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## Cairnmore Hill Ornithology Appendix 8.1

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## 1 INTRODUCTION

MacArthur Green was commissioned by RES ('the Applicant') to undertake the ornithological assessment at the proposed Cairnmore Hill Wind Farm, near Thurso in the Highlands (hereafter referred to as 'the Proposed Development'). The surveys were conducted between September 2012 and August 2017 to inform an assessment of the potential ornithological effects of the Proposed Development on the species assemblage present.

This technical report summarises the methods employed and the results of the field surveys and is supported by the following Annexes.

<b>Annex A</b>	Ornithological Legal Protection
<b>Annex B</b>	Collision Risk Assessments
<b>Annex C</b>	Ornithological Baseline Data and Methodology (Caledonian Conservation Report)
<b>Annex D</b>	Flight Activity Data (2015-2017)
<b>Annex E</b>	RSPB Response and MacArthur Green Reply

A range of surveys were employed to accurately record baseline conditions within the Proposed Development and appropriate survey areas (detailed in **Annex C**). In this Technical Appendix, associated **Annexes A – D**, and **Chapter 8 (Ornithology)** of the Environmental Impact Assessment (EIA) Report, terms referred to are as follows:

- 'the site' refers to the area within the red line boundary, e.g. **Figure 8.1**;
- 'survey area' is defined as the area covered by each survey type for the Proposed Development; and
- 'study area' is defined as the area of consideration of effects on each species at the time of assessment (**Figure 8.1**).

## 2 LEGAL PROTECTION

With limited exceptions, all wild birds and their eggs are protected by law. Specific levels of protection are determined by a species' inclusion on certain lists. **Annex A** to this report details the various levels of legal protection afforded to UK bird species.

## 3 FIELD SURVEYS

The following surveys were undertaken at the site between September 2012 and August 2017:

- Flight activity surveys – September 2012 to February 2013, May 2013 to August 2014 and October 2015 to August 2017 (four breeding seasons and four non-breeding seasons) from up to three vantage points (VPs) (**Figure 8.2**);
- Breeding bird surveys, 500 m survey buffer – spring/summer 2013, 2014, 2016 and 2017;
- Winter walkover surveys, 500 m survey buffer – December 2012 to February 2013 and December 2015 to February 2016;
- Scarce breeding bird surveys, 2 km survey buffer – spring/summer 2013, 2014 and 2016; and
- Foraging goose surveys, 5 km survey buffer – September 2013 to May 2014.

<sup>1</sup> Hours where visibility was >1km are not considered valid for use in collision risk modelling as less than half the 2km viewshed can be seen.

Field surveys were undertaken by Caledonian Conservation and the baseline results of these surveys are detailed in **Annex C** and **Annex D**. All valid surveys were undertaken during suitable weather conditions (as describes within **Annex C**) and where weather conditions deteriorated below acceptable weather conditions (**Annex C**) surveys were either suspended or additional surveys were undertaken. In the case of flight activity surveys, any time where the visibility was <1 km was excluded from total survey effort and subsequent analysis. Schedule 1 surveys were undertaken by appropriately licenced surveyors. Collision modelling was undertaken by MacArthur Green.

The relative importance of the data collected was determined by the specific level of protection assigned to those species recorded, coupled with their perceived susceptibility to potential effects resulting from the Proposed Development. The resulting 'target species' and 'secondary species' lists are a standard assessment tool for wind farm ornithological studies.

## 4 FIELD SURVEY RESULTS

### 4.1 Flight Activity

The flight activity surveys recorded all target species' flight activity within the Proposed Development area and beyond. These data have been used in the collision risk modelling. The flights used included those within the 'Collision Risk Analysis Area' (CRAA) (i.e. the area to be occupied by operational turbines, together with a 500m buffer).

Flight activity surveys across the 2013, 2014, 2016 and 2017 breeding seasons and 2012/2013, 2013/2014, 2015/2016 and 2016/2017 non-breeding seasons were undertaken across up to three VPs and valid survey effort<sup>1</sup> is detailed in **Table 8-1-1**.

**Table 8-1-1 Summary of total hours of valid survey per VP in each season**

Period	VP1	VP2	VP3
2012/2013 non-breeding season	51	-	-
2013 breeding season	39.83	-	-
2013/2014 non-breeding season	78	-	-
2014 breeding season	72	-	-
2015/2016 non-breeding season	78	-	-
2016 breeding season	78	-	-
2016/2017 non-breeding season	-	77	78
2017 breeding season	-	69	63

A total of 16 target species were recorded during the flight activity surveys (further details are provided in **Annex C**). For each species across the whole flight activity survey period, **Table 8-1-2** shows the total number of flights recorded and the total number of birds recorded<sup>2</sup>. The bird seconds are calculated for each observation as the product of flight duration and number of individuals. This is then summed per species to give the total bird seconds recorded across the entire surveyed period.

<sup>2</sup> This includes flights that would not technically be 'at-risk' of collision (e.g. recorded outwith the CRAA and/or not at rotor height).

**Table 8-1-2 Target species recorded and total number of flights recorded during flight activity surveys, 2012-2017**

Species	Total number of flightlines recorded	Total number of birds recorded	Total bird seconds recorded
Arctic skua	5	5	375
Barn owl	2	2	60
Curlew	242	292	14,910
Dunlin	7	39	2,655
Golden plover	123	4,175	382,515
Greenland white-fronted goose	15	396	194,160
Greylag goose	368	12,420	1,709,985
Hen harrier	52	52	5,595
Herring gull	123	162	12,075
Lapwing	815	4,497	986,490
Merlin	4	4	165
Peregrine falcon	6	6	195
Pink-footed goose	183	14,726	1,831,245
Ringed plover	7	72	3,795
Short-eared owl	3	3	60
Whooper swan	30	245	22,905

#### 4.1.1 Flightlines Used in Collision Risk Modelling

Only flightlines identified to be within the CRAA and recorded within the 2km viewshed of the associated VP were considered in the collision risk modelling and **Annex B** provides details of the bird seconds from flights identified to be 'at-risk'.

- 'At-risk' is defined as – a flight having at least part of its duration (i) at Potential Collision Height (PCH)<sup>3</sup>; (ii) within the CRAA; and (iii) recorded within the 2km viewshed of the associated VP.
- PCH is defined as – the altitude between the minimum and maximum blade height<sup>4</sup> (taken to be from 21.5m to 138.5m for the Proposed Development).

