to these bands, they were compared with the flight height data from Johnston *et al*. (2014), the source of "generic" flight height data used for Option 2 and 3 in CRM (*Appendix 11C*). It is apparent from this comparison that the puffins, in the breeding and non-breeding seasons, flying through the Development Area and buffer are occurring in the lowest height band (0 – 5 m) more frequently than predicted by the generic data, though only slightly. It is also apparent that puffins are lower flying than the other auks.

Figure 11A.21 Flight height distribution of flying puffins from boat-based survey data. Green columns are breeding season, amber columns are non-breeding season, and blue columns are generic data from Johnston *et al*. (2014).
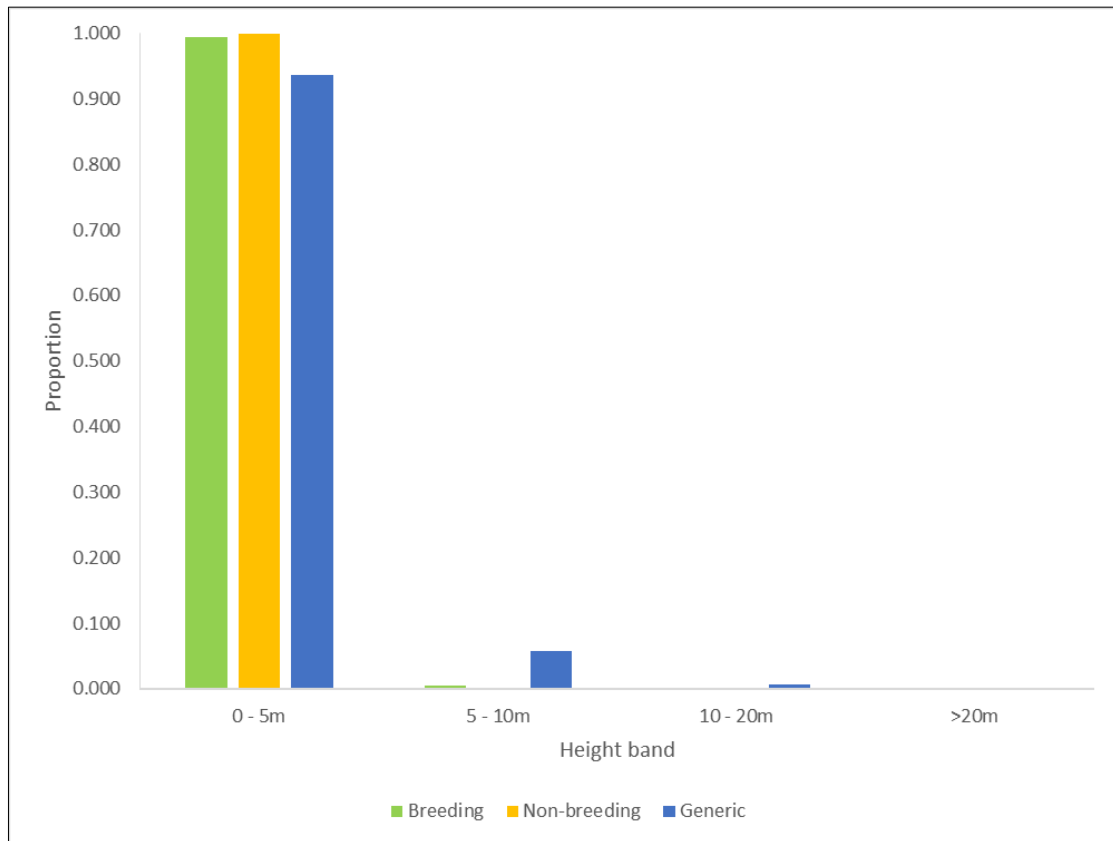
Foraging Behaviour

126   Puffins are a surface foraging species, where they dive though the water column to forage on pelagic and demersal fish, particularly sandeels in the North Sea (Snow & Perrins 1998). They forage up to 200 km from their breeding colony, but the mean of the maximum foraging range is much shorter; 105 km (Thaxter *et al*. 2012). Puffins appear to undertake longer foraging trips than the other auks.

127   It seems reasonable to assume that all puffins recorded on the sea surface are present for foraging purposes. This is more likely to be the case in the breeding season than non-breeding season. This is a precautionary assumption, as resting birds will also spend time on the sea surface. Large proportions of the birds recorded from boat based surveys of the Development Area and buffer in the breeding season were on the water surface, 76 per cent and 71 per cent respectively.

Age Classes

128   Immature puffins cannot be distinguished from breeding age adult puffins from observations at sea. It was therefore necessary to use the age structure from a stable population model to determine the proportions of adults and immature birds in the population of birds at sea.

129   The age distribution of puffins from the population models run for the Forth Islands SPA population assessed in the HRA predicted that the stable age structure of the population would be made up of 38.1 per cent adult birds and 62.0 per cent of younger age classes. As for guillemot, puffins cannot be aged from 'at-sea' survey data and therefore the Scoping Opinion advised that the age structure as determined from a population model should be used in the assessment.

