Chapter 12: Ornithology

Appendix 12.1 Ornithology

Following Appendix Provided as Separate Confidential Annex:

Ornithology Confidential Annex

Appendix 12.1 Ornithology

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Introduction

12.1.1 RPS was commissioned by Partnerships for Renewables (PfR) to undertake ornithological surveys and prepare the ornithological assessment of the Environmental Statement for the proposed West Benhar Wind Farm.

12.1.2 This Technical Report presents a detailed overview of the methods and survey effort undertaken by RPS for the purpose of this ornithological assessment, together with the main findings emerging from the baseline ornithological surveys to date. Thus, the following information is presented:

- detailed baseline survey methods; and
- main results of the baseline surveys, except where associated with breeding site locations of Annex I and Schedule 1 species, for which details are provided in a separate Confidential Annex to this report).

Site Description and Survey Coverage

12.1.3 The site of the proposed wind farm is centred on NS 8956 6175, located with West Benhar Plantation approximately 0.8 km (from the site boundary) to the east of Shotts and 1.4 km (from the site boundary) to the south of Harthill.

12.1.4 The site is located within West Benhar Forest and originally covered 214 ha of land). However, a minor change to the site boundary as proposed in the initial layout resulted in the site area being reduced to 180 ha, as shown in Figure 12.1. Figure 12.1 also shows a satellite image of the site in order to give an indication of the habitat composition of the site which is surrounded by open moorland and bog habitat to the north, west and south and by the plantation forestry of East Benhar to the east.

12.1.5 Baseline surveys were undertaken from September 2011 to August 2012. Survey coverage encompassed the site boundary.

12.1.6 The following baseline surveys were undertaken for the ornithological impact assessment (names of the different surveyors who undertook these different surveys are also given):

- flight activity surveys;
- breeding raptor surveys;
- moorland breeding bird surveys;
- point count surveys; and
- winter walkover (WWO) surveys.

Baseline Survey Methods

Flight Activity Surveys

Survey Effort and VP Locations

12.1.7 Flight activity surveys were undertaken following the vantage point (VP) methodology advocated by Scottish Natural Heritage (SNH) (2005, updated 2010). Each VP survey was undertaken by a single observer in good conditions, i.e. visibility of at least 2 km and the cloud base no lower than 150 m. Weather and visibility conditions were recorded on an hourly basis including information on wind strength and direction, precipitation and cloud cover.

12.1.8 All VP watches were limited to three hours duration by any single observer, with a minimum of one hour between any two consecutive VP surveys. A viewshed radius of 2 km was used to record all species except for geese, where a 3 km viewshed was used, based on these species' larger size and easier detectability.

12.1.9 During each watch, the landscape was scanned continuously until a target species was detected (target species being defined as wildfowl, Annex I and schedule 1 raptors and owls, waders, divers and black grouse). Once detected, the bird or flock was observed until it landed or flew out of sight. The time of first detection was noted, and the flight height was recorded for each 15 second period that the bird or flock was in view, as one of five height bands: <20 m, 20-40 m, 40-100 m, 100-150 m and >150 m. The height bands 20-40 m, 40-100 m and 100-150 m together span the potential collision height (PCH) associated with the proposed turbine types for the development. The paths of all observed flights (flight lines) were drawn onto 1:10,000 scale maps in the field.

12.1.10 Species-specific maps showing the flight lines for each target species were compiled in a Geographic Information System (GIS, ArcView v.10), with each flight line linked to its associated flight duration and height information held in a Microsoft Access database.

12.1.11 Two VP locations were used to provide full coverage of the site boundary (Figure 12.2). Details of these VP locations are shown in Table 1 below.

Table 1 Vantage Point Locations

Vantage Point	Location	Central Viewpoint	Grid Reference
1	Spoil heap to east of site	090°	NS 87645 61552
2	Disused tip to west of site	270°	NS 91575 61938

12.1.12 Surveys from these two VPs were undertaken from September 2011 to August 2012. Table 2 provides information on the monthly breakdown of survey effort from both of these VPs.

Table 2 Monthly Flight Activity Survey Effort

Year	Month	Survey Hours	
		VP 1	VP 2
2011	September	6	6
	October	6	6
	November	6	6
	December	6	6
2012	Jan	6	6
	Feb	6	6
	Mar	6	6
	Apr	-	12
	May	6	6
	Jun	6	6
	Jul	6	6
	Aug	6	6

12.1.13 Six hours survey per VP per month was conducted, with the exception of April 2012 when, due to an error in scheduling, VP2 was surveyed twice (in place of VP1). Thus, the overall, temporal coverage gave a total of 36 hours of survey from each VP over the approximate winter non-breeding period (defined as September to mid-March – SNH 2005), with 30 and 42 hours from VP1 and VP2, respectively, over the summer breeding period (defined as mid-March to end of August – SNH 2005). Thus, coverage complied with the recommended minimum requirements of 36 hours per VP per season (SNH 2005), with the exception of the slightly reduced coverage at VP1 during the summer (which was compensated by the slightly greater coverage of VP2). This error is considered unlikely to have reduced estimated flight activity (and may well have increased the estimated flight activity) because the majority of flight activity was recorded from VP2 (which accounted for 40 of the total 62 flight events of target species, and 28 of the 35 flight events recorded during the breeding season, when the error arose).

12.1.14 There was virtually no overlap in the viewsheds from the two VP locations (Figures 12.2a and 12.2b). Nonetheless, the majority of surveys were arranged so that there was no temporal overlap in survey coverage, so as to avoid any complications to analyses of flight data that may arise from this.

12.1.15 VP surveys were also undertaken so as to give adequate coverage of the dawn, daytime and dusk periods. Details of the timing of individual VP surveys are given in Table 3.

Table 3 Flight Activity Survey Details 2011-12

Date	Vantage Point	Observer	Start Time	End Time	Time at VP
28-Sep-11	1	RJ	07:00	10:00	03:00
28-Sep-11	1	RJ	11:00	14:00	03:00
28-Sep-11	2	GK	11:10	14:10	03:00
28-Sep-11	2	GK	07:10	10:10	03:00
10-Oct-11	2	AA	12:00	15:00	03:00
10-Oct-11	2	AA	15:50	18:50	03:00
11-Oct-11	1	AA	12:00	15:00	03:00
11-Oct-11	1	AA	15:50	18:50	03:00
10-Nov-11	1	AA	09:45	12:45	03:00
10-Nov-11	1	AA	13:45	16:45	03:00
27-Nov-11	2	SJJ	11:35	14:35	03:00
27-Nov-11	2	SJJ	07:35	10:35	03:00
06-Dec-11	1	AA	08:00	11:00	03:00
06-Dec-11	1	AA	12:00	15:00	03:00
13-Dec-11	2	AA	09:15	12:15	03:00
13-Dec-11	2	AA	13:15	16:15	03:00
09-Jan-12	1	AA	09:30	12:30	03:00
09-Jan-12	1	AA	13:30	16:30	03:00
19-Jan-12	2	AA	07:50	10:50	03:00
19-Jan-12	2	AA	11:50	14:50	03:00
07-Feb-12	1	AA	07:20	10:20	03:00
07-Feb-12	1	AA	11:20	14:20	03:00
20-Feb-12	2	AA	11:00	14:00	03:00
20-Feb-12	2	AA	15:00	18:00	03:00
08-Mar-12	1	AA	11:45	14:45	03:00
08-Mar-12	1	AA	15:45	18:45	03:00
20-Mar-12	2	AA	05:40	08:40	03:00
20-Mar-12	2	AA	09:40	12:40	03:00
11-Apr-12	2	AA	13:40	16:40	03:00
11-Apr-12	2	AA	17:40	20:40	03:00
24-Apr-12	2	KEC	06:00	09:00	03:00
24-Apr-12	2	KEC	10:00	13:00	03:00
16-May-12	1	AA	04:40	07:40	03:00
16-May-12	1	AA	08:30	11:30	03:00
28-May-12	2	AA	15:00	18:00	03:00
28-May-12	2	AA	19:00	22:00	03:00
25-Jun-12	2	SJJ	15:55	18:55	03:00