Barn owl and short-eared owl were recorded during flight activity surveys but no flights were considered to be 'at-risk'<sup>5</sup>. Full survey results detailing the findings from each survey visit (including target species' flightlines considered not 'at-risk' and secondary species information) can be found within **Annex C**. Only bird seconds for observations identified as within the CRAA and associated viewshed are considered in the following discussions. Full target species results are detailed within **Annex C** and the collision risk calculations are detailed in **Annex B**.

#### 4.1.2 Collision Risk Model Outputs

The bird seconds for target species flights within the CRAA at PCH were then input into a Collision Risk Model (CRM) to calculate the predicted collision rates per season. The CRM calculations for each species can be found in **Annex E**. **Table 8-1-3** and **Table 8-1-4** provide the estimated collision rates and number of seasons per collision for each species.

<sup>3</sup> In some cases, only part of a total flight duration was recorded at PCH, and it is assumed that this proportion is applicable for that part of the flight within the CRAA and 2km viewshed area.

**Table 8-1-3 Estimated collision rates (NBR = non-breeding season, BR = breeding season)**

Species	2012/ 2013 NBR	2013 BR	2013/ 2014 NBR	2014 BR	2015/ 2016 NBR	2016 BR	2016/ 2017 NBR	2017 BR	Mean BR	Mean NBR	Mean Annual
Arctic skua	0.0033	0.0016	0	0.0014	0	0	0	0	0.0007	0.0008	0.0016
Curlew	0.0119	0.1255	0.0158	0.3674	0.1106	0.2880	0	0.0141	0.1988	0.0346	0.2333
Dunlin	0	0	0.0190	0	0	0	0	0	0.0000	0.0048	0.0048
Golden plover	0	0.0415	0.0847	0.0811	1.4039	0.6676	1.9002	2.9593	0.9374	0.8472	1.7846
Greenland white-fronted goose	0	0	0	0	0	0	0.0082	0	0.0000	0.0021	0.0021
Greylag goose	0.3240	0	0.0653	0	0.4337	0	0.5570	0	0.0000	0.3450	0.3450
Hen harrier	0	0	0.0009	0	0	0	0.0004	0	0.0000	0.0003	0.0003
Herring gull	0	0	0	0.6164	0	0	0	0	0.1541	0.0000	0.1541
Lapwing	0.2224	0.1031	2.2694	0.7620	0.6946	1.4902	0.0465	0.1247	0.6200	0.8082	1.4282
Merlin	0	0	0	0	0	0	0.0006	0	0.0000	0.0002	0.0002
Peregrine falcon	0	0	0	0	0	0	0.0008	0.0020	0.0005	0.0002	0.0007
Pink-footed goose	0	0	0.1222	0	7.7946	0	1.0428	0	0.0000	2.2399	2.2399
Ringed plover	0.2739	0.0076	0	0	0	0	0	0	0.0019	0.0685	0.0704
Whooper swan	0	0	0	0	0.0350	0	0.0260	0	0.0000	0.0152	0.0152

<sup>4</sup> Where the actual rotor blade altitude differs from the pre-defined survey height bands, the collision risk model accounts for this difference on the assumption of an even flight distribution within each particular survey height band, and an adjustment can be made to estimate total flight duration at actual rotor blade altitude.

<sup>5</sup> i.e. the flights were either not within the CRAA and associated viewshed or were only recorded flying above 150m.

**Table 8-1-4 Estimated number of seasons per collision (NBR = non-breeding season, BR = breeding season)**

Species	2012/ 2013 NBR	2013 BR	2013/ 2014 NBR	2014 BR	2015/ 2016 NBR	2016 BR	2016/ 2017 NBR	2017 BR	Mean BR	Mean NBR	Mean Annual
Arctic skua	304	624	-	733	-	-	-	-	1348	1214	639
Curlew	84	8.0	63	2.7	9.0	3.5	-	71	5.0	29	4.3
Dunlin	-	-	53	-	-	-	-	-	-	211	211
Golden plover	-	24	11.8	12.3	0.7	1.5	0.5	0.3	1.1	1.2	0.6
Greenland white-fronted goose	-	-	-	-	-	-	121	-	-	485	485
Greylag goose	3.1	-	15.3	-	2.3	-	1.8	-	-	2.9	2.9
Hen harrier	-	-	1126	-	-	-	2850	-	-	3228	3228
Herring gull	-	-	-	1.6	-	-	-	-	6.5	-	6.5
Lapwing	4.5	9.7	0.4	1.3	1.4	0.7	21.5	8.0	1.6	1.2	0.7
Merlin	-	-	-	-	-	-	1615	-	-	6461	6461
Peregrine falcon	-	-	-	-	-	-	1240	491	1962	4959	1406
Pink-footed goose	-	-	8.2	-	0.1	-	1.0	-	-	0.4	0.4
Ringed plover	3.7	131	-	-	-	-	-	-	525	14.6	14.2
Whooper swan	-	-	-	-	29	-	38	-	-	66	66

## ANNEX A. ORNITHOLOGICAL LEGAL PROTECTION

In Scotland, all wild birds are protected under the Wildlife and Countryside Act 1981 (the 'Act'), as amended by the Nature Conservation (Scotland) Act 2004. This protection also extends to their eggs and nests, with it being an offence to intentionally or recklessly<sup>1</sup>:

- Kill, injure or take any wild bird<sup>2</sup>;
- Take, damage, destroy or otherwise interfere with the nest of any wild bird while it is being built or is in use<sup>3</sup>;
- At any other time take, damage, destroy or otherwise interfere with any nest habitually used by any wild bird included in Schedule A1 (Protected Nests and Nest Sites for Birds: white-tailed eagle and golden eagle)<sup>4</sup>;
- Obstruct or prevent any wild bird from using its nest<sup>5</sup>; or
- Take or destroy an egg of any wild bird<sup>6</sup>.

It is also an offence to have in possession or control any live or dead wild bird or any part thereof; or any egg or part of an egg of any wild bird<sup>7</sup>.