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Annex 11A.1: Distribution Maps of Seabird Species within the Survey Area

Figure 11A.1.1 Gannet seasonal distribution in year one.
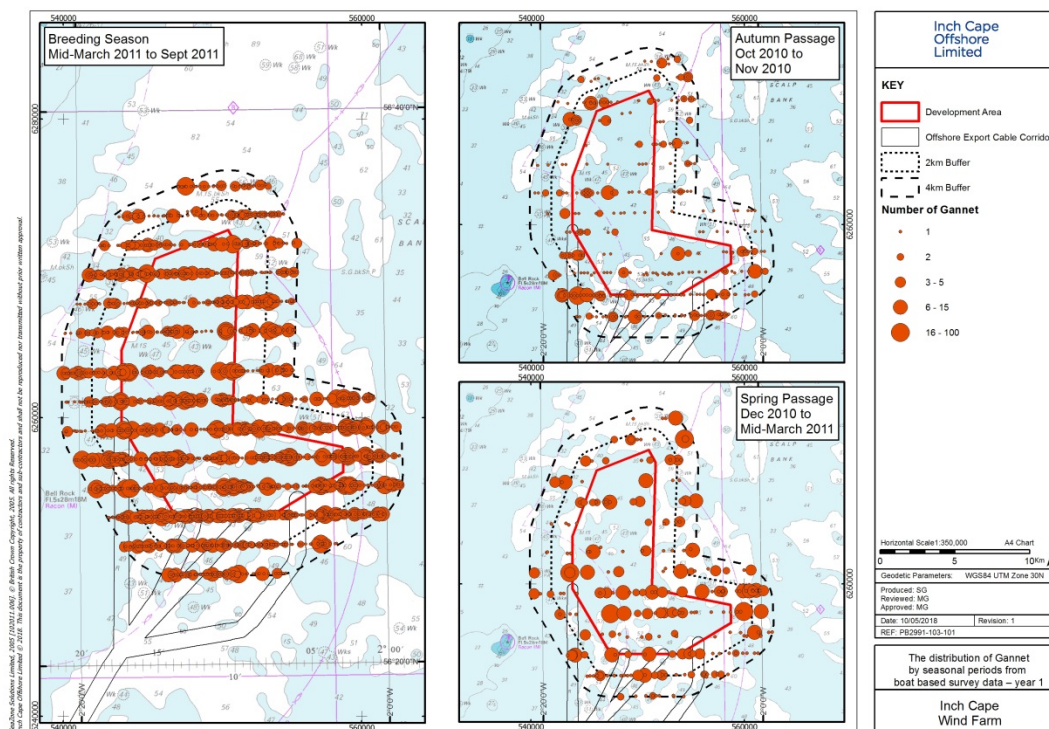
Figure 11A.1.2 Gannet seasonal distribution in year two.
