Natural England Commissioned Report NECR197

Pink-footed goose anthropogenic mortality review: Collision risk modelling

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

Natural England has been advising on the environmental impacts of onshore and offshore wind farms to both applicants and regulators for a number of years. Over that time the cumulative impacts to certain species has been a key issue. Recently one species in particular, the pink-footed goose *Anser brachyrhyncus*, was thought to be reaching levels of cumulative impact that may be unsustainable.

In order to better understand this Natural England commissioned the Wildfowl and Wetlands Trust to undertake a review on the impacts of wind farms to pink-footed geese.

The results provide the best evidence at the current time and they are published in three related reports:

- *Pink-footed Goose anthropogenic mortality review: Avoidance rate review* (NECR196);
- This report *Pink-footed goose anthropogenic mortality: collision risk modelling* (NECR197); and
- *Pink-footed Goose anthropogenic mortality review: Population model* (NECR198).

This information will be used by Natural England, regulators, applicants and their consultants to make better informed decisions about new wind farms.

This report should be cited as WWT Consulting *Pink-footed Goose anthropogenic mortality review: Collision risk modelling*. Natural England Commissioned Report, NECR197.

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Keywords – pink-footed geese, collision risk, mortality, flight height, wind farms, population viability analysis, migration routes, band model, foraging movements

Further information
This report can be downloaded from the Natural England website: **www.gov.uk/government/organisations/natural-england**. For information on Natural England publications contact the Natural England Enquiry Service on 0845 600 3078 or e-mail **enquiries@naturalengland.org.uk**

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1. SUMMARY

1.1 As a regularly occurring migratory species in the UK, the Birds Directive (EC Directive on the conservation of wild birds (2009/147/EC)) requires that pink-footed geese *Anser brachyrhynchus* are protected through a suite of Special Protection Areas (SPAs). Between 2008 and 2012 a peak mean of 326,540 pink-footed geese overwintered in the UK, mainly at a few important sites protected as SPAs, of which eight are in England.

1.2 As the Statutory Nature Conservation Body for England, Natural England has raised concern about the cumulative risk of mortalities from anthropogenic sources, chiefly onshore and offshore wind farms, on the UK overwintering population and contracted Wildfowl & Wetlands Trust (Consulting) Ltd (WWT Consulting) to undertake a review of that risk.

1.3 This report details Collision Risk Modelling used to estimate the risk from mortality by collision at wind farms in the UK and complements separate reports on: a review of a higher avoidance rate proposed by Scottish Natural Heritage (SNH) for use in Collision Risk Modelling of pink-footed geese; and Population Viability Analysis (PVA) of the UK pink-footed goose population.

1.4 For this study the SNH method was used to estimate mortality at each UK onshore and offshore wind farm with a range of geese avoidance rates. Wind farm turbine specifications were requested and where not available were estimated or extrapolated from similar models.

1.5 At the time of the study, there were few detailed data sources on the routes and flight heights taken by migrating and overwintering pink-footed geese. Data from two satellite tagged geese and 275 marked individual re-sightings were used to derive the most likely migration routes through Scotland and England.

1.6 A review of previous studies showed much variation in the proportion of geese flying at collision risk height, so a range of values from 5% to 80% were used in collision risk modelling. To estimate the number of geese passing wind farms, a number of assumptions had to be made and alternative scenarios simulated. These included: estimating the proportion of geese wintering in Scotland and those migrating down the east and west English coasts to sites in Norfolk and Lancashire; the average migration front width; and the proportion of each regional population passing each wind farm.

1.7 The results of the scenarios are presented in matrices showing the range of potential risk and the estimates compared with the outputs from the accompanying PVA report.

1.8 Within-winter daily foraging movements were found to produce the largest potential risk compared to the longer, twice yearly migratory movements. Table 1, below, shows the annual collision estimates of migrating and within-winter foraging birds from all onshore and offshore wind farms within 20km of goose tracks and sites, assuming the birds move along a 20km wide front and assuming 99% avoidance rate. These estimates are for wind farms whose first year of operation, or part thereof, was after October 2012, the last date of count data used in the PVA. Green shading shows additional mortality beneath that predicted from the PVA using a density independent model (WWT Consulting & MacArthur Green 2014) to lead to a 5% increase in predicted risk of a 20% population decline. Amber shading shows additional mortality predicted from PVA to lead to between a 5% and 20% increase in predicted risk of a 20% population decline.

1.9 Following Wright *et al*. (2012), assuming 30% of geese fly at collision risk height on both migration and when flying between winter roosts and feeding sites, 1,034 geese are estimated to collide annually. This is below the threshold predicted by PVA to lead to a 5% increase in predicted risk of a 20% population decline (note that these threshold values have not been confirmed for use by Natural England).

1.10 The limitations of the available data, the resulting assumptions that have to be made for modelling and the caveats of these outputs are discussed, especially in the light that to date no pink-footed goose corpses from wind farms have been discovered and no declines in the population have been detected.

Table 1 - Total number of annual collisions (migration risk and within-winter foraging transit risk summed) for all onshore and offshore wind farms within 20km of sites, re-sighting and satellite track-lines, whose first year of operation, or part thereof, was after October 2012, assuming birds are moving along a 20km wide front and assuming 99% avoidance (summed from Tables 11-13, below)

99%		% at CRH feeding								
		5	10	20	30	40	50	60	75	80
% at CRH migration	5	172	332	652	973	1293	1613	1933	2413	2574
	10	184	344	664	985	1305	1625	1945	2425	2586
	20	209	369	689	1010	1330	1650	1970	2450	2611
	30	233	393	713	1034	1354	1674	1994	2474	2635
	40	259	419	739	1060	1380	1700	2020	2500	2661
	50	283	443	763	1084	1404	1724	2044	2524	2685
	60	307	467	787	1108	1428	1748	2068	2548	2709
	75	344	504	824	1145	1465	1785	2105	2585	2746
	80	356	516	836	1157	1477	1797	2117	2597	2758

2. INTRODUCTION

2.1 Natural England has recently raised concern about the cumulative effect of mortalities from anthropogenic sources, chiefly offshore and onshore wind farms, on the UK overwintering population of pink-footed goose.

2.2 In order to clarify thinking and arrive at an informed position, as well as to inform inter-agency discussion on any agreed stance to related issues, WWT Consulting was contracted to undertake an evidence review.

2.3 The review had three objectives:

- To undertake a review of SNH's decision to change the avoidance rate used for pink-footed geese in Collision Risk Modelling (Band 2000) from 99% to 99.8%;
- To undertake cumulative Collision Risk Modelling to estimate the number of collisions per year; and
- To undertake a Population Viability Analysis for the species, against which the effect of additional mortality on the population could be assessed.

2.4 This report presents work done for the second objective, to estimate the number of collisions per year from constructed wind farms in the UK.

3. METHODS

3.1 A database of wind farm locations, number of turbines, turbine type, hub height and rotor diameters was provided through Natural England from Renewable UK (2014 pers. comm.).

3.2 For Collision Risk Modelling, as per SNH's guidance (SNH 2000, Band 2000), the blade pitch, maximum chord and rotation period were also required. These were appended through Google searches for specifications of the turbine models provided. Where these could not be readily found, which was more common for smaller or older turbines, the values were populated using approximations from similar turbines (e.g. based on rotor diameter). The blade pitch, which was usually variable, was taken for modelling to be 15 degrees.

3.3 To estimate the number of birds predicted to pass through the wind farms, their widths were also required. As these weren't provided in the database, this was assumed to be the rotor diameter for single turbine projects. For projects of two to nine turbines, it was approximated as twice the rotor diameter multiplied by the number of turbines and for projects with ten or more turbines, the Interactive Map of Renewable and Alternative Energy Projects in the UK (http://www.renewables-map.co.uk/) was used alongside Google Earth to measure the widest widths of projects.

3.4 For Collision Risk Modelling, the body length of pink-footed geese was taken as 0.68m and wingspan 1.52m. Flight speed was taken as $15ms^{-1}$ with a 'flapping' mode. Literature consulted for this data included Cramp & Simmons, 1977; Campbell and Lack, 1985; Brooke & Birkhead, 1991; http://www.bto.org/about-birds/birdfacts, and Dong Energy, 2013.

3.5 The Excel spreadsheet designed by Bill Band (2000) was completed using the above variables to estimate the average percentage of birds passing the turbines that would collide.

3.6 To estimate the number of birds passing through the turbines, the proportion of birds flying at collision risk height (CRH) and the number of birds passing each wind farm are required. Unfortunately, these data are not yet readily available, especially for a study at a strategic (national) scale. Thus other sources of available information, listed below, were compiled to estimate which wind farms are likely to be passed by migrating pink-footed geese and then a range of collision risks simulated and presented in a matrix.

Proportion at collision risk height

3.7 Though recent developments in animal-borne sensors allow the recording of flight height, at the time of writing such tags had not been fitted to pink-footed geese. Thus the data we have are from direct visual observations of flying geese, usually for wind farm impact assessments. These are made either by assigning flying birds to height bands based on judgement or a reference structure, such as a Meteorological Mast, or assigning continuous height data using, for example, a laser rangefinder with a clinometer to measure distance and angle. The following is a brief summary of data from these studies and the percentages of pink-footed geese in different height bands recorded from the studies are presented in Table 2, below.

3.8 Boat surveys over Shell Flat in Liverpool Bay on 6 Dec 2002 recorded 37 pink-footed geese flying in the height band 5-15m with none recorded in other height bands (Cirrus Energy, 2002).

3.9 Walney Bird Observatory carried out a series of surveys between 2004/2007 which included recording flocks of pink-footed geese with flight heights using observers based at Hilpsford Point on Walney Island, located 7-9.7km northeast of Barrow offshore wind farm. During the 2004 survey, approximately 40% of geese flew <20m, 50% at 20-130m and 10% over 130m (Walney Bird Observatory, 2004). During the 2006 survey, flight heights of 4,843 pink-footed geese were recorded of which 41.4% were recorded flying at a height no greater than 20 m, and 58.3% recorded flying at heights of 30-150 m (Walney Bird Observatory, 2006). During a 21 day survey period between 24 September and 24 October 2007, 467 pink-footed geese were recorded flying below 20m, 1,630 recorded 20-130m and 2,786 over 130m (NIRAS, 2007).

3.10 ECON reported 74% of recorded pink-footed geese flying in the height band 40-160m from boat surveys around the proposed Lincs offshore wind farm (ECON, 2007).

3.11 Ecology Consulting recorded 10,445 pink-footed geese flights from Vantage Point counts over Hellrigg wind farm between December 2011 and March 2012, of which 1,022 were through the collision risk zone and 82% at CRH (40-120m). Most geese were flying between roosts and feeding fields to the west (Ecology Consulting, 2012).

3.12 Plonczkier & Simms (2012a) used a bird-detecting radar unit overlooking the whole proposed Humber Gateway array in combination with visual observations between 15 September and 11 November 2012 (57 days). Of 205 goose tracks detected by radar, 110 were matched with visual observations which confirmed them all to be pink-footed geese; 7,129 individuals in total. Height information was collected for 95 flocks in relation to the height of meteorological mast located at the western edge of the wind farm footprint. Of all observed flocks, 49 (51.58%) were observed flying below the rotor sweep zone (0-24m), 15 flocks (15.79%) between 24-136m and 31 flocks (32.63%) over 136m.

3.13 Plonczkier & Simms also conducted a four year study on the east coast at Lynn and Inner Dowsing offshore wind farms using similar radar and visual observer methods (2012b). Of 979 flocks, 571 were visually confirmed as pink-footed geese skeins (comprising 39,957 individuals). The study concluded that the geese flew at 250-300m in good visibility in the autumn and at 100-150m in poor visibility with just 9.68% flying at CRH. Unfortunately, the paper does not include actual counts of birds at different flight heights.

3.14 Patterson *et al.* (2012) surveyed pink-footed geese flying between roosts and feeding sites at Caithness Lochs Special Protection Area and reported 25% of flocks (1,127 birds) flying 0-20m, 37.5% of flocks (2,756 birds) flying 21-50m, and 37.5% of flocks (2,710 birds) flying 51-100m.

3.15 Patterson also used a combination of visual assessments (for birds over 100m) and a laser rangefinder with clinometer attached (for birds less than 100m) to derive flight heights of pink-footed geese around Special Protection Areas in the Grampian Region (Patterson, 2013). Patterson reported 69% of ‘foraging’ birds flying less than 150m (mean 114m) whilst ‘returning to roost’ birds had a mean flight height of 165m. Of 40 birds recorded flying over the west edge of Aberdeen and presumed to be making longer flights, 12.5% were flying less than 150m (mean 310m).

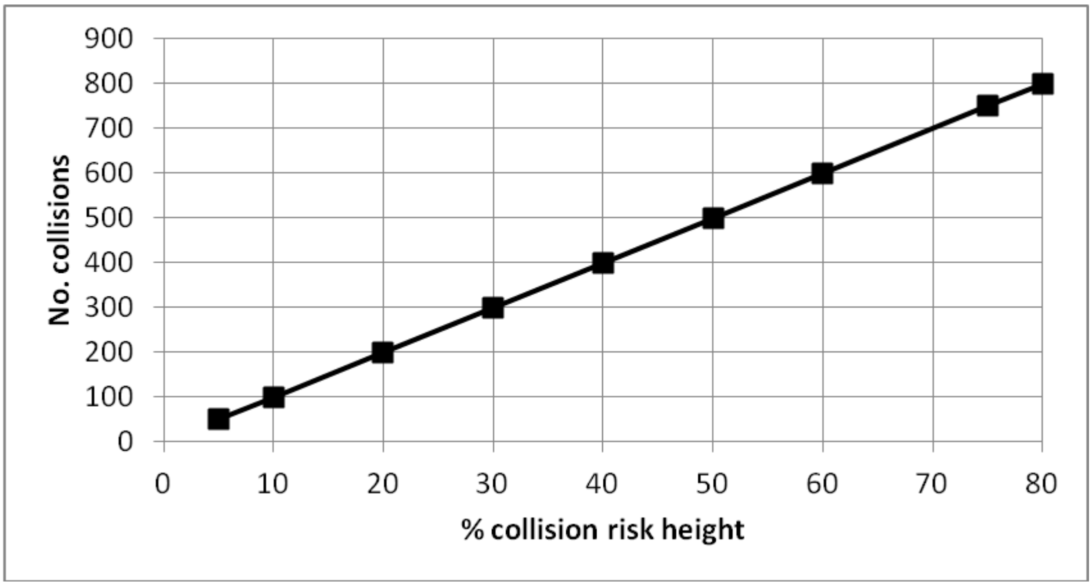
3.16 In SNH’s Guidance Note ‘Assessing impacts to pink-footed and greylag geese from small-scale wind farms in Scotland’ (2014) Patterson (in press) is quoted as reporting that in light winds 86.5% of flocks within 2.5km of take off position flew at 0-100m flight height and 97.6% flew 0-150m. In strong winds all flew lower such that none were above CRH. Patterson (in press) is also referenced reporting that of 10,749 geese recorded around Loch of Strathbeg, 10.8% flew at 0-100m flight height and 24.4% at 0-150m.

3.17 Together, these data show pink-footed geese fly at different heights depending on intrinsic and extrinsic factors. For shorter distances and in poorer conditions they may fly at lower altitudes (e.g. <100m) and in better conditions and for longer flights they may fly higher (e.g. >150m). However, given the variability in flight heights reported for either of these modes, for this wide-scale study, a range of proportions of birds at CRH is presented: 5%, 10%, 20%, 30%, 40%, 50%, 75% and 80%. Where these are pooled across all sites, the CRH is for the 'average turbine' which has a tip height of 98m. Figure 1 shows the linear effect on number of estimated collisions from applying different proportions at CRH.

Table 2 – Summary of evidence on percentage of pink-footed geese in different height bands. Modal values from the studies are shown in bold

Percentage at height band	n	Location	Month	Onshore/offshore	Reference
100% 5-15m 0%>15m	37	Shell Flat OWF	December	Offshore	Cirrus Energy 2002
40%<20m **50%20-130m** 10%>130m		Barrow OWF		Offshore	Walney Bird Observatory 2004
41.4%<20m **58.3% 20-150m** 0%>150m	4,843	Barrow OWF		Offshore	Walney Bird Observatory 2006
9.6%<20m 33.4%20-130m **57.0%>130m**	4,883	Barrow OWF	September - October	Offshore	NIRAS 2007
74% 40-160m		Lincs OWF		Offshore	ECON 2007
51.58% <24m 15.79% 24-136m 32.63%>136m	110 flocks (7,129 inds)	Humber Gateway OWF	September - November	Offshore	Plonczkier & Simms 2012a
82% 40-120m	10,445	Hellrigg Wind farm	December - March	Onshore - foraging	Ecology Consulting 2012
25%<20m **37.5% 21-50m** **37.5% 51-100m**	6,593	Caithness Lochs SPA		Onshore - foraging	Patterson *et al.* 2012
69%<150m		Grampian Region SPAs		Onshore - foraging	Patterson 2013
86.5% <100m 11.1%100-150m 2.4%>150m		Scotland		Onshore -foraging	SNH 2014
10.8% <100m 13.6%100-150m **75.6%>150m**	10,749	Loch of Strathbeg SPA		Onshore - foraging	SNH 2014
87.5%>150m	40	Aberdeen		Onshore - transit	Patterson 2013

Figure 1 – Linear effect of applying different proportions of geese flying at collision risk height on estimated number of collisions



Numbers passing wind farms

3.18 The Great Britain population of wintering pink-footed geese is relatively well monitored through synchronised counts during the Icelandic-breeding Goose Census, and for this study is taken as the 2008-2012 peak mean of 326,540 birds (WWT, 2014). As with the assessment of proportion of birds at CRH, however, the assessment of numbers of geese passing wind farms at a national scale is complicated by a general lack of data. At the time of writing, data on the flight paths of pink-footed geese was available at the finest resolution from two satellite-tagged birds and at a courser resolution (rarely more than two data points) from re-sightings of marked individuals (Mitchell pers. comm.). At best, satellite tag fixes and re-sightings data can be joined by indicative straight lines, though the actual route of the bird (and its flight height) remain unknown. The available satellite data and re-sightings of marked pink-footed geese that had travelled greater than 25km in three days are presented, together with the locations of major roosts (>100 birds five year peak mean) in Figures 2 & 3.

3.19 Though biased towards areas of effort, the re-sightings data generally connect well the distribution of roosts. Fox *et al*. (1994) provide a clear account of the movement patterns gleaned from re-sightings: Large numbers arrive in Grampian Region, east-central Scotland, Borders Region, Lothian Region and Lancashire during October and November. Numbers peak in England in mid-winter then return back through Scottish sites on spring migration with peaks in Grampian and Moray Firth in April. Most marked birds were recovered in the same area they were ringed in; however, 34% (376 of 1093) of consecutive re-sightings of birds marked in Lancashire were of birds moving between different areas; 231 (61%) of these were from more than one area and 21 (6%) from more than two areas. All movements in the autumn and early winter were generally southerly, and after mid-December, northerly. Tables 3 & 4, adapted from Fox *et al*. (1994) show this general trend, but around it there is some variation with birds moving north and both east and west between October and December and some moving south and both east and west between January and May.

Figure 2 - Main sites, re-sightings and satellite-tag fixes (joined by straight line tracks) for pink-footed geese in the UK in relation to wind farms. Wind farms within 10km of sites or tracks are highlighted and were used for subsequent analyses. Wind farm data were supplied by RenewableUK and pink-footed goose data were from Carl Mitchell, WWT (pers. comm.). NB long 'tracks' shown over the water are more likely to have occurred nearer or along the coast

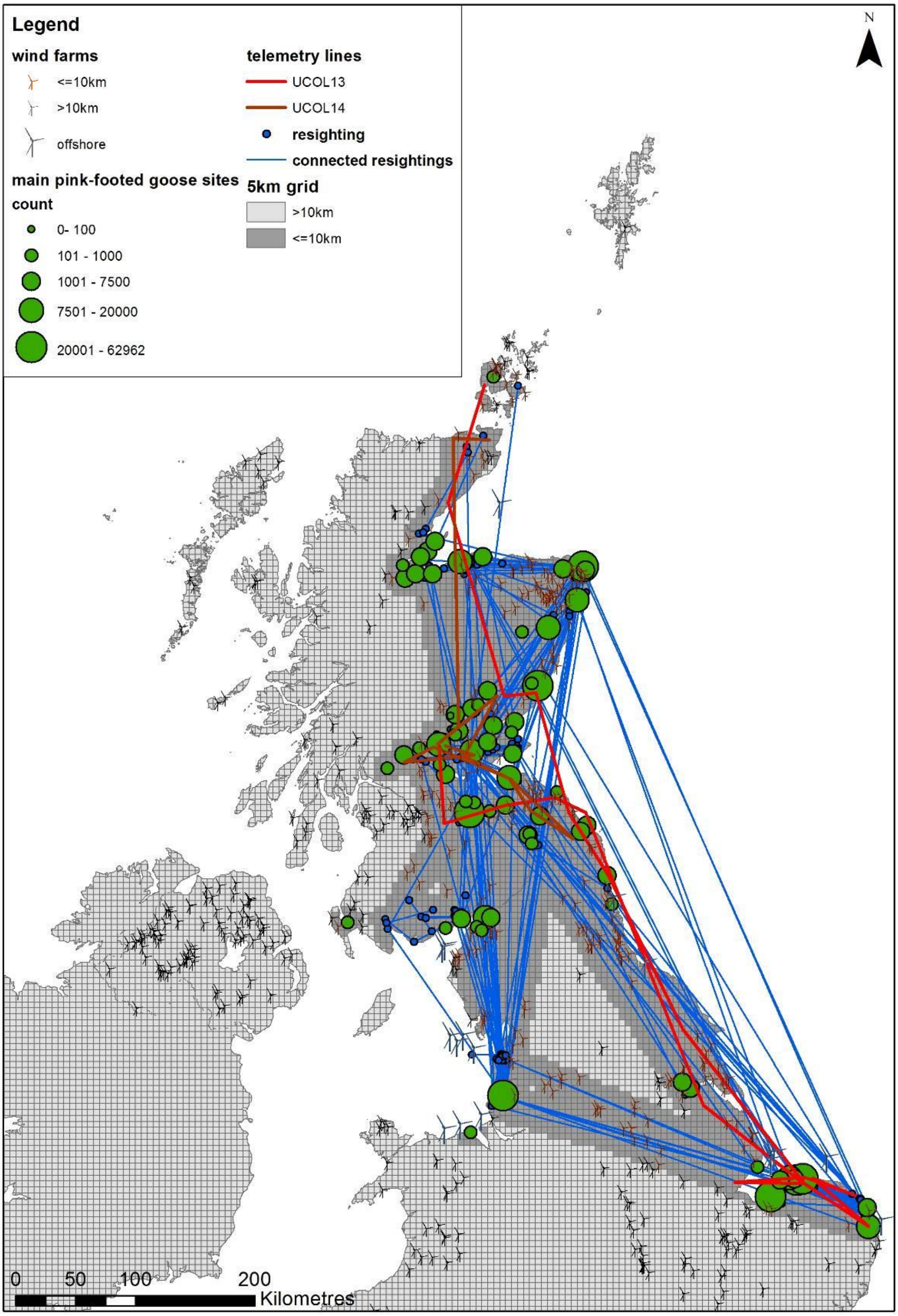


Figure 3 - Main sites, re-sightings and satellite-tag fixes (joined by straight line tracks) for pink-footed geese in the UK in relation to wind farms. Wind farms within 20km of sites or tracks are highlighted and were used for subsequent analyses. Wind farm data were supplied by RenewableUK and pink-footed goose data were from Carl Mitchell, WWT (pers. comm.). NB long 'tracks' shown over the water are more likely to have occurred nearer or along the coast

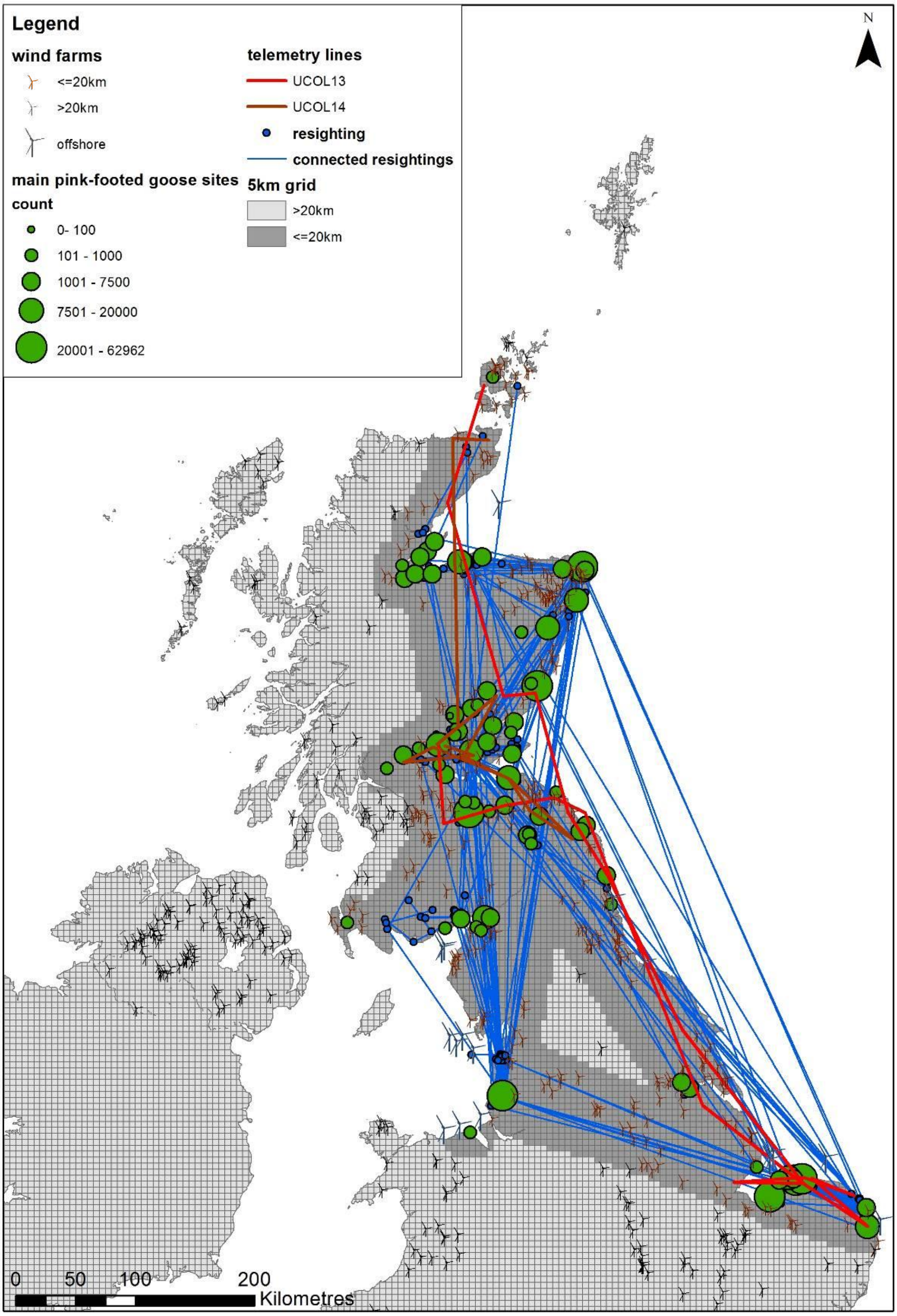


Table 3 – Same winter ringing recoveries of pink-footed geese captured during October-December 1950-1959 recovered between October and December. Values indicate the percentage of all recoveries; columns are the ringing areas, rows are the recovery areas. E England includes Lincolnshire and Yorkshire, SE Scotland includes Borders and Lothians, SW Scotland includes Dumfries and Galloway, EC Scotland includes Fife and Perth, NE Scotland includes Aberdeenshire and Angus. Adapted from Table 4, Fox *et al*. (1994)

Oct-Dec	E England n≈91	Lancashire n≈11	SE Scotland n≈100	SW Scotland n≈34	EC Scotland n≈136	NE Scotland n≈10
Wash	2.3	0	0.6	1.4	0	0
E England	42	6.2	8.6	2.8	2.7	0
Lancashire	3.4	25	2.3	2.8	0.4	0
SE Scotland	0	0	17.1	1.4	2.4	0
SW Scotland	2.8	3.1	9.7	32	5.1	3.9
EC Scotland	1.1	0	13	5.6	30.6	7.7
NE Scotland	0.6	0	5.1	1.4	10.3	26.9
Moray Firth	0	0	0.6	0	1.2	0

Table 4 - Same winter ringing recoveries of pink-footed geese captured during October-December 1950-1959 recovered between January and May. Values indicate the percentage of all recoveries; columns are the ringing areas, rows are the recovery areas. E England includes Lincolnshire and Yorkshire, SE Scotland includes Borders and Lothians, SW Scotland includes Dumfries and Galloway, EC Scotland includes Fife and Perth, NE Scotland includes Aberdeenshire and Angus. Adapted from Table 4, Fox *et al*. (1994)

Jan-May	E England n≈82	Lancashire n≈21	SE Scotland n≈73	SW Scotland n≈38	EC Scotland n≈127	NE Scotland n≈16
Wash	4.1	0	4	0	0.4	3.9
E England	15.6	15.6	9.7	5.6	3.5	0
Lancashire	6.4	28.2	3.4	1.4	3.9	0
SE Scotland	2.3	3.1	4.6	4.2	1.2	0
SW Scotland	13.2	18.8	6.3	27.8	14.8	19.2
EC Scotland	2.9	0	8	5.6	16.3	11.6
NE Scotland	2.3	0	4.5	8.4	6.3	23.1
Moray Firth	0	0	1.2	0	3	3.9

3.20 Supplementing re-sightings data are records of 'Visible Migration' made by volunteers submitted to the online Trektellen database (http://www.trektellen.org/default.asp?site=0&taal=2&land=5). Though these data are again biased to areas of increased effort (in this case largely linked to accessibility or known migration hotspots) they correspond well to the extrapolated re-sightings data, with most records near and between major roosts and down the east coast of England, but with some, rarer data from the west coast of Scotland, Lake District and Pennines, which, especially given poorer coverage in these areas, provides useful direct evidence for geese migrating over these areas.