Further special protection under this legislation is afforded to those species listed on Schedule 1 of the Act. For these species, it is an offence to:

- Intentionally or recklessly disturb any wild bird listed on Schedule 1 while it is nest building, or is in, on or near a nest containing eggs or young, or disturb the dependent young of such a bird<sup>8</sup>;
- Intentionally or recklessly disturb any wild birds included on Schedule 1 which leks, while it is doing so<sup>9</sup> (capercaillie is the only bird this offence applies to in Scotland);
- Intentionally or recklessly harass any wild bird included in Schedule 1A<sup>10</sup>. Section 1, subsection 5B states, 'Subject to the provisions of this Part, any person who intentionally or recklessly harasses any wild bird included in Schedule 1A shall be guilty of an offence'. At this time, Schedule 1A includes golden eagle, hen harrier, red kite and white-tailed eagle. This updated legislation was introduced on 16 March 2013; or
- Intentionally or recklessly take, damage, destroy or otherwise interfere with any nest and/or nest site habitually used by any bird on Schedule A1 at any time. At this time, Schedule 1A includes golden eagle and white-tailed eagle<sup>11</sup>;

It is also an offence to knowingly cause or permit to be done an act which is made unlawful by any of the above provisions.

Further protection is described under the EU Birds Directive which requires member states to maintain wild bird species in favourable conservation status<sup>12</sup> and promote the conservation of bird species listed within Annex 1 of the Birds Directive through the protection of their habitat. This is achieved via the designation of Special Protection Areas (SPAs).

Red List bird species are those deemed to be globally threatened and to be suffering population declines within the UK. Although not legally enforceable, the conservation of Red List bird species represents a material consideration, in planning terms.

<sup>1</sup> Exceptions to these offences exist under various circumstances (e.g. controlling pest species; taking birds during specific season; and killing sick or injured birds etc.).

<sup>2</sup> Wildlife and Countryside Act 1981, Section 1(1)(a)

<sup>3</sup> Wildlife and Countryside Act 1981, Section 1(1)(b)

<sup>4</sup> Wildlife and Countryside Act 1981, Section 1(1)(ba)

<sup>5</sup> Wildlife and Countryside Act 1981, Section 1(1)(bb)

<sup>6</sup> Wildlife and Countryside Act 1981, Section 1(1)(c)

<sup>7</sup> Wildlife and Countryside Act 1981, Section 1(2)

<sup>8</sup> Wildlife and Countryside Act 1981, Section 1(5)

<sup>9</sup> Wildlife and Countryside Act 1981, Section 1(5A)

<sup>10</sup> Wildlife and Countryside Act 1981, Section 1(5B)

<sup>11</sup> This reflects the changes introduced by the Wildlife and Countryside Act 1981 (as amended by: Variation of Schedules A1 and 1A (Scotland) Order 2013.

<sup>12</sup> While the term 'favourable conservation status' is not used in the Birds Directive, EU court cases over recent years have progressively interpreted the concept as meaningful in a Birds Directive context (SNH, 2006).

## ANNEX B. COLLISION RISK ASSESSMENTS

The Collision Risk Analysis Area (CRAA) was created using a 500m buffer from the proposed turbine locations (Figure 8.2). Using the larger 500m area around the turbines accounts for possible inaccuracies in the recording of flightlines and ensures the assessment is precautionary.

The ultimate aim is to have 100% coverage of the turbines and associated CRAA by the viewsheds, however in practice this is often unachievable as a result of the topography of the site and limited to no access outwith the site boundary. For Cairnmore Hill Wind Farm (hereafter referred to as 'the Proposed Development'), although some small areas of the CRAA remain 'invisible' at 20m above ground level (Figure 8.2), the habitat within these areas is of sufficient similarity such that the survey data collected and subsequently assessed are considered to be representative of the whole CRAA. In addition, there were no records made during any of the surveys which would suggest that this area was of any particular importance to target species. Furthermore, the flying time at risk height (secsHahr<sup>1</sup>) for each species is calculated as a single mean activity rate within the entirety of the CRAA.

Table E-1, Table E-2 and Table E-3 present the parameters which apply to each Collision Risk Model (CRM).

Table E-1 Wind farm parameters

Size of wind farm envelope	237.44	hectares (ha)
Number of turbines	5	turbines
Rotor diameter	117	metres (m)
Hub height	80	m
Max. rotor depth	0.90	m (at 15° pitch angle)
Max. chord	4	m
Pitch	15	degrees (°)
Rotation period	3.43	seconds (secs)
Turbine operation time	85	percent (%)
Risk height: highest	138.5	m
Risk height: lowest	21.5	m
Flight risk volume	277801551	m <sup>3</sup>

Table E-2 CRM parameters per species

Species	Length (m)	Wingspan (m)	Assumed flight speed, v (ms <sup>-1</sup> )	Avoidance rate	Probability of collision	Bird transit time (secs)
Arctic skua	0.46	1.25	13.8	0.995	0.0793	0.0983
Curlew	0.6	1.0	13.0	0.98	0.0903	0.1152
Dunlin	0.2	0.43	15.3	0.98	0.0575	0.0717
Golden plover	0.28	0.72	17.9	0.98	0.0584	0.0658
Greenland white-fronted goose	0.715	1.475	17.1	0.998	0.0828	0.0943
Greylag goose	0.825	1.635	17.1	0.998	0.0885	0.1007
Hen harrier	0.48	1.1	12.0	0.99	0.0878	0.1148
Herring gull	0.64	1.5	12.8	0.98	0.0954	0.1201
Lapwing	0.31	0.87	11.9	0.98	0.0759	0.1014
Merlin	0.28	0.56	13.0	0.98	0.0686	0.0905
Peregrine falcon	0.48	1.1	12.1	0.98	0.0872	0.1138
Pink-footed goose	0.675	1.525	17.3	0.998	0.0807	0.0909
Ringed plover	0.2	0.57	19.5	0.98	0.0527	0.0563
Whooper swan	1.525	2.305	17.3	0.995	0.1231	0.1400

Table E-3 Visible area within the CRAA per vantage point

VP	Area (ha)
1	156.18
2	212.10
3	134.92

Birds are assumed to be active during all the daylight hours and this is estimated by calculating the number of hours per day between sunrise and sunset (adjusting for correct latitude) for the survey seasons as defined in Table E-4 below.