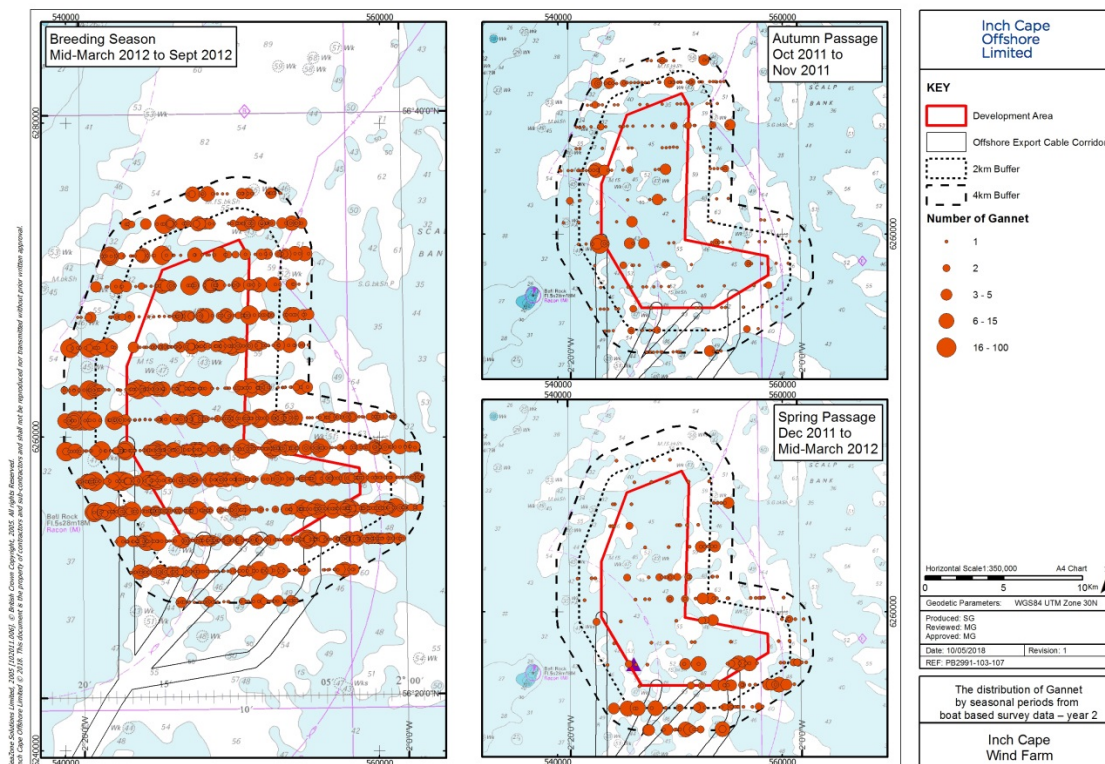
Figure 11A.1.3 Kittiwake seasonal distribution in year one.
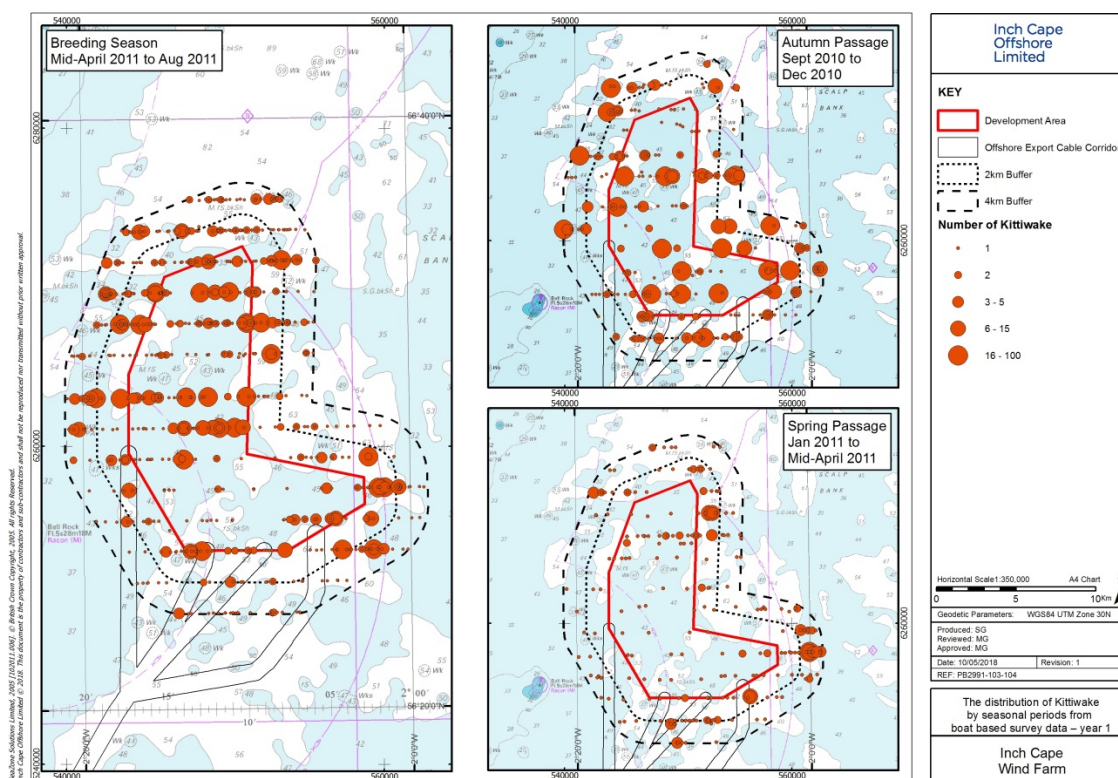
Figure 11A.1.4 Kittiwake seasonal distribution in year two.
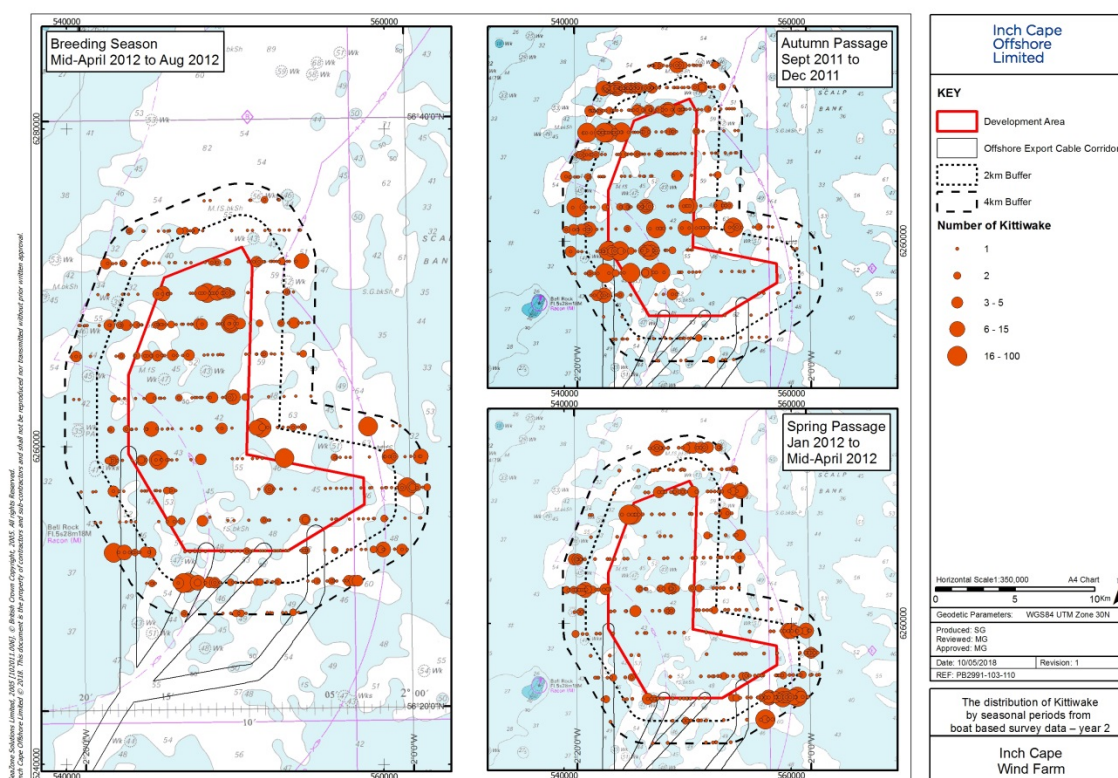