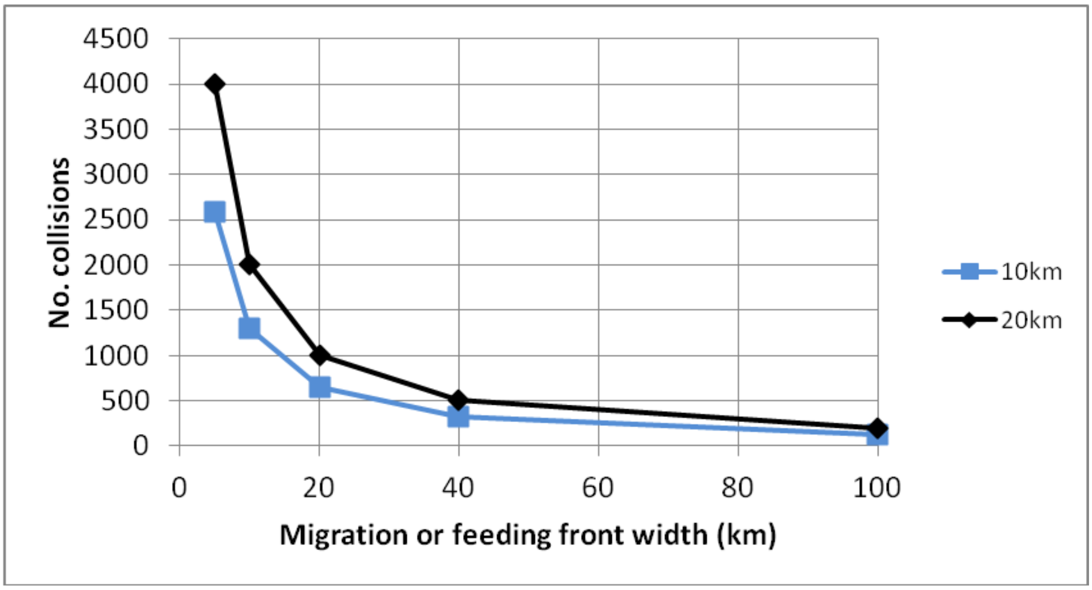
3.21 Though the satellite-tag and re-sightings data presented in Figures 2 & 3 suggest movement over stretches of sea, these are just interpolations of data points and the extent to which geese migrate over sea once in Great Britain is largely unknown. Boat, Vantage Point and radar studies for offshore wind farms at Beatrice, Barrow, Walney, Humber Gateway, Lincs and Lynn and Inner Dowsing have all recorded pink-footed geese flocks offshore, with radar work by Plonczkier & Simms at Humber Gateway (2012) showing a skewed distribution of tracks illustrating a defined pattern of flight behaviour presumably a preferred flight path corridor of offshore flight parallel to the coast. Incidentally, this radar study recorded peak flight activity between 0900 and 1300 GMT and only 18 goose tracks were recorded in the hours of darkness, which suggests that daylight visual observations may not greatly underestimate numbers by virtue of their timing at least.

3.22 Given the general lack of detailed information on the migration routes of pink-footed geese, this study used the general patterns discerned from the re-sightings (and satellite-tag) data to identify 'regional' migration routes and then a range of migration front widths within these were applied for collision risk modelling: 5k, 10km, 20km, 40km and 100km to present a range of scenarios.

3.23 To screen in wind farms for analysis a Geographic Information System (GIS) was used to map the main roost sites used by pink-footed geese, re-sighting data of marked birds connected by straight lines and satellite-tag tracking data (of two birds over winter 2013/14). Hereafter these will be referred to as 'site and track-line' data. To illustrate the effect of not knowing the exact path birds took between re-sightings, wind farms were screened under two scenarios: those within 10km and those within 20km of the track-lines connecting re-sighting (or satellite-tag) data points.

3.24 Figure 4 shows the negative exponential effect of the migration (or foraging) front width applied on the estimated number of collisions and an example of the effect of screening in all wind farms within 10km or 20km of sites or track-lines. Figures 2 & 3, above, highlight those wind farms screened in within 10km and 20km of sites or track-lines, respectively.

Figure 4 – Effect of migration (or foraging) front width and whether all wind farms within 10km or 20km of sites or track-lines are screened in on estimated number of collisions



3.25 A 5km x 5km grid aligned to the Ordnance Survey Great Britain 1936 (OSGB36) datum was originated to cover the UK and cells populated with the number of times a re-sighting or satellite-tag track-line passed within 10km of them. Additional grid cells which were not within 10km of a re-sighting or satellite-tag track-line but which were within 10km of a site were also populated with the number of additional sites this added. For the re-sighting track-lines which passed offshore down the east coast, the counts of lines were added to grid cells within 10km of the coast nearest those lines in case the straight-line interpolations did not accurately reflect the birds movements. This whole process was repeated with grid cells within 20km of site and track-line data.

3.26 By plotting the grid with symbology based on the grid cell values, choropleth maps of cells within 10km or 20km of site or track-line data were produced (Figures 5 & 6). These were, at the time of writing, our best evidence of course migration paths used.

Figure 5 - Choropleth map showing number of sites and track-lines that pass within 10km of each 5km x 5km grid cell. In Collision Risk Modelling calculations it has been assumed that 5% of the regional migratory population fly through green cells (<-0.5SD of mean), 27% through yellow cells (-0.5-0.5SD of mean) and 68% through orange and red cells (>0.5SD)

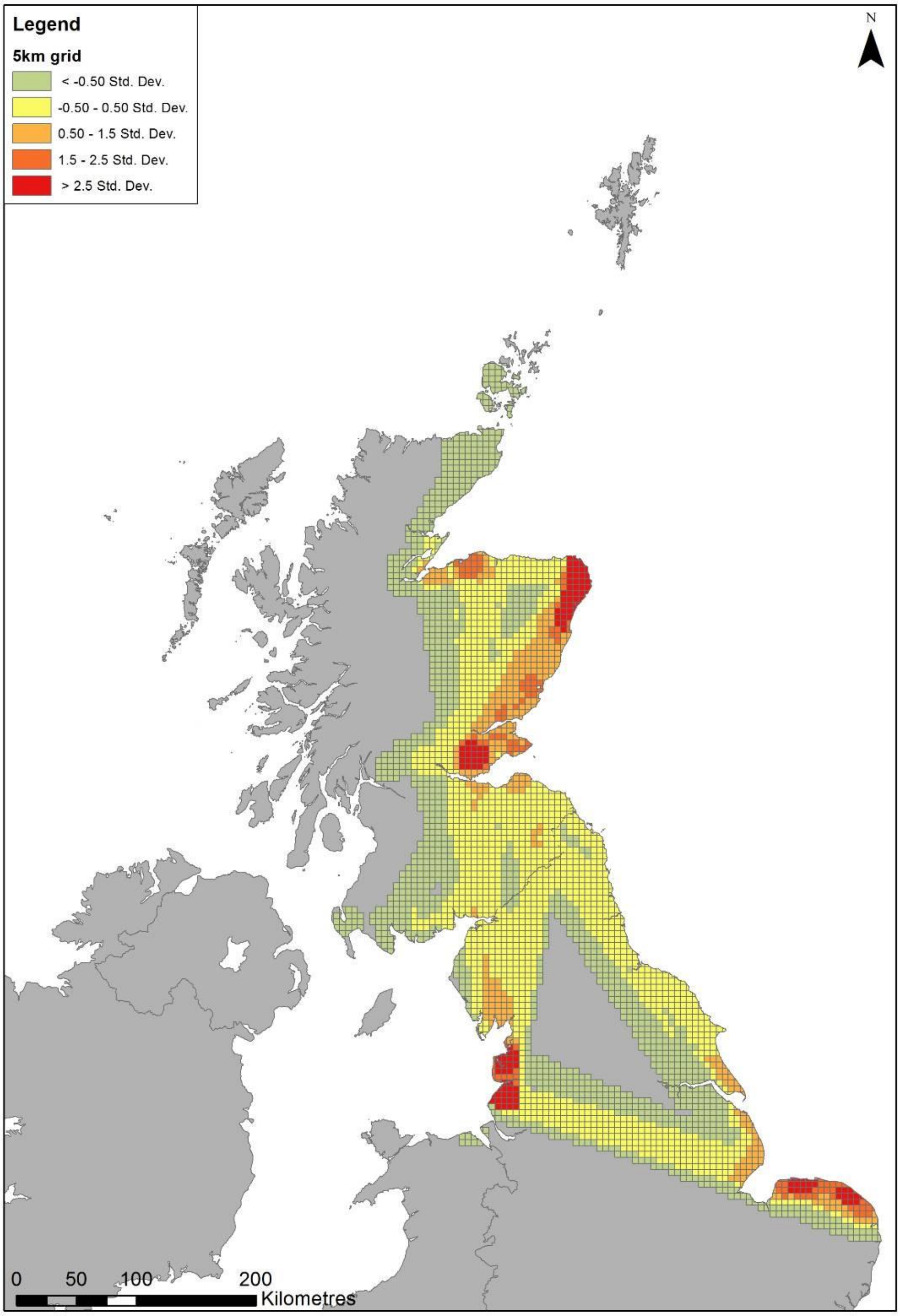
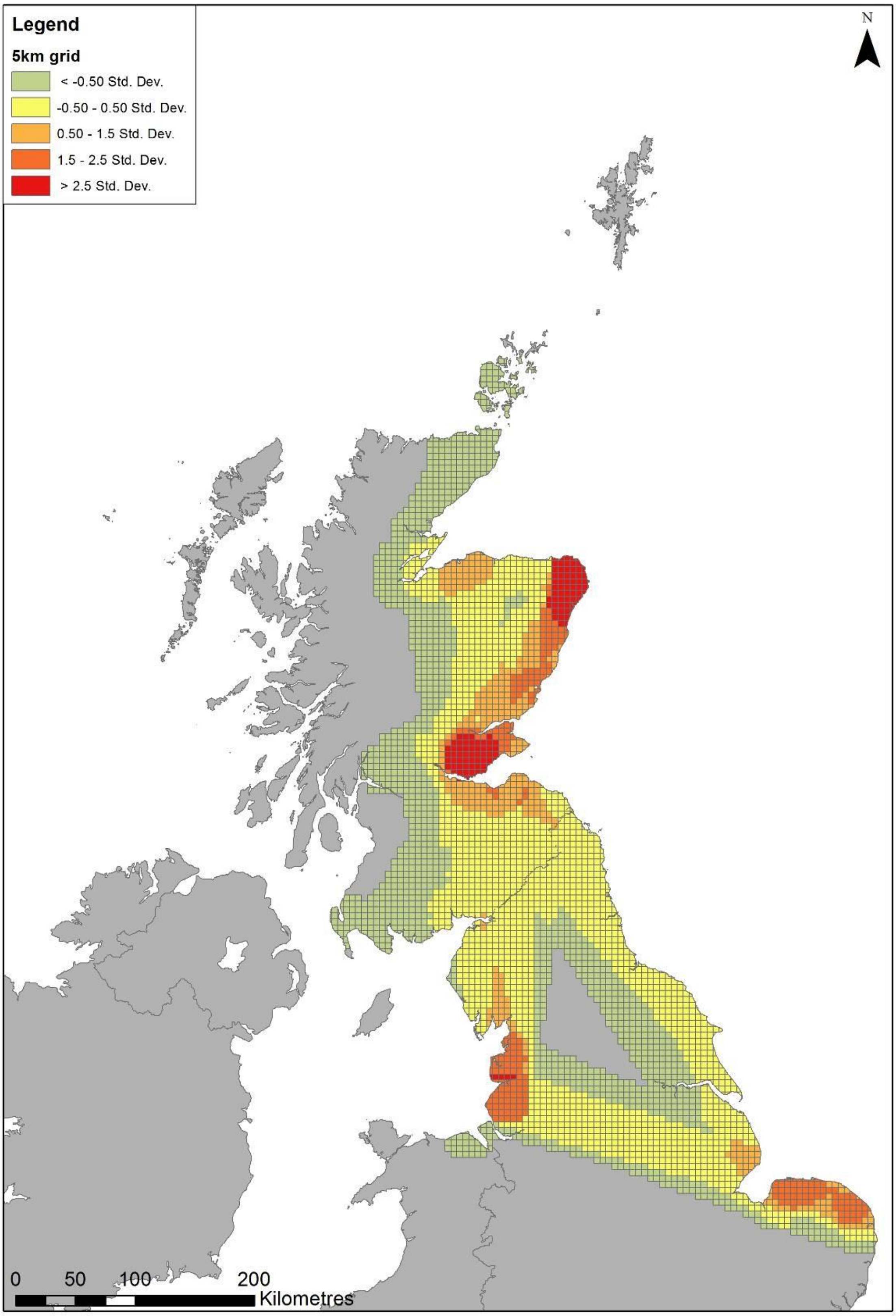


Figure 6 - Choropleth map showing number of sites and track-lines that pass within 20km of each 5km x 5km grid cell. In Collision Risk Modelling calculations it has been assumed that 5% of the regional migratory population fly through green cells (<-0.5SD of mean), 27% through yellow cells (-0.5-0.5SD of mean) and 68% through orange and red cells (>0.5SD)



3.27 Based on site numbers, a review of previous studies and the re-sightings data, for the purpose of collision risk assessment it was assumed that 100% of the UK population migrated through the core areas identified on the choropleth map in Scotland. Based on Icelandic-breeding Goose Census counts from sites, it was then assumed that 50% of the population remained in Scotland, whilst 25% of the population passed down the west coast to Lancashire and 25% down the east coast towards Norfolk. To account for interchange between Lancashire and Norfolk it was assumed that 12.5% of the population flew between these sites. Table 5 shows the proportions of the GB population assumed in each 'regional' migratory populations and this is represented in Figure 7.

Table 5 - Proportions and numbers of GB pink-footed goose population assumed to overfly and overwinter in different regions (see Figure 7)

	Migration Proportion	**Migration number (each migration)**	**Over-wintering Proportion**	**Over-wintering number**
NE and EC Scotland	1	326,540	0.5	163,270
Dumfries & Galloway & West Coast England to Lancashire	0.25	81,635	0.25	81,635
Scottish Borders and East Coast England to Norfolk	0.25	81,635	0.25	81,635
Inland Lancashire to Norfolk	0.125	40,818	0.125	0

3.28 Estimating the number of birds passing through each grid cell was possibly the most challenging stage of the modelling. The number of birds summed from all grid cells does not equal the total population size as the birds will move from one cell to the next approximating the coarsely defined migration paths identified above. We may make the assumption that birds fly along paths with a normal distribution, i.e. most birds use the most preferred line (68% within 1 standard deviation (SD)), a smaller number alongside this (27% from 1-2 SDs), and very few outside this (5%>2SDs). However, as can be seen from Figures 5 & 6, the areas with higher numbers of birds are unique, complicated shapes and, although we assume general seasonal directions, we don't know whether birds move vertically, horizontally or diagonally between any two particular cells. Given this, crude assumptions had to be made. We assumed that the grid cells with the highest numbers of birds in (red and orange on Figures 5 & 6 - >0.5SD of mean number of birds in each cell) had 68% of the regional migratory population passing through, 27% passed through the cells coloured yellow (<0.5SD) and 5% through the cells coloured green (<-0.5SD). The effect of varying any of these values on the number of collisions is linear, so small changes have small effect, but these values were chosen as a 'best estimate'. Table 6, below, shows the relationship between the number of track-lines within 10km and 20km of a grid cell and the proportion of the 'regional' population assigned. As discussed, the actual distribution of birds within regional migration paths is unknown so these values are used as proxy; the effect of a narrower distribution would be more birds encountering fewer wind farms and vice versa.

Figure 7 - Proportion of GB population of 326,540 birds assumed for Collision Risk Modelling to migrate through different regions

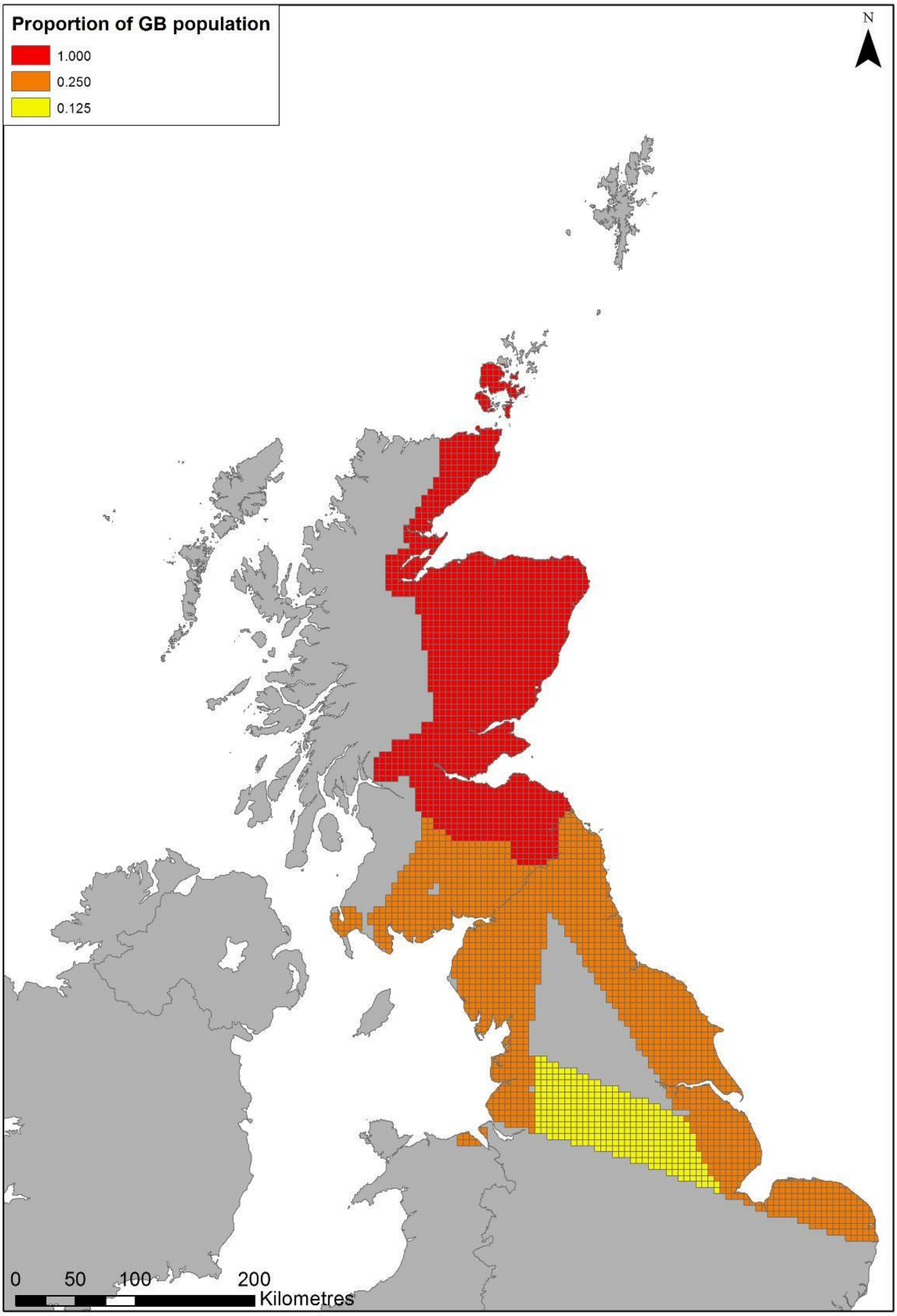


Table 6 - Mean number of sites and track-lines within 10km and 20km of 5km x 5km grid cells (after cells with zero counts removed), with Standard Deviation (SD) classes and proportions of regional migratory population assigned (see Figures 5 & 6)

	10km	**20km**	**Proportion of regional population assigned**
Mean	12	19	-
<-0.5 SD	1-5.4	1-9.6	5%
-0.5-0.5 SD	5.4-19	9.6-29	27%
>0.5 SD	>19	>29	68%

3.29 The number of birds estimated to pass each 5km x 5km grid cell on a migration was thus the UK population multiplied by the proportion of the population assumed to use each regional route, multiplied by the relative proportions from the choropleth maps.

3.30 For example, the migratory population in an orange or red cell near The Wash or in Lancashire in Figures 5 & 6 would be 326,540 x 0.25 x 0.68 = 55,512 geese.

3.31 Note that using this approach, adjacent cells in the same class (as identified by the colours in Figures 5 & 6) can have the same number of birds, indicating a broad flyway within which all wind farms may be encountered. This may lead to overestimation of risk, but as the exact micro-routes taken by birds are not generally known, refining this further may be misleading. Instead, a range of calculations have been presented assuming different widths of migration front passing the wind farms: 5k, 10km, 20km, 40km and 100km.

3.32 For constructed offshore wind farms a similar approach was taken, but taking the number of geese passing from the highest valued terrestrial 5km x 5km coastal grid cell within 10 or 20km. Wind farms screened in were those where the nearest coast was within 20km or 10km of pink-footed goose sites or track-lines (as with terrestrial wind farms above, but allowing for water crossings). Those screened in were: Beatrice Demonstration, Blyth Offshore, Robin Rigg (East & West), Teesside, Ormonde, Walney (1 & 2), Barrow, Burbo Bank, North Hoyle, Rhyl Flats, Lincs, Lynn & Inner Dowsing, Sheringham Shoal and Scroby Sands.

3.33 To estimate within-winter risk to pink-footed geese transiting between roosting sites and feeding areas, 10km and 20km buffers were drawn around pink-footed goose Special Protection Area boundaries and other important roosts (>100 five year mean peak count) and those site counts summed for all wind farms in the intersecting areas (Figure 8). Within-winter flights were assumed to occur twice daily for 140 days through the winter (Natural England pers. comm.). Again, for collision risk modelling, a range of transit flight widths and proportion of flights at CRH are presented.

3.34 As a number of assumptions and scenarios have been used for modelling *in lieu* of more accurate data, these have been summarised in Table 7.

3.35 To enable comparisons to be made with the outputs from the accompanying PVA report (WWT Consulting & MacArthur Green, 2014), the Collision Risk Modelling was re-run including only those wind farms whose first year of operation, or part thereof, was after October 2012, the date of the last count used in the PVA. Estimates from wind farms that became operational between November 2011 and September 2012 were multiplied by the proportion of the eight wintering months (September to April) that their first year exceeded October 2011. For example, an estimate from a wind farm that became operational in January 2012 would be multiplied by 3/8 since mortality from October to December from its first year of operation would not be incorporated in the PVA.

Figure 8 - 10km and 20km buffers around SPAs and main pink-footed goose roost sites (>100 birds five year mean peak count) used in Collision Risk Modelling for within-winter birds transiting to and from roost sites to feed

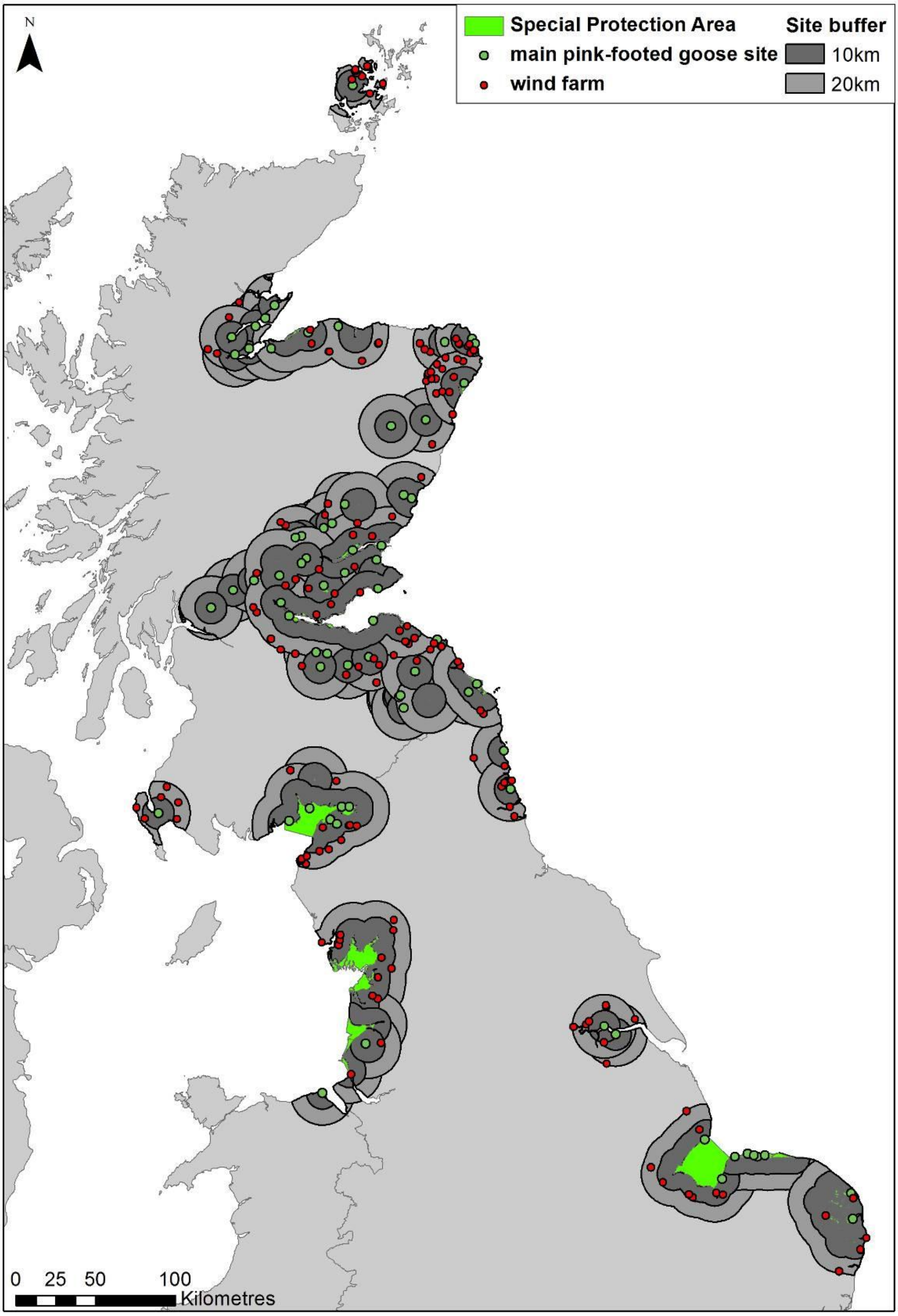


Table 7 – Summary of parameters used for modelling and their effects on outputs

Parameter	**Options**	**Effect**	**Preferred Option**	**Result is precautionary or best estimate**
Percentage of birds at CRH	5%	Increasing this linearly increases number of collisions (Figure 1)	Wright *et al.* suggest 30% for geese. However, review suggestions may be higher, especially between roosting and feeding sites.	Best estimate
	10%			
	20%			
	30%			
	40%			
	50%			
	60%			
Error assumed in location of interpolated flight tracks	10km	Increasing this scopes in more wind farms (Figure 4)	20km. Close to roosts and feeding areas, especially small sites, we expect the error in the interpolated flight tracks to be lower (e.g. <5km), because they are near a known origin/destination. However, moving away from this it is easy to imagine both the variety of regularly used routes and the differences between actual routes and that interpolated to increase very rapidly. However, the magnitude of this error is likely to be reduced where there are more tracks. 20km was considered as a best estimate 'average' value.	Best estimate
	20km			
Proportion of GB population in each regional population	100%	Increasing this linearly increases number of birds passing wind farms	These proportions are based on the proportions of winter counts in Scotland, East England and West England from recent Icelandic-Breeding Goose Censuses. However, it is assumed that 100% of the population passes through Scotland on each migration (with 50% overwintering). This will be a slight overestimate for Scotland, but by how much is unknown. The proportion of birds migrating between Lancashire and Norfolk is also unknown. Tables 3 and 4 show 9.4% of repeat sightings were between East England and Lancashire (or vice versa) between October and December and 22% between January and May, however Figure 1 shows a lower proportion. 12.5% of the GB population is used as a best estimate *in lieu* of better evidence.	Best estimate
	25%			
	12.5%			

Parameter	Options	Effect	Preferred Option	Result is precautionary or best estimate
Proportion of regional population in each 5km x 5km cell	5% 27% 68%	Increasing this linearly increases number of birds passing wind farms	On balance the figures used should be precautionary, i.e. overestimate the number of birds passing wind farms. There may be some 5km x 5km cells where higher proportions of the regional population pass, however, there may be many cells where <5% of the regional population pass and it is unlikely that 68% of the population pass through as many cells as shown.	Precautionary
Migration front width	5km 10km 20km 40km 100km	Increasing width exponentially decreases number of birds in risk envelope of individual wind farms (Figure 4)	20km. Close to roosts and feeding areas, especially small sites, we expect the width of front used by skeins to be narrow, maybe only 1 or 2km, because they are near a known origin/destination. Moving away from this though it is easy to imagine the width of our conceptual front increasing very quickly to encompass all regularly used routes. 20km was considered as a best estimate 'average' value.	Best estimate
Buffers around roosts	10km 20km	Increasing this scopes in more wind farms	20km. Patterson and Mitchell both suggest foraging ranges up to 20km. The collision risks generated would be precautionary though as it assumes the flocks will encounter all wind farms within 20km, however where there are multiple wind farms in different directions from the roost, then it is very unlikely all will be passed.	Precautionary

4. RESULTS

4.1 With the agreement of Natural England names of wind farms have been coded in the CRM tables.

4.2 CRM Tables 1 & 2, Appendix I, show the wind farm specifications used in Collision Risk Modelling and the outputs as percentage of birds passing through the rotors estimated to collide for onshore and offshore wind farms respectively.