Table E-4 Season definitions per species/species group

Species	Breeding season		Hours presumed present	Non-breeding season		Hours presumed present
	Start date	End date		Start date	End date	
Geese and swans	15 <sup>th</sup> May	31 <sup>st</sup> August	1,865	1 <sup>st</sup> September	14 <sup>th</sup> May	2,647
Raptors	15 <sup>th</sup> March	31 <sup>st</sup> August	2,733	1 <sup>st</sup> September	14 <sup>th</sup> March	1,779
Waders	1 <sup>st</sup> April	31 <sup>st</sup> July	2,044	1 <sup>st</sup> August	31 <sup>st</sup> March	2,468
Other	15 <sup>th</sup> March	31 <sup>st</sup> August	2,733	1 <sup>st</sup> September	14 <sup>th</sup> March	1,779

Outputs for the CRM for the following species are presented in the following order below:

- Arctic skua;
- Curlew;
- Dunlin;
- Golden plover;
- Greenland white-fronted goose;
- Greylag goose;
- Hen harrier;
- Herring gull;
- Lapwing;
- Merlin;
- Peregrine falcon;
- Pink-footed goose;
- Ringed plover; and
- Whooper swan

**B.1 Arctic Skua**

Non-Breeding Season 2012/2013

**Table E-5 Arctic Skua flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	69.08	7964.93	0.000002

**Table E-6 Arctic Skua mortality estimates**

Mean activity in wind farm at rotor height	0.0006	hr <sup>1</sup>
Total Combined rotor swept volume	72951	m <sup>3</sup>
Bird occupancy	1.0173	hrs/season
Bird occupancy of rotor swept volume	0.9617	bird-sec
No. of transits through rotors	9.7799	per season
Estimated collisions	0.7752	per season
Estimated collisions after correction for operation	0.6589	per season
Estimated collisions after avoidance factor	0.0033	per season
Equivalent to 1 bird every	303.52	seasons

Breeding Season 2013

**Table E-7 Arctic Skua flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	17.08	6220.46	0.0000008

**Table E-8 Arctic Skua mortality estimates**

Mean activity in wind farm at rotor height	0.0002	hr <sup>1</sup>
Total Combined rotor swept volume	72951	m <sup>3</sup>
Bird occupancy	0.4949	hrs/season
Bird occupancy of rotor swept volume	0.4679	bird-sec
No. of transits through rotors	4.7576	per season
Estimated collisions	0.3771	per season
Estimated collisions after correction for operation	0.3205	per season
Estimated collisions after avoidance factor	0.0016	per season
Equivalent to 1 bird every	623.93	seasons

Breeding Season 2014

**Table E-9 Arctic Skua flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	26.26	11244.61	0.0000006

**Table E-10 Arctic Skua mortality estimates**

Mean activity in wind farm at rotor height	0.0002	hr <sup>1</sup>
Total Combined rotor swept volume	72951	m <sup>3</sup>
Bird occupancy	0.4210	hrs/season
Bird occupancy of rotor swept volume	0.3980	bird-sec
No. of transits through rotors	4.0477	per season
Estimated collisions	0.3208	per season
Estimated collisions after correction for operation	0.2727	per season
Estimated collisions after avoidance factor	0.0014	per season
Equivalent to 1 bird every	733.37	seasons

**B.2 Curlew**

Non-Breeding Season 2012/2013

**Table E-11 Curlew flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	42.05	7964.93	0.0000015

**Table E-12 Curlew mortality estimates**

Mean activity in wind farm at rotor height	0.0003	hr <sup>1</sup>
Total Combined rotor swept volume	80477	m <sup>3</sup>
Bird occupancy	0.8592	hrs/season
Bird occupancy of rotor swept volume	0.8960	bird-sec
No. of transits through rotors	7.7809	per season
Estimated collisions	0.7026	per season
Estimated collisions after correction for operation	0.5972	per season
Estimated collisions after avoidance factor	0.0119	per season
Equivalent to 1 bird every	83.72	seasons

Breeding Season 2013

**Table E-13 Curlew flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	374.76	5595.76	0.00002

**Table E-14 Curlew mortality estimates**

Mean activity in wind farm at rotor height	0.0044	hr <sup>1</sup>
Total Combined rotor swept volume	80477	m <sup>3</sup>
Bird occupancy	9.0289	hrs/season
Bird occupancy of rotor swept volume	9.4162	bird-sec
No. of transits through rotors	81.7672	per season
Estimated collisions	7.3837	per season
Estimated collisions after correction for operation	6.2761	per season
Estimated collisions after avoidance factor	0.1255	per season
Equivalent to 1 bird every	7.97	seasons

Non-Breeding Season 2013/2014

**Table E-15 Curlew flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	99.27	14211.94	0.000002

**Table E-16 Curlew mortality estimates**

Mean activity in wind farm at rotor height	0.0005	hr <sup>1</sup>
Total Combined rotor swept volume	80477	m <sup>3</sup>
Bird occupancy	1.1368	hrs/season
Bird occupancy of rotor swept volume	1.1856	bird-sec
No. of transits through rotors	10.2954	per season
Estimated collisions	0.9297	per season
Estimated collisions after correction for operation	0.7902	per season
Estimated collisions after avoidance factor	0.0158	per season
Equivalent to 1 bird every	63.27	seasons



## Breeding Season 2014

Table E-17 Curlew flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	1744.90	8901.99	0.00005

Table E-18 Curlew mortality estimates

Mean activity in wind farm at rotor height	0.0129	hr <sup>1</sup>
Total Combined rotor swept volume	80477	m <sup>3</sup>
Bird occupancy	26.4257	hrs/season
Bird occupancy of rotor swept volume	27.5592	bird-sec
No. of transits through rotors	239,3150	per season
Estimated collisions	21.6105	per season
Estimated collisions after correction for operation	18,3689	per season
Estimated collisions after avoidance factor	0.3674	per season
Equivalent to 1 bird every	2.72	seasons

## Non-Breeding Season 2015/2016

Table E-19 Curlew flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	709.86	14524.29	0.000014

Table E-20 Curlew mortality estimates

Mean activity in wind farm at rotor height	0.0032	hr <sup>1</sup>
Total Combined rotor swept volume	80477	m <sup>3</sup>
Bird occupancy	7.9541	hrs/season
Bird occupancy of rotor swept volume	8.2953	bird-sec
No. of transits through rotors	72.0337	per season
Estimated collisions	6.5047	per season
Estimated collisions after correction for operation	5.5290	per season
Estimated collisions after avoidance factor	0.1106	per season
Equivalent to 1 bird every	9.04	seasons

## Breeding Season 2016

Table E-21 Curlew flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	1295.77	8433.46	0.00004