Figure 11A.1.5 Herring gull seasonal distribution in year one.
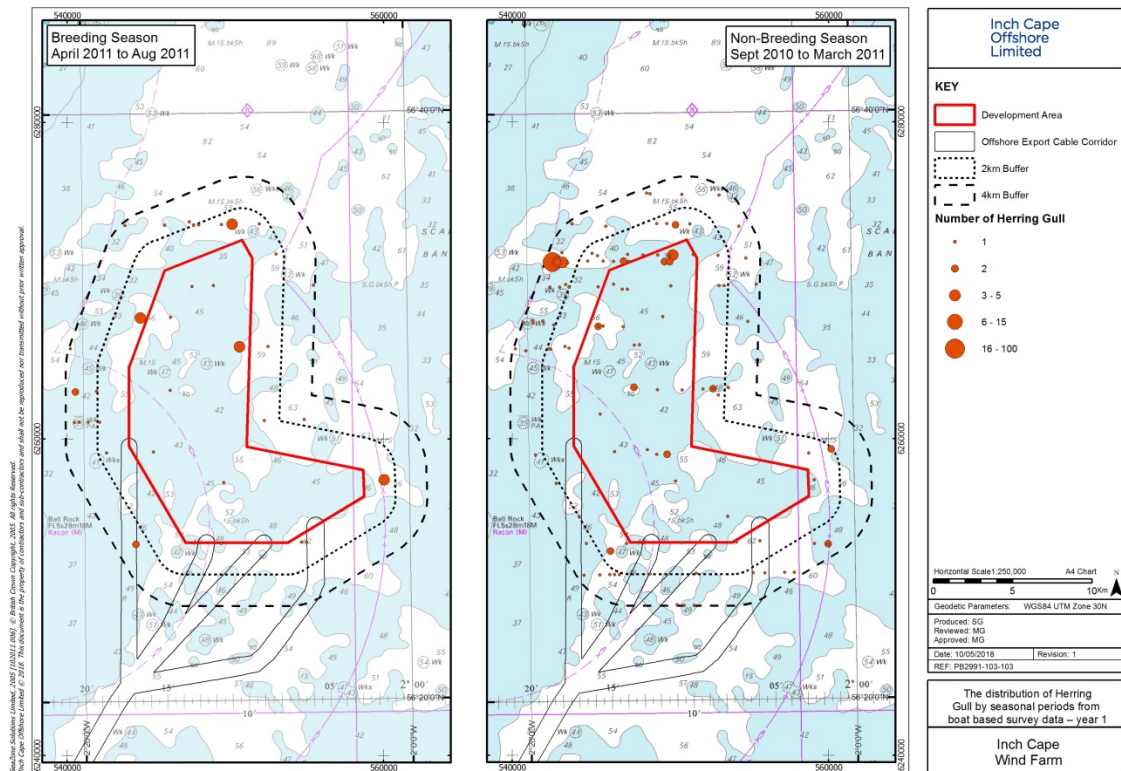
Figure 11A.1.6 Herring gull seasonal distribution in year two.
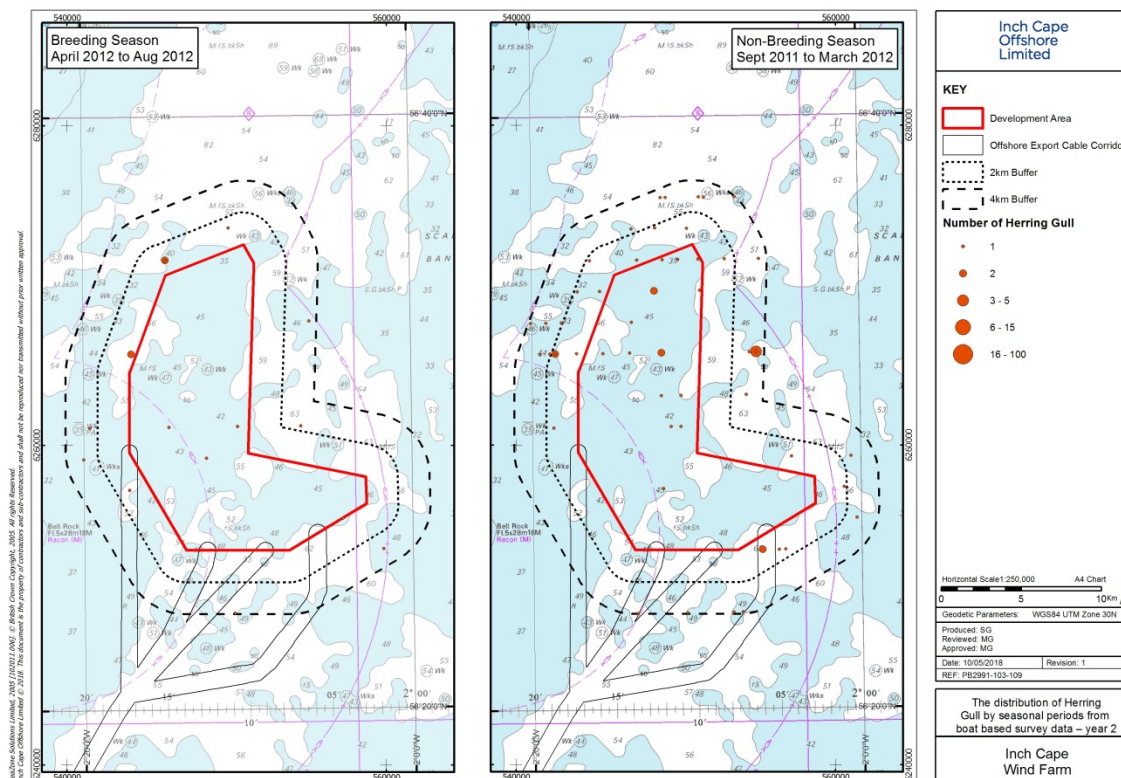
Figure 11A.1.7 Guillemot seasonal distribution in year one.
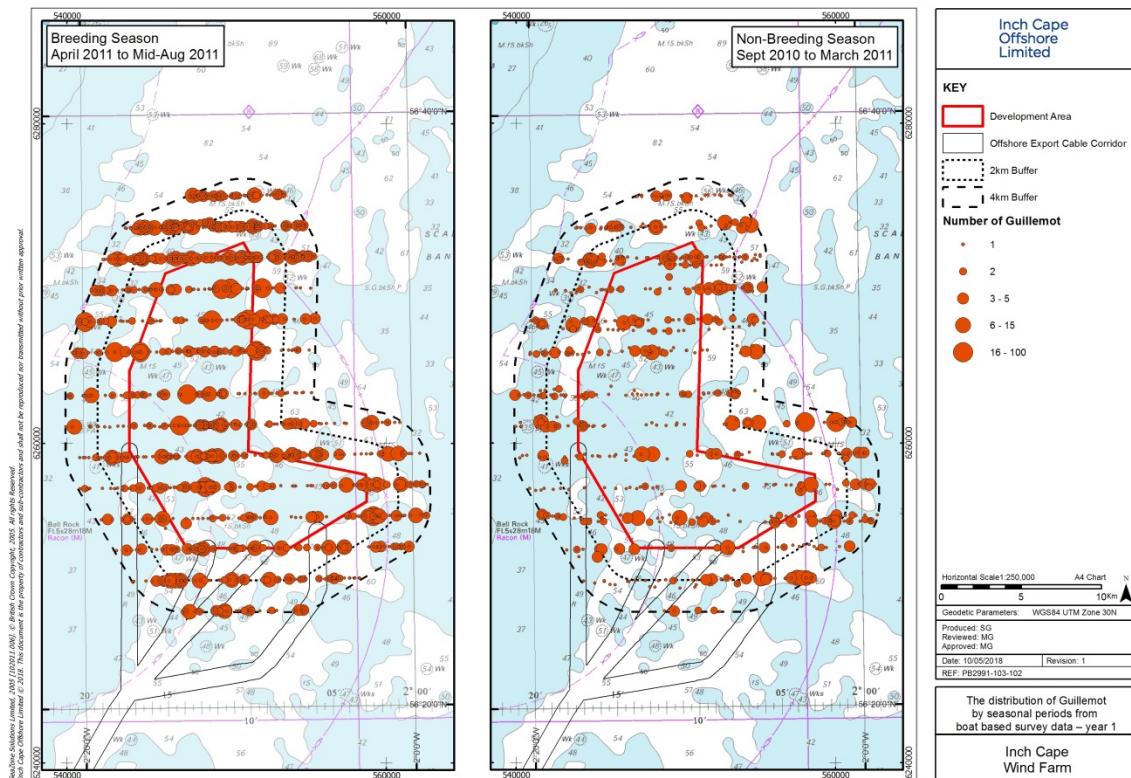