4.3 CRM Tables 3 & 4, Appendix I, show worked examples of the estimated number of collisions at different avoidance rates for each onshore and offshore wind farm respectively. These examples show estimates based on 20% of the population being at CRH (on average <98m for onshore, <133m for offshore) and moving along a 10km migration front along the different regional routes identified for a single migration and encountering all wind farms within 20km of sites or track-lines.

4.4 CRM Table 5, Appendix I, shows a worked example of the estimated number of collisions of within-winter foraging geese at different avoidance rates for each onshore wind farm respectively. This example shows estimates based on 20% of the population being at CRH (on average <98m) and moving along a 10km transiting front encountering all wind farms within 20km of main roost sites for twice daily journeys for 140 days through the winter (Natural England pers. comm.).

4.5 Table 8 presents the estimated annual number of collisions for the different simulations summed for all onshore wind farms. These estimates assume that the whole population of 326,540 birds makes two transits (autumn and spring) along the respective migration front widths passed every wind farm within 10km or 20km of sites or track-lines. Note that birds may transit over wind farms more than twice through the winter but conversely it is unlikely that the migration front will pass all wind farms.

4.6 Table 9 shows a re-run of the Collision Risk Modelling using only wind farms whose first year of operation, or part thereof was after October 2012, the date of the last count data used in the PVA. Green shading shows additional mortality beneath that predicted from PVA using a density independent model (WWT Consulting & MacArthur Green, 2014) to lead to a 5% increase in predicted risk of a 20% population decline. Amber shading shows additional mortality predicted from PVA to lead to between a 5% and 20% increase in predicted risk of a 20% population decline. Using the density independent model results in slightly more precautionary thresholds than using the density dependent model (5,200 birds c.f. 5,500 collisions for a 20% increase in predicted risk of a 20% decline); however, note this is not suggesting the independent model is the more accurate. Note also that these threshold values have not been confirmed for use by Natural England.

4.7 It is clear from the results how the estimates scale with the avoidance rate, percentage at CRH, migration front width and error assumed in re-sighting data (10km or 20km) values used.

4.8 Using an avoidance rate of 99%, as recommended in Task 1 (review of avoidance rates), it can be seen from these tables that annual migratory collision estimates from onshore wind farms range from four birds assuming 5% of birds are at CRH and a 100km wide migration front passes all wind farms within 10km of sites or track-lines up to 2,137 birds assuming 80% of birds are at CRH and migrate along a 5km wide migration front past all wind farms within 20km of sites or track-lines.

Table 8 - Estimated annual number of collisions of migrating pink-footed geese at onshore wind farms within 10km and 20km of sites or track-lines. The top-left cell shows the avoidance rate used (95%, 98%, 99% or 99.8%)

95%	**All wind farms within 10km**									**All wind farms within 20km**								
Migration front width	**Percentage of birds at collision risk height**									**Percentage of birds at collision risk height**								
	5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
5	432	863	1726	2590	3453	4316	5179	6474	6905	668	1336	2671	4007	5343	6679	8014	10018	10686
10	216	432	863	1295	1726	2158	2590	3237	3453	334	668	1336	2004	2671	3339	4007	5009	5343
20	108	216	432	647	863	1079	1295	1618	1726	167	334	668	1002	1336	1670	2004	2504	2671
40	54	108	216	324	432	539	647	809	863	83	167	334	501	668	835	1002	1252	1336
100	22	43	86	129	173	216	259	324	345	33	67	134	200	267	334	401	501	534

98%	**All wind farms within 10km**									**All wind farms within 20km**								
Migration front width	**Percentage of birds at collision risk height**									**Percentage of birds at collision risk height**								
	5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
5	173	345	691	1036	1381	1726	2072	2590	2762	267	534	1069	1603	2137	2671	3206	4007	4274
10	86	173	345	518	691	863	1036	1295	1381	134	267	534	801	1069	1336	1603	2004	2137
20	43	86	173	259	345	432	518	647	691	67	134	267	401	534	668	801	1002	1069
40	22	43	86	129	173	216	259	324	345	33	67	134	200	267	334	401	501	534
100	9	17	35	52	69	86	104	129	138	13	27	53	80	107	134	160	200	214

99%	**All wind farms within 10km**									**All wind farms within 20km**								
Migration front width	**Percentage of birds at collision risk height**									**Percentage of birds at collision risk height**								
	5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
5	86	173	345	518	691	863	1036	1295	1381	134	267	534	801	1069	1336	1603	2004	2137
10	43	86	173	259	345	432	518	647	691	67	134	267	401	534	668	801	1002	1069
20	22	43	86	129	173	216	259	324	345	33	67	134	200	267	334	401	501	534
40	11	22	43	65	86	108	129	162	173	17	33	67	100	134	167	200	250	267
100	4	9	17	26	35	43	52	65	69	7	13	27	40	53	67	80	100	107

Table 8 continued

99.8%	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	10	20	30	40	50	60	75	80	5	10	20	30	40	50	60	75	80
5	17	35	69	104	138	173	207	259	276	27	53	107	160	214	267	321	401	427
10	9	17	35	52	69	86	104	129	138	13	27	53	80	107	134	160	200	214
20	4	9	17	26	35	43	52	65	69	7	13	27	40	53	67	80	100	107
40	2	4	9	13	17	22	26	32	35	3	7	13	20	27	33	40	50	53
100	1	2	3	5	7	9	10	13	14	1	3	5	8	11	13	16	20	21

Table 9 - Estimated annual number of collisions of migrating pink-footed geese at onshore wind farms within 10km and 20km of sites or track-lines, whose first year of operation, or part thereof, was after October 2012. The top-left cell shows the avoidance rate used (95%, 98%, 99% or 99.8%). Green shading shows additional mortality beneath that predicted from PVA using a density independent model (WWT Consulting & MacArthur Green, 2014) to lead to a 5% increase in predicted risk of a 20% population decline. Amber shading shows additional mortality beneath that predicted from PVA to lead to a 20% increase in predicted risk of a 20% population decline. Note that these threshold values have not been confirmed for use by Natural England

95%	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	10	20	30	40	50	60	75	80	5	10	20	30	40	50	60	75	80
5	149	297	594	891	1188	1485	1782	2228	2376	184	368	736	1104	1472	1840	2208	2760	2944
10	74	149	297	446	594	743	891	1114	1188	92	184	368	552	736	920	1104	1380	1472
20	37	74	149	223	297	371	446	557	594	46	92	184	276	368	460	552	690	736
40	19	37	74	111	149	186	223	278	297	23	46	92	138	184	230	276	345	368
100	7	15	30	45	59	74	89	111	119	9	18	37	55	74	92	110	138	147

Table 9 continued

98%	**All wind farms within 10km**									**All wind farms within 20km**								
Migration front width	**Percentage of birds at collision risk height**									**Percentage of birds at collision risk height**								
	5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
5	59	119	238	356	475	594	713	891	951	74	147	294	442	589	736	883	1104	1178
10	30	59	119	178	238	297	356	446	475	37	74	147	221	294	368	442	552	589
20	15	30	59	89	119	149	178	223	238	18	37	74	110	147	184	221	276	294
40	7	15	30	45	59	74	89	111	119	9	18	37	55	74	92	110	138	147
100	3	6	12	18	24	30	36	45	48	4	7	15	22	29	37	44	55	59

99%	**All wind farms within 10km**									**All wind farms within 20km**								
Migration front width	**Percentage of birds at collision risk height**									**Percentage of birds at collision risk height**								
	5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
5	30	59	119	178	238	297	356	446	475	37	74	147	221	294	368	442	552	589
10	15	30	59	89	119	149	178	223	238	18	37	74	110	147	184	221	276	294
20	7	15	30	45	59	74	89	111	119	9	18	37	55	74	92	110	138	147
40	4	7	15	22	30	37	45	56	59	5	9	18	28	37	46	55	69	74
100	1	3	6	9	12	15	18	22	24	2	4	7	11	15	18	22	28	29

99.8%	**All wind farms within 10km**									**All wind farms within 20km**								
Migration front width	**Percentage of birds at collision risk height**									**Percentage of birds at collision risk height**								
	5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
5	6	12	24	36	48	59	71	89	95	7	15	29	44	59	74	88	110	118
10	3	6	12	18	24	30	36	45	48	4	7	15	22	29	37	44	55	59
20	1	3	6	9	12	15	18	22	24	2	4	7	11	15	18	22	28	29
40	1	1	3	4	6	7	9	11	12	1	2	4	6	7	9	11	14	15
100	0	1	1	2	2	3	4	4	5	0	1	1	2	3	4	4	6	6

Table 10 – Estimated annual number of collisions of migrating pink-footed geese at offshore wind farms within 10km and 20km of sites or track-lines. The top-left cell shows the avoidance rate used (95%, 98%, 99% or 99.8%)

95	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	10	20	30	40	50	60	75	80	5	10	20	30	40	50	60	75	80
5	123	247	493	740	986	1233	1480	1850	1973	124	248	496	744	992	1240	1487	1859	1983
10	62	123	247	370	493	617	740	925	986	62	124	248	372	496	620	744	930	992
20	31	62	123	185	247	308	370	462	493	31	62	124	186	248	310	372	465	496
40	15	31	62	92	123	154	185	231	247	15	31	62	93	124	155	186	232	248
100	6	12	25	37	49	62	74	92	99	6	12	25	37	50	62	74	93	99

98	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	10	20	30	40	50	60	75	80	5	10	20	30	40	50	60	75	80
5	49	99	197	296	395	493	592	740	789	50	99	198	297	397	496	595	744	793
10	25	49	99	148	197	247	296	370	395	25	50	99	149	198	248	297	372	397
20	12	25	49	74	99	123	148	185	197	12	25	50	74	99	124	149	186	198
40	6	12	25	37	49	62	74	92	99	6	12	25	37	50	62	74	93	99
100	2	5	10	15	20	25	30	37	39	2	5	10	15	20	25	30	37	40

99	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	10	20	30	40	50	60	75	80	5	10	20	30	40	50	60	75	80
5	25	49	99	148	197	247	296	370	395	25	50	99	149	198	248	297	372	397
10	12	25	49	74	99	123	148	185	197	12	25	50	74	99	124	149	186	198
20	6	12	25	37	49	62	74	92	99	6	12	25	37	50	62	74	93	99
40	3	6	12	18	25	31	37	46	49	3	6	12	19	25	31	37	46	50
100	1	2	5	7	10	12	15	18	20	1	2	5	7	10	12	15	19	20

Table 10 continued

99.8	All wind farms within 10km									All wind farms within 20km								
Migration front width	**Percentage of birds at collision risk height**									**Percentage of birds at collision risk height**								
	5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
5	5	10	20	30	39	49	59	74	79	5	10	20	30	40	50	59	74	79
10	2	5	10	15	20	25	30	37	39	2	5	10	15	20	25	30	37	40
20	1	2	5	7	10	12	15	18	20	1	2	5	7	10	12	15	19	20
40	1	1	2	4	5	6	7	9	10	1	1	2	4	5	6	7	9	10
100	0	0	1	1	2	2	3	4	4	0	0	1	1	2	2	3	4	4

Table 11 - Estimated annual number of collisions of migrating pink-footed geese at offshore wind farms within 10km and 20km of sites or track-lines, whose first year of operation, or part thereof, was after October 2012. The top-left cell shows the avoidance rate used (95%, 98%, 99% or 99.8%). Green shading shows additional mortality beneath that predicted from PVA using a density independent model (WWT Consulting & MacArthur Green, 2014) to lead to a 5% increase in predicted risk of a 20% population decline. Amber shading shows additional mortality beneath that predicted from PVA to lead to a 20% increase in predicted risk of a 20% population decline. Note that these threshold values have not been confirmed for use by Natural England

95	All wind farms within 10km									All wind farms within 20km								
Migration front width	**Percentage of birds at collision risk height**									**Percentage of birds at collision risk height**								
	5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
5	62	123	246	370	493	616	739	924	986	62	123	246	370	493	616	739	924	986
10	31	62	123	185	246	308	370	462	493	31	62	123	185	246	308	370	462	493
20	15	31	62	92	123	154	185	231	246	15	31	62	92	123	154	185	231	246
40	8	15	31	46	62	77	92	116	123	8	15	31	46	62	77	92	116	123
100	3	6	12	18	25	31	37	46	49	3	6	12	18	25	31	37	46	49

Table 11 continued

98	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	10	20	30	40	50	60	75	80	5	10	20	30	40	50	60	75	80
5	25	49	99	148	197	246	296	370	394	25	49	99	148	197	246	296	370	394
10	12	25	49	74	99	123	148	185	197	12	25	49	74	99	123	148	185	197
20	6	12	25	37	49	62	74	92	99	6	12	25	37	49	62	74	92	99
40	3	6	12	18	25	31	37	46	49	3	6	12	18	25	31	37	46	49
100	1	2	5	7	10	12	15	18	20	1	2	5	7	10	12	15	18	20

99	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	10	20	30	40	50	60	75	80	5	10	20	30	40	50	60	75	80
5	12	25	49	74	99	123	148	185	197	12	25	49	74	99	123	148	185	197
10	6	12	25	37	49	62	74	92	99	6	12	25	37	49	62	74	92	99
20	3	6	12	18	25	31	37	46	49	3	6	12	18	25	31	37	46	49
40	2	3	6	9	12	15	18	23	25	2	3	6	9	12	15	18	23	25
100	1	1	2	4	5	6	7	9	10	1	1	2	4	5	6	7	9	10

99.8	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	10	20	30	40	50	60	75	80	5	10	20	30	40	50	60	75	80
5	2	5	10	15	20	25	30	37	39	2	5	10	15	20	25	30	37	39
10	1	2	5	7	10	12	15	18	20	1	2	5	7	10	12	15	18	20
20	1	1	2	4	5	6	7	9	10	1	1	2	4	5	6	7	9	10
40	0	1	1	2	2	3	4	5	5	0	1	1	2	2	3	4	5	5
100	0	0	0	1	1	1	1	2	2	0	0	0	1	1	1	1	2	2

4.9 Looking at the equivalent estimates in Table 9, which represents additional mortality beyond that included in the PVA, values range from one to 589 per annum. These values are below the range estimated through PVA to lead to a 5% increase in predicted risk of a 20% population decline.

4.10 The collision estimates for offshore wind farms are presented in Tables 10 and 11, above, for all wind farms and those only leading to additional mortality beyond that modelled in the PVA respectively. These show that much lower numbers are estimated to be killed on migration by the existing operational offshore wind farms compared with those onshore, with total annual mortality up to 397 birds (at 80% at CRH and 99% avoidance rate) and additional mortality beyond that included in the PVA up to 197 birds.

4.11 The results of Collision Risk Modelling for within-winter transits between roosting and feeding sites are presented in Tables 12 and 13, below. Colour shading for Table 13 as for Tables 9 and 11, though with the addition of red shading showing additional mortality above that predicted from PVA to lead to a 20% increase in predicted risk of a 20% population decline. The results show that under the scenarios run, risks from within-winter movements are potentially much higher than from the biannual migratory movements.

4.12 Using an avoidance rate of 99%, the total annual within-winter collision estimates range from 34 birds assuming 5% of birds are at CRH and a 100km wide migration front passes all wind farms within 10km of sites, observations and straight-line tracks up to 39,000 birds assuming 80% of birds are at CRH and migrate along a 5km wide migration front past all wind farms within 20km of sites or track-lines. Out of 90 possible scenarios, 18 (20%) fall above the range estimated through PVA to lead to a 5% increase in predicted risk of a 20% population decline and 4 (4%) above the range estimated through PVA to lead to a 20% increase in predicted risk of a 20% population decline, with 68 values (76%) falling below this.

4.13 Tables 14 to 17, below, present examples of combing the collision risk estimates for onshore and offshore wind farms from migratory and within-winter movements. The examples presented screen in all wind-farms within 20km (to allow for errors in interpolating between re-sightings data points and to allow geese to forage up to 20km from sites), with geese moving along a 20km migration front (more precautionary, but feasible) and assuming 99% (Tables 14 and 15) and 99.8% (Tables 16 and 17) avoidance rates. Tables 14 and 16 show total collision estimates, whereas tables 15 and 17 show additional mortality to that already included in the PVA (i.e. from wind farms that became operational after October 2011). Within the tables, a range of percentages of birds at CRH are presented, allowing, for example, migrating birds to fly higher than birds making shorter foraging flights. Using a 99% avoidance rate total annual mortality estimated ranged from 648 to 10,383 assuming 5% and 80% at CRH respectively. Additional mortality exceeds the threshold from PVA for a 5% increase in predicted risk of a 20% population decline above 40% percentage at CRH for within winter movements, with the percentage at CRH on migration not affecting this.

4.14 Taking the recommendation of Wright *et al*. (2012) to use a percentage of geese at CRH of 30% (for both migration and foraging movements), at an avoidance rate of 99%, an additional mortality of 1,034 geese (3,893 total) is estimated annually. This figure is below the threshold for a 5% increase in predicted risk of a 20% population decline.

4.15 Tables 16 and 17 show the estimated mortality using an avoidance rate of 99.8% as advocated by SNH. Total annual mortality drops to between 130 and 2,077 assuming 5% and 80% at CRH respectively. The additional annual mortality likewise drops to between 35 and 551 geese, all below the threshold for a 5% increase in predicted risk of a 20% population decline. Taking 30% of geese at CRH (for both migration and foraging movements) a total annual mortality of 778 is estimated including an additional mortality of 207 geese.

Table 12 - Estimated annual number of collisions of pink-footed geese making within-winter foraging movements at wind farms within 10km and 20km of sites or track-lines. The top-left cell shows the avoidance rate used (95%, 98%, 99% or 99.8%). These estimates assume two flights daily over 140 days (Natural England pers. comm.)

95	**All wind farms within 10km**									**All wind farms within 20km**								
Migration front width	**Percentage of birds at collision risk height**									**Percentage of birds at collision risk height**								
	5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
5	3380	6760	13521	20281	27042	33802	40562	50703	54083	12188	24375	48750	73125	97500	121875	146250	182813	195000
10	1690	3380	6760	10141	13521	16901	20281	25351	27042	6094	12188	24375	36563	48750	60938	73125	91406	97500
20	845	1690	3380	5070	6760	8450	10141	12676	13521	3047	6094	12188	18281	24375	30469	36563	45703	48750
40	423	845	1690	2535	3380	4225	5070	6338	6760	1523	3047	6094	9141	12188	15234	18281	22852	24375
100	169	338	676	1014	1352	1690	2028	2535	2704	609	1219	2438	3656	4875	6094	7313	9141	9750

98	**All wind farms within 10km**									**All wind farms within 20km**								
Migration front width	**Percentage of birds at collision risk height**									**Percentage of birds at collision risk height**								
	5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
5	1352	2704	5408	8112	10817	13521	16225	20281	21633	4875	9750	19500	29250	39000	48750	58500	73125	78000
10	676	1352	2704	4056	5408	6760	8112	10141	10817	2438	4875	9750	14625	19500	24375	29250	36563	39000
20	338	676	1352	2028	2704	3380	4056	5070	5408	1219	2438	4875	7313	9750	12188	14625	18281	19500
40	169	338	676	1014	1352	1690	2028	2535	2704	609	1219	2438	3656	4875	6094	7313	9141	9750
100	68	135	270	406	541	676	811	1014	1082	244	488	975	1463	1950	2438	2925	3656	3900

Table 12 continued

99	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
5	676	1352	2704	4056	5408	6760	8112	10141	10817	2438	4875	9750	14625	19500	24375	29250	36563	39000
10	338	676	1352	2028	2704	3380	4056	5070	5408	1219	2438	4875	7313	9750	12188	14625	18281	19500
20	169	338	676	1014	1352	1690	2028	2535	2704	609	1219	2438	3656	4875	6094	7313	9141	9750
40	85	169	338	507	676	845	1014	1268	1352	305	609	1219	1828	2438	3047	3656	4570	4875
100	34	68	135	203	270	338	406	507	541	122	244	488	731	975	1219	1463	1828	1950

99.8	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
5	135	270	541	811	1082	1352	1622	2028	2163	488	975	1950	2925	3900	4875	5850	7313	7800
10	68	135	270	406	541	676	811	1014	1082	244	488	975	1463	1950	2438	2925	3656	3900
20	34	68	135	203	270	338	406	507	541	122	244	488	731	975	1219	1463	1828	1950
40	17	34	68	101	135	169	203	254	270	61	122	244	366	488	609	731	914	975
100	7	14	27	41	54	68	81	101	108	24	49	98	146	195	244	293	366	390

Table 13 - Estimated annual number of collisions of pink-footed geese making within-winter foraging movements at wind farms within 10km and 20km of sites or track-lines, whose first year of operation, or part thereof, was after October 2012. The top-left cell shows the avoidance rate used (95%, 98%, 99% or 99.8%). These estimates assume two flights daily over 140 days (Natural England pers. comm.). Green shading shows additional mortality beneath that predicted from PVA using a density independent model (WWT Consulting & MacArthur Green, 2014) to lead to a 5% increase in predicted risk of a 20% population decline. Amber shading shows additional mortality beneath that predicted from PVA to lead to a 20% increase in predicted risk of a 20% population decline. Red shading shows additional mortality above that predicted from PVA to lead to a 20% increase in predicted risk of a 20% population decline. Note that these threshold values have not been confirmed for use by Natural England

95	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	10	20	30	40	50	60	75	80	5	10	20	30	40	50	60	75	80
5	1173	2347	4694	7041	9388	11735	14082	17602	18776	3202	6404	12808	19212	25615	32019	38423	48029	51231
10	587	1173	2347	3520	4694	5867	7041	8801	9388	1601	3202	6404	9606	12808	16010	19212	24014	25615
20	293	587	1173	1760	2347	2934	3520	4401	4694	800	1601	3202	4803	6404	8005	9606	12007	12808
40	147	293	587	880	1173	1467	1760	2200	2347	400	800	1601	2401	3202	4002	4803	6004	6404
100	59	117	235	352	469	587	704	880	939	160	320	640	961	1281	1601	1921	2401	2562

98	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	10	20	30	40	50	60	75	80	5	10	20	30	40	50	60	75	80
5	469	939	1878	2816	3755	4694	5633	7041	7510	1281	2562	5123	7685	10246	12808	15369	19212	20492
10	235	469	939	1408	1878	2347	2816	3520	3755	640	1281	2562	3842	5123	6404	7685	9606	10246
20	117	235	469	704	939	1173	1408	1760	1878	320	640	1281	1921	2562	3202	3842	4803	5123
40	59	117	235	352	469	587	704	880	939	160	320	640	961	1281	1601	1921	2401	2562
100	23	47	94	141	188	235	282	352	376	64	128	256	384	512	640	768	961	1025

Table 13 continued

99	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	10	20	30	40	50	60	75	80	5	10	20	30	40	50	60	75	80
5	235	469	939	1408	1878	2347	2816	3520	3755	640	1281	2562	3842	5123	6404	7685	9606	10246
10	117	235	469	704	939	1173	1408	1760	1878	320	640	1281	1921	2562	3202	3842	4803	5123
20	59	117	235	352	469	587	704	880	939	160	320	640	961	1281	1601	1921	2401	2562
40	29	59	117	176	235	293	352	440	469	80	160	320	480	640	800	961	1201	1281
100	12	23	47	70	94	117	141	176	188	32	64	128	192	256	320	384	480	512

99.8	All wind farms within 10km									All wind farms within 20km								
Migration front width	Percentage of birds at collision risk height									Percentage of birds at collision risk height								
	5	10	20	30	40	50	60	75	80	5	10	20	30	40	50	60	75	80
5	47	94	188	282	376	469	563	704	751	128	256	512	768	1025	1281	1537	1921	2049
10	23	47	94	141	188	235	282	352	376	64	128	256	384	512	640	768	961	1025
20	12	23	47	70	94	117	141	176	188	32	64	128	192	256	320	384	480	512
40	6	12	23	35	47	59	70	88	94	16	32	64	96	128	160	192	240	256
100	2	5	9	14	19	23	28	35	38	6	13	26	38	51	64	77	96	102

Table 14 – Total number of collisions (migration risk and within-winter foraging transit risk summed) for all onshore and offshore wind farms within 20km of sites or track-lines assuming birds are moving along a 20km wide front and assuming 99% avoidance (summed from Tables 11-13, above)

99%		% at CRH feeding								
		5	10	20	30	40	50	60	75	80
% at CRH migration	5	648	1258	2477	3695	4914	6133	7352	9180	9789
	10	688	1298	2517	3735	4954	6173	7392	9220	9829
	20	768	1378	2597	3815	5034	6253	7472	9300	9909
	30	846	1456	2675	3893	5112	6331	7550	9378	9987
	40	926	1536	2755	3973	5192	6411	7630	9458	10067
	50	1005	1615	2834	4052	5271	6490	7709	9537	10146
	60	1084	1694	2913	4131	5350	6569	7788	9616	10225
	75	1203	1813	3032	4250	5469	6688	7907	9735	10344
	80	1242	1852	3071	4289	5508	6727	7946	9774	10383

Table 15 – Total number of collisions (migration risk and within-winter foraging transit risk summed) for all onshore and offshore wind farms within 20km of sites or track-lines , whose first year of operation, or part thereof, was after October 2012, assuming birds are moving along a 20km wide front and assuming 99% avoidance (summed from Tables 11-13 above). Green shading shows additional mortality beneath that predicted from PVA using a density independent model (WWT Consulting & MacArthur Green, 2014) to lead to a 5% increase in predicted risk of a 20% population decline. Amber shading shows additional mortality beneath that predicted from PVA to lead to a 20% increase in predicted risk of a 20% population decline. Note that these threshold values have not been confirmed for use by Natural England

99%		% at CRH feeding								
		5	10	20	30	40	50	60	75	80
% at CRH migration	5	172	332	652	973	1293	1613	1933	2413	2574
	10	184	344	664	985	1305	1625	1945	2425	2586
	20	209	369	689	1010	1330	1650	1970	2450	2611
	30	233	393	713	1034	1354	1674	1994	2474	2635
	40	259	419	739	1060	1380	1700	2020	2500	2661
	50	283	443	763	1084	1404	1724	2044	2524	2685
	60	307	467	787	1108	1428	1748	2068	2548	2709
	75	344	504	824	1145	1465	1785	2105	2585	2746
	80	356	516	836	1157	1477	1797	2117	2597	2758

Table 16 - Total number of collisions (migration risk and within-winter foraging transit risk summed) for all onshore and offshore wind farms within 20km of sites or track-lines assuming birds are moving along a 20km wide front and assuming 99.8% avoidance (summed from Tables 11-13, above)

99.8%		**% at CRH feeding**								
		5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
% at CRH migration	**5**	130	252	496	739	983	1227	1471	1836	1958
	10	137	259	503	746	990	1234	1478	1843	1965
	20	154	276	520	763	1007	1251	1495	1860	1982
	30	169	291	535	778	1022	1266	1510	1875	1997
	40	185	307	551	794	1038	1282	1526	1891	2013
	50	201	323	567	810	1054	1298	1542	1907	2029
	60	217	339	583	826	1070	1314	1558	1923	2045
	75	241	363	607	850	1094	1338	1582	1947	2069
	80	249	371	615	858	1102	1346	1590	1955	2077

Table 17 -Total number of collisions (migration risk and within-winter foraging transit risk summed) for all onshore and offshore wind farms within 20km of sites or track-lines, whose first year of operation, or part thereof, was after October 2012, assuming birds are moving along a 20km wide front and assuming 99.8% avoidance (summed from Tables 11-13, above). Green shading shows additional mortality beneath that predicted from PVA using a density independent model (WWT Consulting & MacArthur Green, 2014) to lead to a 5% increase in predicted risk of a 20% population decline. Note that these threshold values have not been confirmed for use by Natural England

99.8%		**% at CRH feeding**								
		5	**10**	**20**	**30**	**40**	**50**	**60**	**75**	**80**
% at CRH migration	**5**	35	67	131	195	259	323	387	483	515
	10	37	69	133	197	261	325	389	485	517
	20	41	73	137	201	265	329	393	489	521
	30	47	79	143	207	271	335	399	495	527
	40	52	84	148	212	276	340	404	500	532
	50	56	88	152	216	280	344	408	504	536
	60	61	93	157	221	285	349	413	509	541
	75	69	101	165	229	293	357	421	517	549
	80	71	103	167	231	295	359	423	519	551

5. DISCUSSION

5.1 This study has produced matrices of collision mortality estimates from onshore and offshore wind farms in the UK under a range of scenarios. This approach was taken as there are few data on precise migration movements of pink-footed geese in the UK.