Date	Vantage Point	Observer	Start Time	End Time	Time at VP
25-Jun-12	2	SJJ	19:55	22:55	03:00
26-Jun-12	1	SJJ	16:00	19:00	03:00
30-Jun-12	1	SJJ	20:00	23:00	03:00
26-Jul-12	1	RJ	04:45	07:45	03:00
26-Jul-12	2	GK	04:45	07:45	03:00
28-Jul-12	1	GK	06:30	09:30	03:00
28-Jul-12	2	GK	14:45	17:45	03:00
21-Aug-12	2	GK	18:00	21:00	03:00
21-Aug-12	2	GK	13:30	16:30	03:00
22-Aug-12	1	GK	18:00	21:00	03:00
22-Aug-12	1	GK	14:00	17:00	03:00

Moorland Bird Survey

12.1.16 Moorland Breeding Bird Surveys were undertaken within a 500 m buffer of the site boundary (but extending slightly beyond this to the east of the site due to the boundary change – see 12.1.3) in April, May, June and July 2012 in the areas of open habitat, primarily moorland and other unforested areas, but including the main forest rides and other open areas within otherwise afforested land (Figure 12.3). The survey method followed those of Brown and Shepherd (1993).

12.1.17 Surveyors walked a pre-determined route ensuring that all parts of the survey area (where accessible) were approached to within 100 m. A handheld GPS unit was used to ensure that the survey route was maintained. The location and behaviour of all birds encountered during the survey visits were recorded on 1:10,000 scale maps using standard British Trust for Ornithology (BTO) notation, with the exception of meadow pipit for which the total number of individuals encountered was recorded.

12.1.18 Surveys were undertaken monthly between April and July to give four complete survey visits of the site, and ensure that key phases of the breeding cycle were not missed. Details of these surveys are provided in Table 4.

Table 4 Moorland Bird Survey Effort 2012

Visit Number	Date	Time Start	Time End	Observer
1	17 April	06:00	12:00	KC
	18 April	06:00	11:00	KC
2	12 May	06:10	11:15	RJ
	12 May	05:55	11:25	GK
3	08 June	06:50	11:50	GK
	08 June	07:00	12:00	RJ
4	08 July	07:40	12:45	GK
	08 July	07:40	12:45	RJ

12.1.19 Birds were assumed to be breeding or holding territory at the recorded location if one or more of the following was observed:

- courtship, displaying or singing;
- presence of a nest, eggs or young (including newly fledged);
- agitated behaviour, including alarm calls or distraction display;
- adults carrying food or nesting material; or
- territorial dispute.

12.1.20 In the absence of any of these indicative behaviours, a pair observed together in suitable habitat was considered to represent a breeding pair. Other records were considered to be of non-breeding birds.

Point Counts

12.1.21 Point counts were undertaken in order to survey a representative sample of habitats within the forestry plantation at West Benhar Forest. Using GIS software, a grid of points (300m apart) was generated and laid onto the site plus a surrounding 500m boundary. Fifteen of these points which occurred in woodland habitat were then selected randomly (Figure 12.3). Four survey visits were made: two during the winter season (November and January) and two during the breeding season (April and June) (Table 5). All 15 points were sampled on each visit.

Table 5 Point Count Survey Effort 2011-2012

Visit	Date	Time Start	Time End	Observer
1	28 November 2011	09:20	15:07	SJJ
2	13 January 2012	10:34	15:45	AA
3	18 April 2012	07:02	09:30	AA
4	09 June 2012	05:10	12:00	AA

12.1.22 Counts took place within five hours of sunrise. The duration of each count at each point was five minutes, with a two minute settling period before each count. Birds heard or seen during a point count were recorded in one of three distance bands from the observer: 0-50 m, 50-100 m and > 100 m.

12.1.23 Point counts undertaken during the breeding season also distinguished whether birds were singing, calling or showing other signs indicative of breeding on the site, as opposed to flying overhead or being present without showing any behaviour indicative of possible breeding.

12.1.24 Broad habitat categories within 100 m of each survey point were also recorded on the first survey visit.

Winter Walkover Surveys

12.1.25 Surveys involved three winter walkover (WWO) visits between October 2011 and February 2012, inclusive, in order to determine the winter bird assemblage on-site. Dates of these surveys are shown in Table 6.

12.1.26 The area covered includes the proposed turbine layout plus a 500 m buffer, but extending slightly further than this to the east of the site due to the boundary change (see 12.1.3; WWO area in Figure 12.3). This survey covered as much of the site as possible, focussing on open

habitat within the survey area but also making use of tracks, footpaths, and accessible forest rides to aid efficiency in recording birds. The same route was used each month, although walked in alternate directions on the different surveys.

12.1.27 The survey method involved accessing the study area on foot and approaching all habitats to within at least 250 m. Surveyors combined shortened VP watches with a walk route between VP locations, approaching landscape features of potential ornithological importance (e.g. burns, valleys). All bird observations were recorded on a 1:10,000 scale map using standard BTO notation, with notes made on behaviour, flight lines and any other details of interest. Data were then digitised for analysis and presentation.

Table 6 Winter Walkover Survey Details 2011-12

Visit	Date	Start Time	End Time	Surveyor
1	31 October 2011	07:45	13:10	GK
2	19 December 2011	08:40	15:50	SJJ
3	24 February 2012	09:30	15:30	AA

Breeding Raptor Surveys

12.1.28 The proposed development site plus a 2 km buffer zone (but extending slightly beyond this to the east of the site due to the boundary change - see 12.1.3) was surveyed for all breeding raptor species in 2012 (Figure 12.3). Target species were any Annex I (EU Birds Directive) and Schedule 1 (Wildlife and Countryside Act) listed species. Visits were carried out under a SNH Schedule 1 license.

12.1.29 Species-specific survey protocols followed the guidelines as set out by Hardey et al.(2009). Surveys were conducted in areas of suitable habitat within 2 km of the proposed development site in April, May, June and July 2012 (Table 7). Target species were osprey, hen harrier, peregrine, merlin, goshawk, short-eared owl and barn owl. Observations of buzzard, sparrowhawk, kestrel and raven were also recorded within 1 km.

