

Environmental Impact Assessment

Sandy Knowe Wind Farm Extension

Appendix: 7-1 Ornithology

ERG UK Holding Ltd.



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1 Introduction

This Technical Appendix supports Chapter 7: Ornithology of the EIAR and should be read in conjunction with Chapter 7 and Technical Appendix 7-2 Confidential Annex.

It provides the result of the desk study, describes the survey methodology and the results of those surveys, and describes the methodologies for the collision risk assessment and cumulative assessment.

Initial ornithology survey work in support of this application was carried out by ITP Energised Environments Limited from September 2019 and continued until August 2020. Atmos Consulting Ltd then carried out bird surveys in support of the Proposed Development between September 2020 and August 2021.

1.1 Proposed Development Description

The Proposed Development is located approximately 9 kilometres West of Sanquhar and 13 kilometres south west of Cumnock.

The Proposed Development Site is located on low lying hills to the north of the Southern Uplands hill range, which extend across southern Scotland from Dumfries and Galloway to the Scottish Borders. The Proposed Development is on the northern fringes of the Southern Uplands, to the south of the undulating upland hills and plateaux area that extends towards the Clyde Valley to the north. The Proposed Development is contained within Dumfries and Galloway, on the hills south of the A76 to the south-west of Kirkconnel.

The Proposed Development is focused to the south of the Nithsdale on the lower-lying northern slopes of hills which include High Cairn (553m Above Ordnance Datum (AOD)) and White Hill (418m AOD). The surrounding area is largely characterised by moorland landcover with blocks of coniferous forest cover. Sandy Knowe Wind Farm is located to the immediate south-east of the Proposed Development Footprint.

A number of small upland tributaries pass through the Proposed Development Footprint, including the Polhote Burn within the western part of the site. Tributaries across the Proposed Development Footprint flow north into the River Nith, which flows south-east and joins the Solway Firth to the south of Dumfries.

The Proposed Development lies to the south of the Muirkirk and North Lowther Uplands Special Protection Area (SPA), at its closest point approximately four kilometres to the north.

It should be noted that initially the western extension area (comprising turbines T25, T26, T27 and T28 and supporting infrastructure) was proposed and so initial ornithology surveys carried only this area. As a result, surveys over the northern extension area (comprising turbines T29 and T30 plus supporting infrastructure) commenced later.

2 Ornithological legislation and conservation Status

2.1 Wildlife and Countryside Act 1981 (as amended) & Conservation (Natural Habitats & c.) Regulations 1994 (as amended in Scotland)

The Wildlife and Countryside Act 1981 (as amended) (WCA) is the principal mechanism for the legislative protection of wildlife in Great Britain. All wild birds and their active nests, eggs and young are protected from damage, destruction or capture under the WCA. Bird species listed on Schedule 1 gain additional protection particularly around their nests, with disturbance listed as an offence, with special penalties for breaches of the law related to those Schedule 1 species. The WCA also provides the mechanism by which the Conservation of Wild Birds (Directive 2009/147/EC, the 'Birds Directive') is transposed into UK law, allowing for the designation of Special Protection Areas (SPAs).

The Birds Directive lays out special measures to conserve wild birds, their eggs, nests and habitats, and applies special protection to those species as listed under Annex 1 of the Directive. This is to apply special protection, in particular, to those species which are migratory and are considered to be of a shared heritage and conservation responsibility across all European Union member states.

The Conservation of Habitats and Species Regulations (1994) (as amended in Scotland), or 'Habitat Regulations', are the method by which the relevant European Directives are translated into Scottish law, with the most recent modification consisting of the Amendment (Scotland) 2012 revision. Specifically, the Habitat Regulations transpose the Convention on the Conservation of European Wildlife and Natural Habitats (the 'Bern Convention') and Natural Habitats and Wild Fauna and Flora (92/43/EEC, the 'Habitats Directive') into a Scottish context.

2.2 Nature Conservation (Scotland) Act 2004

The Scottish Biodiversity List (SBL) was developed to meet the requirements of Section 2 (4) of the Nature Conservation (Scotland) 2004 Act (NCSA) for the conservation of biodiversity. This legislation required Scottish Ministers to publish lists of species of flora, fauna and habitats considered to be of principal importance for the purposes of biodiversity.

Taken together, the WCA (1981) and NCSA (2004) ensure that all wild birds, their nests and eggs are protected by making it an offence to:

- Intentionally or recklessly kill, injure or take any wild bird;
- Intentionally or recklessly take, damage or destroy the nest of any wild bird while it is in use or being built;
- Intentionally or recklessly take or destroy the egg of any wild bird; and
- Intentionally or recklessly disturb any wild bird listed on Schedule 1 while it is nest building or is at (or near) a nest with eggs or young, or disturb the dependent young of such a bird without a Schedule 1 license provided by Naturescot (NS).

2.3 Birds of Conservation Concern 4 (BoCC)

The leading government (Joint Nature Conservation Committee (JNCC)) and non-government conservation organisations in the UK jointly reviewed the population status of the 247 bird species that are regularly found within the United Kingdom using data from national monitoring schemes. This was most recently reviewed in 2015 (Eaton et al. 2015) and was an update to the earlier 2009 BoCC report.