5.2 In producing the matrices, a number of assumptions were made and caveats have to be made clear.

5.3 The migratory flyways used for Collision Risk Modelling were compiled largely from joining re-sightings data with straight lines. Though a relatively large number of re-sightings data were available it should be noted that they include some bias towards areas with more people looking for marked birds and the accuracy of the straight lines between them decreases from the data points, such that actual locations of birds between two distant data points may be 100km or more from the line. Nevertheless these are the best data we have, so to mitigate against, and explore the effects of this inaccuracy, wind farms were screened in if they were within 10km or 20km of the straight line interpolations.

5.4 Once migratory routes had been identified, the numbers of birds migrating down them were estimated by proportioning the GB population based on counts at their constituent sites and a review of previous studies. These fell close to the rounded numbers of 25% of the GB population migrating to sites in Lancashire and to Norfolk and the east coast. Though there is some evidence of birds migrating directly to Lancashire, a more precautionary scenario of all birds (100%) migrating first through Scotland was assumed. To account for interchange between Lancashire and Norfolk a quarter of their combined populations (12.5% of GB population) was assumed to be involved. Again, the accuracy of this is not known but it seems a reasonable approximation from site and re-sightings data and these simple figures allow adjustments to be readily made in the future as better data become available.

5.5 The number of birds assumed to be migrating within each 5km x 5km grid cell within which wind turbines were located was then taken by fitting a much generalised distribution to the migratory flyways based on the number of main sites, re-sightings of marked birds or satellite-tag track-lines falling within 10km or 20km of each cell. The actual distribution of birds along the migratory paths is likely to include preferred routes, probably based on terrain topography, however the general distribution values were used as proxy; the effect of a narrower distribution would be more birds encountering fewer wind farms and vice versa.

5.6 Neighbouring 5km x 5km grid cells have the same number of birds estimated to be moving through them within each proportion of population category. Although only a proportion (0.68, 0.27 or 0.05) of the regional population is assumed to enter each cell, this is likely to result in an overestimate of the number of birds at risk so, again, as more accurate migration path routes are not currently known, a range of migratory front widths from 5km to 100km are presented for Collision Risk Modelling to reduce, in a clear and transparent way, the number of birds actually encountering each wind farm.

5.7 For within-winter movements, geese were assumed to fly one return trip from the roost past all wind farms within 10km or 20km of major roosts daily for 140 winter days. Though it is possible for birds to make subsequent flights between nearby sites or following a disturbance event, this basic assumption will lead to overestimation of risk as the birds are very unlikely to fly past all wind farms. Again effort has been made to offset this, and to examine the effect, by using different transit front widths, but undoubtedly this is no substitute for site-specific studies.

5.8 Note that though Patterson (2013) suggests pink-footed geese generally feed within 20km of SPA roosts, and Bell (1988) reported that 82% of pink-footed geese in northeast Scotland forage within 8km (median distance 4km) of roost sites, Mitchell (pers. comm.) notes pink-footed geese can undertake flights of over 20km (sometimes up to c.30km) between roost and foraging areas, though considered these unusual.

5.9 As noted by Rees (2012) and WWT Consulting & MacArthur Green (2014), actual mortality data from constructed wind farms are very scarce, possibly due to higher avoidance rates than those assumed, but with interpretation complicated by relatively few studies and only a small proportion of these using robust methods to account for search efficiency, corpse removal, etc. As such, at the time of writing, comparison of the results presented can only be made from a selection of wind farm projects where site-specific collision risk estimates have been produced.

5.10 At Hellrigg wind farm, 110 collisions per annum were estimated using an avoidance rate of 95% (Percival 2010). Values for Hellrigg using a 95% avoidance rate in this study were 136 per annum (2 on migration, 134 within-winter) assuming a 10k migration front and 20% at CRH (from CRM Tables 3 and 5, Appendix I). Though a slight over-estimate, the values are similar. However, from this single, simple comparison it cannot be deduced whether the parameters used are the most appropriate (as different combinations would produce similar results) and it should be noted in different areas the assumptions used may result in more diverging results.

5.11 To compare offshore estimates, CRM Table 6, Appendix I, shows constructed offshore wind farm collision risk estimates compiled by Natural England and RSPB. Comparison with CRM Table 4, Appendix I, shows, with the exception of OWF6, estimates produced in this study were between four and 22 times lower than those compiled from Appropriate Assessments and Environmental Statements, with a maximum difference of 42 fewer birds at Lincs. Results for OWF6 were slightly higher in this study (three geese compared to two at 99% Avoidance Rate). However, as noted in the CRM Table 6, the provenance of the offshore wind farm estimates and the assumptions made are not always clear, so conclusions as to the magnitude and relevance of differences between the studies cannot be made here.

5.12 In their comments on the first draft of this report, Natural England asked if the results could be put into the context of population modelling work also carried out as part of this contract (WWT Consulting & MacArthur Green, 2014). Tables 9, 11, 13, 15 & 17 made reference to Figure 13 of the PVA report to identify those additional mortality estimates that would be over that expected to lead to a 5% or 20% increase in risk of a 20% population decline. However, it is unlikely that current annual monitoring would detect the population changes these levels of additional annual mortality would produce. A quick power analysis showed the last 25 years of count data used in the PVA had a CV of 0.21 and would detect a c7% annual decrease in population with a power of 0.8. This equates to a population decline of over 80% over the 25 years of simulations. Thus it is possible that the predicted mortality estimates from the CRM presented here are being realised but are either not being detected, or have not lead to population decline. However, it should be noted that, at the time of writing, no pink-footed goose corpses have been found at wind farms in the UK so, even given the challenges of detecting corpses even at onshore wind farms, it would be surprising if the number of collisions predicted in Table 14 have been missed and thus are likely overestimates. Further refinements, following more distribution and tracking data collection, are required to assess whether those lower figures in Table 16 using a 99.8% avoidance rate are also overestimates.

5.13 At the time of writing, data were just becoming available on the movements of two satellite tracked birds which are already showing that there is considerable within-season movement and great variation between the two individuals. It is hoped that more birds will be tracked in the future, including the provision for flight height to be recorded.

5.14 As these new data become available, it is intended that the matrices can be used to identify the most appropriate scenarios of proportion of birds at CRH and width of migration front used in different areas. Alongside this it is hoped that data from individual project assessments become compiled and made accessible as only site-specific pre-construction monitoring can accurately describe the numbers and movements of birds through sites and robust post-construction monitoring is required to estimate mortality and refine our assumptions on avoidance.

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7. REFERENCES

BAND, W. 2000. Calculation of collision risk for birds passing through a rotor area. Microsoft Excel Spreadsheet.

BELL, M.V. 1988. Feeding behaviour of wintering Pink-footed and Greylag Geese in northeast
Scotland. *Wildfowl* **39**: 43 – 53.

BOW. 2007. Results from Walney Island Bird Survey, Autumn 2007. Appendix to *Barrow Offshore Wind farm – First post construction monitoring report*. BOWind, NIRAS A/S, Aarhus, Denmark.

BROOKE, M. & BIRKHEAD, T. (editors). 1991. *The Cambridge Encyclopedia of Birds*. Cambridge University Press.

CAMPBELL, B. & LACK, E. 1985. *Dictionary of Birds*. T & A D Poyser.

CIRRUS ENERGY. 2002. *Cirrus Shell Flat Array Offshore Wind farm Environmental Statement.* Chapter 7.

CRAMP S. & SIMMONS K.E.L. 1977. *The Birds of the Western Palearctic Volume I.* Oxford University Press, Oxford, New York, 722 p.

DBERR. 2007. *Appropriate Assessment with regard to Walney Offshore Wind farm*. DBERR.

DBERR. 2008. *Appropriate Assessment for Lincs Offshore Wind farm*. DBERR.

DECC. 2009. *Appropriate Assessment for Humber Gateway Offshore Wind farm*, *May 2009*. DECC.

DONG ENERGY. 2013. Annex B.7.C: Theoretical Collision Assessment. *Walney Extension Offshore Wind farm. Volume 2. Environmental Statement Annexes*.

DTI. 2007. *Appropriate Assessment with regard to Ormonde Wind farm, January 2007*.

ECOLOGY CONSULTING. 2012. *Hellrigg Wind farm: Goose Refuge Monitoring Report Winter 2011-12*.

ECON. 2007. *Additional information on the potential use of the proposed Lincs OWF by Common Scoters Melanitta nigra and the potential collision risk of pink-footed goose Anser brachyrhynchus. Response to the comments of Natural England and the RSPB on the Lincs OWF Environmental Statement*. Report to Centrica Renewable Energy Ltd).

FOX, A.D., MITCHELL, C., STEWART, A., FLETCHER, J.D., TURNER, J.V.N., BOYD, H., SHIMMINGS, P., SALMON, D.G., HAINES, W.G. & TOMLINSON, C. 1994. Winter movements and site-fidelity of pink-footed geese Anser brachyrhynchus ringed in Britain, with particular emphasis on those marked in Lancashire. *Bird Study*. **41**:221-234.

NIRAS. 2007. Results from Walney Island Bird Survey – Autumn 2007. Appendix to *Barrow Offshore Wind farm – First Post Construction Monitoring Report.*

PATTERSON, I.J. 2013. *Goose distribution in relation to SPAs in Grampian*. Scottish Natural
Heritage Commissioned Report No. 546.

PATTERSON, I.J., LAMBIE, D., SMITH, J. & SMITH, R. 2012. *Survey of the feeding areas,
roosts and flight activity of qualifying species of the Caithness Lochs Special Protection Area*. Scottish Natural Heritage Commissioned Report No.523.

PERCIVAL, S. 2006. *Report to Inform an Appropriate Assessment for the Proposed Ormonde Offshore Wind farm*. Technical Report to DTI.

PERCIVAL, S. 2010. *Hellrigg wind farm: goose refuge management scheme*. Report to RWE Npower Renewables.

PLONCZKEIR P & SIMMS IC. 2012a. *Radar monitoring of Geese at Humber Gateway*.

PLONCZKEIR P & SIMMS IC. 2012b. Radar monitoring of pink-footed geese: behavioural responses to offshore wind farm development. *Journal of Applied Ecology* **49**, 1187-1194.

REES, E.C. 2012. Impact of wind farms on swans and geese: a review. *Wildfowl*. 62: 37-72.

RPS. 2006. *Walney Offshore Wind farm Ornithological Impact Assessment*.

RSK. 2002. *Barrow Offshore Wind farm Environmental Impact Statement*. Warwick Energy Limited. P4186.

SCOTTISH NATURAL HERITAGE. 2000. *Wind farms and birds: Calculating a theoretical collision risk assuming no avoiding action*. Guidance Note Series.

SCOTTISH NATURAL HERITAGE. 2014. *Assessing impacts to pink-footed and greylag geese from small-scale wind farms in Scotland*. Guidance Note Series.

WALNEY BIRD OBSERVATORY. 2004. *Wildfowl and seabird migration along the eastern Irish Sea flyway. A late autumn study by Walney Bird Observatory*.

WALNEY BIRD OBSERVATORY. 2006. Wildfowl and Seabird Migration along the Eastern Irish Sea Flyway. Annex 5.5.3 to *Environmental Statement for Walney offshore Wind farms*, March 2006.

WALNEY OFFSHORE WIND FARMS. 2012. *Construction Monitoring Report Walney Offshore Wind farm May 2012*.

WRIGHT, L.J., ROSS-SMITH, V.H., AUSTIN, G.E., MASSIMO, D., DADAM, D., COOK, A.S.C.P., CALBRADE, N.A. & BURTON, N.H.K. 2012. *Assessing the risk of offshore wind farm development to migratory birds designated as features of UK Special Protection Areas (and other Annex 1 species)*. Report to SOSS.

WWT. 2014. Waterbird Monitoring – pink-footed goose *Anser brachyrhynchus* species account: http://monitoring.wwt.org.uk/our-work/goose-swan-monitoring-programme/species-accounts/pink-footed-goose/. Accessed October 2014.

WWT CONSULTING. 2014. P*ink-footed goose anthropogenic mortality review: Avoidance rate review*. Draft report to Natural England.

WWT CONSULTING & MACARTHUR GREEN. 2014. P*ink-footed goose anthropogenic mortality review: population model*. Draft report to Natural England.

APPENDIX I. Collision risk modelling tables

CRM Table 1 – Onshore wind farms within 20km of main pink-footed goose sites, re-sightings or satellite tracking fixes (and their straight-line tracks) in the UK. Data are as supplied by RenewableUK (2014 pers. comm.) appended by internet searches for additional specification data. Where data could not be readily found, approximations were made using similar turbine model data (usually based on rotor diameter). The last column gives the percentage of birds passing through the turbine rotors which are estimated to collide from Collision Risk Modelling following Band (2000)

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
ESE23	06/05/2011	1	0.15		44	52	17	52.618889	1.392778	1.3	1.33	Y	Y	24.7
S1	01/03/2006	4	0.75	Vestas V17	44	52	17	57.657222	-3.580000	1.3	1.33	Y	Y	24.7
EE1	13/10/2012	2	0.10	Endurance E3120	25	35	19	54.088056	-0.421667	1.3	1.40	Y	Y	22.5
S2	31/03/2012	1	0.10	Northern Power Systems (NPS100-21-50HZ))	36	47	21	55.905000	-4.021389	1.3	1.02	Y	Y	23.2
S3	30/11/2012	2	0.20	Northwind 100	37	48	21	56.195833	-3.533611	1.3	1.02	Y	Y	23.2
S4	08/07/2011	1	0.10		37	48	21	56.506389	-3.091111	1.3	1.02	Y	Y	23.2
ENE1	01/11/2005	1	0.22	Vestas V27	32	46	27	54.973889	-1.509167	1.3	1.39	Y	Y	17.7
EE2	28/09/2010	2	0.40		32	45	28	53.447500	-1.071389	1.3	1.40	Y	Y	17.4
S5	01/01/2013	1	0.22	ACSA A27	32	45	28	56.325556	-3.072500	1.3	1.40	Y	Y	17.4
ESE1	26/01/2010	1	0.22	Vestas V29	31	45	29	53.108889	-0.942222	1.3	1.82	Y	Y	15.5
ESE2	16/11/2011	1	0.28	Vergnet GEV MP-R	32	49	32	53.236111	0.128333	1.3	1.30	Y	Y	16.8
ENE2	01/11/2012	1	0.28		55	71	32	55.110000	-1.563056	1.3	1.30	Y	Y	16.8
ESE3	01/06/2011	1	0.28		55	71	32	53.071944	-1.019167	1.3	1.30	N	Y	16.8
S6	01/06/2012	1	0.28		32	49	32	55.879167	-2.183611	1.3	1.30	Y	Y	16.8

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
S7	30/04/2012	1	0.28		32	49	32	55.966667	-2.608611	1.3	1.30	Y	Y	16.8
ESE4	01/06/2012	1	0.28		55	71	32	53.118889	-1.083889	1.3	1.30	N	Y	16.8
S8	15/02/2013	1	0.33	Enercon E33	44	61	33	57.580833	-3.558611	1.3	1.33	Y	Y	16.4
ESE5	12/02/2013	1	0.33	Enercon E33	51	67	33	52.981667	-0.645000	1.3	1.33	N	Y	16.4
S9	18/02/2013	1	0.33	Enercon E33	51	67	33	57.376667	-2.354722	1.3	1.33	Y	Y	16.4
EE3	27/07/2011	1	0.33	Enercon E33	37	54	33	53.863889	-0.341944	1.3	1.33	Y	Y	16.4
S10	01/11/2012	1	0.33	Enercon E33	44	61	33	57.376944	-2.354167	1.3	1.33	Y	Y	16.4
S11	16/04/2012	1	0.33	Enercon E33	49	67	33	57.189722	-2.077778	1.3	1.33	Y	Y	16.4
S12	12/02/2013	1	0.33	Enercon E-33	37	54	33	54.929722	-5.169722	1.3	1.33	N	Y	16.4
S13	08/11/2012	1	0.33		37	54	34	56.610000	-2.693611	1.3	1.33	Y	Y	16.2
ENW1	01/09/1993	12	4.80	Vestas WD34	25	42	34	54.246111	-3.152222	1.3	1.33	Y	Y	16.2
ENW2	01/12/1992	24	9.60	Vestas WD34	32	49	34	53.748611	-2.167500	1.3	1.33	Y	Y	16.2
EE4	01/06/1993	23	9.20	Vestas WD34	37	54	34	53.774167	-1.934722	1.3	1.33	Y	Y	16.2
EE5	01/11/1993	13	6.50	Bonus 450	35	54	37	53.531944	-1.669444	1.4	2.00	Y	Y	13.1
ENW3	01/01/1997	5	2.50	Wind World W3700	35	54	37	54.218889	-3.157778	1.9	2.00	Y	Y	14.6
S14	01/03/2001	1	0.60	Enercon E40/600	65	87	40	55.742222	-4.160000	1.9	1.76	N	Y	14.7
ESE6	01/07/2002	2	1.20	Enercon E40	65	87	40	53.327222	0.240278	1.9	1.76	Y	Y	14.7
S15	01/10/1997	34	17.00	Bonus	35	56	41	57.714444	-4.434167	1.4	2.07	N	Y	12.1
S16	01/11/1995	26	15.60	Bonus	45	65	41	55.550556	-3.918333	1.4	2.07	Y	Y	12.1
ENW4	01/10/1996	7	4.20	Vestas V42	40	61	42	54.671111	-3.543056	2.5	2.00	Y	Y	15.1

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
ENW5	01/10/1996	9	5.40	Vestas V42	40	61	42	54.659444	-3.559444	2.5	2.00	N	Y	15.1
ENW6	01/07/1998	4	2.40	Wind World W4200	42	63	42	54.200833	-3.329167	2.4	2.13	N	Y	14.5
S17	01/09/1996	36	21.60	Nordtank NTK600	36	54	43	55.291944	-4.205000	2.4	2.22	Y	Y	14.1
ESE7	01/11/2004	8	4.80	Enercon E44	65	87	44	53.321111	0.232500	2.4	1.74	Y	Y	15.4
S18	01/08/2012	1	0.90	Enercon E44/900	45	67	44	58.997778	-2.985000	2.4	1.74	Y	Y	15.4
S19	30/09/2010	5	4.50	Enercon E44	45	67	44	59.094722	-3.075278	2.4	1.74	Y	Y	15.4
S20	01/10/2009	1	0.90	Enercon E44	45	67	44	59.075833	-3.188056	2.4	1.74	Y	Y	15.4
S21	01/10/2011	1	0.90	Enercon E44	45	67	44	59.055278	-2.845556	2.4	1.74	Y	Y	15.4
S22	01/10/2011	1	0.90	Enercon E44	45	67	44	59.151944	-3.021111	2.4	1.74	N	Y	15.4
S23	21/10/2011	1	0.90	Enercon E44	45	67	44	58.826667	-3.326111	2.4	1.74	Y	Y	15.4
S24	17/11/2011	1	0.90	Enercon E44	45	67	44	59.085000	-2.683889	2.4	1.74	N	Y	15.4
S25	18/02/2013	3	2.70	Enercon E-44	45	67	44	58.921667	-2.715556	2.4	1.74	Y	Y	15.4
ESE8	01/04/2008	20	12.00	Enercon E48/800	63	87	44	53.425556	-0.080000	2.4	1.76	Y	Y	15.3
ENE3	01/04/2008	2	1.20	Vestas V47	55	77	44	54.920000	-1.468056	2.4	1.92	Y	Y	14.7
ENW7	01/04/1999	6	3.60	Vestas V44	50	72	44	53.458611	-3.030278	2.4	2.14	N	Y	14.1

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
ENE4	01/05/2000	3	1.80	Nordex N43/600	45	68	46	55.082778	-1.990556	2.4	2.21	Y	Y	13.5
S26	01/11/2000	20	13.00	Vestas V47	40	64	47	55.351667	-4.117778	2.4	1.92	Y	Y	14.2
ENW8	01/07/1999	7	4.62	Vestas V47	40	64	47	54.187222	-3.172222	2.4	1.92	Y	Y	14.2
S27	01/07/2000	26	17.16	Vestas V47	40	64	47	55.807500	-2.860278	2.4	1.92	Y	Y	14.2
ENW9	01/12/1999	6	3.96	Vestas V47	45	69	47	54.866944	-3.075278	2.4	1.92	Y	Y	14.2
ENW10	01/03/2000	7	4.62	Vestas V47	40	64	47	54.592778	-3.575833	2.4	1.92	N	Y	14.2
ENE5	01/11/2005	6	3.96	Vestas V47	55	78	47	54.920000	-1.468056	2.4	1.92	Y	Y	14.2
ENW11	01/12/1999	3	1.98	Vestas V47	45	69	47	54.864167	-3.087500	2.4	1.92	Y	Y	14.2
S28	11/09/2010	1	0.75	GWP47	55	81	47	56.182222	-3.008333	2.4	2.35	Y	Y	13.1
S29	30/11/2013	1	0.50	Enercon E48	55	79	48	57.507222	-4.548333	2.4	1.94	Y	Y	14
S30	01/11/2012	1	0.50		55	78	48	55.742222	-4.075556	2.4	1.94	N	Y	14
ESE9	01/11/2012	1	0.50		55	78	48	53.515278	-0.613056	2.4	1.94	N	Y	14
ENW12	31/03/2005	3	1.50		55	79	48	53.773056	-2.303333	2.4	1.94	Y	Y	14
ESE10	01/11/2006	6	4.80	Enercon E48	65	89	48	53.327500	0.232500	2.4	1.94	Y	Y	14
S31	18/02/2013	3	2.40	Enercon E48	60	84	48	55.861667	-2.298611	2.4	1.94	Y	Y	14
S32	01/03/2009	3	2.40	Enercon E48	55	79	48	57.556944	-2.371667	2.4	1.94	Y	Y	14
S33	27/07/2010	3	2.40	Enercon E48	56	80	48	57.617222	-2.040833	2.4	1.94	Y	Y	14
S34	20/03/2012	3	2.40	Enercon E48	55	79	48	57.469722	-2.508889	2.4	1.94	Y	Y	14
S35	05/07/2009	3	2.40	Enercon E48	56	80	48	57.422778	-2.334444	2.4	1.94	Y	Y	14
S36	15/10/2010	3	2.40	Enercon E48	50	74	48	57.400556	-2.067500	2.4	1.94	Y	Y	14
S37	04/11/2010	3	2.40	Enercon E48	60	84	48	57.500556	-2.030000	2.4	1.94	Y	Y	14
ESE11	29/06/2012	1	0.80	Enercon E48/800	50	74	48	52.765833	0.130556	2.4	1.94	N	Y	14

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
S38	20/10/2011	2	1.60	Enercon E48	55	79	48	57.552500	-1.856389	2.4	1.94	Y	Y	14
S39	01/12/2009	1	0.80	Enercon E48	56	80	48	57.550000	-1.854722	2.4	1.94	Y	Y	14
S40	01/12/2009	1	0.80	Enercon E48	55	79	48	57.392778	-2.424167	2.4	1.94	Y	Y	14
ESE12	28/05/2008	20	16.00	Enercon E48	65	89	48	53.425556	-0.081389	2.4	1.94	Y	Y	14
S41	22/12/2011	1	0.80	Enercon E48	50	74	48	56.911667	-2.445556	2.4	1.94	Y	Y	14
S42	01/10/2009	1	0.80	Enercon E48	56	80	48	57.404722	-2.429444	2.4	1.94	Y	Y	14
S43	01/06/2012	1	0.80	Enercon E48	55	79	48	57.535556	-1.891389	2.4	1.94	Y	Y	14
S44	01/12/2009	1	0.80	Enercon E48	56	80	48	57.542500	-2.312778	2.4	1.94	Y	Y	14
S45	01/12/2009	4	3.20	Enercon E48	55	77	48	57.446667	-2.185000	2.4	1.94	Y	Y	14
S46	01/08/2011	1	0.80	Enercon E48	56	80	48	57.317222	-2.184167	2.4	1.94	Y	Y	14
S47	01/02/2009	1	0.80	Enercon E-48	55	79	48	57.586667	-2.863056	2.4	1.94	Y	Y	14
S48	18/02/2013	1	0.80	Enercon E-48	58	80	48	57.488889	-1.969167	2.4	1.94	Y	Y	14
S49	01/07/2008	2	1.60	Enercon E-48	55	79	48	57.585833	-2.005833	2.4	1.94	Y	Y	14
S50	02/05/2013	8	6.40	Enercon E48	50	81	48	56.571667	-3.049722	2.4	1.94	Y	Y	14
S51	05/07/2013	2	1.60		50	81	48	57.592500	-2.852500	2.4	1.94	Y	Y	14
S52	30/09/2011	1	0.80		50	81	48	57.509167	-2.152222	2.4	1.94	Y	Y	14
ENW13	01/04/2013	1	0.80		50	65	48	54.861111	-3.013333	2.4	1.94	Y	Y	14
ENE6	01/03/2014	1	0.80		50	74	48	55.792778	-2.023889	2.4	1.94	Y	Y	14
S53	01/07/2010	1	0.80		50	80	48	57.591389	-2.016944	2.4	1.94	Y	Y	14