12.1.30 Areas of suitable habitat included trees along the forest edge and older stands of trees within the forest, heather moor and other areas of open habitat, craggy rock faces and cliffs, and steep sided burns. Potentially suitable buildings for nesting and roosting barn owls were also checked for occupancy by this species.

12.1.31 Surveys followed a combination of vantage point watches and 'walkabouts' designed to assist in determining the presence of breeding raptors.

Table 7 Breeding Raptor Surveys 2012

Date	Time Start	Time End	Observer
20 April	09:00	15:00	AA
11 May	08:50	14:00	AA
09 June	05:30	11:30	RJ
28 July	0:40	14:30	GK

Methods for Collision Risk Modelling

12.1.32 This section contains details of the methods used for the estimation of turbine collision rates. All of the mapped flight data were collated in a GIS (ArcView v10), with each flight's

attributes (e.g. date, number of birds, vantage point recorded) included in an attribute table. These data were used in collision risk models to predict the number of birds that would collide with the turbines during each year.

Choice of Directional or Non-Directional Models

12.1.33 CRM followed the method of Band et al. (2007). For each target species for which sufficient flights were recorded at PCH within the wind farm polygon (including the 200m buffer – see below), an annual collision rate was predicted using either a directional or non-directional collision risk model. Four was taken to be the minimum number of individual 'at-risk' flight events required to justify undertaking CRM. The choice of model for each target species was based on its pattern of flight behaviour within the study area. The directional model is appropriate when the flights of a species are predominantly regular, directional, transits across the wind farm area. This type of flight behaviour is characteristic of species on migration or making regular movements between feeding and roosting sites, as is frequently the case for groups such as geese, swans, divers and ducks. A non-directional model is more appropriate where the flights of a particular species represent more general usage of the airspace in and around the wind farm area and are not predominantly regular transits through the site. This is usually the case where birds have breeding or hunting territories that are wholly or partly within the site of interest. This approach, which assumes that the direction of flights is random, is usually appropriate for breeding and non-breeding raptors and waders.

12.1.34 The main difference between the directional and non-directional methods concerns whether it is more appropriate to consider collision risk, either:

(a) across a two-dimensional risk area in front of a bird as it flies towards the wind farm area with the intention of continuing on in the same direction (directional model); or

(b) within a three-dimensional risk volume as a bird flies around within the wind farm area in no consistent direction (non-directional model).

Definition of the Risk Zone: the Wind Farm Polygon

12.1.35 The zone within which birds were considered to be at risk of collision was defined as the area enclosed by the tips of the outermost turbine rotors, plus a 200 m buffer to allow for a degree of surveyor error when mapping flightlines. This area is referred to as the Wind Farm Polygon (WP). Any bird flying within the WP at PCH was considered to be "at risk" of passing through the airspace swept by a turbine rotor (i.e. a rotor transit).

12.1.36 Within the WP, the estimation of flight activity through the rotor-swept airspace differs between directional and non-directional models.

12.1.37 For the directional model, the number of rotor transits was calculated as follows:

1. a 'Risk Area' was defined as the area spanned by the rotors of the wind farm as presented to a particular species following its normal flight direction though the wind farm. The size of this area is determined by the distance between the outermost rotors in front of the birds, multiplied by the height of the rotors;

2. the Rotor-swept Area is defined as the total area swept by all of the rotors in the wind farm;

3. the number of rotor transits was calculated from the number of birds passing through the Risk Area by applying the ratio of the Rotor-swept Area to the Risk Area. For example: 20 birds x (5,000 m^2 [rotor swept area] / 50,000 m^2 [risk area]) = 2 rotor transits.

12.1.38 For the non-directional model, flight activity is calculated in terms of overall time within the Risk Volume (as opposed to the number of flights through the Risk Area). Thus, the ratio of the Rotor-swept Volume to the Risk Volume is used, where; (i) Risk Volume is defined as the volume of airspace at PCH above the WP (i.e. the area of the WP x the diameter of the rotors); and (ii) Rotor-swept Volume is defined as the total volume of air swept by all of the rotors in the wind farm (determined for an individual rotor as the area swept multiplied by the thickness of the rotor blades).

The Modelling Process: Stage 1

12.1.39 The first stage of the modelling process can be summarised as follows:

For the Directional Model - Estimation of the Number Rotor Transits

12.1.40 For each target species, the data from the VP surveys were used to estimate the total number of flights through the airspace swept by the proposed wind farm's rotors, during the appropriate season. This total was extrapolated from the overall numbers at which "at risk" birds were recorded moving through the proposed wind farm area. This was achieved using GIS features which enabled the 'clipping' of flights within the WP to determine those 'at-risk', based on which VP they were recorded from.

12.1.41 The number of birds observed flying through the risk window was totalled across the season, for each of the VPs used. For a bird or flock to be considered "at risk" it had to satisfy three conditions:

1. occur within Height Bands 2-4 (20-150 m above ground) at any point. This height range only approximated to true PCH but was relatively easy for the surveyor to visualise. The totals were then adjusted to reflect actual PCH (i.e. 28–132 m for the REpower-3.4-M104 model and 30-130 m for the Nordex N100 model see Table 14 below) by multiplying the number of birds in each of the two height bands that were only partially encompassed by the PCH by the proportion of the height band that was within actual PCH. Thus, the number of birds recorded within height band 2 was multiplied by 0.6 or 0.5 and that within height band 4 by 0.64 or 0.6, for the Repower and Nordex models, respectively;
2. pass over the survey WP at any point;
3. occur within 2 km of the VP at some point.

12.1.42 The risk window was measured as the distance between the outermost turbine rotors that would be facing a bird (i.e. perpendicular) on its typical orientation through the proposed wind farm. For the purposes of assigning flights to the risk window, a 200 m buffer extending from the turbine rotor tips was included. This buffer mitigates against a degree of observer error when drawing flightlines on the map. However, the actual length of the risk window (without a buffer) was used when calculating collision risk.

12.1.43 For each VP the rate at which birds were recorded flying through the risk window (the flux of birds) was determined, by calculating the number of birds per hour per km^2 of the risk window observed within the viewshed.

12.1.44 The flux rates for each VP were then weighted to account of the difference in survey effort between them (where survey effort was defined as the product of survey time at the VP and the area of the WP within the viewshed of the VP). The weight for a VP was calculated as its proportion of the total survey effort made from all VPs. This weight was then applied to the unweighted flux for each VP (unweighted flux * weight).

12.1.45 The weighted flux values for the two VPs were then summed to give the total flux through the proposed wind farm during the surveys.

12.1.46 The flux of at risk birds through the wind farm during the period of interest was extrapolated from the total flux rate, by multiplying the rate by the total length of the survey risk window in metres, and the total number of minutes that the species was considered to be potentially active during the period (including a 25% nocturnal activity rate for geese and other wildfowl).