Figure 11A.1.8 Guillemot seasonal distribution in year two.
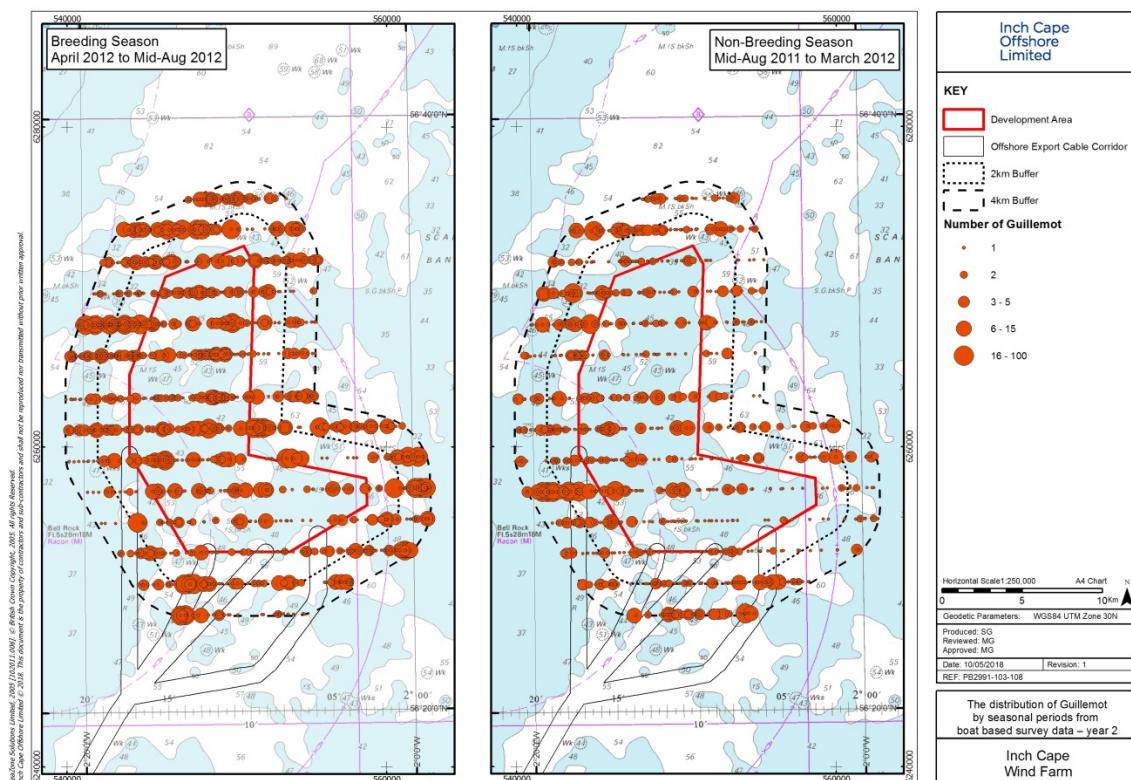
Figure 11A.1.9 Razorbill seasonal distribution in year one.
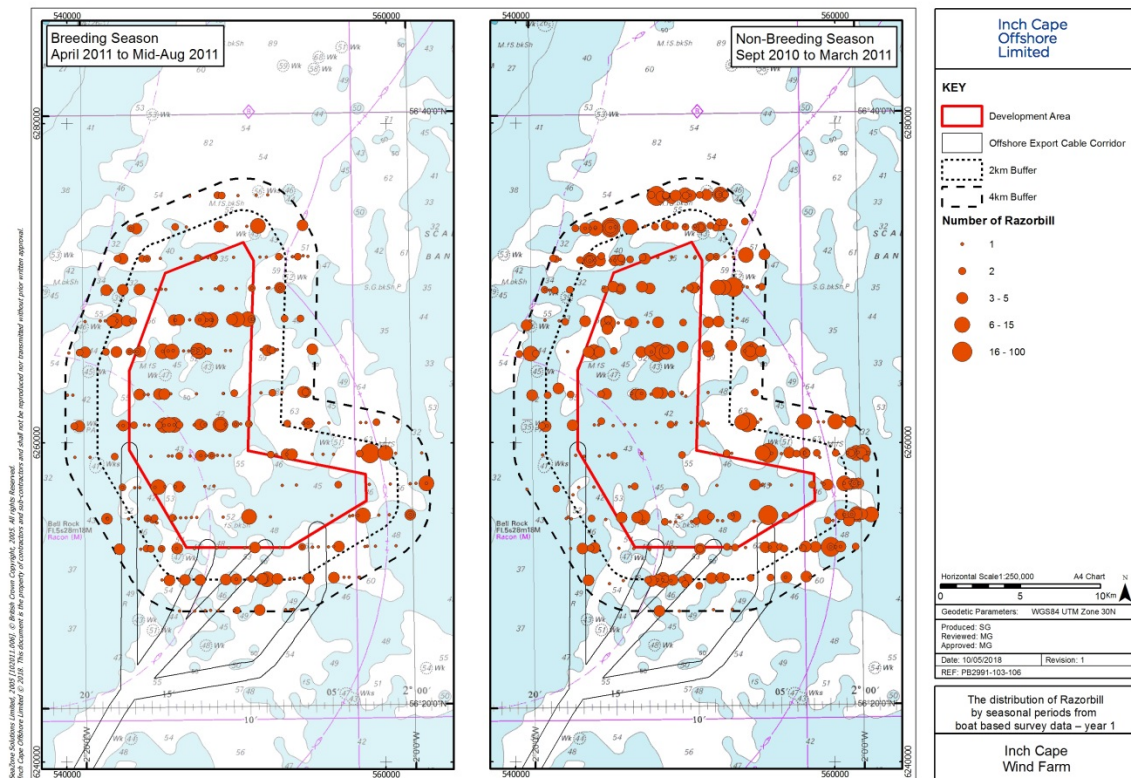
Figure 11A.1.10 Razorbill seasonal distribution in year two.