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
ENE7	01/12/2001	3	2.25	Nordex N52/800	46	71	50	54.760000	-1.780833	2.4	2.73	Y	Y	12
ENW14	09/12/2011	3	2.25		55	79	50	53.639444	-2.753333	2.4	2.73	Y	Y	12
ENE8	01/12/2001	3	2.30	Nordex N50/800	50	75	50	54.760278	-1.782500	2.4	2.73	Y	Y	12
S54	10/10/2010	1	0.90	Enercon E44	55	81	52	57.310000	-2.245556	2.4	1.74	Y	Y	14.4
S55	23/07/2010	3	2.55	Vestas V52	55	81	52	57.308333	-2.825000	2.3	1.91	Y	Y	13.4
S56	19/10/2009	35	29.75	Vestas V52	49	75	52	55.807500	-2.860278	2.3	1.91	Y	Y	13.4
S57	01/07/2007	1	0.85	Vestas V52	49	75	52	57.473056	-2.238611	2.3	1.91	Y	Y	13.4
S58	01/12/2007	3	2.55	Vestas V52	45	70	52	57.376944	-2.397500	2.3	1.91	Y	Y	13.4
ENW15	19/02/2005	8	6.80	Vestas V52	45	71	52	54.864167	-3.087500	2.3	1.91	Y	Y	13.4
ENW16	13/05/2009	7	5.95	Vestas V52	50	81	52	54.642222	-3.496944	2.3	1.91	Y	Y	13.4
S59	17/07/2009	2	1.70	Vestas V52	49	75	52	57.473056	-2.238611	2.3	1.91	Y	Y	13.4
S60	01/10/2005	15	13.00	Vestas V52	46	57	52	58.300000	-3.433333	2.3	1.91	Y	Y	13.4
S61	01/02/2005	1	0.90	Vestas V52	44	75	52	58.870833	-2.894722	2.3	1.91	Y	Y	13.4
S62	01/07/2008	2	2.00		44	75	52	57.376111	-2.393056	2.6	1.91	Y	Y	14.1
S63	01/07/2013	12	10.20	Gamesa G52	44	70	52	57.020556	-2.286667	2.4	1.95	Y	Y	13.4

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
ENW17	01/03/2005	4	3.40	Vestas	50	76	52	54.200833	-3.329167	2.4	1.95	N	Y	13.4
S64	30/09/2013	1	0.50		60	86	53	56.614722	-3.379444	2.4	1.94	Y	Y	13.4
S65	09/05/2011	12	9.60	Enercon E53	60	91	53	56.306667	-3.430278	2.4	2.12	Y	Y	12.7
S66	01/01/2007	1	0.80	Enercon E53	60	86	53	55.875833	-4.009444	2.4	2.12	Y	Y	12.7
ESE22	01/01/2013	1	0.80	Enercon E53	73	99	53	53.229444	-0.911944	2.4	2.12	Y	Y	12.7
S67	01/03/2002	3	2.70	GE Wind 900S	50	77	54	59.083056	-2.664722	2.4	1.91	N	Y	13.4
EE6	29/11/2013	1	0.50		51	78	54	53.757500	-0.771111	2.4	1.94	Y	Y	13.3
EE7	01/10/2012	1	0.50		50	80	54	53.955278	-0.319167	2.4	1.94	Y	Y	13.3
S68	19/09/2012	1	0.50	Directwind 54-500	52	79	54	55.706667	-4.133333	2.4	2.14	N	Y	12.6
ESE13	01/09/2012	1	0.50	EWT DW 54	40	67	54	53.420278	0.049167	2.4	2.14	Y	Y	12.6
S69	26/02/2014	1	0.50	EWT DW 54	40	66	54	55.732222	-4.048611	2.4	2.14	N	Y	12.6
ESE14	17/03/2012	1	0.50	EWT DW 54	50	77	54	53.387500	-1.284167	2.4	2.14	Y	Y	12.6
ENW18	01/06/2013	1	0.50	Directwind 54-500	50	77	54	54.119167	-2.756667	2.4	2.14	Y	Y	12.6
EE8	22/03/2012	1	0.90	PowerWind 56	72	100	56	53.385556	-1.382500	2.4	2.16	Y	Y	12.3
S70	14/11/2012	1	0.50	Power Wind 500	50	78	56	55.848611	-3.802222	2.4	2.41	Y	Y	11.7
S71	16/08/2013	9	7.65	Gamesa G58	71	100	58	56.865278	-2.241111	2.5	2.61	Y	Y	11.2
S72	01/09/2002	24	31.20	Nordex	50	80	60	55.715556	-3.139722	2.6	3.13	Y	Y	10.5
ENE9	01/10/2008	4	5.20	Nordex N60/1300	46	76	60	54.764722	-1.768333	2.6	3.13	Y	Y	10.5
S73	01/11/2000	1	1.30	Nordex N60	46	76	60	59.131389	-3.149167	2.6	3.13	N	Y	10.5

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
S74	01/02/2008	3	3.90	Nordex N60	60	90	60	58.471944	-3.313333	2.6	3.13	Y	Y	10.5
S75	01/09/2012	22	28.60	Nordex N60	45	76	60	55.897778	-2.261944	2.6	3.13	Y	Y	10.5
ENW19	01/02/2011	5	6.50	Nordex N60	50	80	60	54.573611	-3.525278	2.6	3.13	N	Y	10.5
ENW20	01/03/2007	3	3.90	Nordex N60	60	91	60	54.780833	-3.159722	2.6	3.13	Y	Y	10.5
EE9	01/02/2008	1	1.30	Nordex N60	46	76	60	53.743611	-0.238056	2.6	3.13	Y	Y	10.5
EE10	01/02/2008	2	2.60	Nordex N60	60	90	60	53.757222	-0.937778	2.6	3.13	N	Y	10.5
ESE15	01/07/2008	2	2.60	Nordex N60	60	91	60	53.129444	0.248056	2.6	3.13	Y	Y	10.5
ENE10	01/10/2008	4	5.20	Nordex N60	46	76	60	54.713056	-1.419444	2.6	3.13	Y	Y	10.5
ENW21	08/08/2007	8	10.40	Nordex N60	50	81	60	54.726667	-3.282500	2.6	3.13	Y	Y	10.5
ENE11	01/03/2007	2	2.60	Nordex N60	60	91	60	54.838889	-1.417778	2.6	3.13	Y	Y	10.5
S76	01/03/2003	2	2.32	Bonus 1.3	50	78	62	58.607778	-3.667500	2.6	3.16	Y	Y	10.2
S77	23/07/2005	20	26.00	Bonus 1.3	47	78	62	57.424444	-2.642778	2.6	3.16	Y	Y	10.2
ENW22	01/09/2000	5	6.50	Bonus	43	74	62	54.335278	-2.638333	2.6	3.16	Y	Y	10.2
EE11	01/03/2002	7	9.10	Bonus	49	80	62	53.667500	-0.101111	2.6	3.16	Y	Y	10.2
S78	01/05/2007	14	18.20	Siemens 1.3	62	93	62	55.222222	-4.041667	2.6	3.16	Y	Y	10.2
S79	01/07/2005	15	19.50	Siemens 1.3	45	76	62	54.966111	-4.766389	2.6	3.16	N	Y	10.2
S80	01/09/2012	7	9.10	Siemens 1.3	45	76	62	54.966111	-4.766389	2.6	3.16	N	Y	10.2
S81	01/02/2007	22	28.60	Siemens SWT 1.3	47	63	62	55.798333	-2.433889	2.6	3.16	Y	Y	10.2
S82	01/07/2007	4	5.20	Siemens SWT 1.3	47	78	62	58.607778	-3.669722	2.6	3.16	Y	Y	10.2

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
S83	01/10/2008	20	26.00	Siemens SWT 1.3	60	80	62	55.556111	-3.900833	2.6	3.16	Y	Y	10.2
S84	27/03/2013	11	14.30	Siemens SWT 1.3MW	45	76	62	55.581111	-3.898333	2.6	3.16	Y	Y	10.2
S85	20/01/2012	4	5.20	Siemens 1.3	45	76	62	56.938611	-2.303889	2.6	3.16	Y	Y	10.2
S86	01/04/2007	7	12.25	Vestas V66	47	80	66	57.409167	-2.731389	2.6	2.45	Y	Y	11.4
ESE24	24/07/2000	1	1.50	Enercon E66	65	100	66	52.709167	1.655556	2.6	2.73	Y	Y	10.5
ESE25	16/08/1999	1	1.50	Enercon E-66	66	100	66	52.656389	0.685278	2.6	2.73	N	Y	10.5
S87	01/09/2006	17	30.00	Vestas V66	60	107	66	57.801667	-4.332222	2.6	2.82	Y	Y	10.3
ESE26	30/10/2013	1	1.50		60	100	66	52.771111	0.385556	2.6	3.16	Y	Y	9.8
ENW23	18/02/2013	1	2.00	Enercon E70	64	100	70	54.010278	-2.786944	3.0	2.79	Y	Y	10.7
S88	01/05/2006	7	14.00	Enercon E70	64	100	70	57.646389	-2.604722	3.0	2.79	Y	Y	10.7
S89	01/05/2006	2	4.00	Enercon E70	85	120	70	56.499722	-2.896944	3.0	2.79	Y	Y	10.7
S90	25/07/2012	1	2.00	Enercon E70	64	99	70	58.826667	-3.123889	3.0	2.79	N	Y	10.7
S91	18/02/2013	1	2.20	Enercon E70	56	91	70	55.723889	-3.956111	3.0	2.79	Y	Y	10.7
S92	01/03/2012	16	36.60	Enercon E70/2300	64	106	70	57.714444	-4.434167	3.0	2.79	N	Y	10.7
S93	12/11/2009	1	2.30	Enercon E70	64	100	70	59.120278	-3.152778	3.0	2.79	Y	Y	10.7
S94	01/01/2011	1	2.30	Enercon E70	64	100	70	57.591389	-2.421389	3.0	2.79	Y	Y	10.7
S95	22/07/2013	8	18.40	Enercon E70	57	93	70	57.273333	-2.968333	3.0	2.79	Y	Y	10.7

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
S96	21/12/2011	4	9.20	Enercon E70	64	100	70	57.391667	-2.297778	3.0	2.79	Y	Y	10.7
S97	01/01/2012	2	4.60	Enercon E70	62	98	70	57.610000	-2.734444	3.0	2.79	Y	Y	10.7
S98	01/06/2009	2	4.60	Enercon E70	64	100	70	57.627778	-2.581111	3.0	2.79	Y	Y	10.7
S99	01/12/2009	1	2.30	Enercon E70	63	98	70	57.627778	-2.581111	3.0	2.79	Y	Y	10.7
S100	01/07/2009	2	4.60	Enercon E70	64	100	70	57.801389	-4.331944	3.0	2.79	Y	Y	10.7
S101	25/01/2010	1	2.30	Enercon E70	65	100	70	57.646389	-2.604722	3.0	2.79	Y	Y	10.7
S102	01/02/2010	1	2.30		59	94	70	57.390000	-2.257500	3.0	2.79	Y	Y	10.7
S103	13/09/2011	1	2.30		59	94	70	57.411111	-2.340833	3.0	2.79	Y	Y	10.7
S104	25/05/2011	2	4.60		59	94	70	57.429167	-2.308056	3.0	2.79	Y	Y	10.7
S105	08/02/2010	3	6.90	Enercon E70	64	100	70	57.315556	-2.114444	3.0	2.79	Y	Y	10.7
S106	16/01/2013	3	6.90	Enercon E70	57	92	70	56.941667	-2.287500	3.0	2.79	Y	Y	10.7
ENE12	01/07/2012	6	13.80	Enercon E70	64	100	70	54.893333	-1.937500	3.0	2.79	Y	Y	10.7
S107	30/03/2013	3	6.90	Enercon E70	29	64	70	57.493889	-2.534722	3.0	2.79	Y	Y	10.7
ENW24	01/07/2006	8	16.00	Repower MM70	55	90	70	54.060833	-2.656944	3.0	3.00	Y	Y	10.4

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
S108	24/09/2008	18	27.00	Acciona AW1500	60	95	70	56.248889	-3.666944	3.0	3.59	Y	Y	9.7
EE12	05/10/2010	3	4.50	Acciona AW1500	60	95	70	53.310000	-1.243611	3.0	3.59	Y	Y	9.7
S109	18/02/2012	1	2.30	Enercon 250	64	99	71	57.663889	-2.642500	3.0	2.79	Y	Y	10.6
S166	01/11/2013	4	9.20		64	100	72	57.585000	-1.900556	3.0	2.79	Y	Y	10.6
ENW25	01/02/2007	3	4.50	REPower MD 70/77	62	110	77	53.788611	-2.160833	3.5	3.16	Y	Y	10.4
S110	01/02/2007	36	72.00	Vestas V80	60	100	80	56.276111	-4.062500	3.5	3.14	Y	Y	10.2
S111	04/07/2013	25	50.00	Vestas V80	80	120	80	58.403611	-3.295000	3.5	3.14	Y	Y	10.2
S112	01/02/2012	11	22.00	Vestas V80	60	105	80	55.539167	-3.458056	3.5	3.14	Y	Y	10.2
ENE13	01/03/2012	18	36.00	Vestas V80	60	100	80	55.132222	-2.151111	3.5	3.14	Y	Y	10.2
ENE14	01/03/2011	2	4.00	Vestas V80	60	100	80	54.784167	-1.447778	3.5	3.14	Y	Y	10.2
S113	01/01/2010	11	22.00	Vestas V80	60	100	80	54.867500	-5.086944	3.5	3.14	Y	Y	10.2
S114	01/01/2010	7	14.00	Vestas V80	67	107	80	55.826667	-3.653611	3.5	3.14	Y	Y	10.2
EE13	12/06/2012	5	10.00	Vestas V80	60	100	80	53.845556	-0.609167	3.5	3.14	Y	Y	10.2
ENE15	25/01/2013	3	6.00	Vestas V80	65	100	80	54.832778	-1.401944	3.5	3.14	Y	Y	10.2
S115	18/12/2012	3	6.00	Vestas V80	60	100	80	57.572778	-1.919722	3.5	3.14	Y	Y	10.2
ENW26	09/07/2013	6	12.00	Vestas V80	60	100	80	54.716389	-3.371667	3.5	3.14	Y	Y	10.2
S116	14/06/2011	60	120.0	Gamesa G80	78	118	80	55.053333	-4.882222	3.5	3.16	N	Y	10.2
ESE27	19/06/2013	3	6.00	Gamesa G80	60	100	80	52.756944	0.446667	3.5	3.16	Y	Y	10.2
S117	01/01/2000	2	3.50	Nordex N80	56	96	80	59.109444	-3.140278	3.5	3.17	Y	Y	10.1
S118	01/05/2007	5	12.50	Nordex N80	60	100	80	55.895000	-2.513056	3.2	3.17	Y	Y	9.7
S119	01/05/2004	20	50.00	Nordex	60	100	80	55.895000	-2.513056	3.5	3.17	Y	Y	10.1

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
S120	04/01/2012	3	7.50	Nordex N80	59	99	80	58.002778	-4.352778	3.2	3.17	N	Y	9.7
EE14	31/03/2013	3	7.50	Nordex N80	60	101	80	53.547500	-1.704722	3.2	3.17	Y	Y	9.7
S121	01/02/2007	2	5.00	Nordex N80	60	100	80	59.120278	-3.145833	3.2	3.17	Y	Y	9.7
S122	18/09/2007	4	10.00	Nordex N80	60	100	80	55.212778	-3.109444	3.2	3.17	Y	Y	9.7
S123	31/03/2010	8	20.00	Nordex N80	85	125	80	56.055278	-4.050556	3.2	3.17	Y	Y	9.7
S124	01/12/2007	15	37.50	Nordex N80	75	115	80	56.083333	-4.083333	3.2	3.17	Y	Y	9.7
S125	17/06/2013	5	12.50	Nordex N80	59	100	80	57.444167	-2.478333	3.2	3.17	Y	Y	9.7
ENW27	01/09/2008	26	65.00	Nordex N80	60	100	80	53.666944	-2.273889	3.2	3.17	Y	Y	9.7
S126	29/09/2010	7	17.50	Nordex N80	60	100	80	56.835278	-2.399722	3.2	3.17	Y	Y	9.7
ENE16	01/09/2004	2	5.08	NEG Micon NM80	60	100	80	54.762500	-1.416389	3.5	3.43	Y	Y	9.8
ENE17	01/05/2004	2	5.08	NEG Micon NM80	60	100	80	54.838333	-1.676389	3.5	3.43	Y	Y	9.8
ENE18	01/12/2003	3	7.83	NEG Micon NM80	60	100	80	54.699444	-1.291389	3.5	3.43	Y	Y	9.8
ESE28	01/01/2005	1	2.75	NEG Micon NM80	80	126	80	52.479722	1.760556	3.5	3.43	N	Y	9.8
S127	01/05/2002	1	2.75	NEG Micon NM80	70	116	80	59.125278	-3.154444	3.5	3.43	Y	Y	9.8
S128	01/09/2005	42	96.60	Siemens 2.3	70	110	80	55.766944	-3.738889	4.2	3.75	Y	Y	10.5
S129	01/06/2012	21	48.30	Siemens 2.3	60	100	80	57.486667	-3.027500	4.2	3.75	Y	Y	10.5
S130	01/09/2006	12	27.60	Siemens 2.3	70	110	80	55.766944	-3.738889	4.2	3.75	Y	Y	10.5

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
S131	19/07/2013	14	32.20	Siemens 2.3	69	109	80	56.566389	-3.833889	4.2	3.75	Y	Y	10.5
S132	01/12/2011	56	128.8	Siemens 2.3	82	122	80	55.467222	-3.654444	4.2	3.75	Y	Y	10.5
S133	10/05/2005	22	50.60	Siemens 2.3	60	100	80	57.537222	-3.371389	4.2	3.75	Y	Y	10.5
ENE19	01/02/2014	18	54.00		80	125	80	55.497778	-1.768889	4.2	4.00	Y	Y	10.3
EE15	15/02/2013	3	6.90	Enercon	64	95	81	53.531944	-1.669444	4.2	2.79	Y	Y	11.8
ESE29	01/07/2003	1	1.80	Enercon E82	85	120	82	52.656944	0.700833	4.3	3.24	N	Y	11.1
ESE16	01/01/2009	1	2.00	Enercon E-82	79	120	82	53.295278	-1.088056	4.3	3.24	Y	Y	11.1
ENW36	27/02/2012	4	9.20	Enercon E82	79	120	82	54.850000	-3.345833	4.3	3.24	Y	Y	11.1
EE16	01/12/2013	3	10.20	Enercon E82	85	132	82	53.749167	-0.114444	4.3	3.24	Y	Y	11.1
ENE20	01/04/2011	10	18.80	REpower MM82	69	110	82	54.670833	-1.393333	4.3	3.51	Y	Y	10.7
S134	12/06/2012	35	70.00	REP MM82 2MW 80HH 82RD	69	110	82	58.109167	-3.936389	4.3	3.51	Y	Y	10.7
ENW28	01/10/2006	2	4.00	Repower MM82	67	108	82	54.664167	-3.542500	4.3	3.51	Y	Y	10.7
EE17	14/12/2011	3	6.00	Repower MM82	60	100	82	53.533611	-1.729167	4.3	3.51	Y	Y	10.7
S135	16/09/2013	5	10.00	Repower MM82	60	101	82	58.441389	-3.240833	4.3	3.51	N	Y	10.7
ENE21	01/12/2008	4	8.00	Repower MM82	60	100	82	54.795000	-1.667222	4.3	3.51	Y	Y	10.7
ENW29	10/04/2013	6	12.00	REpower MM82	60	100	82	54.276111	-2.641944	4.3	3.51	Y	Y	10.7
ESE17	01/09/2008	13	26.00	Repower MM82	60	100	82	52.926111	-0.216389	4.3	3.51	N	Y	10.7
S136	01/09/2010	13	26.00	Repower MM82	60	100	82	56.211389	-3.766944	4.3	3.51	Y	Y	10.7

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
S137	21/10/2008	15	30.00	Repower MM82	80	125	82	55.170278	-3.673611	4.3	3.51	Y	Y	10.7
S138	28/02/2010	20	40.00	Repower MM82	60	100	82	57.529722	-4.646389	4.3	3.51	N	Y	10.7
ESE18	01/08/2006	6	12.00	Repower MM82	59	100	82	52.839722	-0.106667	4.3	3.51	N	Y	10.7
S139	05/12/2007	2	4.00	REPower MM82	60	100	82	55.908333	-3.901944	4.3	3.51	Y	Y	10.7
ENW30	16/08/2013	3	6.00	Repower MM82	69	110	82	53.788611	-2.160833	4.3	3.51	Y	Y	10.7
ENE22	01/12/2010	5	10.00	REPower MM82	70	110	82	54.775278	-1.456111	4.3	3.51	Y	Y	10.7
S140	01/11/2009	19	38.00	Repower MM82	60	110	82	55.673056	-2.836389	4.3	3.51	Y	Y	10.7
EE18	01/08/2010	12	24.00	Repower MM82	60	100	82	53.725556	-0.920833	4.3	3.51	N	Y	10.7
ENE23	01/08/2008	7	14.00	Repower MM82	69	110	82	54.674167	-1.384444	4.3	3.51	Y	Y	10.7
ENE24	01/05/2009	12	24.00	REpower MM82	60	100	82	54.768056	-1.821667	4.3	3.51	Y	Y	10.7
ENE25	01/12/2008	4	8.00	Repower MM82s	59	99	82	54.885278	-1.837778	4.3	3.51	Y	Y	10.7
EE19	28/05/2013	12	24.60	REpower MM82	60	100	82	53.873611	-0.360833	4.3	3.51	Y	Y	10.7
ENW31	01/01/2013	12	24.60	Repower MM82	81	122	82	53.713611	-2.377222	4.3	3.51	Y	Y	10.7
S141	17/07/2009	3	6.15	REpower MM82	60	100	82	55.704722	-3.946111	4.3	3.51	Y	Y	10.7
EE20	01/09/2013	6	12.30	Repower MM82	60	102	82	53.836389	-0.605000	4.3	3.51	Y	Y	10.7
S142	01/05/2009	3	6.15	Repower MM82s	59	100	82	58.437222	-3.191944	4.3	3.51	N	Y	10.7

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
EE21	19/03/2013	9	18.50	Repower MM82	80	121	82	53.846667	-0.162222	4.3	3.51	Y	Y	10.7
S143	01/11/2004	21	48.30	Bonus 2.3	60	100	82	58.429444	-3.508611	1.9	3.53	Y	Y	7.3
S167	01/05/2006	40	92.00	Bonus 2.3	60	100	82	57.325000	-4.094167	1.9	3.53	Y	Y	7.3
S144	01/05/2008	16	36.80	Siemens SWT 2.3	80	121	82	55.112778	-3.216389	4.2	3.53	Y	Y	10.5
S145	01/05/2006	28	64.40	Bonus	60	100	82	57.446111	-3.476111	1.9	3.53	Y	Y	7.3
S146	06/12/2011	1	1.50	Acciona	59	100	82	56.052222	-3.445000	4.2	3.59	Y	Y	10.5
ENE26	28/02/2012	13	26.00	Gamesa G87	78	121	87	55.203889	-1.560833	3.4	3.16	Y	Y	9.6
S147	14/06/2011	28	56.00	Gamesa G87	66	110	87	54.993611	-4.932500	3.4	3.16	N	Y	9.6
EE22	01/09/2013	3	6.90	Nordex N90	70	111	90	53.754167	-0.044444	4.2	3.31	Y	Y	10.3
ENE27	01/03/2013	6	15.00	Nordex N90	80	110	90	55.249167	-1.867778	4.2	3.31	Y	Y	10.3
S148	01/09/2011	8	20.00	Nordex N90	80	115	90	58.047778	-4.127778	4.2	3.31	N	Y	10.3
EE23	01/02/2009	12	30.00	Nordex N90	80	125	90	54.009722	-0.254167	4.2	3.31	Y	Y	10.3
ENW32	01/12/2008	4	10.00	Nordex N90	80	125	90	53.458611	-3.030278	4.2	3.31	N	Y	10.3
S149	01/03/2013	5	12.50	Nordex N90	70	110	90	56.172778	-3.265833	4.2	3.31	Y	Y	10.3
S150	01/08/2008	19	47.50	Nordex N90 /2500 HS	80	115	90	58.047778	-4.127778	4.2	3.31	N	Y	10.3
S151	01/09/2013	6	15.00	Nordex N90/2500	80	115	90	55.578889	-3.992222	4.2	3.31	N	Y	10.3
S152	21/10/2008	16	36.80	Siemens SWT 2.3	62	107	90	56.679444	-3.356389	4.2	3.53	Y	Y	10
S153	06/04/2010	51	117.3	Siemens 2.3	80	125	90	55.906667	-2.551667	4.2	3.75	Y	Y	9.7

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
S154	06/04/2010	9	20.70	Siemens 2.3	65	110	90	55.904167	-2.543889	4.2	3.75	Y	Y	9.7
S155	04/09/2013	18	41.40	Siemens 2.3	80	125	90	57.536944	-3.379722	4.2	3.75	Y	Y	9.7
S156	01/06/2010	12	27.60	Siemens 2.3	80	125	90	55.772222	-2.806667	4.2	3.75	Y	Y	9.7
ESE19	03/09/2010	5	9.00	Vestas V90	80	125	90	53.116111	-1.146667	3.5	4.00	N	Y	8.6
ESE31	01/11/2006	8	14.40	Vestas V90	85	125	90	52.626111	0.749722	3.5	4.00	N	Y	8.6
EE24	01/04/2013	9	17.10	Vestas V90-1.9	80	126	90	53.746111	-0.068056	3.5	4.00	Y	Y	8.6
ENW33	17/06/2013	2	4.00	Vestas V90	80	125	90	53.903056	-2.839444	3.5	4.00	Y	Y	8.6
ESE20	15/05/2013	7	14.00	Vestas V90	80	127	90	52.750556	0.166111	3.5	4.00	N	Y	8.6
EE25	01/10/2012	22	44.00	Vestas V90	80	125	90	53.609444	-0.913611	3.5	4.00	N	Y	8.6
ENE28	01/06/2012	2	4.00		80	87	90	54.847500	-1.754444	3.5	4.00	Y	Y	8.6
S157	01/05/2009	16	48.00	Vestas V90	80	125	90	55.926667	-2.457778	3.5	4.00	Y	Y	8.6
S158	01/03/2013	48	144.0	Vestas V90	80	125	90	55.826944	-2.663889	3.5	4.00	Y	Y	8.6
ENE29	31/03/2010	4	7.82	REPower MM92	60	115	92	54.833056	-1.429444	4.2	4.00	Y	Y	9.4
ENE30	01/12/2010	2	4.00	Repower MM92	80	125	92	55.090278	-1.591111	4.2	4.00	Y	Y	9.4
S159	01/08/2013	4	8.00	Repower MM92	70	112	92	54.874167	-4.769444	4.2	4.00	N	Y	9.4
ESE21	30/07/2009	8	16.00	Repower MM92	80	125	92	53.637222	-0.632778	4.2	4.00	Y	Y	9.4
ENE31	01/02/2013	3	6.00	Repower MM92	70	110	92	54.899444	-1.887500	4.2	4.00	Y	Y	9.4

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
EE26	01/10/2008	1	2.00	Repower MM92	80	125	92	53.761944	-0.332778	4.2	4.00	Y	Y	9.4
ENW34	01/11/2010	1	2.00	Repower MM92	80	126	92	53.888333	-2.786389	4.2	4.00	Y	Y	9.4
EE27	13/03/2012	4	8.00	Repower MM92	80	125	92	53.533056	-1.239722	4.2	4.00	Y	Y	9.4
ENE32	01/11/2012	3	6.00	Repower MM92	80	125	92	54.491111	-1.254444	4.2	4.00	Y	Y	9.4
EE28	01/11/2012	2	4.00	Repower MM92	80	125	92	54.491111	-1.254444	4.2	4.00	Y	Y	9.4
EE29	01/04/2014	4	8.20	Repower MM92	80	125	92	53.580000	-1.234167	4.2	4.00	Y	Y	9.4
ESE30	09/08/2011	2	4.10	Repower MM92	80	125	92	52.415833	1.698333	4.2	4.00	N	Y	9.4
EE30	01/07/2013	10	20.50	Repower MM92	80	125	92	53.739722	-0.800556	4.2	4.00	Y	Y	9.4
ENE33	01/03/2014	10	20.50	Repower MM92	80	125	92	55.518611	-1.795556	4.2	4.00	Y	Y	9.4
ENW35	15/03/2013	3	6.15	Repower MM92	70	115	92	54.684722	-3.493611	4.2	4.00	Y	Y	9.4
S160	01/03/2011	6	12.30	Repower MM92	80	125	92	55.761111	-3.583889	4.2	4.00	Y	Y	9.4
S161	15/01/2014	3	7.50	Repower MM92	60	115	92	55.756667	-4.109722	4.2	4.00	N	Y	9.4
S162	15/01/2014	3	9.00	Repower MM92	60	115	92	55.756667	-4.109722	4.2	4.00	N	Y	9.4
S163	21/06/2010	3	6.00	Siemens 2.3	59	105	93	55.761667	-3.013611	4.2	3.75	Y	Y	9.6
S168	01/10/2012	96	220.8	SWT 2.3-93 2.3MW 80HH 93RD	76	122	93	55.467222	-3.654444	4.2	3.75	Y	Y	9.6
ENE34	02/04/2013	1	2.50	Clipper Liberty 2500	82	130	96	55.772222	-1.998056	4.2	3.87	Y	Y	9.3
S164	29/11/2012	9	24.75	GE 2.75	75	125	100	56.109444	-3.303889	4.2	2.40	Y	Y	12.1
S165	27/02/2012	68	156.4	Siemens SWT-2.3-101	74	124	101	56.552500	-3.782778	4.2	3.75	Y	Y	9.1
EE31	12/04/2013	6	20.40	Repower 3.4M104	78	130	104	53.389444	-1.284722	3.8	4.35	Y	Y	8