12.1.47 The area of the risk window was determined, to allow calculation of the proportion of the risk window that would be rotor-swept within the proposed wind farm. It was calculated as the width of the risk window perpendicular to the average flight direction of the species within the site, multiplied by the height of the rotors. The width of the proposed wind farm in this instance is measured between the outermost rotors (tip to tip, with no 200 m buffer).

12.1.48 The rotor-swept area was determined as the square of the rotor blade length multiplied first by π, and then by the number of turbines proposed for the site.

12.1.49 The total number of birds expected to fly through the rotors during the period, was then estimated by multiplying the number flying through the risk window by the proportion of the risk window that was rotor swept.

12.1.50 This figure was then taken forward to Stage 3 of the process (see below).

For Non-directional Model - Estimating the Number of Rotor Transits

12.1.51 As described above, for the non-directional model, collision risk is regarded as a function of the time spent within the rotor-swept volume. The stage 1 calculation for this model is described below.

12.1.52 For each target species, the total amount of time that the species was observed flying within the risk volume during the period of interest was determined separately for each of the VPs (referred to as the VP occupancy totals).

12.1.53 For a bird (or flock) to be considered within the survey risk volume it had to satisfy three conditions:

1. occur within height Bands 2-4 (20-150 m above ground) at any point (with the same corrections applied as for the directional model – see paragraph 1.1.40);
2. pass over the survey WP at any point;
3. occur within 2 km viewshed of the VP at some point.

12.1.54 The VP occupancy totals were each converted to a rate, per unit effort (seconds per hour per km^2), and were then weighted to account for differences in survey effort between the VPs, in same was as for the directional model (1.1.43). Weighted values were then summed to give the overall occupancy rate of the proposed wind farm during the surveys.

12.1.55 The total occupancy of the survey risk volume during the period of interest was extrapolated from the overall occupancy rate, by multiplying the rate by the size of the risk area and the total number of minutes that the species was potentially active during the period.

12.1.56 The risk volume was determined by multiplying the risk area by the height of the rotors.

12.1.57 The rotor-swept volume of the proposed wind farm was determined as: $N*\pi r^2*(d+L)$, where N is the number of turbines, d is the width of the rotor blades at their widest point and L is the body length (in metres) of the bird species for which collision risk is being calculated.

12.1.58 The total occupancy of the rotor-swept volume during the period was then calculated by multiplying the occupancy of the risk volume by the proportion of the risk volume that was rotor-swept. The number of rotor transits was then estimated by dividing the total occupancy of the rotor-swept volume by the average time taken by the species to make one rotor transit (with transit time estimated from (d+L)/s, where d is the depth of the rotor swept area (m), L is the length of the species (m), and s is the average flight speed of the species (m/s)).

12.1.59 This figure was then taken forward to Stage 3 of the process (see below).

Stage 2

12.1.60 The probability was calculated that a bird of the species for which collision risk is being estimated will collide with a turbine rotor if it passed through the Rotor-swept Area/Volume. This probability is a function of the dimensions and flight speed of the species and of various turbine-specific. The calculation is facilitated by use of a spreadsheet supplied by SNH (2000). The relevant species biometrics and turbine parameters were entered into this spreadsheet which then calculated the probability of collision. Average flight speed values were taken from Pennycuick (2008), with other taxonomic data taken from Cramp (1998) or BTO BirdFacts (2012).

Stage 3

12.1.61 The predicted number of collisions per season (breeding or non-breeding), or per year, was first calculated under the assumptions that the birds take no action to avoid the turbine rotors, and that turbines are operational all of the time. This was calculated as:

No. of birds flying through Rotor swept Area/Volume x Probability of collision

- i.e. (Stage 1 x Stage 2)

12.1.62 This estimate was then adjusted on the basis of the following factors:

(i) that turbines will not be operational all of the time, with the standard assumption of 85% operational time used; and

(ii) a range of plausible avoidance rates applied from 95 – 99.8%, with emphasis placed upon the rate that is recommended for the species of interest by SNH (2010, 2013).

Baseline Description

Flight Activity Surveys

12.1.63 Flight activity in relation to the proposed wind farm is summarised for all target species recorded during the flight activity surveys at West Benhar in Table 8, with their flight locations shown in Figures 12.5 – 12.7. A total of 16 target species (plus two records of unidentified

grey geese) were recorded during all flight activity surveys from VPs 1 and 2 between September 2011 and August 2012. Appendix 2 holds all flight activity records.

12.1.64 Of these, 16 species, curlew had the most recorded flight events (at 12), with greylag goose (eight flights), golden plover (six flights), peregrine (six flights), mallard (six flights), pink-footed goose (five flights), lapwing (four flights) and snipe (four flights) also relatively frequent. No more than one or two flights were recorded for each of the remaining species.

12.1.65 Once flights were considered in relation to whether they occurred within the wind farm polygon (plus surrounding 200 m buffer) and at potential collision height (PCH), there was one species only (greylag goose) with more than three flight events that (on this basis) were appropriate for inclusion in any CRM. CRM was only undertaken for this species, because reliable predictions of collision risk were unlikely with fewer flight events. Also, the collision risk for species with fewer flights than this would be low. Results are presented in the Collision Risk Modelling Results section.

Table 8 Summary of Flight Activity Results for Target Species Recorded during Vantage Point Surveys between September 2011 and August 2012 at West Benhar

Species	Season	Total no. of Flight Events (all VPs)	Total Time in Flight (sec)	Total no. of Birds	No. of Birds at PCH	No. Of Birds at PCH Within WP	No. of Flight Events for CRM	Peak Count (month)
Wildfowl								
Canada goose	summer	1	75	2	2	2	1	2 (May)
Goosander	winter	1	30	1	1	0	0	1 (Nov)
Greylag goose	winter	6	1140	47	34	17	3	16 (Dec)
	summer	2	150	5	1	1	1	
Mallard	winter	2	285	5	5	0	0	5 (May)
	summer	3	225	10	5	5	2	
Pink-footed goose	winter	5	975	415	235	101	2	180 (Oct)
Tufted duck	winter	1	60	1	1	0	0	1 (Nov)
Whooper swan	winter	1	165	3	3	0	0	3 (Feb)
Waders								
Curlew	winter	3	435	3	3	1	1	2 (May, June)
	summer	9	645	12	11	2	1	
Golden plover	winter	6	975	196	186	0	0	110 (Oct)
Lapwing	winter	3	390	6	6	0	0	2 (Mar, May)
	summer	1	60	2	2	0	0	
Oystercatcher	summer	1	90	2	2	0	0	2 (Jun)
Snipe	summer	4	675	5	5	0	0	3 (Jun)
Raptors								
Goshawk	winter	1	180	1	1	1	1	1 (Sep)

Species	Season	Total no. of Flight Events (all VPs)	Total Time in Flight (sec)	Total no. of Birds	No. of Birds at PCH	No. Of Birds at PCH Within WP	No. of Flight Events for CRM	Peak Count (month)
Hen harrier	winter	1	315	1	1	0	0	1 (Oct)
Merlin	winter	2	630	3	3	3	2	2 (Sep)
Peregrine	winter	2	150	2	2	1	1	2 (Jun)
	summer	4	1485	5	5	0	0	

Note:
For the purposes of the CRM the winter (non-breeding) period is defined as 1 September to 15 April, and the summer (breeding) period as 16 April to 31 August.