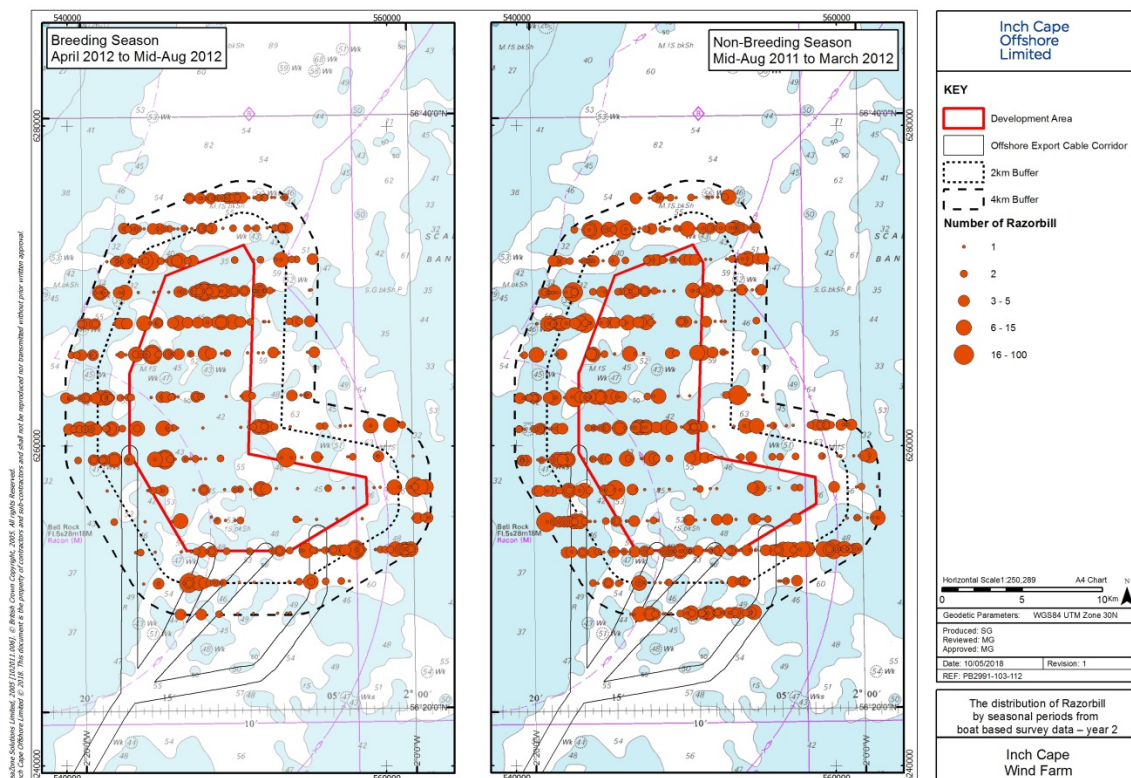
Figure 11A.1.11 Puffin seasonal distribution in year one.
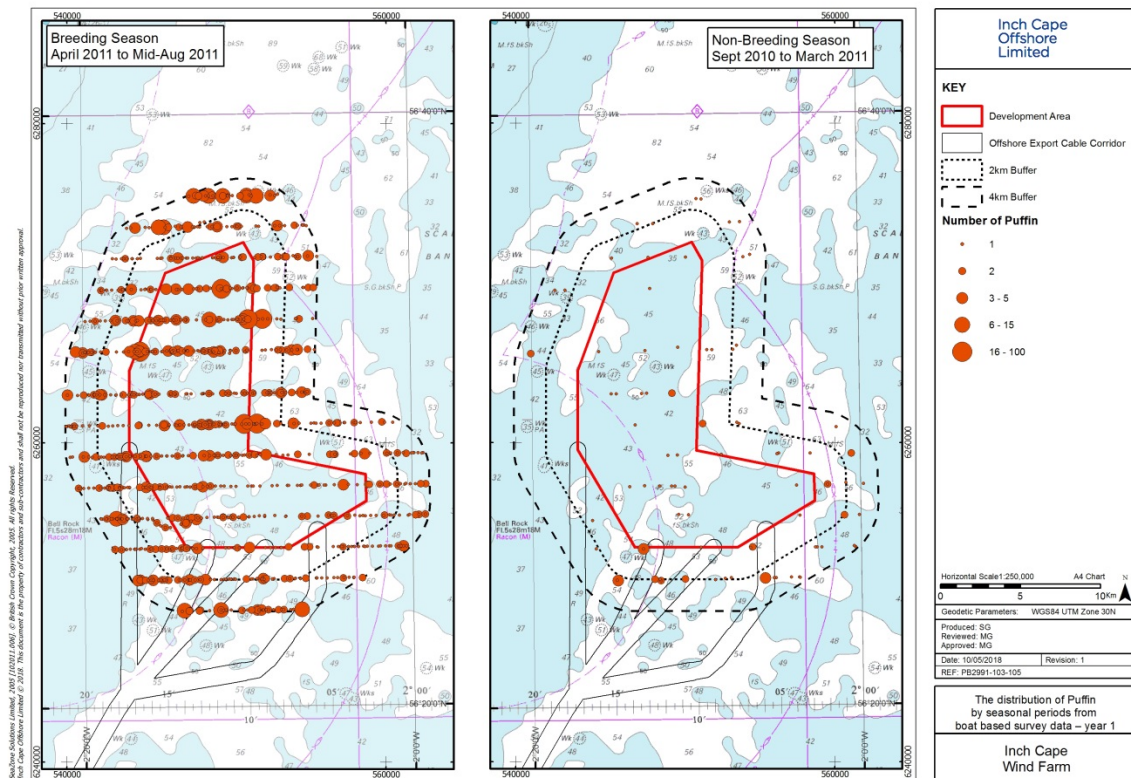
Figure 11A.1.12 Puffin seasonal distribution in year two.
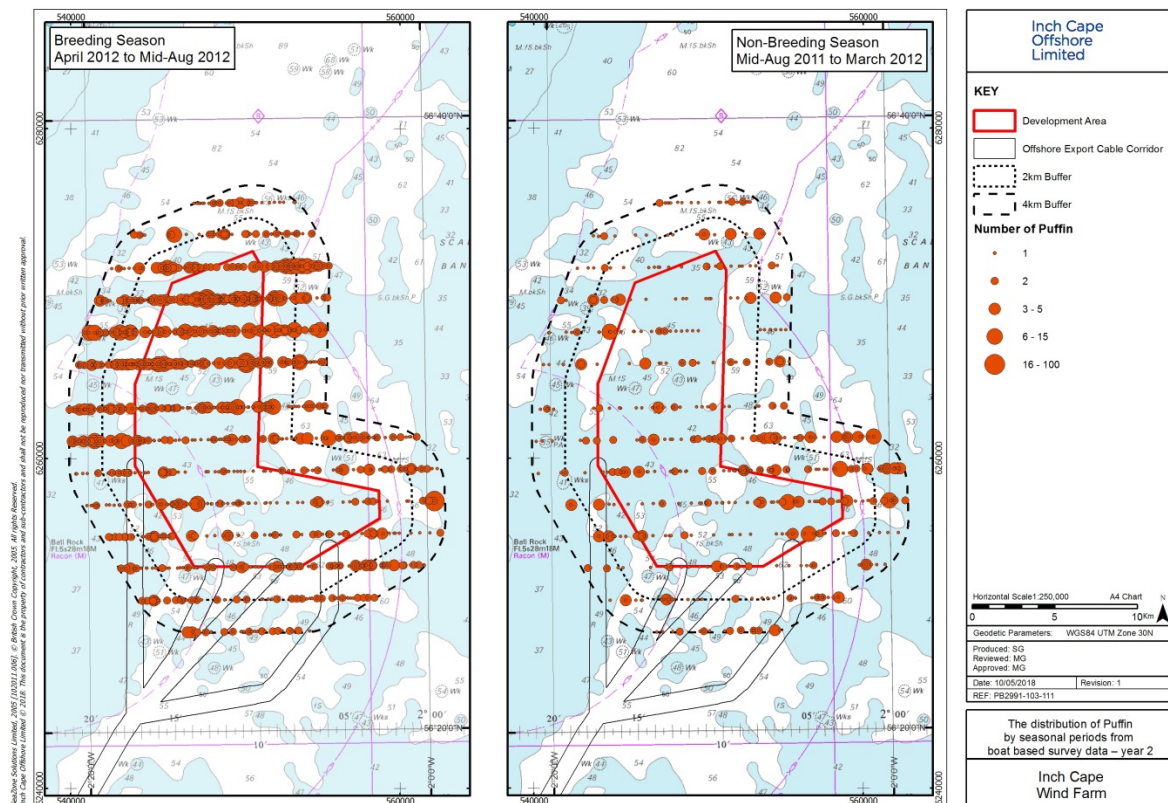
Annex 11A.2: Boat-Based Survey Data