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
ENE35	26/03/2013	1	3.40	REPower 3.4M104	78	130	104	55.119722	-1.493889	3.8	4.35	Y	Y	8

CRM Table 2 – Offshore wind farms within 20km of main pink-footed goose sites, colour marking re-sightings or satellite tracking fixes (and their straight-line points) in the UK. Data are as supplied by RenewableUK (2014 pers. comm.) appended by internet searches for additional specification data. Where data could not be readily found, approximations were made using similar turbine model data (usually based on rotor diameter). The last column gives the percentage of birds passing through the turbine rotors which are estimated to collide from Collision Risk Modelling following Band (2000)

Wind farm	Operational date	No turbines	MW	Turbine Model	Hub Height	Tip Height	Rotor Diameter	Latitude	Longitude	Max Chord	Rotation Period	within 10km	within 20km	% birds from CRM
OWF1	01/07/2007	2	10	Senvion 5M	107.0	170.0	126	58.098	-3.078	4.6	5	Y	Y	8.9
OWF2	01/12/2000	2	4	Vestas V66	62.0	95.0	66	55.136	-1.49	2.6	3	Y	Y	11.5
OWF3	16/04/2010	60	180	Vestas V90	80.0	125.0	90	54.756	-3.71	3.5	4	Y	Y	9.7
OWF4	01/08/2013	27	62	Siemens 2.3	80.0	126.5	93	54.65	-1.096	4.2	4	Y	Y	11.2
OWF5	22/02/2012	30	150	Senvion 5M	100.0	163.0	126	54.088	-3.437	4.6	5	Y	Y	8.9
OWF6	11/07/2011	51	184	Siemens 3.6	83.5	137.0	107	54.041	-3.514	4.2	5	Y	Y	9.3
OWF7	09/01/2012	51	184	Siemens 3.6	90.2	150.2	120	54.081	-3.605	4.2	5	Y	Y	9
OWF8	01/07/2006	30	90	Vestas V90	75.0	120.0	90	53.991	-3.295	3.5	4	Y	Y	9.7
OWF9	25/10/2007	25	90	Siemens 3.6	83.5	137.0	107	53.488	-3.187	4.2	5	Y	Y	9.3
OWF10	01/12/2003	30	60	Vestas V80	67.0	107.0	80	53.417	-3.448	3.5	3	Y	Y	11.9
OWF11	02/12/2009	25	90	Siemens 3.6	80.0	133.5	107	53.378	-3.646	4.2	5	N	Y	9.3
OWF12	01/08/2013	75	270	Siemens 3.6	100.0	160.0	120	53.191	0.491	4.2	5	Y	Y	9
OWF13	30/03/2009	54	194	Siemens 3.6	80.0	133.5	107	53.136	0.458	4.2	5	Y	Y	9.3
OWF14	27/09/2012	88	317	Siemens 3.6	81.8	135.2	107	53.135	1.147	4.2	5	Y	Y	9.3
OWF15	01/03/2004	30	60	Vestas V80	60.0	100.0	80	52.645	1.1787	3.5	3	Y	Y	11.9

CRM Table 3 – Estimated number of collisions from each onshore wind farm during migration using different avoidance rates. This example shows estimates based on 20% of migrating geese being at CRH (on average <98m) and moving along a 10km migration front along the different regional routes identified (see Figure 5, Appendix I) for a single migration leg (i.e. Autumn or Spring), encountering all wind farms within 20km of main sites, re-sightings or satellite-tag track-lines. For proficiency, widths of wind farms were the greatest width for projects with ten or more turbines, 2 x No. turbines x Height to tip x Rotor diameter for projects of two to nine turbines and Height to tip x Rotor diameter for single turbine projects. The area presented by rotors (A) is taken as No. turbines x π x Rotor radius^2. The number passing through the risk window was taken as the width of the wind farm divided by the width of the migratory front (10,000m in this example) multiplied by the proportion of birds at CRH (0.2 in this example) multiplied by the proportion of the GB population estimated on the respective regional migratory route multiplied by the proportion of that regional migratory population in the 5km x 5km grid cell containing the wind farm. The number passing through rotors is the number passing the risk window multiplied by A/W and the number of collisions is this multiplied by the % birds estimated to collide from Collision Risk Modelling, adjusted by avoidance rate

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	Proportion of GB Population attributed to Regional Population	Proportion of Regional Population	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number of collisions at different avoidance rates				
											0%	95%	98%	99%	99.8%
ESE23	1	24.7	884.0	227.0	0.3	0.25	0.68	55512	18.9	4.8	1.2	0.1	0.0	0.0	0.0
S1	4	24.7	7072.0	907.9	0.1	1	0.68	222047	604.0	77.5	19.2	1.0	0.4	0.2	0.0
EE1	2	22.5	2657.3	579.1	0.2	0.25	0.27	22041	33.9	7.4	1.7	0.1	0.0	0.0	0.0
S2	1	23.2	987.0	346.4	0.4	1	0.05	16327	6.9	2.4	0.6	0.0	0.0	0.0	0.0
S3	2	23.2	3990.0	692.7	0.2	1	0.68	222047	373.0	64.8	15.0	0.8	0.3	0.2	0.0
S4	1	23.2	1008.0	346.4	0.3	1	0.68	222047	93.3	32.0	7.4	0.4	0.1	0.1	0.0
ENE1	1	17.7	1228.5	572.6	0.5	0.25	0.27	22041	11.9	5.5	1.0	0.0	0.0	0.0	0.0
EE2	2	17.4	5040.0	1231.5	0.2	0.125	0.27	11021	24.7	6.0	1.0	0.1	0.0	0.0	0.0
S5	1	17.4	1260.0	615.8	0.5	1	0.68	222047	124.3	60.8	10.6	0.5	0.2	0.1	0.0
ESE1	1	15.5	1305.0	660.5	0.5	0.125	0.27	11021	6.4	3.2	0.5	0.0	0.0	0.0	0.0
ESE2	1	16.8	1568.0	804.2	0.5	0.25	0.68	55512	35.5	18.2	3.1	0.2	0.1	0.0	0.0
ENE2	1	16.8	2272.0	804.2	0.4	0.25	0.27	22041	14.1	5.0	0.8	0.0	0.0	0.0	0.0
ESE3	1	16.8	2272.0	804.2	0.4	0.125	0.05	2041	1.3	0.5	0.1	0.0	0.0	0.0	0.0
S6	1	16.8	1568.0	804.2	0.5	1	0.27	88166	56.4	28.9	4.9	0.2	0.1	0.0	0.0
S7	1	16.8	1568.0	804.2	0.5	1	0.68	222047	142.1	72.9	12.2	0.6	0.2	0.1	0.0
ESE4	1	16.8	2272.0	804.2	0.4	0.125	0.05	2041	1.3	0.5	0.1	0.0	0.0	0.0	0.0
S8	1	16.4	2013.0	855.3	0.4	1	0.68	222047	146.6	62.3	10.2	0.5	0.2	0.1	0.0
ESE5	1	16.4	2211.0	855.3	0.4	0.125	0.05	2041	1.3	0.5	0.1	0.0	0.0	0.0	0.0

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	Proportion of GB Population attributed to Regional Population	Proportion of Regional Population	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number of collisions at different avoidance rates				
											0%	95%	98%	99%	99.8%
S9	1	16.4	2211.0	855.3	0.4	1	0.68	222047	146.6	56.7	9.3	0.5	0.2	0.1	0.0
EE3	1	16.4	1782.0	855.3	0.5	0.25	0.27	22041	14.5	7.0	1.1	0.1	0.0	0.0	0.0
S10	1	16.4	2013.0	855.3	0.4	1	0.68	222047	146.6	62.3	10.2	0.5	0.2	0.1	0.0
S11	1	16.4	2211.0	855.3	0.4	1	0.68	222047	146.6	56.7	9.3	0.5	0.2	0.1	0.0
S12	1	16.4	1782.0	855.3	0.5	0.25	0.05	4082	2.7	1.3	0.2	0.0	0.0	0.0	0.0
S13	1	16.2	1836.0	907.9	0.5	1	0.68	222047	151.0	74.7	12.1	0.6	0.2	0.1	0.0
ENW1	12	16.2	56112.0	10895.0	0.2	0.25	0.27	22041	588.9	114.4	18.5	0.9	0.4	0.2	0.0
ENW2	24	16.2	61740.0	21790.1	0.4	0.125	0.05	2041	51.4	18.2	2.9	0.1	0.1	0.0	0.0
EE4	23	16.2	72792.0	20882.2	0.3	0.125	0.05	2041	55.0	15.8	2.6	0.1	0.1	0.0	0.0
EE5	13	13.1	21870.0	13977.7	0.6	0.125	0.27	11021	89.3	57.1	7.5	0.4	0.1	0.1	0.0
ENW3	5	14.6	19980.0	5376.1	0.3	0.25	0.27	22041	163.1	43.9	6.4	0.3	0.1	0.1	0.0
S14	1	14.7	3506.1	1275.6	0.4	0.25	0.05	4082	3.3	1.2	0.2	0.0	0.0	0.0	0.0
ESE6	2	14.7	14024.4	2551.1	0.2	0.25	0.27	22041	71.1	12.9	1.9	0.1	0.0	0.0	0.0
S15	34	12.1	194880.0	44888.6	0.2	1	0.05	16327	1136.4	261.7	31.7	1.6	0.6	0.3	0.1
S16	26	12.1	71370.0	34326.6	0.5	0.25	0.05	4082	89.6	43.1	5.2	0.3	0.1	0.1	0.0
ENW4	7	15.1	35868.0	9698.1	0.3	0.25	0.05	4082	48.0	13.0	2.0	0.1	0.0	0.0	0.0
ENW5	9	15.1	46116.0	12469.0	0.3	0.25	0.05	4082	61.7	16.7	2.5	0.1	0.1	0.0	0.0
ENW6	4	14.5	21168.0	5541.8	0.3	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S17	36	14.1	136404.0	52279.2	0.4	0.25	0.05	4082	206.2	79.0	11.1	0.6	0.2	0.1	0.0
ESE7	8	15.4	61248.0	12164.2	0.2	0.25	0.27	22041	310.3	61.6	9.5	0.5	0.2	0.1	0.0
S18	1	15.4	2948.0	1520.5	0.5	1	0.05	16327	14.4	7.4	1.1	0.1	0.0	0.0	0.0
S19	5	15.4	29480.0	7602.7	0.3	1	0.05	16327	143.7	37.1	5.7	0.3	0.1	0.1	0.0
S20	1	15.4	2948.0	1520.5	0.5	1	0.05	16327	14.4	7.4	1.1	0.1	0.0	0.0	0.0

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	Proportion of GB Population attributed to Regional Population	Proportion of Regional Population	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number of collisions at different avoidance rates				
											0%	95%	98%	99%	99.8%
S21	1	15.4	2948.0	1520.5	0.5	1	0.05	16327	14.4	7.4	1.1	0.1	0.0	0.0	0.0
S22	1	15.4	2948.0	1520.5	0.5	0	0.05	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S23	1	15.4	2948.0	1520.5	0.5	1	0.05	16327	14.4	7.4	1.1	0.1	0.0	0.0	0.0
S24	1	15.4	2948.0	1520.5	0.5	0	0.05	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S25	3	15.4	17688.0	4561.6	0.3	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ESE8	20	15.3	93177.0	30410.6	0.3	0.25	0.27	22041	472.1	154.1	23.6	1.2	0.5	0.2	0.0
ENE3	2	14.7	13552.0	3041.1	0.2	0.25	0.27	22041	77.6	17.4	2.6	0.1	0.1	0.0	0.0
ENW7	6	14.1	38016.0	9123.2	0.2	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENE4	3	13.5	18768.0	4985.7	0.3	0.25	0.27	22041	121.7	32.3	4.4	0.2	0.1	0.0	0.0
S26	20	14.2	173888.0	34698.9	0.2	0.25	0.05	4082	221.8	44.3	6.3	0.3	0.1	0.1	0.0
ENW8	7	14.2	42112.0	12144.6	0.3	0.25	0.27	22041	290.1	83.7	11.9	0.6	0.2	0.1	0.0
S27	26	14.2	112896.0	45108.6	0.4	1	0.68	222047	7833.8	3130.1	444.5	22.2	8.9	4.4	0.9
ENW9	6	14.2	38916.0	10409.7	0.3	0.25	0.27	22041	248.6	66.5	9.4	0.5	0.2	0.1	0.0
ENW10	7	14.2	42112.0	12144.6	0.3	0.25	0.05	4082	53.7	15.5	2.2	0.1	0.0	0.0	0.0
ENE5	6	14.2	43992.0	10409.7	0.2	0.25	0.27	22041	248.6	58.8	8.4	0.4	0.2	0.1	0.0
ENW11	3	14.2	19458.0	5204.8	0.3	0.25	0.27	22041	124.3	33.3	4.7	0.2	0.1	0.0	0.0
S28	1	13.1	3807.0	1734.9	0.5	1	0.68	222047	208.7	95.1	12.5	0.6	0.2	0.1	0.0
S29	1	14	3792.0	1809.6	0.5	1	0.05	16327	15.7	7.5	1.0	0.1	0.0	0.0	0.0
S30	1	14	3744.0	1809.6	0.5	0.25	0.05	4082	3.9	1.9	0.3	0.0	0.0	0.0	0.0
ESE9	1	14	3744.0	1809.6	0.5	0.25	0.05	4082	3.9	1.9	0.3	0.0	0.0	0.0	0.0
ENW12	3	14	22752.0	5428.7	0.2	0.125	0.05	2041	11.8	2.8	0.4	0.0	0.0	0.0	0.0

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	Proportion of GB Population attributed to Regional Population	Proportion of Regional Population	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number of collisions at different avoidance rates				
											0%	95%	98%	99%	99.8%
ESE10	6	14	51264.0	10857.3	0.2	0.25	0.27	22041	253.9	53.8	7.5	0.4	0.2	0.1	0.0
S31	3	14	24192.0	5428.7	0.2	1	0.27	88166	507.8	114.0	16.0	0.8	0.3	0.2	0.0
S32	3	14	22752.0	5428.7	0.2	1	0.68	222047	1279.0	305.2	42.7	2.1	0.9	0.4	0.1
S33	3	14	23040.0	5428.7	0.2	1	0.68	222047	1279.0	301.4	42.2	2.1	0.8	0.4	0.1
S34	3	14	22752.0	5428.7	0.2	1	0.27	88166	507.8	121.2	17.0	0.8	0.3	0.2	0.0
S35	3	14	23040.0	5428.7	0.2	1	0.68	222047	1279.0	301.4	42.2	2.1	0.8	0.4	0.1
S36	3	14	21312.0	5428.7	0.3	1	0.68	222047	1279.0	325.8	45.6	2.3	0.9	0.5	0.1
S37	3	14	24192.0	5428.7	0.2	1	0.68	222047	1279.0	287.0	40.2	2.0	0.8	0.4	0.1
ESE11	1	14	3552.0	1809.6	0.5	0.25	0.05	4082	3.9	2.0	0.3	0.0	0.0	0.0	0.0
S38	2	14	15168.0	3619.1	0.2	1	0.68	222047	852.7	203.4	28.5	1.4	0.6	0.3	0.1
S39	1	14	3840.0	1809.6	0.5	1	0.68	222047	213.2	100.5	14.1	0.7	0.3	0.1	0.0
S40	1	14	3792.0	1809.6	0.5	1	0.27	88166	84.6	40.4	5.7	0.3	0.1	0.1	0.0
ESE12	20	14	94607.0	36191.1	0.4	0.25	0.27	22041	468.6	179.3	25.1	1.3	0.5	0.3	0.1
S41	1	14	3552.0	1809.6	0.5	1	0.68	222047	213.2	108.6	15.2	0.8	0.3	0.2	0.0
S42	1	14	3840.0	1809.6	0.5	1	0.27	88166	84.6	39.9	5.6	0.3	0.1	0.1	0.0
S43	1	14	3792.0	1809.6	0.5	1	0.68	222047	213.2	101.7	14.2	0.7	0.3	0.1	0.0
S44	1	14	3840.0	1809.6	0.5	1	0.68	222047	213.2	100.5	14.1	0.7	0.3	0.1	0.0
S45	4	14	29568.0	7238.2	0.2	1	0.68	222047	1705.3	417.5	58.4	2.9	1.2	0.6	0.1
S46	1	14	3840.0	1809.6	0.5	1	0.68	222047	213.2	100.5	14.1	0.7	0.3	0.1	0.0
S47	1	14	3792.0	1809.6	0.5	1	0.27	88166	84.6	40.4	5.7	0.3	0.1	0.1	0.0
S48	1	14	3840.0	1809.6	0.5	1	0.68	222047	213.2	100.5	14.1	0.7	0.3	0.1	0.0
S49	2	14	15168.0	3619.1	0.2	1	0.68	222047	852.7	203.4	28.5	1.4	0.6	0.3	0.1
S50	8	14	62208.0	14476.5	0.2	1	0.68	222047	3410.6	793.7	111.1	5.6	2.2	1.1	0.2
S51	2	14	15552.0	3619.1	0.2	1	0.27	88166	338.6	78.8	11.0	0.6	0.2	0.1	0.0
S52	1	14	3888.0	1809.6	0.5	1	0.68	222047	213.2	99.2	13.9	0.7	0.3	0.1	0.0

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											0%	95%	98%	99%	99.8%
ENW13	1	14	3120.0	1809.6	0.6	0.25	0.27	22041	21.2	12.3	1.7	0.1	0.0	0.0	0.0
ENE6	1	14	3552.0	1809.6	0.5	0.25	0.27	22041	21.2	10.8	1.5	0.1	0.0	0.0	0.0
S53	1	14	3840.0	1809.6	0.5	1	0.68	222047	213.2	100.5	14.1	0.7	0.3	0.1	0.0
ENE7	3	12	21300.0	5890.5	0.3	0.25	0.05	4082	24.5	6.8	0.8	0.0	0.0	0.0	0.0
ENW14	3	12	23700.0	5890.5	0.2	0.25	0.68	55512	333.1	82.8	9.9	0.5	0.2	0.1	0.0
ENE8	3	12	22500.0	5890.5	0.3	0.25	0.05	4082	24.5	6.4	0.8	0.0	0.0	0.0	0.0
S54	1	14.4	4212.0	2123.7	0.5	1	0.68	222047	230.9	116.4	16.8	0.8	0.3	0.2	0.0
S55	3	13.4	25272.0	6371.1	0.3	1	0.05	16327	101.9	25.7	3.4	0.2	0.1	0.0	0.0
S56	35	13.4	184950.0	74330.1	0.4	1	0.68	222047	10951.4	4401.3	589.8	29.5	11.8	5.9	1.2
S57	1	13.4	3900.0	2123.7	0.5	1	0.68	222047	230.9	125.8	16.9	0.8	0.3	0.2	0.0
S58	3	13.4	21840.0	6371.1	0.3	1	0.27	88166	550.2	160.5	21.5	1.1	0.4	0.2	0.0
ENW15	8	13.4	59072.0	16989.7	0.3	0.25	0.27	22041	366.8	105.5	14.1	0.7	0.3	0.1	0.0
ENW16	7	13.4	58968.0	14866.0	0.3	0.25	0.27	22041	320.9	80.9	10.8	0.5	0.2	0.1	0.0
S59	2	13.4	15600.0	4247.4	0.3	1	0.68	222047	923.7	251.5	33.7	1.7	0.7	0.3	0.1
S60	15	13.4	42408.0	31855.7	0.8	1	0.05	16327	242.9	182.5	24.5	1.2	0.5	0.2	0.0
S61	1	13.4	3900.0	2123.7	0.5	1	0.05	16327	17.0	9.2	1.2	0.1	0.0	0.0	0.0
S62	2	14.1	15600.0	4247.4	0.3	1	0.27	88166	366.8	99.9	14.1	0.7	0.3	0.1	0.0
S63	12	13.4	98490.0	25484.6	0.3	1	0.68	222047	6248.4	1616.8	216.7	10.8	4.3	2.2	0.4
ENW17	4	13.4	31616.0	8494.9	0.3	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S64	1	13.4	4558.0	2206.2	0.5	1	0.27	88166	93.5	45.2	6.1	0.3	0.1	0.1	0.0

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											0%	95%	98%	99%	99.8%
S65	12	12.7	92365.0	26474.2	0.3	1	0.68	222047	4507.6	1292.0	164.1	8.2	3.3	1.6	0.3
S66	1	12.7	4558.0	2206.2	0.5	1	0.05	16327	17.3	8.4	1.1	0.1	0.0	0.0	0.0
ESE22	1	12.7	5247.0	2206.2	0.4	0.125	0.27	11021	11.7	4.9	0.6	0.0	0.0	0.0	0.0
S67	3	13.4	24948.0	6870.7	0.3	0	0.05	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EE6	1	13.3	4212.0	2290.2	0.5	0.25	0.05	4082	4.4	2.4	0.3	0.0	0.0	0.0	0.0
EE7	1	13.3	4320.0	2290.2	0.5	0.25	0.27	22041	23.8	12.6	1.7	0.1	0.0	0.0	0.0
S68	1	12.6	4266.0	2290.2	0.5	0.25	0.05	4082	4.4	2.4	0.3	0.0	0.0	0.0	0.0
ESE13	1	12.6	3618.0	2290.2	0.6	0.25	0.27	22041	23.8	15.1	1.9	0.1	0.0	0.0	0.0
S69	1	12.6	3564.0	2290.2	0.6	0.25	0.05	4082	4.4	2.8	0.4	0.0	0.0	0.0	0.0
ESE14	1	12.6	4158.0	2290.2	0.6	0.125	0.27	11021	11.9	6.6	0.8	0.0	0.0	0.0	0.0
ENW18	1	12.6	4158.0	2290.2	0.6	0.25	0.68	55512	60.0	33.0	4.2	0.2	0.1	0.0	0.0
EE8	1	12.3	5600.0	2463.0	0.4	0.125	0.27	11021	12.3	5.4	0.7	0.0	0.0	0.0	0.0
S70	1	11.7	4368.0	2463.0	0.6	1	0.05	16327	18.3	10.3	1.2	0.1	0.0	0.0	0.0
S71	9	11.2	104400.0	23778.7	0.2	1	0.68	222047	4636.3	1056.0	118.3	5.9	2.4	1.2	0.2
S72	24	10.5	154720.0	67858.4	0.4	1	0.27	88166	3410.3	1495.7	157.0	7.9	3.1	1.6	0.3
ENE9	4	10.5	36480.0	11309.7	0.3	0.25	0.05	4082	39.2	12.1	1.3	0.1	0.0	0.0	0.0
S73	1	10.5	4560.0	2827.4	0.6	1	0.05	16327	19.6	12.1	1.3	0.1	0.0	0.0	0.0
S74	3	10.5	32400.0	8482.3	0.3	1	0.05	16327	117.6	30.8	3.2	0.2	0.1	0.0	0.0
S75	22	10.5	117192.0	62203.5	0.5	1	0.27	88166	2719.0	1443.2	151.5	7.6	3.0	1.5	0.3
ENW19	5	10.5	48000.0	14137.2	0.3	0.25	0.05	4082	49.0	14.4	1.5	0.1	0.0	0.0	0.0
ENW20	3	10.5	32760.0	8482.3	0.3	0.25	0.27	22041	158.7	41.1	4.3	0.2	0.1	0.0	0.0
EE9	1	10.5	4560.0	2827.4	0.6	0.25	0.27	22041	26.4	16.4	1.7	0.1	0.0	0.0	0.0

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	Proportion of GB Population attributed to Regional Population	Proportion of Regional Population	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number of collisions at different avoidance rates				
											0%	95%	98%	99%	99.8%
EE10	2	10.5	21600.0	5654.9	0.3	0.25	0.05	4082	19.6	5.1	0.5	0.0	0.0	0.0	0.0
ESE15	2	10.5	21840.0	5654.9	0.3	0.25	0.68	55512	266.5	69.0	7.2	0.4	0.1	0.1	0.0
ENE10	4	10.5	36480.0	11309.7	0.3	0.25	0.27	22041	211.6	65.6	6.9	0.3	0.1	0.1	0.0
ENW21	8	10.5	77760.0	22619.5	0.3	0.25	0.27	22041	423.2	123.1	12.9	0.6	0.3	0.1	0.0
ENE11	2	10.5	21840.0	5654.9	0.3	0.25	0.27	22041	105.8	27.4	2.9	0.1	0.1	0.0	0.0
S76	2	10.2	19344.0	6038.1	0.3	1	0.05	16327	81.0	25.3	2.6	0.1	0.1	0.0	0.0
S77	20	10.2	169182.0	60381.4	0.4	1	0.27	88166	3824.6	1365.0	139.2	7.0	2.8	1.4	0.3
ENW22	5	10.2	45880.0	15095.4	0.3	0.25	0.27	22041	273.3	89.9	9.2	0.5	0.2	0.1	0.0
EE11	7	10.2	69440.0	21133.5	0.3	0.25	0.27	22041	382.6	116.5	11.9	0.6	0.2	0.1	0.0
S78	14	10.2	108996.0	42267.0	0.4	0.25	0.05	4082	95.7	37.1	3.8	0.2	0.1	0.0	0.0
S79	15	10.2	122892.0	45286.1	0.4	0.25	0.05	4082	132.0	48.6	5.0	0.2	0.1	0.0	0.0
S80	7	10.2	65968.0	21133.5	0.3	0.25	0.05	4082	70.9	22.7	2.3	0.1	0.0	0.0	0.0
S81	22	10.2	120708.0	66419.6	0.6	1	0.68	222047	8508.8	4682.0	477.6	23.9	9.6	4.8	1.0
S82	4	10.2	38688.0	12076.3	0.3	1	0.05	16327	162.0	50.6	5.2	0.3	0.1	0.1	0.0
S83	20	10.2	84480.0	60381.4	0.7	0.25	0.05	4082	86.2	61.6	6.3	0.3	0.1	0.1	0.0
S84	11	10.2	80256.0	33209.8	0.4	0.25	0.05	4082	86.2	35.7	3.6	0.2	0.1	0.0	0.0
S85	4	10.2	37696.0	12076.3	0.3	1	0.68	222047	2202.7	705.7	72.0	3.6	1.4	0.7	0.1
S86	7	11.4	73920.0	23948.4	0.3	1	0.05	16327	301.7	97.8	11.1	0.6	0.2	0.1	0.0
ESE24	1	10.5	6600.0	3421.2	0.5	0.25	0.68	55512	73.3	38.0	4.0	0.2	0.1	0.0	0.0
ESE25	1	10.5	6600.0	3421.2	0.5	0.25	0.27	22041	29.1	15.1	1.6	0.1	0.0	0.0	0.0
S87	17	10.3	203300.0	58160.3	0.3	1	0.05	16327	620.4	177.5	18.3	0.9	0.4	0.2	0.0
ESE26	1	9.8	6600.0	3421.2	0.5	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	Proportion of GB Population attributed to Regional Population	Proportion of Regional Population	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number of collisions at different avoidance rates				
											0%	95%	98%	99%	99.8%
ENW23	1	10.7	7000.0	3848.5	0.5	0.25	0.68	55512	77.7	42.7	4.6	0.2	0.1	0.0	0.0
S88	7	10.7	98000.0	26939.2	0.3	1	0.27	88166	1728.0	475.0	50.8	2.5	1.0	0.5	0.1
S89	2	10.7	33600.0	7696.9	0.2	1	0.68	222047	1243.5	284.8	30.5	1.5	0.6	0.3	0.1
S90	1	10.7	6930.0	3848.5	0.6	0	0.05	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S91	1	10.7	6370.0	3848.5	0.6	1	0.05	16327	22.9	13.8	1.5	0.1	0.0	0.0	0.0
S92	16	10.7	174476.0	61575.2	0.4	1	0.05	16327	537.5	189.7	20.3	1.0	0.4	0.2	0.0
S93	1	10.7	7000.0	3848.5	0.5	1	0.05	16327	22.9	12.6	1.3	0.1	0.0	0.0	0.0
S94	1	10.7	7000.0	3848.5	0.5	1	0.27	88166	123.4	67.9	7.3	0.4	0.1	0.1	0.0
S95	8	10.7	104160.0	30787.6	0.3	1	0.27	88166	1974.9	583.7	62.5	3.1	1.2	0.6	0.1
S96	4	10.7	56000.0	15393.8	0.3	1	0.68	222047	2486.9	683.6	73.1	3.7	1.5	0.7	0.1
S97	2	10.7	27440.0	7696.9	0.3	1	0.27	88166	493.7	138.5	14.8	0.7	0.3	0.1	0.0
S98	2	10.7	28000.0	7696.9	0.3	1	0.27	88166	493.7	135.7	14.5	0.7	0.3	0.1	0.0
S99	1	10.7	6860.0	3848.5	0.6	1	0.27	88166	123.4	69.2	7.4	0.4	0.1	0.1	0.0
S100	2	10.7	14000.0	7696.9	0.5	1	0.05	16327	45.7	25.1	2.7	0.1	0.1	0.0	0.0
S101	1	10.7	7000.0	3848.5	0.5	1	0.27	88166	123.4	67.9	7.3	0.4	0.1	0.1	0.0
S102	1	10.7	6580.0	3848.5	0.6	1	0.68	222047	310.9	181.8	19.5	1.0	0.4	0.2	0.0
S103	1	10.7	13160.0	3848.5	0.3	1	0.68	222047	621.7	181.8	19.5	1.0	0.4	0.2	0.0
S104	2	10.7	26320.0	7696.9	0.3	1	0.68	222047	1243.5	363.6	38.9	1.9	0.8	0.4	0.1
S105	3	10.7	42000.0	11545.4	0.3	1	0.68	222047	1865.2	512.7	54.9	2.7	1.1	0.5	0.1