Moorland Breeding Bird Surveys

12.1.66 Of the 57 species identified during the moorland breeding bird surveys, 38 were assumed to be breeding on site, based on the behaviours and activities recorded (Table 9). Of these 38 species, 16 were of conservation concern, with the approximate location of their breeding territories shown in Figure 12.8. These comprised six red-listed species (in Birds of Conservation Concern, BoCC), all of which are also Scottish Biodiversity List (SBL) species (lesser redpoll, linnet, cuckoo, tree pipit, song thrush and skylark), and nine amber-listed species (curlew, dunnock, kestrel, reed bunting, meadow pipit, snipe, swallow, whitethroat and willow warbler), of which curlew, dunnock, kestrel and reed bunting are also SBL species. Nine of these species are also listed on either (or both of) the North Lanarkshire or West Lothian LBAPs. Siskin, a SBL species, but neither red- nor ambler-listed in BoCC, was also recorded as breeding. There were no Annex I or Schedule 1 species considered to be breeding on site, although merlin, osprey and crossbill were recorded during these surveys.

12.1.67 Table 9 presents the summary findings from the moorland breeding survey.

Table 9 Occurrence and Abundance of Birds at West Benhar, as Derived from Territory Analysis of Moorland Breeding Bird Survey Data

Common Name	Number of Territories	Annex I	Sched-ule 1	BoCC Red-listed	BoCC Amber-listed	SBL	NL LBAP	WL LBAP
Blackbird	14							
Blackcap	3							
Black-headed gull	-				✓	✓		
Blue tit	1							
Bullfinch	-				✓	✓		✓
Buzzard	1							
Carrion crow	3							
Chaffinch	91							
Chiffchaff	1							
Coal tit	30							
Collared dove	3							

Common Name	Number of Territories	Annex I	Sched-ule 1	BoCC Red-listed	BoCC Amber-listed	SBL	NL LBAP	WL LBAP
Crossbill	-		✓					✓
Cuckoo	3			✓		✓		
Curlew	7				✓	✓		
Dunnock	22				✓	✓		
Feral pigeon	-							
Goldcrest	33							
Goldfinch	2							
Great spotted woodpecker	2							
Great tit	30							
Greenfinch	2							
Heron	-							
Herring gull	-			✓		✓		
House martin	-				✓			
Jackdaw	-							
Jay	1							
Kestrel	1				✓	✓		✓
Lapwing	-			✓		✓	✓	✓
Lesser black-backed gull	-				✓			
Lesser redpoll	10			✓		✓		
Linnet	1			✓		✓		✓
Long-tailed tit	1							
Magpie	1							
Mallard	-							
Meadow pipit	9/km^{2} †				✓			
Merlin	-	✓	✓		✓	✓		✓
Mistle thrush	-				✓			
Osprey	-		✓			✓		
Pied wagtail	-							
Reed bunting	4				✓	✓		✓
Robin	51							
Rook	-							
Sand martin	-				✓			
Siskin	4					✓		
Sedge warbler	1							
Skylark	22			✓		✓		✓
Snipe	2				✓		✓	✓

Common Name	Number of Territories	Annex I	Sched-ule 1	BoCC Red-listed	BoCC Amber-listed	SBL	NL LBAP	WL LBAP
Song thrush	29			✓		✓		✓
Starling	-			✓		✓		
Stonechat	1							
Swallow	1				✓			✓
Swift	-				✓	✓	✓	
Tree pipit	19			✓		✓		
Whitethroat	4				✓			
Willow warbler	138				✓			
Wood pigeon	12							
Wren	75							

Notes:

- indicates species that were recorded during the survey but not considered to be breeding within the survey area.

†Meadow pipit recorded as individual birds/km^2 within the moorland bird survey area based upon the peak count from the three earlier survey visits, as opposed to the estimated number of territories.

Breeding Season Point Count Surveys

12.1.68 A total of 39 species were recorded during the two breeding season point count survey visits, of which 31 species were considered to be breeding within the survey area - the other eight species being recorded as present or flying over the site only (Table 10). Few species of conservation value were recorded as breeding, with one Schedule 1 species (crossbill), six red-listed species (cuckoo, grasshopper warbler, lesser redpoll, linnet, song thrush and skylark), and seven amber-listed species (black-headed gull, bullfinch, curlew, dunnock, meadow pipit, whitethroat and willow warbler). All of these red-listed species plus bullfinch, curlew, dunnock and kestrel are also SBL species, whilst eight of the species are listed on the West Lothian LBAP. As in the moorland breeding bird surveys, siskin (a SBL species but not on the red or amber list of BoCC) was also recorded.

Table 10 Breeding Season Point Count Survey Results for West Benhar

Common Name	Status	Peak Survey Count	Relative Abund-ance*	Annex I	Sched-ule 1	BoCC Red-listed	BoCC Amber-listed	SBL	NL LBAP	WL LBAP
Blackbird	Breeding	4 (Jun)	40%							
Black-headed gull	Breeding	2 (Apr)	7%				✓	✓		
Blue tit	Breeding	3 (Apr)	27%							
Bullfinch	Breeding	2 (Jun)	13%				✓	✓		✓
Buzzard	Flying over	2 (Apr)	13%							
Carrion crow	Breeding	10 (Apr)	47%							
Chaffinch	Breeding	26 (Jun)	100%							
Chiffchaff	Breeding	2 (Apr)	20%							
Coal tit	Breeding	18 (Apr)	87%							

Common Name	Status	Peak Survey Count	Relative Abund-ance*	Annex I	Sched -ule 1	BoCC Red-listed	BoCC Amber -listed	SBL	NL LBAP	WL LBAP
Collard dove	Breeding	2 (Jun)	7%							
Cormorant	Flying over	2 (Apr)	7%							
Crossbill	Breeding	13 (Apr)	33%		✓					✓
Cuckoo	Breeding	3 (Jun)	20%			✓		✓		
Curlew	Breeding	1 (Apr)	7%				✓	✓		✓
Dunnock	Breeding	7 (Apr)	53%				✓	✓		
Goldcrest	Breeding	9 (Jun)	67%							
Grasshopper warbler	Breeding	1 (Apr)	7%			✓		✓		
Great tit	Breeding	1 (Apr/ Jun)	13%							
Kestrel	Flying over	3 (Apr)	20%				✓	✓		✓
Lesser black-backed gull	Flying over	11 (Apr)	13%				✓			
Lesser redpoll	Breeding	12 (Apr)	60%			✓		✓		
Linnet	Breeding	1 (Apr)	7%			✓		✓		✓
Magpie	Breeding	4 (Apr)	20%							
Meadow pipit	Breeding	5 (Jun)	13%				✓			
Pheasant	Breeding	1 (Apr)	7%							
Pied wagtail	Breeding	2 (Apr)	7%							
Pink-footed goose	Flying over	52 (Apr)	7%				✓			✓
Raven	Flying over	1 (Apr)	7%							
Robin	Breeding	22 (Jun)	87%							
Siskin	Breeding	6 (Apr)	33%					✓		
Skylark	Breeding	1 (Apr)	7%			✓		✓		✓
Song thrush	Breeding	12 (Jun)	67%			✓		✓		✓
Sparrow hawk	Flying over	3 (Apr)	13%							
Treecreeper	Breeding	1 (Apr)	7%							
Wheatear	Present – no indication of breeding	1 (Apr)	7%				✓			
White throat	Breeding	1 (Apr)	7%				✓			
Willow warbler	Breeding	50 (Jun)	100%				✓			
Wood pigeon	Breeding	12 (Apr)	67%							