130   *Tables 11A.2.1* and *11A.2.2* provide an overview of the raw count data collected in the Survey Area in survey years one (September 2010 to August 2011) and two (September 2011 – September 2012). Note that these data include all observations, regardless of distance from vessel, snapshot status or on/off effort and therefore differ from abundance information used in both the species accounts and impact assessment (with the latter having been analysed to provide a suitable density and abundance estimates in the Development Area and a two kilometre buffer).

131   *Tables 11A.2.3* to *11A.2.8* provide the analysed estimates of the numbers of birds on the water (with the 95 per cent confidence limits) and in flight separately for the Development Area and four kilometre buffer individually for each survey for gannet, kittiwake, herring gull, guillemot, razorbill and puffin, respectively.

Table 11A.2.1 Monthly survey counts for the Inch Cape Development Area and four kilometre buffer for year one. DA = Development Area, BF = Buffer

Year	2010						2011																	
Month	September		October		December		January		February		March		April		May		June		July		August	
Species	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF	DA	BF
Gannet	33	268	107	236	1	6	6	35	97	254	113	192	245	509	334	551	238	764	543	800	447	688
Kittiwake	2	96	537	746	6	11	15	365	2	14	25	82	24	75	263	159	121	447	400	1,025	258	116
Herring gull			4	6	15	32	16	70	2	18	1	12		10		2	9	26				
Guillemot	7	62	115	265	28	126	100	167	20	80	159	320	11	40	186	199	499	1,243	226	790	171	176
Razorbill	5	64	169	675	20	50	27	34	6	42	62	107	6	27	13	31	18	27	244	364	51	25
Puffin	3	25	2	21	1	3	1	2	17	29	19	151	231	358	126	195	114	173	241	296	2,008	3