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											0%	95%	98%	99%	99.8%
S106	3	10.7	38640.0	11545.4	0.3	1	0.68	222047	1865.2	557.3	59.6	3.0	1.2	0.6	0.1
ENE12	6	10.7	84000.0	23090.7	0.3	0.25	0.27	22041	370.3	101.8	10.9	0.5	0.2	0.1	0.0
S107	3	10.7	26880.0	11545.4	0.4	1	0.27	88166	740.6	318.1	34.0	1.7	0.7	0.3	0.1
ENW24	8	10.4	100800.0	30787.6	0.3	0.25	0.68	55512	1243.5	379.8	39.5	2.0	0.8	0.4	0.1
S108	18	9.7	190855.0	69272.1	0.4	1	0.68	222047	8921.9	3238.2	314.1	15.7	6.3	3.1	0.6
EE12	3	9.7	39900.0	11545.4	0.3	0.125	0.27	11021	92.6	26.8	2.6	0.1	0.1	0.0	0.0
S109	1	10.6	7029.0	3959.2	0.6	1	0.27	88166	125.2	70.5	7.5	0.4	0.1	0.1	0.0
S166	4	10.6	275000.0	16286.0	0.1	1	0.68	222047	12212.6	723.3	76.7	3.8	1.5	0.8	0.2
ENW25	3	10.4	50820.0	13969.9	0.3	0.125	0.05	2041	18.9	5.2	0.5	0.0	0.0	0.0	0.0
S110	36	10.2	322600.0	180955.7	0.6	1	0.27	88166	5688.5	3190.8	325.5	16.3	6.5	3.3	0.7
S111	25	10.2	393240.0	125663.7	0.3	1	0.05	16327	1070.1	342.0	34.9	1.7	0.7	0.3	0.1
S112	11	10.2	239610.0	55292.0	0.2	0.25	0.27	22041	1006.0	232.1	23.7	1.2	0.5	0.2	0.0
ENE13	18	10.2	198600.0	90477.9	0.5	0.25	0.27	22041	875.5	398.9	40.7	2.0	0.8	0.4	0.1
ENE14	2	10.2	32000.0	10053.1	0.3	0.25	0.27	22041	141.1	44.3	4.5	0.2	0.1	0.0	0.0
S113	11	10.2	132400.0	55292.0	0.4	0.25	0.05	4082	108.1	45.1	4.6	0.2	0.1	0.0	0.0
S114	7	10.2	119840.0	35185.8	0.3	1	0.68	222047	4973.9	1460.4	149.0	7.4	3.0	1.5	0.3
EE13	5	10.2	80000.0	25132.7	0.3	0.25	0.05	4082	65.3	20.5	2.1	0.1	0.0	0.0	0.0
ENE15	3	10.2	48000.0	15079.6	0.3	0.25	0.27	22041	211.6	66.5	6.8	0.3	0.1	0.1	0.0
S115	3	10.2	48000.0	15079.6	0.3	1	0.68	222047	2131.7	669.7	68.3	3.4	1.4	0.7	0.1
ENW26	6	10.2	96000.0	30159.3	0.3	0.25	0.27	22041	423.2	133.0	13.6	0.7	0.3	0.1	0.0
S116	60	10.2	739742.0	301592.9	0.4	0.25	0.05	4082	511.8	208.6	21.3	1.1	0.4	0.2	0.0
ESE27	3	10.2	48000.0	15079.6	0.3	0.25	0.68	55512	532.9	167.4	17.1	0.9	0.3	0.2	0.0

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											0%	95%	98%	99%	99.8%
S117	2	10.1	30720.0	10053.1	0.3	1	0.05	16327	104.5	34.2	3.5	0.2	0.1	0.0	0.0
S118	5	9.7	233100.0	25132.7	0.1	1	0.68	222047	10351.8	1116.1	108.3	5.4	2.2	1.1	0.2
S119	20	10.1	320000.0	100531.0	0.3	1	0.68	222047	14211.0	4464.5	450.9	22.5	9.0	4.5	0.9
S120	3	9.7	47520.0	15079.6	0.3	1	0.05	16327	156.7	49.7	4.8	0.2	0.1	0.0	0.0
EE14	3	9.7	48480.0	15079.6	0.3	0.125	0.27	11021	105.8	32.9	3.2	0.2	0.1	0.0	0.0
S121	2	9.7	32000.0	10053.1	0.3	1	0.05	16327	104.5	32.8	3.2	0.2	0.1	0.0	0.0
S122	4	9.7	64000.0	20106.2	0.3	0.25	0.27	22041	282.1	88.6	8.6	0.4	0.2	0.1	0.0
S123	8	9.7	160000.0	40212.4	0.3	1	0.05	16327	418.0	105.0	10.2	0.5	0.2	0.1	0.0
S124	15	9.7	343275.0	75398.2	0.2	1	0.05	16327	974.7	214.1	20.8	1.0	0.4	0.2	0.0
S125	5	9.7	80000.0	25132.7	0.3	1	0.27	88166	1410.7	443.2	43.0	2.1	0.9	0.4	0.1
ENW27	26	9.7	334700.0	130690.3	0.4	0.125	0.27	11021	737.7	288.1	27.9	1.4	0.6	0.3	0.1
S126	7	9.7	112000.0	35185.8	0.3	1	0.68	222047	4973.9	1562.6	151.6	7.6	3.0	1.5	0.3
ENE16	2	9.8	32000.0	10053.1	0.3	0.25	0.27	22041	141.1	44.3	4.3	0.2	0.1	0.0	0.0
ENE17	2	9.8	32000.0	10053.1	0.3	0.25	0.27	22041	141.1	44.3	4.3	0.2	0.1	0.0	0.0
ENE18	3	9.8	48000.0	15079.6	0.3	0.25	0.27	22041	211.6	66.5	6.5	0.3	0.1	0.1	0.0
ESE28	1	9.8	10080.0	5026.5	0.5	0.25	0.05	4082	6.5	3.3	0.3	0.0	0.0	0.0	0.0
S127	1	9.8	9280.0	5026.5	0.5	1	0.05	16327	26.1	14.1	1.4	0.1	0.0	0.0	0.0
S128	42	10.5	355960.0	211115.0	0.6	1	0.27	88166	5706.1	3384.2	355.3	17.8	7.1	3.6	0.7
S129	21	10.5	197300.0	105557.5	0.5	1	0.27	88166	3479.0	1861.3	195.4	9.8	3.9	2.0	0.4
S130	12	10.5	160160.0	60318.6	0.4	1	0.27	88166	2567.4	966.9	101.5	5.1	2.0	1.0	0.2
S131	14	10.5	449516.0	70371.7	0.2	1	0.05	16327	1346.7	210.8	22.1	1.1	0.4	0.2	0.0
S132	56	10.5	246196.0	281486.7	1.1	0.25	0.05	4082	164.7	188.4	19.8	1.0	0.4	0.2	0.0

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											0%	95%	98%	99%	99.8%
S133	22	10.5	192600.0	110584.1	0.6	1	0.68	222047	8553.3	4911.0	515.7	25.8	10.3	5.2	1.0
ENE19	18	10.3	386250.0	90477.9	0.2	0.25	0.27	22041	1362.2	319.1	32.9	1.6	0.7	0.3	0.1
EE15	3	11.8	46170.0	15459.0	0.3	0.125	0.27	11021	107.1	35.9	4.2	0.2	0.1	0.0	0.0
ESE29	1	11.1	9840.0	5281.0	0.5	0.25	0.27	22041	36.1	19.4	2.2	0.1	0.0	0.0	0.0
ESE16	1	11.1	9840.0	5281.0	0.5	0.125	0.27	11021	18.1	9.7	1.1	0.1	0.0	0.0	0.0
ENW36	4	11.1	78720.0	21124.1	0.3	0.25	0.27	22041	289.2	77.6	8.6	0.4	0.2	0.1	0.0
EE16	3	11.1	64944.0	15843.1	0.2	0.25	0.27	22041	216.9	52.9	5.9	0.3	0.1	0.1	0.0
ENE20	10	10.7	147400.0	52810.2	0.4	0.25	0.27	22041	590.7	211.6	22.6	1.1	0.5	0.2	0.0
S134	35	10.7	326480.0	184835.6	0.6	1	0.05	16327	969.2	548.7	58.7	2.9	1.2	0.6	0.1
ENW28	2	10.7	35424.0	10562.0	0.3	0.25	0.05	4082	26.8	8.0	0.9	0.0	0.0	0.0	0.0
EE17	3	10.7	49200.0	15843.1	0.3	0.125	0.27	11021	108.4	34.9	3.7	0.2	0.1	0.0	0.0
S135	5	10.7	82820.0	26405.1	0.3	1	0.05	16327	267.8	85.4	9.1	0.5	0.2	0.1	0.0
ENE21	4	10.7	65600.0	21124.1	0.3	0.25	0.27	22041	289.2	93.1	10.0	0.5	0.2	0.1	0.0
ENW29	6	10.7	98400.0	31686.1	0.3	0.25	0.27	22041	433.8	139.7	14.9	0.7	0.3	0.1	0.0
ESE17	13	10.7	194900.0	68653.2	0.4	0.25	0.05	4082	159.1	56.0	6.0	0.3	0.1	0.1	0.0
S136	13	10.7	155500.0	68653.2	0.4	1	0.68	222047	6905.7	3048.9	326.2	16.3	6.5	3.3	0.7
S137	15	10.7	173375.0	79215.3	0.5	0.25	0.27	22041	611.4	279.4	29.9	1.5	0.6	0.3	0.1
S138	20	10.7	160000.0	105620.3	0.7	1	0.05	16327	522.5	344.9	36.9	1.8	0.7	0.4	0.1
ESE18	6	10.7	98400.0	31686.1	0.3	0.25	0.05	4082	80.3	25.9	2.8	0.1	0.1	0.0	0.0
S139	2	10.7	32800.0	10562.0	0.3	1	0.05	16327	107.1	34.5	3.7	0.2	0.1	0.0	0.0
ENW30	3	10.7	54120.0	15843.1	0.3	0.125	0.05	2041	20.1	5.9	0.6	0.0	0.0	0.0	0.0
ENE22	5	10.7	90200.0	26405.1	0.3	0.25	0.27	22041	361.5	105.8	11.3	0.6	0.2	0.1	0.0
S140	19	10.7	170610.0	100339.3	0.6	1	0.27	88166	2734.9	1608.5	172.1	8.6	3.4	1.7	0.3

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											0%	95%	98%	99%	99.8%
EE18	12	10.7	140000.0	63372.2	0.5	0.25	0.05	4082	114.3	51.7	5.5	0.3	0.1	0.1	0.0
ENE23	7	10.7	126280.0	36967.1	0.3	0.25	0.27	22041	506.1	148.1	15.9	0.8	0.3	0.2	0.0
ENE24	12	10.7	276800.0	63372.2	0.2	0.25	0.05	4082	226.0	51.7	5.5	0.3	0.1	0.1	0.0
ENE25	4	10.7	64944.0	21124.1	0.3	0.25	0.27	22041	289.2	94.1	10.1	0.5	0.2	0.1	0.0
EE19	12	10.7	140900.0	63372.2	0.4	0.25	0.27	22041	621.1	279.4	29.9	1.5	0.6	0.3	0.1
ENW31	12	10.7	193492.0	63372.2	0.3	0.25	0.27	22041	699.2	229.0	24.5	1.2	0.5	0.2	0.0
S141	3	10.7	49200.0	15843.1	0.3	0.25	0.05	4082	40.2	12.9	1.4	0.1	0.0	0.0	0.0
EE20	6	10.7	100368.0	31686.1	0.3	0.25	0.05	4082	80.3	25.4	2.7	0.1	0.1	0.0	0.0
S142	3	10.7	49200.0	15843.1	0.3	1	0.05	16327	160.7	51.7	5.5	0.3	0.1	0.1	0.0
EE21	9	10.7	178596.0	47529.2	0.3	0.25	0.27	22041	650.7	173.2	18.5	0.9	0.4	0.2	0.0
S143	21	7.3	233100.0	110901.4	0.5	1	0.05	16327	761.2	362.1	26.4	1.3	0.5	0.3	0.1
S167	40	7.3	272300.0	211240.7	0.8	1	0.05	16327	889.2	689.8	50.4	2.5	1.0	0.5	0.1
S144	16	10.5	317504.0	84496.3	0.3	0.25	0.27	22041	1156.7	307.8	32.3	1.6	0.6	0.3	0.1
S145	28	7.3	459200.0	147868.5	0.3	1	0.68	222047	20392.8	6566.8	479.4	24.0	9.6	4.8	1.0
S146	1	10.5	8200.0	5281.0	0.6	1	0.68	222047	364.2	234.5	24.6	1.2	0.5	0.2	0.0
ENE26	13	9.6	157300.0	77280.8	0.5	0.25	0.27	22041	573.1	281.6	27.0	1.4	0.5	0.3	0.1
S147	28	9.6	310310.0	166451.0	0.5	0.25	0.05	4082	230.3	123.5	11.9	0.6	0.2	0.1	0.0
EE22	3	10.3	119103.0	19085.2	0.2	0.25	0.27	22041	473.0	75.8	7.8	0.4	0.2	0.1	0.0
ENE27	6	10.3	118800.0	38170.4	0.3	0.25	0.27	22041	476.1	153.0	15.8	0.8	0.3	0.2	0.0
S148	8	10.3	165600.0	50893.8	0.3	1	0.05	16327	470.2	144.5	14.9	0.7	0.3	0.1	0.0
EE23	12	10.3	171500.0	76340.7	0.4	0.25	0.27	22041	604.8	269.2	27.7	1.4	0.6	0.3	0.1
ENW32	4	10.3	90000.0	25446.9	0.3	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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											0%	95%	98%	99%	99.8%
S149	5	10.3	99000.0	31808.6	0.3	1	0.68	222047	3996.8	1284.2	132.3	6.6	2.6	1.3	0.3
S150	19	10.3	354890.0	120872.8	0.3	1	0.05	16327	1007.7	343.2	35.4	1.8	0.7	0.4	0.1
S151	6	10.3	124200.0	38170.4	0.3	0.25	0.05	4082	88.2	27.1	2.8	0.1	0.1	0.0	0.0
S152	16	10	187250.0	101787.6	0.5	1	0.27	88166	3085.8	1677.4	167.7	8.4	3.4	1.7	0.3
S153	51	9.7	490000.0	324448.0	0.7	1	0.68	222047	17408.5	11526.8	1118.1	55.9	22.4	11.2	2.2
S154	9	9.7	178200.0	57255.5	0.3	1	0.68	222047	7194.3	2311.5	224.2	11.2	4.5	2.2	0.4
S155	18	9.7	260750.0	114511.1	0.4	1	0.68	222047	9263.8	4068.3	394.6	19.7	7.9	3.9	0.8
S156	12	9.7	582000.0	76340.7	0.1	1	0.27	88166	8210.0	1076.9	104.5	5.2	2.1	1.0	0.2
ESE19	5	8.6	112500.0	31808.6	0.3	0.125	0.05	2041	36.7	10.4	0.9	0.0	0.0	0.0	0.0
ESE31	8	8.6	180000.0	50893.8	0.3	0.25	0.05	4082	117.6	33.2	2.9	0.1	0.1	0.0	0.0
EE24	9	8.6	204120.0	57255.5	0.3	0.25	0.27	22041	714.1	200.3	17.2	0.9	0.3	0.2	0.0
ENW33	2	8.6	45000.0	12723.5	0.3	0.25	0.68	55512	399.7	113.0	9.7	0.5	0.2	0.1	0.0
ESE20	7	8.6	160020.0	44532.1	0.3	0.25	0.05	4082	102.9	28.6	2.5	0.1	0.0	0.0	0.0
EE25	22	8.6	327500.0	139958.0	0.4	0.25	0.05	4082	213.9	91.4	7.9	0.4	0.2	0.1	0.0
ENE28	2	8.6	31320.0	12723.5	0.4	0.25	0.27	22041	158.7	64.5	5.5	0.3	0.1	0.1	0.0
S157	16	8.6	203875.0	101787.6	0.5	1	0.68	222047	7243.2	3616.3	311.0	15.5	6.2	3.1	0.6
S158	48	8.6	413625.0	305362.8	0.7	1	0.68	222047	14695.1	10848.8	933.0	46.6	18.7	9.3	1.9
ENE29	4	9.4	84640.0	26590.4	0.3	0.25	0.27	22041	324.5	101.9	9.6	0.5	0.2	0.1	0.0
ENE30	2	9.4	46000.0	13295.2	0.3	0.25	0.27	22041	162.2	46.9	4.4	0.2	0.1	0.0	0.0
S159	4	9.4	82432.0	26590.4	0.3	0.25	0.05	4082	60.1	19.4	1.8	0.1	0.0	0.0	0.0
ESE21	8	9.4	184000.0	53180.9	0.3	0.25	0.05	4082	120.2	34.7	3.3	0.2	0.1	0.0	0.0
ENE31	3	9.4	60720.0	19942.8	0.3	0.25	0.27	22041	243.3	79.9	7.5	0.4	0.2	0.1	0.0

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	Proportion of GB Population attributed to Regional Population	Proportion of Regional Population	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number of collisions at different avoidance rates				
											0%	95%	98%	99%	99.8%
EE26	1	9.4	11500.0	6647.6	0.6	0.25	0.27	22041	40.6	23.4	2.2	0.1	0.0	0.0	0.0
ENW34	1	9.4	11592.0	6647.6	0.6	0.25	0.68	55512	102.1	58.6	5.5	0.3	0.1	0.1	0.0
EE27	4	9.4	92000.0	26590.4	0.3	0.125	0.05	2041	30.0	8.7	0.8	0.0	0.0	0.0	0.0
ENE32	3	9.4	69000.0	19942.8	0.3	0.25	0.27	22041	243.3	70.3	6.6	0.3	0.1	0.1	0.0
EE28	2	9.4	46000.0	13295.2	0.3	0.25	0.27	22041	162.2	46.9	4.4	0.2	0.1	0.0	0.0
EE29	4	9.4	92000.0	26590.4	0.3	0.125	0.05	2041	30.0	8.7	0.8	0.0	0.0	0.0	0.0
ESE30	2	9.4	46000.0	13295.2	0.3	0.25	0.05	4082	30.0	8.7	0.8	0.0	0.0	0.0	0.0
EE30	10	9.4	150000.0	66476.1	0.4	0.25	0.05	4082	98.0	43.4	4.1	0.2	0.1	0.0	0.0
ENE33	10	9.4	238125.0	66476.1	0.3	0.25	0.27	22041	839.8	234.4	22.0	1.1	0.4	0.2	0.0
ENW35	3	9.4	63480.0	19942.8	0.3	0.25	0.27	22041	243.3	76.4	7.2	0.4	0.1	0.1	0.0
S160	6	9.4	138000.0	39885.7	0.3	1	0.27	88166	1946.7	562.6	52.9	2.6	1.1	0.5	0.1
S161	3	9.4	63480.0	19942.8	0.3	0.25	0.05	4082	45.1	14.2	1.3	0.1	0.0	0.0	0.0
S162	3	9.4	63480.0	19942.8	0.3	0.25	0.05	4082	45.1	14.2	1.3	0.1	0.0	0.0	0.0
S163	3	9.6	58590.0	20378.7	0.3	1	0.68	222047	2478.0	861.9	82.7	4.1	1.7	0.8	0.2
S168	96	9.6	202642.0	652119.2	3.2	0.25	0.05	4082	135.6	436.4	41.9	2.1	0.8	0.4	0.1
ENE34	1	9.3	12480.0	7238.2	0.6	0.25	0.27	22041	42.3	24.5	2.3	0.1	0.0	0.0	0.0
S164	9	12.1	225000.0	70685.8	0.3	1	0.68	222047	7993.7	2511.3	303.9	15.2	6.1	3.0	0.6
S165	68	9.1	1275092.0	544805.6	0.4	1	0.05	16327	3357.8	1434.7	130.6	6.5	2.6	1.3	0.3
EE31	6	8	162240.0	50969.2	0.3	0.125	0.27	11021	275.1	86.4	6.9	0.3	0.1	0.1	0.0

CRM Table 4 - Estimated number of collisions from each offshore wind farm using different avoidance rates. This example shows estimates based on 20% of the population being at CRH and moving along a 10km migration front for a single migratory transit and encountering all wind farms whose nearest coast is within 20km of main sites, re-sightings or satellite tracking fixes (and their straight-line points). For proficiency, widths of wind farms were the greatest width for projects with ten or more turbines, 2 x No. turbines x Height to tip x Rotor diameter for projects of two to nine turbines and Height to tip x Rotor diameter for single turbine projects. The area presented by rotors (A) is taken as No. turbines x **π** x Rotor radius^2. The number passing through the risk window was taken as the width of the wind farm divided by the width of the migratory front (10,000m in this example) multiplied by the proportion of birds at CRH (0.2 in this example) multiplied by the proportion of the GB population estimated on the respective regional migratory route multiplied by the highest proportion of that regional migratory population in the nearest coastal 5km x 5km grid cell to the wind farm. The number passing through rotors is the number passing the risk window multiplied by A/W and the number of collisions is this multiplied by the % birds estimated to collide from Collision Risk Modelling, adjusted by avoidance rate

Wind farm	No. turbines	Rotor Diameter	Max Chord	Rotation Period	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	Proportion of GB Population attributed to Regional Population	Proportion of Regional Population	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number of collisions at different avoidance rates				
														0%	95%	98%	99%	99.8%
OWF1	2	126	4.6	4.96	8.9	85680.0	24938.0	0.3	1	0.27	88166	889	259	23	1.15	0.46	0.23	0.05
OWF2	2	66	2.6	2.82	11.5	25080.0	6842.4	0.3	0.25	0.27	22041	116	32	4	0.18	0.07	0.04	0.01
OWF3	60	90	3.5	4.00	9.7	787500.0	381703.5	0.5	0.25	0.27	22041	2777	1346	131	6.53	2.61	1.31	0.26
OWF4	27	93	4.2	3.75	11.2	290950.0	183408.5	0.6	0.25	0.27	22041	1014	639	72	3.58	1.43	0.72	0.14
OWF5	30	126	4.6	4.96	8.9	766100.0	374069.4	0.5	0.25	0.27	22041	2072	1012	90	4.50	1.80	0.90	0.18
OWF6	51	107	4.2	4.62	9.3	914201.0	458593.2	0.5	0.25	0.27	22041	2942	1476	137	6.86	2.74	1.37	0.27
OWF7	51	120	4.2	4.62	9	1231339.6	576796.4	0.5	0.25	0.27	22041	3614	1693	152	7.62	3.05	1.52	0.30
OWF8	30	90	3.5	4.00	9.7	565080.0	190851.8	0.3	0.25	0.27	22041	2076	701	68	3.40	1.36	0.68	0.14
OWF9	25	107	4.2	4.62	9.3	722264.0	224800.6	0.3	0.25	0.27	22041	2324	723	67	3.36	1.35	0.67	0.13
OWF10	30	80	3.5	3.14	11.9	427893.0	150796.4	0.4	0.25	0.05	4082	326	115	14	0.68	0.27	0.14	0.03
OWF11	25	107	4.2	4.62	9.3	699540.0	224800.6	0.3	0.25	0.05	4082	428	137	13	0.64	0.26	0.13	0.03
OWF12	75	120	4.2	4.62	9	2165760.0	848230.0	0.4	0.25	0.68	55512	15028	5886	530	26.49	10.59	5.30	1.06
OWF13	54	107	4.2	4.62	9.3	400500.0	485569.3	1.2	0.25	0.68	55512	3331	4038	376	18.78	7.51	3.76	0.75

Wind farm	No. turbines	Rotor Diameter	Max Chord	Rotation Period	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	Proportion of GB Population attributed to Regional Population	Proportion of Regional Population	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number of collisions at different avoidance rates				
														0%	95%	98%	99%	99.8%
OWF14	88	107	4.2	4.62	9.3	838240.0	791298.1	0.9	0.25	0.68	55512	6883	6498	604	30.22	12.09	6.04	1.21
OWF15	30	80	3.5	3.14	11.9	390000.0	150796.4	0.4	0.25	0.68	55512	4330	1674	199	9.96	3.98	1.99	0.40

*Note all wind farms are within 10km, except Rhyl Flats which is within 20km

CRM Table 5 - Estimated number of collisions from each onshore wind farm during within-winter foraging movements using different avoidance rates. This example shows estimates based on 20% of transiting geese being at CRH (on average <98m) and moving along a 10km front encountering all wind farms within 20km of main roost sites for twice daily journeys for 140 days through the winter. For proficiency widths of wind farms were the greatest width for projects with ten or more turbines, 2 x No. turbines x Height to tip x Rotor diameter for projects of two to nine turbines and Height to tip x Rotor diameter for single turbine projects. The area presented by rotors (A) is taken as No. turbines x **π** x Rotor radius^2. The number of birds passing each wind farm was estimated using geoprocessing to sum the five year mean peak counts from sites within 20km (see Figure 6, Appendix I). The number passing through the risk window was taken as the width of the wind farm divided by the width of the transit front (10,000m in this example) multiplied by the proportion of birds at CRH (in this example 0.2) multiplied by the number of birds passing the wind farm. The number passing through rotors is the number passing through the risk window multiplied by A/W and the number of collisions is this multiplied by the % birds estimated to collide from Collision Risk Modelling multiplied by two (twice daily) and 140 (number of days), adjusted by avoidance rate