Common Name	Status	Peak Survey Count	Relative Abund-ance*	Annex I	Sched -ule 1	BoCC Red-listed	BoCC Amber -listed	SBL	NL LBAP	WL LBAP
Wren	Breeding	8 (Apr)	53%							

Notes:

* The index of relative abundance represents the percentage of points at which each species was recorded across the two survey visits

Breeding Raptor Surveys

12.1.69 One target raptor species (peregrine) was recorded during the breeding raptor surveys undertaken between April and end of July 2012, with details of this record provided in the Confidential Ornithology Appendix.

12.1.70 There were no other target raptor species recorded during the dedicated raptor surveys, although hen harrier, merlin and goshawk were all recorded on the site during VP surveys (as shown in Figure 12.7, Table 8) and winter walkover surveys (Figure 12.9). There was no evidence of breeding on the site for any of these species. The details of the records of these species are summarised in Table 11.

Table 11 Records of Target Raptor Species Recorded during baseline Surveys at West Benhar

Species	Year	Notes
Peregrine		Details provided in Confidential Ornithology Appendix.
Hen harrier	2011/2012	No evidence of breeding. Two observations of a single male in flight during the winter from the VP surveys, both out with the site boundary. One additional record from the FCS of a hen harrier in flight within the south of the site during 2012.
Merlin	2011/ 2012	No evidence of breeding. Two observations of merlin flights on site: single female observed during the breeding season flying west to east across the site; and a pair hunting over the west of the site during the winter season.
Goshawk	2011/ 2012	No evidence of breeding. One observation of a single bird being mobbed by 2 sparrowhawks during the winter season.

12.1.71 Three non-target raptors were also recorded during the raptor surveys: buzzard, sparrowhawk and kestrel. Results from the moorland breeding bird survey indicate that one pair of breeding buzzards were present on the site. Evidence of past breeding attempts by sparrowhawk were also identified on site, at the western site entrance.

Winter Point Count Surveys

12.1.72 A total of 24 species were recorded from the two point count survey visits undertaken within the plantation forestry during the winter months (Table 12). Few species of conservation value were recorded, with one Schedule 1 species (crossbill) and one red-listed species (lesser redpoll). There were also seven amber-listed species (bullfinch, dunnock, greylag goose, lesser black-backed gull, meadow pipit, oystercatcher and reed bunting). The red-listed species and three of the amber-listed species (bullfinch, dunnock and reed bunting), as well as siskin, are SBL species. Crossbill, bullfinch and reed bunting were also listed on the West Lothian LBAP.

Table 12 Winter Point Count Survey Results for West Benhar

Common Name	Peak Survey Count	Relative Abund-ance	Annex I	Sched-ule 1	BoCC Red-listed	BoCC Amber-listed	SBL	NL LBAP	WL LBAP
Blackbird	2 (Nov)	13%							
Blue tit	1 (Nov)	7%							
Bullfinch	15 (Nov)	47%				✓	✓		✓
Carrion crow	5 (Nov)	33%							
Chaffinch	2 (Jan)	13%							
Coal tit	13 (Nov/ Jan)	73%							
Crossbill	21 (Nov)	40%		✓					✓
Dunnock	1 (Jan)	7%				✓	✓		
Goldcrest	12 (Nov)	60%							
Goldfinch	2 (Nov)	13%							
Great spotted woodpecker	1 (Nov)	7%							
Greylag goose	48 (Nov)	7%				✓			
Jay	1 (Jan)	7%							
Lesser black-backed gull	114 (Jan)	13%				✓			
Lesser redpoll	2 (Jan)	7%			✓		✓		
Magpie	1 (Nov)	13%							
Meadow pipit	1 (Nov)	7%				✓			
Oyster catcher	1 (Nov)	7%				✓			
Raven	3 (Jan)	13%							
Reed bunting	1 (Nov)	7%				✓	✓		✓
Robin	2 (Jan)	13%							
Siskin	10 (Nov)	13%					✓		
Wood pigeon	5 (Jan)	7%							
Wren	2 (Nov/ Jan)	27%							

Notes:

* The index of relative abundance represents the percentage of points at which each species was recorded across the two survey visits

Winter Walkover Surveys

12.1.73 The winter walkover surveys recorded a bird community that was, not surprisingly, dominated by a typical suite of woodland passerines (Figure 12.9). In total, 37 species were recorded within the application site boundary plus 500m buffer (Table 13). Of these, 19 species were of conservation concern, including one Annex I species (hen harrier), which is also a Schedule 1, red-listed and SBL species. Three other Schedule 1 species were recorded (crossbill, fieldfare and redwing), of which fieldfare and redwing are also red-listed. There were four other red-listed species (herring gull, lesser redpoll, skylark and song

thrush), all of which are also SBL species, as well as 10 amber-listed species, of which five (bullfinch, curlew, dunnock reed bunting and kestrel) are also SBL species. Siskin (a SBL but not on red or amber list of BOCC) was also recorded. Eleven of the species were also listed on the North Lanarkshire or West Lothian LBAPs.

Table 13 Occurrence and Numbers of Birds at West Benhar as Recorded by Winter Walkover Surveys

Species	Peak Count	Number of Visits on which Recorded	Annex I	Sched-ule 1	BoCC Red-listed	BoCC Amber-listed	SBL	NL LBAP	WL LBAP
Blackbird	1 (Dec/ Feb)	2							
Blue tit	6 (Oct)	1							
Bullfinch	25 (Dec)	3				✓	✓		✓
Buzzard	6 (Feb)	3							
Carrion crow	38 (Oct)	3							
Chaffinch	6 (Oct)	3							
Crossbill	26 (Feb)	3		✓					✓
Coal tit	30 (Dec)	3							
Curlew	1 (Feb)	1				✓	✓		✓
Dunnock	3 (Oct/ Feb)	3				✓	✓		
Fieldfare	10 (Oct)	2		✓	✓				✓
Goldcrest	15 (Dec)	3							
Goldfinch	1 (Oct)	1							
Great spotted woodpecker	1 (Oct)	1							
Hen harrier	1 (Feb)	1	✓	✓	✓		✓		✓
Herring gull	126 (Dec)	2			✓		✓		
Jack snipe	1 (Feb)	1				✓			
Kestrel	4 (Oct)	1				✓	✓		✓
Lesser black-backed gull	18 (Oct)	2				✓			
Lesser redpoll	9 (Oct)	2			✓		✓		
Magpie	7 (Oct)	3							
Mallard	2 (Feb)	1							
Meadow pipit	13 (Oct)	2				✓			
Pink-footed goose	40 (Feb)	1				✓			✓
Raven	3 (Dec)	1							
Redwing	22 (Oct)	2		✓	✓		✓		
Reed bunting	1	2				✓	✓		✓