Table 11A.2.2 Monthly survey counts for the Inch Cape Development Area and four kilometre buffer for year two. DA = Development Area, BF = Buffer

Year	2011								2012																	
Month	September		October		November		December		January		February		March		April		May		June		July		August		September	
Species	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
Gannet	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
Kittiwake	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
Herring gull			1	5	3	4	4	7	2	6	4	7	4	15			2	5		2		6	1	1		
Guillemot	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
Razorbill	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
Puffin	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

Table 11A.2.3 Population estimates of gannet in the Development Area and four kilometre buffer. DA = Development Area, BF = Buffer

Survey month	Area	Birds on the water			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

Survey month	Area	Birds on the water			Birds in flight	Total
		N	LCI	UCI	N	
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 11A.2.4 Population estimates of kittiwake in the Development Area and four kilometre buffer. DA = Development Area, BF = Buffer

Survey month	Area	Birds on the water			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

Survey month	Area	Birds on the water			Birds in flight	Total
		N	LCI	UCI	N	
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 11A.2.5 Population estimates of herring gull in the Development Area and four kilometre buffer. DA = Development Area, BF = Buffer

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 11A.2.6 Population estimates of guillemot in the Development Area and four kilometre buffer. DA = Development Area, BF = Buffer

Survey month	Area	Birds on the water			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

Survey month	Area	Birds on the water			Birds in flight	Total
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 11A.2.7 Population estimates of razorbill in the Development Area and four kilometre buffer. DA = Development Area, BF = Buffer

Survey month	Area	Birds on the water			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

Survey month	Area	Birds on the water			Birds in flight	Total
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 11A.2.8 Population estimates of puffin in the Development Area and four kilometre buffer. DA = Development Area, BF = Buffer

Survey month	Area	Birds on the water			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

Survey month	Area	Birds on the water			Birds in flight	Total
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