Table E-22 Curlew mortality estimates

Mean activity in wind farm at rotor height	0.0101	hr <sup>1</sup>
Total Combined rotor swept volume	80477	m <sup>3</sup>
Bird occupancy	20.7140	hrs/season
Bird occupancy of rotor swept volume	21.6025	bird-sec
No. of transits through rotors	187,5890	per season
Estimated collisions	16.9395	per season
Estimated collisions after correction for operation	14.3986	per season
Estimated collisions after avoidance factor	0.2880	per season
Equivalent to 1 bird every	3.47	seasons

## Breeding Season 2017

Table E-23 Curlew flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
2	83.05	11453.44	0.0000012
3	58.34	7285.57	0.0000009

Table E-24 Curlew mortality estimates

Mean activity in wind farm at rotor height	0.0005	hr <sup>1</sup>
Total Combined rotor swept volume	80477	m <sup>3</sup>
Bird occupancy	1.0172	hrs/season
Bird occupancy of rotor swept volume	1.0608	bird-sec
No. of transits through rotors	9.2119	per season
Estimated collisions	0.8318	per season
Estimated collisions after correction for operation	0.7071	per season
Estimated collisions after avoidance factor	0.0141	per season
Equivalent to 1 bird every	70.71	seasons

## B.3 Dunlin

## Non-Breeding Season 2013/2014

Table E-25 Dunlin flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	159.29	14211.94	0.000003

Table E-26 Dunlin mortality estimates

Mean activity in wind farm at rotor height	0.0007	hr <sup>1</sup>
Total Combined rotor swept volume	58974	m <sup>3</sup>
Bird occupancy	1.8242	hrs/season
Bird occupancy of rotor swept volume	1.3941	bird-sec
No. of transits through rotors	19.4425	per season
Estimated collisions	1.1177	per season
Estimated collisions after correction for operation	0.9501	per season
Estimated collisions after avoidance factor	0.0190	per season
Equivalent to 1 bird every	52.63	seasons

## B.4 Golden Plover

### Breeding Season 2013

**Table E-27 Golden plover flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	139.28	5595.76	0.00007

**Table E-28 Golden plover mortality estimates**

Mean activity in wind farm at rotor height	0.0016	hr <sup>1</sup>
Total Combined rotor swept volume	63275	m <sup>3</sup>
Bird occupancy	3.3557	hrs/season
Bird occupancy of rotor swept volume	2.7516	bird-sec
No. of transits through rotors	41.8441	per season
Estimated collisions	2.4441	per season
Estimated collisions after correction for operation	2.0775	per season
Estimated collisions after avoidance factor	0.0415	per season
Equivalent to 1 bird every	24.07	seasons

### Non-Breeding Season 2013/2014

**Table E-29 Golden plover flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	597.26	14211.94	0.000012

**Table E-30 Golden plover mortality estimates**

Mean activity in wind farm at rotor height	0.0028	hr <sup>1</sup>
Total Combined rotor swept volume	63275	m <sup>3</sup>
Bird occupancy	6.8395	hrs/season
Bird occupancy of rotor swept volume	5.6082	bird-sec
No. of transits through rotors	85.2860	per season
Estimated collisions	4.9815	per season
Estimated collisions after correction for operation	4.2343	per season
Estimated collisions after avoidance factor	0.0847	per season
Equivalent to 1 bird every	11.81	seasons

### Breeding Season 2014

**Table E-31 Golden plover flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	432.57	8901.99	0.000013

**Table E-32 Golden plover mortality estimates**

Mean activity in wind farm at rotor height	0.0032	hr <sup>1</sup>
Total Combined rotor swept volume	63275	m <sup>3</sup>
Bird occupancy	6.5511	hrs/season
Bird occupancy of rotor swept volume	5.3717	bird-sec
No. of transits through rotors	81.6898	per season
Estimated collisions	4.7715	per season
Estimated collisions after correction for operation	4.0558	per season
Estimated collisions after avoidance factor	0.0811	per season
Equivalent to 1 bird every	12.33	seasons

### Non-Breeding Season 2015/2016

**Table E-33 Golden plover flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	10118.81	14524.29	0.0002

**Table E-34 Golden plover mortality estimates**

Mean activity in wind farm at rotor height	0.0459	hr <sup>1</sup>
Total Combined rotor swept volume	63275	m <sup>3</sup>
Bird occupancy	113.3833	hrs/season
Bird occupancy of rotor swept volume	92.9711	bird-sec
No. of transits through rotors	1413.8444	per season
Estimated collisions	82.5823	per season
Estimated collisions after correction for operation	70.1950	per season
Estimated collisions after avoidance factor	1.4039	per season
Equivalent to 1 bird every	0.71	seasons

### Breeding Season 2016

**Table E-35 Golden plover flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	3372.91	8433.46	0.00011

**Table E-36 Golden plover mortality estimates**

Mean activity in wind farm at rotor height	0.0264	hr <sup>1</sup>
Total Combined rotor swept volume	63275	m <sup>3</sup>
Bird occupancy	53.9190	hrs/season
Bird occupancy of rotor swept volume	44.2120	bird-sec
No. of transits through rotors	672.3478	per season
Estimated collisions	39.2717	per season
Estimated collisions after correction for operation	33.3809	per season
Estimated collisions after avoidance factor	0.6676	per season
Equivalent to 1 bird every	1.50	seasons

### Non-Breeding Season 2016/2017

**Table E-37 Golden plover flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
2	23993.75	17604.37	0.00022
3	4618.49	11333.10	0.00004

**Table E-38 Golden plover mortality estimates**

Mean activity in wind farm at rotor height	0.0622	hr <sup>1</sup>
Total Combined rotor swept volume	63275	m <sup>3</sup>
Bird occupancy	153.4642	hrs/season
Bird occupancy of rotor swept volume	125.8363	bird-sec
No. of transits through rotors	1913.6376	per season
Estimated collisions	111.7751	per season
Estimated collisions after correction for operation	95.0088	per season
Estimated collisions after avoidance factor	1.9002	per season
Equivalent to 1 bird every	0.53	seasons

## Breeding Season 2017

Table E-39 Golden plover flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
2	33220.25	11453.44	0.0005
3	0.00	7285.57	0.00

Table E-40 Golden plover mortality estimates

Mean activity in wind farm at rotor height	0.1169	hr <sup>1</sup>
Total Combined rotor swept volume	63275	m <sup>3</sup>
Bird occupancy	239.0004	hrs/season
Bird occupancy of rotor swept volume	195.9736	bird-sec
No. of transits through rotors	2980.2387	per season
Estimated collisions	174.0750	per season
Estimated collisions after correction for operation	147.9638	per season
Estimated collisions after avoidance factor	2.9593	per season
Equivalent to 1 bird every	0.34	seasons