Species	Peak Count	Number of Visits on which Recorded	Annex I	Sched-ule 1	BoCC Red-listed	BoCC Amber-listed	SBL	NL LBAP	WL LBAP
	(Oct/Dec)								
Robin	7 (Oct/ Feb)	2							
Siskin	1 (Oct/Dec /Feb)	3					✓		
Skylark	10 (Feb)	1			✓		✓		✓
Snipe	4 (Oct)	3				✓		✓	✓
Song thrush	2 (Feb)	1			✓		✓		✓
Sparrowhawk	1 (Feb)	2							
Treecreeper	1 (Feb)	1							
Wood pigeon	18 (Feb)	2							
Wren	8 (Oct)	3							

Collision Risk Modelling Results

12.1.74 Greylag goose was the only species for which there were sufficient flights through the proposed wind farm polygon at PCH to merit undertaking CRM (Table 8). Flights by greylag geese were predominantly regular transits through the proposed wind farm, and as such a directional model was most appropriate. Flights were recorded during both winter (non-breeding) and summer (breeding) seasons, with CRM undertaken separately for each season and the respective estimates summed to give an overall annual collision risk.

12.1.75 Thus, greylag goose flight activity data were extrapolated to estimates of their total non-breeding and breeding flights through the risk area (as a directional model) for each of the two turbine types being considered for this site (Table 14). These totals were then entered into the collision risk model to generate estimates of the non-breeding and breeding rate of turbine collisions for the species, for each turbine type, with the output from the turbine type giving the highest collision risk estimate being presented (although differences resulting from turbine type were very small – i.e. 0.005 using the recommended avoidance rate). Given that final choice of turbine model to be selected for the proposed wind farm will be dependent upon the wind analysis, turbine economics and available technology at the time of procurement, for the purposes of the CRM the two turbine models selected were based upon the "worst case" possible candidate turbines for the site at the time of submission of this application. These comprise the Repower-3.4-M104 turbine (which has the biggest rotor diamter) and the Nordex N100 (which has the greatest rotation speed). The specifications for these two candidate turbines are set out in Table 14 below.

Table 14 Wind Turbine Specifications

Specification	Repower-3.4-M104	Nordex N100
Rotor diameter	104m	100m
Max. Chord	3.8m	3.8m*
Blade pitch	10°	10°
Rotation speed	13.8 r.p.m.	14.9 r.p.m.
Hub height	80m	80m
Number of turbines	8	8
Note: *value for maximum chord is assumed as it was not provided in specifications		

12.1.76 Detailed results from the CRM are presented below (Tables 15 and 16), with predictions of collisions per season presented using a range of avoidance rates from zero to 99.8%. The recommended avoidance rate for greylag goose is 99.8% (SNH 2013), which gives predictions of 0.08 and 0.006 collisions during the non-breeding and breeding seasons, respectively. This the estimated annual number of greylag goose collisions per year at the proposed West Benhar wind farm is 0.086 (equivalent to one death every 11 – 12 years).

Table 15 Non-breeding Season Collision Risk Modelling Output for Greylag Goose Based on the Nordex N100 Turbine Specifications (Directional Model)

Vantage Point	1	2
Number of birds observed within WF at PCH	17	0
Observed time (hours)	42	48
Area of wind farm visible within viewshed (km^2)	1.03	0.22
Effort at each VP (time * area)	43.3	10.8
Proportion of effort at each VP	0.80	0.20
Rate of birds per hour per km^2	0.39	0.00
Rate of birds per hour per km^2 weighted for effort	0.31	0.00
Overall rate (birds per hour per km^2)	0.31	
Turbine area (convex hull buffered by radius; km^2)	1.237	
Risk window length (m)	1438.7	
Risk window height (m)	100	
Area of risk window (m^2)	143874.2	
Number of turbines	8	
Rotor swept area (m^2)	62831.8	
Potentially active hours (daylight during relevant period plus 25% of night hours)	3070.9	
Predicted number of birds flying through risk window during period	1194.4	
Flights transiting rotors during period	521.6	
Probability of collision (Band model)	0.086	
Collisions during study period with 100 % operation and no avoidance	44.93	
SNH recommended avoidance rate	0.998	

Predicted number of collisions per year with 85 % operational rate and:	No avoidance	38.19
	95 % avoidance	1.91
	98 % avoidance	0.76
	99 % avoidance	0.38
	99.8% avoidance	**0.08**

Table 16 Breeding Season Collision Risk Modelling Output for Greylag Goose Based on the Nordex N100 Turbine Specifications (Directional Model)

Vantage Point		1	2
Number of birds observed within WF at PCH		1	0
Observed time (hours)		24	30
Area of wind farm visible within viewshed (km^2)		1.03	0.22
Effort at each VP (time * area)		24.7	6.7
Proportion of effort at each VP		0.79	0.21
Rate of birds per hour per km^2		0.04	0.00
Rate of birds per hour per km^2 weighted for effort		0.03	0.00
Overall rate (birds per hour per km^2)		0.03	
Turbine area (convex hull buffered by radius; km^2)		1.237	
Risk window length (m)		1438.7	
Risk window height (m)		100	
Area of risk window (m^2)		143874.2	
Number of turbines		8	
Rotor swept area (m^2)		62831.8	
Potentially active hours (daylight during relevant period plus 25% of night hours)		2508.3	
Predicted number of birds flying through risk window during period		98.6	
Flights transiting rotors during period		43.0	
Probability of collision (Band model)		0.086	
Collisions during study period with 100 % operation and no avoidance		3.71	
SNH recommended avoidance rate		0.998	
Predicted number of collisions per year with 85 % operational rate and:	No avoidance	3.15	
	95 % avoidance	0.16	
	98 % avoidance	0.06	
	99 % avoidance	0.03	
	99.8% avoidance	**0.006**	