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number colliding - no avoidance	Number of collisions if birds pass twice daily for 140 days				
										0%	95%	98%	99%	99.8%
ESE32	2	14	15168	3619.1	0.24	18368	70.53	16.83	2.36	659.71	32.99	13.19	6.60	1.32
ESE33	1	16.8	2272	804.2	0.35	18368	11.76	4.16	0.70	195.75	9.79	3.91	1.96	0.39
ESE23	1	24.7	884	227.0	0.26	18368	6.25	1.60	0.40	110.90	5.54	2.22	1.11	0.22
S1	4	24.7	7072	907.9	0.13	10480	28.51	3.66	0.90	253.10	12.65	5.06	2.53	0.51
S3	2	23.2	3990	692.7	0.17	54904	92.24	16.01	3.72	1040.27	52.01	20.81	10.40	2.08
S4	1	23.2	1008	346.4	0.34	12501	5.25	1.80	0.42	117.19	5.86	2.34	1.17	0.23
ENE1	1	17.7	1228.5	572.6	0.47	368	0.20	0.09	0.02	4.59	0.23	0.09	0.05	0.01
S5	1	17.4	1260	615.8	0.49	32673	18.30	8.94	1.56	435.63	21.78	8.71	4.36	0.87
ESE2	1	16.8	1568	804.2	0.51	36654	23.46	12.03	2.02	565.99	28.30	11.32	5.66	1.13
ENE2	1	16.8	2272	804.2	0.35	2151	1.38	0.49	0.08	22.92	1.15	0.46	0.23	0.05
S6	1	16.8	1568	804.2	0.51	781	0.50	0.26	0.04	12.06	0.60	0.24	0.12	0.02
S7	1	16.8	1568	804.2	0.51	20887	13.37	6.86	1.15	322.53	16.13	6.45	3.23	0.65
S8	1	16.4	2013	855.3	0.42	16900	11.15	4.74	0.78	217.62	10.88	4.35	2.18	0.44
S9	1	16.4	2211	855.3	0.39	14252	9.41	3.64	0.60	167.09	8.35	3.34	1.67	0.33
S10	1	16.4	2013	855.3	0.42	14252	9.41	4.00	0.66	183.53	9.18	3.67	1.84	0.37
S11	1	16.4	2211	855.3	0.39	30803	20.33	7.86	1.29	361.13	18.06	7.22	3.61	0.72
S12	1	16.4	1782	855.3	0.48	126	0.08	0.04	0.01	1.83	0.09	0.04	0.02	0.00
S13	1	16.2	1836	907.9	0.49	42208	28.70	14.19	2.30	643.80	32.19	12.88	6.44	1.29
ENW1	12	16.2	56112	10895.0	0.19	100	2.67	0.52	0.08	23.53	1.18	0.47	0.24	0.05

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number colliding - no avoidance	Number of collisions if birds pass twice daily for 140 days				
										0%	95%	98%	99%	99.8%
ENW3	5	14.6	19980	5376.1	0.27	100	0.74	0.20	0.03	8.14	0.41	0.16	0.08	0.02
S15	34	12.1	194880	44888.7	0.23	2006	139.62	32.16	3.89	1089.56	54.48	21.79	10.90	2.18
ENW4	7	15.1	35868	9698.1	0.27	24527	288.44	77.99	11.78	3297.36	164.87	65.95	32.97	6.59
ENW5	9	15.1	46116	12469.0	0.27	24527	370.85	100.27	15.14	4239.46	211.97	84.79	42.39	8.48
ENW6	4	14.5	21168	5541.8	0.26	100	0.67	0.18	0.03	7.14	0.36	0.14	0.07	0.01
S18	1	15.4	2948	1520.5	0.52	187	0.16	0.08	0.01	3.66	0.18	0.07	0.04	0.01
S19	5	15.4	29480	7602.7	0.26	187	1.65	0.42	0.07	18.30	0.91	0.37	0.18	0.04
S20	1	15.4	2948	1520.5	0.52	187	0.16	0.08	0.01	3.66	0.18	0.07	0.04	0.01
S21	1	15.4	2948	1520.5	0.52	187	0.16	0.08	0.01	3.66	0.18	0.07	0.04	0.01
S22	1	15.4	2948	1520.5	0.52	187	0.16	0.08	0.01	3.66	0.18	0.07	0.04	0.01
ENE3	2	14.7	13552	3041.1	0.22	368	1.30	0.29	0.04	11.96	0.60	0.24	0.12	0.02
ENW7	6	14.1	38016	9123.2	0.24	100	1.06	0.25	0.04	10.01	0.50	0.20	0.10	0.02
ENW8	7	14.2	42112	12144.6	0.29	100	1.32	0.38	0.05	15.09	0.75	0.30	0.15	0.03
S27	26	14.2	112896	45108.6	0.40	25585	902.64	360.66	51.21	14339.72	716.99	286.79	143.40	28.68
ENW9	6	14.2	38916	10409.7	0.27	24527	276.66	74.01	10.51	2942.45	147.12	58.85	29.42	5.88
ENE5	6	14.2	43992	10409.7	0.24	368	4.15	0.98	0.14	39.05	1.95	0.78	0.39	0.08
ENW11	3	14.2	19458	5204.8	0.27	24527	138.33	37.00	5.25	1471.22	73.56	29.42	14.71	2.94
S28	1	13.1	3807	1734.9	0.46	47124	44.30	20.19	2.64	740.46	37.02	14.81	7.40	1.48
S29	1	14	3792	1809.6	0.48	4510	4.33	2.07	0.29	80.99	4.05	1.62	0.81	0.16
ESE9	1	14	3744	1809.6	0.48	4117	3.95	1.91	0.27	74.88	3.74	1.50	0.75	0.15
S31	3	14	24192	5428.7	0.22	6541	37.68	8.45	1.18	331.42	16.57	6.63	3.31	0.66
S32	3	14	22752	5428.7	0.24	5932	34.17	8.15	1.14	319.58	15.98	6.39	3.20	0.64

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number colliding - no avoidance	Number of collisions if birds pass twice daily for 140 days				
										0%	95%	98%	99%	99.8%
S33	3	14	23040	5428.7	0.24	41870	241.17	56.82	7.96	2227.53	111.38	44.55	22.28	4.46
S35	3	14	23040	5428.7	0.24	14252	82.09	19.34	2.71	758.22	37.91	15.16	7.58	1.52
S36	3	14	21312	5428.7	0.25	14252	82.09	20.91	2.93	819.70	40.98	16.39	8.20	1.64
S37	3	14	24192	5428.7	0.22	41870	241.17	54.12	7.58	2121.45	106.07	42.43	21.21	4.24
ESE11	1	14	3552	1809.6	0.51	36654	35.19	17.93	2.51	702.71	35.14	14.05	7.03	1.41
S38	2	14	15168	3619.1	0.24	41870	160.78	38.36	5.37	1503.82	75.19	30.08	15.04	3.01
S39	1	14	3840	1809.6	0.47	41870	40.20	18.94	2.65	742.51	37.13	14.85	7.43	1.49
S43	1	14	3792	1809.6	0.48	56122	53.88	25.71	3.60	1007.85	50.39	20.16	10.08	2.02
S44	1	14	3840	1809.6	0.47	5932	5.69	2.68	0.38	105.20	5.26	2.10	1.05	0.21
S45	4	14	29568	7238.2	0.24	20184	155.01	37.95	5.31	1487.53	74.38	29.75	14.88	2.98
S46	1	14	3840	1809.6	0.47	14252	13.68	6.45	0.90	252.74	12.64	5.05	2.53	0.51
S47	1	14	3792	1809.6	0.48	8450	8.11	3.87	0.54	151.75	7.59	3.03	1.52	0.30
S48	1	14	3840	1809.6	0.47	56122	53.88	25.39	3.55	995.25	49.76	19.90	9.95	1.99
S49	2	14	15168	3619.1	0.24	41870	160.78	38.36	5.37	1503.82	75.19	30.08	15.04	3.01
S50	8	14	62208	14476.5	0.23	10012	153.78	35.79	5.01	1402.86	70.14	28.06	14.03	2.81
S51	2	14	15552	3619.1	0.23	8450	32.45	7.55	1.06	296.00	14.80	5.92	2.96	0.59
S52	1	14	3888	1809.6	0.47	54894	52.70	24.53	3.43	961.45	48.07	19.23	9.61	1.92
ENW13	1	14	3120	1809.6	0.58	24527	23.55	13.66	1.91	535.33	26.77	10.71	5.35	1.07
ENE6	1	14	3552	1809.6	0.51	5313	5.10	2.60	0.36	101.86	5.09	2.04	1.02	0.20
S53	1	14	3840	1809.6	0.47	41870	40.20	18.94	2.65	742.51	37.13	14.85	7.43	1.49
ENW14	3	12	23700	5890.5	0.25	63062	378.37	94.04	11.29	3159.81	157.99	63.20	31.60	6.32
S54	1	14.4	4212	2123.7	0.50	30803	32.04	16.15	2.33	651.26	32.56	13.03	6.51	1.30
S56	35	13.4	184950	74330.1	0.40	25585	1261.85	507.13	67.96	19027.49	951.37	380.55	190.27	38.05
S57	1	13.4	3900	2123.7	0.54	20184	20.99	11.43	1.53	428.88	21.44	8.58	4.29	0.86
ENW15	8	13.4	59072	16989.7	0.29	24527	408.13	117.38	15.73	4404.18	220.21	88.08	44.04	8.81

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number colliding - no avoidance	Number of collisions if birds pass twice daily for 140 days				
										0%	95%	98%	99%	99.8%
ENW16	7	13.4	58968	14866.0	0.25	24527	357.11	90.03	12.06	3377.90	168.90	67.56	33.78	6.76
S59	2	13.4	15600	4247.4	0.27	20184	83.97	22.86	3.06	857.76	42.89	17.16	8.58	1.72
S63	12	13.4	98490	25484.6	0.26	16551	465.75	120.51	16.15	4521.65	226.08	90.43	45.22	9.04
ENW17	4	13.4	31616	8494.9	0.27	100	0.83	0.22	0.03	8.39	0.42	0.17	0.08	0.02
S64	1	13.4	4558	2206.2	0.48	10591	11.23	5.43	0.73	203.88	10.19	4.08	2.04	0.41
S65	12	12.7	92365	26474.2	0.29	39498	801.81	229.82	29.19	8172.38	408.62	163.45	81.72	16.34
EE6	1	13.3	4212	2290.2	0.54	6870	7.42	4.03	0.54	150.24	7.51	3.00	1.50	0.30
ENW18	1	12.6	4158	2290.2	0.55	100	0.11	0.06	0.01	2.10	0.10	0.04	0.02	0.00
S70	1	11.7	4368	2463.0	0.56	20887	23.39	13.19	1.54	432.14	21.61	8.64	4.32	0.86
S72	24	10.5	154720	67858.4	0.44	36450	1409.89	618.36	64.93	18179.77	908.99	363.60	181.80	36.36
S73	1	10.5	4560	2827.4	0.62	187	0.22	0.14	0.01	4.09	0.20	0.08	0.04	0.01
S75	22	10.5	117192	62203.5	0.53	21668	668.24	354.69	37.24	10427.92	521.40	208.56	104.28	20.86
ENW20	3	10.5	32760	8482.3	0.26	24527	176.59	45.72	4.80	1344.29	67.21	26.89	13.44	2.69
ESE15	2	10.5	21840	5654.9	0.26	36654	175.94	45.55	4.78	1339.31	66.97	26.79	13.39	2.68
ENW21	8	10.5	77760	22619.5	0.29	24527	470.92	136.98	14.38	4027.35	201.37	80.55	40.27	8.05
ENW22	5	10.2	45880	15095.4	0.33	100	1.24	0.41	0.04	11.65	0.58	0.23	0.12	0.02
S79	15	10.2	122892	45286.1	0.37	126	4.07	1.50	0.15	42.89	2.14	0.86	0.43	0.09
S80	7	10.2	65968	21133.5	0.32	126	2.19	0.70	0.07	20.01	1.00	0.40	0.20	0.04
S81	22	10.2	120708	66419.6	0.55	6541	250.65	137.92	14.07	3939.02	196.95	78.78	39.39	7.88
ESE24	1	10.5	6600	3421.2	0.52	18368	24.25	12.57	1.32	369.50	18.48	7.39	3.70	0.74
S87	17	10.3	203300	58160.3	0.29	5305	201.59	57.67	5.94	1663.24	83.16	33.26	16.63	3.33
ESE26	1	9.8	6600	3421.2	0.52	36654	48.38	25.08	2.46	688.20	34.41	13.76	6.88	1.38

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number colliding - no avoidance	Number of collisions if birds pass twice daily for 140 days				
										0%	95%	98%	99%	99.8%
ENW23	1	10.7	7000	3848.5	0.55	100	0.14	0.08	0.01	2.31	0.12	0.05	0.02	0.00
S89	2	10.7	33600	7696.9	0.23	3740	20.94	4.80	0.51	143.74	7.19	2.87	1.44	0.29
S92	16	10.7	174476	61575.2	0.35	2006	66.04	23.31	2.49	698.24	34.91	13.96	6.98	1.40
S93	1	10.7	7000	3848.5	0.55	187	0.26	0.14	0.02	4.31	0.22	0.09	0.04	0.01
S94	1	10.7	7000	3848.5	0.55	5932	8.30	4.57	0.49	136.79	6.84	2.74	1.37	0.27
S96	4	10.7	56000	15393.8	0.27	14252	159.62	43.88	4.69	1314.60	65.73	26.29	13.15	2.63
S100	2	10.7	14000	7696.9	0.55	5305	14.85	8.17	0.87	244.67	12.23	4.89	2.45	0.49
S102	1	10.7	6580	3848.5	0.58	14252	19.95	11.67	1.25	349.63	17.48	6.99	3.50	0.70
S103	1	10.7	13160	3848.5	0.29	14252	39.91	11.67	1.25	349.63	17.48	6.99	3.50	0.70
S104	2	10.7	26320	7696.9	0.29	14252	79.81	23.34	2.50	699.26	34.96	13.99	6.99	1.40
S105	3	10.7	42000	11545.4	0.27	14252	119.72	32.91	3.52	985.95	49.30	19.72	9.86	1.97
ENW24	8	10.4	100800	30787.6	0.31	100	2.24	0.68	0.07	19.92	1.00	0.40	0.20	0.04
S108	18	9.7	190855	69272.1	0.36	54904	2206.04	800.70	77.67	21746.96	1087.35	434.94	217.47	43.49
S166	4	10.6	275000	16286.0	0.06	41870	2302.85	136.38	14.46	4047.73	202.39	80.95	40.48	8.10
S110	36	10.2	322600	180955.7	0.56	21364	1378.41	773.19	78.87	22082.24	1104.11	441.64	220.82	44.16
S113	11	10.2	132400	55292.0	0.42	126	3.34	1.39	0.14	39.79	1.99	0.80	0.40	0.08
S114	7	10.2	119840	35185.8	0.29	31719	710.51	208.61	21.28	5957.88	297.89	119.16	59.58	11.92
EE13	5	10.2	80000	25132.7	0.31	6870	109.92	34.53	3.52	986.24	49.31	19.72	9.86	1.97
S115	3	10.2	48000	15079.6	0.31	41870	401.95	126.28	12.88	3606.47	180.32	72.13	36.06	7.21

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number colliding - no avoidance	Number of collisions if birds pass twice daily for 140 days				
										0%	95%	98%	99%	99.8%
ENW26	6	10.2	96000	30159.3	0.31	24527	470.92	147.94	15.09	4225.26	211.26	84.51	42.25	8.45
S116	60	10.2	739742	301592.9	0.41	126	15.80	6.44	0.66	183.95	9.20	3.68	1.84	0.37
ESE27	3	10.2	48000	15079.6	0.31	36654	351.88	110.55	11.28	3157.19	157.86	63.14	31.57	6.31
S117	2	10.1	30720	10053.1	0.33	187	1.20	0.39	0.04	11.08	0.55	0.22	0.11	0.02
S118	5	9.7	233100	25132.7	0.11	27428	1278.69	137.87	13.37	3744.50	187.23	74.89	37.44	7.49
S119	20	10.1	320000	100531.0	0.31	27428	1755.39	551.47	55.70	15595.65	779.78	311.91	155.96	31.19
S121	2	9.7	32000	10053.1	0.31	187	1.20	0.38	0.04	10.21	0.51	0.20	0.10	0.02
S123	8	9.7	160000	40212.4	0.25	20887	534.71	134.39	13.04	3649.94	182.50	73.00	36.50	7.30
S124	15	9.7	343275	75398.2	0.22	23289	1390.35	305.38	29.62	8294.19	414.71	165.88	82.94	16.59
S126	7	9.7	112000	35185.8	0.31	38468	861.68	270.71	26.26	7352.37	367.62	147.05	73.52	14.70
ESE28	1	9.8	10080	5026.5	0.50	18368	29.39	14.66	1.44	402.14	20.11	8.04	4.02	0.80
S127	1	9.8	9280	5026.5	0.54	187	0.30	0.16	0.02	4.45	0.22	0.09	0.04	0.01
S129	21	10.5	197300	105557.5	0.54	8450	333.44	178.39	18.73	5244.73	262.24	104.89	52.45	10.49
S131	14	10.5	449516	70371.7	0.16	2030	167.43	26.21	2.75	770.63	38.53	15.41	7.71	1.54
S133	22	10.5	192600	110584.1	0.57	10480	403.69	231.78	24.34	6814.46	340.72	136.29	68.14	13.63
ENE19	18	10.3	386250	90477.9	0.23	5651	349.23	81.81	8.43	2359.30	117.96	47.19	23.59	4.72
ENW36	4	11.1	78720	21124.1	0.27	24527	321.79	86.35	9.59	2683.81	134.19	53.68	26.84	5.37
ENW28	2	10.7	35424	10562.0	0.30	24527	160.90	47.97	5.13	1437.28	71.86	28.75	14.37	2.87
ENW29	6	10.7	98400	31686.1	0.32	100	1.97	0.63	0.07	18.99	0.95	0.38	0.19	0.04
ESE17	13	10.7	194900	68653.2	0.35	36654	1428.77	503.28	53.85	15078.36	753.92	301.57	150.78	30.16
S136	13	10.7	155500	68653.2	0.44	40453	1258.09	555.45	59.43	16641.16	832.06	332.82	166.41	33.28
S137	15	10.7	173375	79215.3	0.46	24627	683.15	312.13	33.40	9351.52	467.58	187.03	93.52	18.70
S138	20	10.7	160000	105620.3	0.66	4510	144.32	95.27	10.19	2854.28	142.71	57.09	28.54	5.71

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number colliding - no avoidance	Number of collisions if birds pass twice daily for 140 days				
										0%	95%	98%	99%	99.8%
ESE18	6	10.7	98400	31686.1	0.32	36654	721.35	232.28	24.85	6959.24	347.96	139.18	69.59	13.92
S139	2	10.7	32800	10562.0	0.32	20887	137.02	44.12	4.72	1321.89	66.09	26.44	13.22	2.64
S140	19	10.7	170610	100339.3	0.59	6348	196.92	115.81	12.39	3469.66	173.48	69.39	34.70	6.94
EE18	12	10.7	140000	63372.2	0.45	2753	77.08	34.89	3.73	1045.39	52.27	20.91	10.45	2.09
EE20	6	10.7	100368	31686.1	0.32	6870	135.20	42.68	4.57	1278.78	63.94	25.58	12.79	2.56
S144	16	10.5	317504	84496.3	0.27	24627	1292.43	343.95	36.11	10112.09	505.60	202.24	101.12	20.22
S146	1	10.5	8200	5281.0	0.64	35338	57.95	37.32	3.92	1097.33	54.87	21.95	10.97	2.19
ENE26	13	9.6	157300	77280.8	0.49	2151	55.93	27.48	2.64	738.56	36.93	14.77	7.39	1.48
S147	28	9.6	310310	166451.0	0.54	126	7.11	3.81	0.37	102.50	5.12	2.05	1.02	0.21
ENE27	6	10.3	118800	38170.4	0.32	1783	38.51	12.37	1.27	356.87	17.84	7.14	3.57	0.71
ENW32	4	10.3	90000	25446.9	0.28	100	1.44	0.41	0.04	11.74	0.59	0.23	0.12	0.02
S149	5	10.3	99000	31808.6	0.32	40819	734.74	236.07	24.32	6808.32	340.42	136.17	68.08	13.62
S152	16	10	187250	101787.6	0.54	8761	306.64	166.68	16.67	4667.16	233.36	93.34	46.67	9.33
S153	51	9.7	490000	324448.0	0.66	26647	2089.13	1383.29	134.18	37570.17	1878.51	751.40	375.70	75.14
S118	9	9.7	178200	57255.5	0.32	27428	888.67	285.53	27.70	7754.94	387.75	155.10	77.55	15.51
S155	18	9.7	260750	114511.1	0.44	10480	437.23	192.01	18.63	5215.05	260.75	104.30	52.15	10.43
S156	12	9.7	582000	76340.7	0.13	4698	437.48	57.38	5.57	1558.54	77.93	31.17	15.59	3.12
ENW33	2	8.6	45000	12723.5	0.28	200	1.44	0.41	0.04	9.80	0.49	0.20	0.10	0.02
ESE20	7	8.6	160020	44532.1	0.28	36654	923.68	257.05	22.11	6189.81	309.49	123.80	61.90	12.38
S157	16	8.6	203875	101787.6	0.50	21668	706.81	352.89	30.35	8497.48	424.87	169.95	84.97	16.99
S158	48	8.6	413625	305362.8	0.74	30913	2045.82	1510.35	129.89	36369.20	1818.46	727.38	363.69	72.74
ENE30	2	9.4	46000	13295.2	0.29	368	2.71	0.78	0.07	20.60	1.03	0.41	0.21	0.04
S159	4	9.4	82432	26590.4	0.32	126	1.85	0.60	0.06	15.75	0.79	0.31	0.16	0.03

Wind farm	No. turbines	% birds from CRM	Width x height of wind farm (W)	Area presented by rotors (A)	A/W	No. of birds passing wind farm	No. passing through risk window	No. passing through rotors	Number colliding - no avoidance	Number of collisions if birds pass twice daily for 140 days				
										0%	95%	98%	99%	99.8%
ESE21	8	9.4	184000	53180.9	0.29	6870	202.25	58.46	5.49	1538.57	76.93	30.77	15.39	3.08
EE26	1	9.4	11500	6647.6	0.58	6870	12.64	7.31	0.69	192.32	9.62	3.85	1.92	0.38
ENW34	1	9.4	11592	6647.6	0.57	200	0.37	0.21	0.02	5.55	0.28	0.11	0.06	0.01
ESE30	2	9.4	46000	13295.2	0.29	18368	135.19	39.07	3.67	1028.40	51.42	20.57	10.28	2.06
EE30	10	9.4	150000	66476.1	0.44	6870	164.88	73.07	6.87	1923.22	96.16	38.46	19.23	3.85
ENE33	10	9.4	238125	66476.1	0.28	5651	215.30	60.11	5.65	1581.96	79.10	31.64	15.82	3.16
ENW35	3	9.4	63480	19942.8	0.31	24527	270.78	85.07	8.00	2238.98	111.95	44.78	22.39	4.48
S160	6	9.4	138000	39885.7	0.29	32445	716.39	207.05	19.46	5449.67	272.48	108.99	54.50	10.90
S163	3	9.6	58590	20378.7	0.35	4698	52.43	18.24	1.75	490.19	24.51	9.80	4.90	0.98
ENE34	1	9.3	12480	7238.2	0.58	5651	10.85	6.29	0.59	163.86	8.19	3.28	1.64	0.33
S164	9	12.1	225000	70685.8	0.31	35338	1272.17	399.66	48.36	13540.59	677.03	270.81	135.41	27.08
S165	68	9.1	1275092	544805.6	0.43	2030	417.49	178.38	16.23	4545.12	227.26	90.90	45.45	9.09
ENE35	1	8	13520	8494.9	0.63	2151	4.47	2.81	0.22	62.97	3.15	1.26	0.63	0.13

CRM Table 6 – Constructed offshore wind farm collision risk estimates compiled by Natural England and RSPB, with notes

Wind farm	Copy of NE + RSPB WF PFG table v2				Wind farm PFG cases updated Jun 2012				Summary of PFG collision 25-06-12			NE notes
	No. turbines	**95% AR**	**98% AR**	**99% AR**	**No. turbines**	**95% AR**	**98% AR**	**99% AR**	**95% AR**	**98% AR**	**99% AR**	
Ormonde	30	75	30	15	30	75	30	15	75	30	15	Ormonde AA (DTI, 2007) presents figs for a worst case scenario (WCS) and likely scenario (LS): 95%AR - WCS=180, LS=70; 99%AR - WCS=40, LCS=5. These numbers may have come from Percival (2006). NE did some remodelling of figures, but AA only presents these with respect to cumulative (Ormonde, Barrow, Walney, West of Duddon, Shell Flats). Fig of 15@99%AR matches that presented in Humber Gateway AA (DECC, 2009).
Walney 1	102	10	4	2	102	10	4	2	10	4	2	In Walney AA (DBERR, 2007), figs for PFG CRM presented for base case (45x3.6MW & 48x6MW turbines – RPS, 2006) - 95%AR=1.03 collisions/yr for Lancs only population or 3.76/yr for Lancs + Norfolk pop; 99%AR=0.21/yr Lancs & 0.75/yr Lancs+Norfolk. For worst case (think 53x3MW & 97x4.5MW turbine - RPS 2006): 95%AR= 1.762/yr Lancs & 5.91/yr Lancs+Norfolk; 99%AR=0.32/yr Lancs & 1.18/yr for Lancs + Norfolk. Fig of 2@99%AR matches that presented in Humber Gateway AA (DECC, 2009). Some construction radar monitoring: 'From the radar test study it can be seen that the majority of the geese pass the survey area no more than 6 km from Walney Island, and no flocks had a direction towards Walney Offshore Wind farm. Even though the radar study was not set up to cover the migration fully, this seems to indicate that PFG migrations do not pass through Walney OWF. This result is supported by the boat survey which only found one flock of (unidentified) geese. This flock is flying below rotor sweep height...' - from Walney Offshore Wind farms (2012).
Walney Ext.	107-214	-	-	-	-	-	-	-	-	-	-	Figures presented in Annex B.7.C of PINS submission are: 12.82 @95%AR, 5.13 @98%AR & 2.56@99%AR based on worst case of 207x3.6MW turbines. In this they did a cumulative assessment based on a new migration model for Irish Sea OWFs only, and not a comprehensive CIA at the UK level (which we eventually accepted due to negligible contribution predicted from WE OWF). In our supplementary expert report NE calculated a figure of 20.51 PFG collisions per year for Walney Ext. based on 99%AR, 40% of west coast flyway population interacting with the OWF & 60% @PCH

Wind farm	**Copy of NE + RSPB WF PFG table v2**				**Wind farm PFG cases updated Jun 2012**			**Summary of PFG collision 25-06-12**				**NE notes**
Barrow	30	75	30	15	30	75	30	15	75	30	15	No PFG recorded during pre-consent surveys (RSK, 2002). However, location suggests PFG may migrate through site & post construction surveys confirmed this (BOW, 2007) – surveys undertaken by Walney Bird Observatory over 21 days in Sep & Oct 2007 recorded a total of 4,732 PFG. 33% flying @PCH, of which 12% (576 birds) were recorded within approx line of the constructed WF. Results indicated that birds flying in direction of the OWF adjusted flight height to pass above OWF. Nine PFG entered OWF at rotor height & all flew between the turbines without any observed collisions (BOW 2007). NE raised concerns over this survey due to range of radar. Fig of 2@99%AR matches that presented in Humber Gateway AA (DECC, 2009), although this notes: 'Based on the size of the constructed wind farm which is similar to Ormonde, previous collision risk assessments have indicated that similar numbers of geese could be predicted to be at risk and therefore for the purposes of this collision risk assessment, fifteen pink-footed geese are predicted to collide with the turbines (Percival, 2006)
Lincs	69	262.5	105	52.5	75				262.5	105	52.5	AA for Lincs OWF (DBERR, 2008) presents: 171-262 @95%AR, 68-105 @98%AR & 34-52 @99%AR based on assumptions about annual passage rates. Numbers presented in the RSPB+NE file reflect the highest (worst case) numbers (and match those presented in the HGW OWF AA, DECC 2009). The OWF12 AA (DBERR, 2008) states: 'The collision rate has been calculated in two ways: firstly on the basis of the annual passage rate which was derived from the density of birds at the wind farm site obtained from boat survey data ('standard approach'). Due to the low counts in the wind farm site during surveys an alternative method has been used by the applicant that modelled the proportion of 152,514 individuals wintering in Norfolk that could potentially fly through the site assuming a 'half normal distribution' from the coast and a decreasing number further offshore. Three different shaped 'half normal' distributions were used. This method is likely to result in an overestimation of annual passage and therefore of collision mortality.' Not clear which scenario the highest (worst case) CRM figures relate to. Wind farm PFG cases updated spreadsheet from RSPB notes that post construction monitoring results are needed to update these figures.

Wind farm	Copy of NE + RSPB WF PFG table v2				Wind farm PFG cases updated Jun 2012			Summary of PFG collision 25-06-12				NE notes
Lynn & Inner Dowsing	30	165	66	33	54	As Lincs	As Lincs	As Lincs	165	66	33	Numbers presented in RSPB+NE file are same as those presented in Humber Gateway AA (DECC, 2009). Pre & post construction monitoring 2007 (pre) 2008-10 (post) radar survey results presented in Plonczkier & Simms (2012a) – Wind farm. PFG cases updated spreadsheet from RSPB notes that post construction monitoring results are needed to update these figures.