## B.5 Greenland White-Fronted Goose

## Non-Breeding Season 2016/2017

Table E-41 Greenland white-fronted goose flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
2	1203.84	26512.60	0.000008
3	0.00	16190.15	0.00

Table E-42 Greenland white-fronted goose mortality estimates

Mean activity in wind farm at rotor height	0.0019	hr <sup>1</sup>
Total Combined rotor swept volume	86659	m <sup>3</sup>
Bird occupancy	4.9212	hrs/season
Bird occupancy of rotor swept volume	5.5265	bird-sec
No. of transits through rotors	58.6229	per season
Estimated collisions	4.8524	per season
Estimated collisions after correction for operation	4.1245	per season
Estimated collisions after avoidance factor	0.0082	per season
Equivalent to 1 bird every	121.23	seasons

## B.6 Greylag Goose

## Non-Breeding Season 2012/2013

Table E-43 Greylag goose flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
1	8893.47	8589.64	0.0003

Table E-44 Greylag goose mortality estimates

Mean activity in wind farm at rotor height	0.0683	hr <sup>1</sup>
Total Combined rotor swept volume	92572	m <sup>3</sup>
Bird occupancy	180.7400	hrs/season
Bird occupancy of rotor swept volume	216.8217	bird-sec
No. of transits through rotors	2153.0291	per season
Estimated collisions	190.6134	per season
Estimated collisions after correction for operation	162.0214	per season
Estimated collisions after avoidance factor	0.3240	per season
Equivalent to 1 bird every	3.09	seasons

## Non-Breeding Season 2013/2014

Table E-45 Greylag goose flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
1	3616.65	17335.45	0.00006

Table E-46 Greylag goose mortality estimates

Mean activity in wind farm at rotor height	0.0138	hr <sup>1</sup>
Total Combined rotor swept volume	92572	m <sup>3</sup>
Bird occupancy	36.4192	hrs/season
Bird occupancy of rotor swept volume	43.6896	bird-sec
No. of transits through rotors	433.8360	per season
Estimated collisions	38.4087	per season
Estimated collisions after correction for operation	32.6474	per season
Estimated collisions after avoidance factor	0.0653	per season
Equivalent to 1 bird every	15.32	seasons

## Non-Breeding Season 2015/2016

Table E-47 Greylag goose flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
1	26618.73	19209.55	0.0004

Table E-48 Greylag goose mortality estimates

Mean activity in wind farm at rotor height	0.0914	hr <sup>1</sup>
Total Combined rotor swept volume	92572	m <sup>3</sup>
Bird occupancy	241.8958	hrs/season
Bird occupancy of rotor swept volume	290.1861	bird-sec
No. of transits through rotors	2881.5349	per season
Estimated collisions	255.1100	per season
Estimated collisions after correction for operation	216.8435	per season
Estimated collisions after avoidance factor	0.4337	per season
Equivalent to 1 bird every	2.31	seasons

## Non-Breeding Season 2016/2017

Table E-49 Greylag goose flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
2	58646.27	26512.60	0.00038
3	17349.23	16190.15	0.00011

Table E-50 Greylag goose mortality estimates

Mean activity in wind farm at rotor height	0.1174	hr <sup>-1</sup>
Total Combined rotor swept volume	92572	m <sup>3</sup>
Bird occupancy	310.6634	hrs/season
Bird occupancy of rotor swept volume	372.6820	bird-sec
No. of transits through rotors	3700.7155	per season
Estimated collisions	327.6343	per season
Estimated collisions after correction for operation	278.4891	per season
Estimated collisions after avoidance factor	0.5570	per season
Equivalent to 1 bird every	1.80	seasons

## B.7 Hen Harrier

## Non-Breeding Season 2013/2014

Table E-51 Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
1	14.79	12181.66	0.000003

Table E-52 Hen harrier mortality estimates

Mean activity in wind farm at rotor height	0.00008	hr <sup>-1</sup>
Total Combined rotor swept volume	74026	m <sup>3</sup>
Bird occupancy	0.1424	hrs/season
Bird occupancy of rotor swept volume	0.1366	bird-sec
No. of transits through rotors	1.1907	per season
Estimated collisions	0.1045	per season
Estimated collisions after correction for operation	0.0888	per season
Estimated collisions after avoidance factor	0.0009	per season
Equivalent to 1 bird every	1125.65	seasons

## Non-Breeding Season 2016/2017

Table E-53 Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
2	12.88	16331.76	0.0000013
3	0.00	10523.60	0.00

Table E-54 Hen harrier mortality estimates

Mean activity in wind farm at rotor height	0.00003	hr <sup>-1</sup>
Total Combined rotor swept volume	74026	m <sup>3</sup>
Bird occupancy	0.0563	hrs/season
Bird occupancy of rotor swept volume	0.0540	bird-sec
No. of transits through rotors	0.4703	per season
Estimated collisions	0.0413	per season
Estimated collisions after correction for operation	0.0351	per season
Estimated collisions after avoidance factor	0.0004	per season
Equivalent to 1 bird every	2849.68	seasons

## B.8 Herring Gull

## Breeding Season 2014

Table E-55 Herring gull flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
1	2657.72	11244.61	0.00007

Table E-56 Herring gull mortality estimates

Mean activity in wind farm at rotor height	0.0156	hr <sup>-1</sup>
Total Combined rotor swept volume	82627	m <sup>3</sup>
Bird occupancy	42.6057	hrs/season
Bird occupancy of rotor swept volume	45.6203	bird-sec
No. of transits through rotors	379.9066	per season
Estimated collisions	36.2576	per season
Estimated collisions after correction for operation	30.8189	per season
Estimated collisions after avoidance factor	0.6164	per season
Equivalent to 1 bird every	1.62	seasons

## B.9 Lapwing

Non-Breeding Season 2012/2013

**Table E-57 Lapwing flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	1017.13	7964.93	0.00004

**Table E-58 Lapwing mortality estimates**

Mean activity in wind farm at rotor height	0.0084	hr <sup>1</sup>
Total Combined rotor swept volume	64888	m <sup>3</sup>
Bird occupancy	20.7830	hrs/season
Bird occupancy of rotor swept volume	17.4758	bird-sec
No. of transits through rotors	172.2880	per season
Estimated collisions	13.0820	per season
Estimated collisions after correction for operation	11.1197	per season
Estimated collisions after avoidance factor	0.2224	per season
Equivalent to 1 bird every	4.50	seasons