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Appendix 1 – Species List

Common Name	*Scientific Name*	Common Name	*Scientific Name*
Barn owl	*Tyto alba*	Reed bunting	*Emberiza schoeniclus*
Blackbird	*Turdus merula*	Robin	*Erithacus rubecula*
Blackcap	*Sylvia atricapilla*	Rook	*Corvus frugilegus*
Black-headed gull	*Chroicocephalus ridibundus*	Sand martin	*Riparia riparia*
Blue tit	*Cyanistes caeruleus*	Sedge warbler	*Acrocephalus schoenobaenus*
Bullfinch	*Pyrrhula pyrrhula*	Short-eared owl	*Asio flammeus*
Buzzard	*Buteo buteo*	Siskin	*Carduelis spinus*
Canada goose	*Branta canadensis*	Skylark	*Alauda arvensis*
Carrion crow	*Corvus corone*	Snipe	*Gallinago gallinago*
Chaffinch	*Fringilla coelebs*	Song thrush	*Turdus philomelos*
Chiffchaff	*Phylloscopus collybita*	Sparrowhawk	*Accipiter nisus*
Coal tit	*Periparus ater*	Starling	*Sturnus vulgaris*
Collared dove	*Streptopelia decaocto*	Stonechat	*Saxicola torquata*
Cormorant	*Phalacrocorax carbo*	Swallow	*Hirundo rustica*
Crossbill	*Loxia curvirostra*	Swift	*Apus apus*
Cuckoo	*Cuculus canorus*	Tree pipit	*Anthus trivialis*
Curlew	*Numenius arquata*	Treecreeper	*Certhia familiaris*
Dunnock	*Prunella modularis*	Tufted duck	*Aythya fuligula*
Feral pigeon	*Columba livia*	Wheatear	*Oenanthe oenanthe*
Fieldfare	*Turdus pilaris*	White throat	*Sylvia communis*
Goldcrest	*Regulus regulus*	Whooper swan	*Cygnus cygnus*
Golden plover	*Pluvialis apricaria*	Willow warbler	*Phylloscopus trochilus*
Goldfinch	*Carduelis carduelis*	Woodpigeon	*Columba palumbus*
Goshawk	*Accipiter gentilis*	Wren	*Troglodytes troglodytes*
Grasshopper warbler	*Locustella naevia*		
Great spotted woodpecker	*Dendrocopos major*		
Great tit	*Parus major*		
Greenfinch	*Carduelis chloris*		
Grey heron	*Ardea cinerea*		
Greylag goose	*Anser anser*		
Hen harrier	*Circus cyaneus*		
Herring gull	*Larus argentatus*		
House martin	*Delichon urbica*		
Jack snipe	*Lymnocryptes minimus*		
Jackdaw	*Corvus monedula*		
Jay	*Garrulus glandarius*		
Kestrel	*Falco tinnunculus*		
Lapwing	*Vanellus vanellus*		
Lesser black-backed gull	*Larus fuscus*		
Lesser redpoll	*Carduelis cabaret*		
Linnet	*Carduelis cannabina*		
Long-tailed tit	*Aegithalos caudatus*		
Magpie	*Pica pica*		
Mallard	*Anas platyrhynchos*		
Meadow pipit	*Anthus pratensis*		
Merlin	*Falco columbarius*		
Mistle thrush	*Turdus viscivorus*		
Osprey	*Pandion haliaetus*		
Oystercatcher	*Haematopus ostralegus*		
Peregrine	*Falco peregrinus*		
Pheasant	*Phasianus colchicus*		
Pied wagtail	*Motacilla alba*		
Pink-footed goose	*Anser brachyrhynchus*		
Raven	*Corvus corax*		
Redwing	*Turdus iliacus*		

Appendix 2 – Flight Activity Records 2011-2012

Survey Date	Survey Time	Species	Flock Size	Time in Flight (s)	Surveyor
28-Sep-11	07:20	Greylag goose	13	75	GK
28-Sep-11	09:54	Golden plover	16	330	GK
28-Sep-11	11:44	Merlin	2	285	GK
28-Sep-11	12:40	Goshawk	1	180	RJ
10-Oct-11	12:31	Pink-footed goose	54	165	AA
10-Oct-11	14:17	Hen harrier	1	315	AA
10-Oct-11	15:56	Unidentified goose	110	315	AA
10-Oct-11	18:07	Golden plover	4	105	AA
11-Oct-11	12:47	Golden plover	110	225	AA
11-Oct-11	12:54	Golden plover	52	135	AA
11-Oct-11	14:00	Pink-footed goose	80	210	AA
11-Oct-11	16:27	Pink-footed goose	180	300	AA
10-Nov-11	10:17	Peregrine	1	75	AA
10-Nov-11	10:38	Golden plover	10	135	AA
27-Nov-11	09:05	Pink-footed goose	90	90	SJJ
27-Nov-11	10:03	Goosander	1	30	SJJ
27-Nov-11	13:01	Golden plover	4	45	SJJ
06-Dec-11	10:46	Pink-footed goose	11	210	AA
06-Dec-11	10:46	Greylag goose	7	210	AA
06-Dec-11	12:04	Greylag goose	7	345	AA
06-Dec-11	12:04	Greylag goose	3	120	AA
06-Dec-11	13:10	Greylag goose	16	240	AA
06-Dec-11	13:53	Peregrine	1	75	AA
19-Jan-12	08:05	Greylag goose	1	150	AA
19-Jan-12	09:11	Mallard	2	195	AA
07-Feb-12	08:12	Whooper swan	3	165	AA
07-Feb-12	09:40	Unidentified goose	62	255	AA
20-Mar-12	10:01	Lapwing	2	165	AA
20-Mar-12	10:17	Lapwing	2	195	AA
20-Mar-12	10:32	Curlew	1	225	AA
20-Mar-12	10:40	Mallard	3	90	AA
20-Mar-12	10:59	Curlew	1	60	AA
20-Mar-12	11:14	Lapwing	2	30	AA
20-Mar-12	12:13	Curlew	1	150	AA
11-Apr-12	19:34	Merlin	1	345	AA
16-May-12	05:11	Greylag goose	1	90	AA

Survey Date	Survey Time	Species	Flock Size	Time in Flight (s)	Surveyor
16-May-12	05:52	Mallard	5	60	AA
16-May-12	06:36	Canada Goose	2	75	AA
16-May-12	06:50	Greylag goose	4	60	AA
16-May-12	07:22	Mallard	3	75	AA
16-May-12	07:22	Mallard	2	90	AA
28-May-12	16:02	Lapwing	2	60	AA
28-May-12	16:51	Curlew	1	45	AA
28-May-12	16:53	Curlew	2	45	AA
28-May-12	16:55	Curlew	1	75	AA
28-May-12	16:57	Curlew	2	60	AA
28-May-12	16:58	Curlew	1	75	AA
28-May-12	19:32	Curlew	1	45	AA
28-May-12	-	Mallard	1	45	AA
28-May-12	-	Snipe	2	360	AA
25-Jun-12	15:56	Oystercatcher	2	90	SJJ
25-Jun-12	17:00	Peregrine	1	990	SJJ
25-Jun-12	17:52	Curlew	1	75	SJJ
25-Jun-12	17:53	Peregrine	1	135	SJJ
25-Jun-12	18:11	Peregrine	2	120	SJJ
25-Jun-12	20:26	Snipe	1	330	SJJ
25-Jun-12	20:37	Curlew	1	105	SJJ
25-Jun-12	20:51	Curlew	2	120	SJJ
25-Jun-12	20:57	Snipe	3	240	SJJ
25-Jun-12	21:02	Snipe	1	105	SJJ
26-Jun-12	17:26	Tufted duck	1	60	SJJ
28-Jul-12	15:41	Peregrine	1	240	GK

Note:
- indicates two records for which time of sighting was not recorded.

Following Appendix Provided as Separate Confidential Annex:

Ornithology Confidential Annex