Breeding Season 2013

**Table E-59 Lapwing flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	400.07	5595.76	0.00002

**Table E-60 Lapwing mortality estimates**

Mean activity in wind farm at rotor height	0.0047	hr <sup>1</sup>
Total Combined rotor swept volume	64888	m <sup>3</sup>
Bird occupancy	9.6387	hrs/season
Bird occupancy of rotor swept volume	8.1049	bird-sec
No. of transits through rotors	79.9036	per season
Estimated collisions	6.0672	per season
Estimated collisions after correction for operation	5.1571	per season
Estimated collisions after avoidance factor	0.1031	per season
Equivalent to 1 bird every	9.70	seasons

Non-Breeding Season 2013/2014

**Table E-61 Lapwing flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	18519.40	14211.94	0.0004

**Table E-62 Lapwing mortality estimates**

Mean activity in wind farm at rotor height	0.0859	hr <sup>1</sup>
Total Combined rotor swept volume	64888	m <sup>3</sup>
Bird occupancy	212.0743	hrs/season
Bird occupancy of rotor swept volume	178.3270	bird-sec
No. of transits through rotors	1758.0632	per season
Estimated collisions	133.4913	per season
Estimated collisions after correction for operation	113.4676	per season
Estimated collisions after avoidance factor	2.2694	per season
Equivalent to 1 bird every	0.44	seasons

Breeding Season 2014

**Table E-63 Lapwing flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	4702.12	8901.99	0.00015

**Table E-64 Lapwing mortality estimates**

Mean activity in wind farm at rotor height	0.0348	hr <sup>1</sup>
Total Combined rotor swept volume	64888	m <sup>3</sup>
Bird occupancy	71.2114	hrs/season
Bird occupancy of rotor swept volume	59.8795	bird-sec
No. of transits through rotors	590.3312	per season
Estimated collisions	44.8244	per season
Estimated collisions after correction for operation	38.1007	per season
Estimated collisions after avoidance factor	0.7620	per season
Equivalent to 1 bird every	1.31	seasons

Non-Breeding Season 2015/2016

**Table E-65 Lapwing flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	5793.14	14524.29	0.00011

**Table E-66 Lapwing mortality estimates**

Mean activity in wind farm at rotor height	0.0263	hr <sup>1</sup>
Total Combined rotor swept volume	64888	m <sup>3</sup>
Bird occupancy	64.9132	hrs/season
Bird occupancy of rotor swept volume	54.5836	bird-sec
No. of transits through rotors	538.1207	per season
Estimated collisions	40.8600	per season
Estimated collisions after correction for operation	34.7310	per season
Estimated collisions after avoidance factor	0.6946	per season
Equivalent to 1 bird every	1.44	seasons

Breeding Season 2016

**Table E-67 Lapwing flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>1</sup> )
1	8711.26	8433.46	0.0003

**Table E-68 Lapwing mortality estimates**

Mean activity in wind farm at rotor height	0.0681	hr <sup>1</sup>
Total Combined rotor swept volume	64888	m <sup>3</sup>
Bird occupancy	139.2571	hrs/season
Bird occupancy of rotor swept volume	117.0972	bird-sec
No. of transits through rotors	1154.4200	per season
Estimated collisions	87.6561	per season
Estimated collisions after correction for operation	74.5077	per season
Estimated collisions after avoidance factor	1.4902	per season
Equivalent to 1 bird every	0.67	seasons

## Non-Breeding Season 2016/2017

Table E-69 Lapwing flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
2	810.16	17604.37	0.000007
3	0.00	11333.10	0.00

Table E-70 Lapwing mortality estimates

Mean activity in wind farm at rotor height	0.0018	hr <sup>-1</sup>
Total Combined rotor swept volume	64888	m <sup>3</sup>
Bird occupancy	4.3454	hrs/season
Bird occupancy of rotor swept volume	3.6539	bird-sec
No. of transits through rotors	36.0223	per season
Estimated collisions	2.7352	per season
Estimated collisions after correction for operation	2.3249	per season
Estimated collisions after avoidance factor	0.0465	per season
Equivalent to 1 bird every	21.51	seasons

## Breeding Season 2017

Table E-71 Lapwing flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
2	850.86	11453.44	0.000013
3	768.72	7285.57	0.000011

Table E-72 Lapwing mortality estimates

Mean activity in wind farm at rotor height	0.0057	hr <sup>-1</sup>
Total Combined rotor swept volume	64888	m <sup>3</sup>
Bird occupancy	11.6519	hrs/season
Bird occupancy of rotor swept volume	9.7977	bird-sec
No. of transits through rotors	96.5923	per season
Estimated collisions	7.3343	per season
Estimated collisions after correction for operation	6.2342	per season
Estimated collisions after avoidance factor	0.1247	per season
Equivalent to 1 bird every	8.02	seasons

## B.10 Merlin

## Non-Breeding Season 2016/2017

Table E-73 Merlin flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
2	13.42	16331.76	0.00000014
3	0.00	10523.60	0.00

Table E-74 Merlin mortality estimates

Mean activity in wind farm at rotor height	0.00003	hr <sup>-1</sup>
Total Combined rotor swept volume	63275	m <sup>3</sup>
Bird occupancy	0.059	hrs/season
Bird occupancy of rotor swept volume	0.048	bird-sec
No. of transits through rotors	0.531	per season
Estimated collisions	0.036	per season
Estimated collisions after correction for operation	0.031	per season
Estimated collisions after avoidance factor	0.001	per season
Equivalent to 1 bird every	1615.3	seasons

## B.11 Peregrine Falcon

## Non-Breeding Season 2016/2017

Table E-75 Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
2	14.77	16331.76	0.0000002
3	0.00	10523.60	0.00

Table E-76 Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.00004	hr <sup>-1</sup>
Total Combined rotor swept volume	74026	m <sup>3</sup>
Bird occupancy	0.0645	hrs/season
Bird occupancy of rotor swept volume	0.0619	bird-sec
No. of transits through rotors	0.5438	per season
Estimated collisions	0.0474	per season
Estimated collisions after correction for operation	0.0403	per season
Estimated collisions after avoidance factor	0.0008	per season
Equivalent to 1 bird every	1239.80	seasons

## Breeding Season 2017

Table E-77 Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
2	20.93	14634.96	0.0000003
3	0.00	8499.83	0.00

Table E-78 Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.00006	hr <sup>-1</sup>
Total Combined rotor swept volume	74026	m <sup>3</sup>
Bird occupancy	0.1631	hrs/season
Bird occupancy of rotor swept volume	0.1564	bird-sec
No. of transits through rotors	1.3745	per season
Estimated collisions	0.1199	per season
Estimated collisions after correction for operation	0.1019	per season
Estimated collisions after avoidance factor	0.0020	per season
Equivalent to 1 bird every	490.57	seasons

## B.12 Pink-Footed Goose

## Non-Breeding Season 2013/2014

Table E-79 Pink-footed goose flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
1	7338.07	17335.45	0.00012

Table E-80 Pink-footed goose mortality estimates

Mean activity in wind farm at rotor height	0.0279	hr <sup>-1</sup>
Total Combined rotor swept volume	84509	m <sup>3</sup>
Bird occupancy	73.8933	hrs/season
Bird occupancy of rotor swept volume	80.9235	bird-sec
No. of transits through rotors	890.5345	per season
Estimated collisions	71.8682	per season
Estimated collisions after correction for operation	61.0879	per season
Estimated collisions after avoidance factor	0.1222	per season
Equivalent to 1 bird every	8.18	seasons

## Non-Breeding Season 2015/2016

Table E-81 Pink-footed goose flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
1	518767.23	19209.55	0.0075

Table E-82 Pink-footed goose mortality estimates

Mean activity in wind farm at rotor height	1.7812	hr <sup>-1</sup>
Total Combined rotor swept volume	84509	m <sup>3</sup>
Bird occupancy	4714.2592	hrs/season
Bird occupancy of rotor swept volume	5162.7686	bird-sec
No. of transits through rotors	56814.4760	per season
Estimated collisions	4585.0585	per season
Estimated collisions after correction for operation	3897.2997	per season
Estimated collisions after avoidance factor	7.7946	per season
Equivalent to 1 bird every	0.13	seasons

## Non-Breeding Season 2016/2017

Table E-83 Pink-footed goose flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>-1</sup> )
2	127339.62	26512.60	0.0008
3	26950.14	16190.15	0.0002

Table E-84 Pink-footed goose mortality estimates

Mean activity in wind farm at rotor height	0.2383	hr <sup>-1</sup>
Total Combined rotor swept volume	84509	m <sup>3</sup>
Bird occupancy	630.7240	hrs/season
Bird occupancy of rotor swept volume	690.7304	bird-sec
No. of transits through rotors	7601.2481	per season
Estimated collisions	613.4382	per season
Estimated collisions after correction for operation	521.4224	per season
Estimated collisions after avoidance factor	1.0428	per season
Equivalent to 1 bird every	0.96	seasons



**B.14 Ringed Plover**

Non-Breeding Season 2012/2013

**Table E-85 Ringed plover flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>3</sup> )
1	1100.98	7964.93	0.00004

**Table E-86 Ringed plover mortality estimates**

Mean activity in wind farm at rotor height	0.0091	hr <sup>1</sup>
Total Combined rotor swept volume	58974	m <sup>3</sup>
Bird occupancy	22.4963	hrs/season
Bird occupancy of rotor swept volume	17.1926	bird-sec
No. of transits through rotors	305.5946	per season
Estimated collisions	16.1143	per season
Estimated collisions after correction for operation	13.6972	per season
Estimated collisions after avoidance factor	0.2739	per season
Equivalent to 1 bird every	3.65	seasons

Breeding Season 2013

**Table E-87 Ringed plover flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>3</sup> )
1	25.98	5595.76	0.0000013

**Table E-88 Ringed plover mortality estimates**

Mean activity in wind farm at rotor height	0.0003	hr <sup>1</sup>
Total Combined rotor swept volume	58974	m <sup>3</sup>
Bird occupancy	0.6259	hrs/season
Bird occupancy of rotor swept volume	0.4783	bird-sec
No. of transits through rotors	8.5021	per season
Estimated collisions	0.4483	per season
Estimated collisions after correction for operation	0.3811	per season
Estimated collisions after avoidance factor	0.0076	per season
Equivalent to 1 bird every	131.21	seasons

**B.15 Whooper Swan**

Non-Breeding Season 2015/2016

**Table E-89 Whooper swan flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>3</sup> )
1	610.56	19209.55	0.000009

**Table E-90 Whooper swan mortality estimates**

Mean activity in wind farm at rotor height	0.0021	hr <sup>1</sup>
Total Combined rotor swept volume	130202	m <sup>3</sup>
Bird occupancy	5.5484	hrs/season
Bird occupancy of rotor swept volume	9.3617	bird-sec
No. of transits through rotors	66.8675	per season
Estimated collisions	8.2322	per season
Estimated collisions after correction for operation	6.9974	per season
Estimated collisions after avoidance factor	0.0350	per season
Equivalent to 1 bird every	28.58	seasons

Non-Breeding Season 2016/2017

**Table E-91 Whooper swan flight activity**

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr <sup>3</sup> )
2	1007.81	26512.60	0.000007
3	0.00	16190.15	0.00

**Table E-92 Whooper swan mortality estimates**

Mean activity in wind farm at rotor height	0.0016	hr <sup>1</sup>
Total Combined rotor swept volume	130202	m <sup>3</sup>
Bird occupancy	4.1199	hrs/season
Bird occupancy of rotor swept volume	6.9513	bird-sec
No. of transits through rotors	49.6510	per season
Estimated collisions	6.1126	per season
Estimated collisions after correction for operation	5.1957	per season
Estimated collisions after avoidance factor	0.0260	per season
Equivalent to 1 bird every	38.49	seasons



## **ANNEX C. ORNITHOLOGICAL BASELINE DATA AND METHODOLOGY (CALEDONIAN CONSERVATION REPORT)**

Detailed on the pages below is the baseline report written by Caledonian Conservation Ltd. in December 2014 and details the results of baseline surveys undertaken between September 2012 and August 2014. It should be noted that any preliminary assessment (including preliminary collision modelling) contained in this report has been superseded by the assessment undertaken in Chapter 8: Ornithology.

Further baseline surveys were undertaken by Caledonian Conservation Ltd. between October 2015 and August 2017, the results of which were provided to RES/MacArthur Green in shapefiles and in a Microsoft Access Database – these have been detailed where relevant in Section 8.3 Baseline Conditions of Chapter 8 (Ornithology) of the EIA Report.