On the basis of seven quantitative criteria, each species has been placed on one of three lists, these being:

- Red – red list species are those that are globally threatened, have had an historical population decline in the UK from 1800 -1995, a rapid (> or = 50%) decline in UK breeding population over the past 25 years, or a rapid (> or = 50%) contraction of UK breeding range over the past 25 years;
- Amber – amber listed species are those that have had a historical population decline from 1800-1995 but are recovering (population size has more than doubled over the past 25 years), a moderate (25-49%) decline in UK breeding population over the past 25 years, a moderate (25-49%) contraction of UK breeding range over the past 25 years, a moderate (25-49%) decline in UK non-breeding population over the past 25 years, or species with unfavourable conservation status in Europe also known as Species of European Conservation Concern (SPEC); and
- Green – green listed species are those that have no identified threat to their population status.

2.4 Ornithological Guidance

NS, formerly Scottish Natural Heritage, has produced a number of guidance documents in relation to the assessment of impacts of wind farm developments on bird populations. The following guidance informed the survey work and any subsequent assessments:

- Windfarms and birds: calculating a theoretical collision risk assuming no avoidance action (2000);
- Environmental Statements and Annexes of Environmentally Sensitive Bird Information (2009);
- Assessing the Cumulative Impacts of Onshore Wind Energy Developments (2012a);
- Recommended bird survey methods to inform impact assessment of onshore wind farms (2014);
- Natural Heritage Zones Bird Population Estimates (2015) (published by the Scottish Windfarm Bird Steering Group (SWBSG)) (Wilson, 2015);
- Assessing Connectivity with Special Protection Areas (2016a);
- Assessing the Significance of Impacts from Onshore Wind Farms on Birds at Sites Outwith Designated Areas (2016b);
- Avoidance Rates for the Onshore SNH Bird Wind Farm Collision Risk Model (2017)
- Recommended bird survey methods to inform impact assessment of onshore wind farms (2017); and,
- Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal (Chartered Institute of Ecology and Environmental Management (CIEEM, 2018).

3 Methodology

3.1 Desk study

3.1.1 Designated sites

A desktop search of designated sites in proximity to the Proposed Development was undertaken using the following criteria:

- Any nationally/internationally designated site with an avian designation (e.g. Natura sites, Sites of Special Scientific Interest (SSSIs)) within 10km of the Proposed Development boundary; and
- Any internationally designated site with geese as a qualifying feature within 20km of the Proposed Development.

Criteria were chosen based upon likely connectivity of selected receptors (NS, 2016).

3.1.2 Other available data

Sandy Knowe Wind Farm EIAR 7.1 Ornithology Technical Report

The technical results which were submitted in support of Sandy Knowe Wind Farm application as part of the EIAR were considered to provide background data for findings for previous surveys of Sandy Knowe Wind Farm (WSP 2012) (This report, details vantage point surveys, breeding bird surveys, black grouse survey, winter bird surveys and woodland point count surveys carried out between April 2011 and July 2012). Methodology for surveys are described in detail in this report.

These surveys were completed on the now consented Sandy Knowe Wind Farm different areas of which lie variously to the east or to the south of Proposed Development.

Raptor study group data consultation

Data was requested from the Dumfries and Galloway Raptor Study Group in 2021 for records of Annex I or Schedule 1 birds of prey recorded in the last 10 years but data returned stretched back as far as 2013. This data is reported in Confidential Technical Appendix 7-2.

RSPB data consultation

Data was requested from the RSPB in 2021 for bird records within two kilometres of the Proposed Development Footprint from 2011 onwards. This data is reported in Confidential Technical Appendix 7.2.

3.2 Vantage Point Surveys

Vantage point (VP) surveys of the Proposed Development were carried out following current NS guidance (NS 2017).

Initially one VP was used to carry out vantage point surveys, covering the western extension area. Surveys commenced in September 2019 and were completed in October 2021. A second VP location was introduced in March 2021 to take account of

a change in development footprint. VP locations and bearings are shown in Table 1, and on Figure 7-1.

Table 1 Vantage point locations: November 2020 to October 2021

Vantage point	Grid reference	View bearing
VP1	268007, 610735	135°/120° ^{footnote 1}
VP2	270487, 611749	190°

Following guidance, surveys were undertaken in watches of no longer than three hours. Each VP watch was undertaken by a suitably experienced single observer in conditions of good visibility. The surveyor positioned themselves as inconspicuously as possible to minimise their effects on the birds' natural behaviour. Table 2 summarises the observation effort of the VP watches, with a total of 161 hours of survey undertaken between September 2019 and October 2021

Dates and times of all VPs are provided in Appendix A: summary of VP data.

Table 2 Vantage point observation effort: September 2019 to October 2021

VP No.	Year	J	F	M	A	M	J	J	A	S	O	N	D	Total Hrs/Year
1	2019									6	6	6	6	24
	2020	6	6	6	6	6	6	6	6			6	6	60
	2021	12	6	6	6	6	3		3		6			48
2	2021			6	6	4.8		6			6			28.8

3.3 Breeding Bird Surveys

Breeding bird surveys conducted in support of the Proposed Development followed the NS (2017) guidance. Surveys followed an amended Brown and Shepherd (1993) methodology. This involved following a transect route covering the Survey Area which included a 500 m buffer (Figure 6.2). The route was walked slowly at a steady speed, using periodic scanning with binoculars as required, with the identity of all birds seen and heard recorded and any breeding activity noted. This activity included males in song, birds carrying nesting material or food, birds seen on nests or adults with young.

Surveys carried out in 2019 covered the western extension area. The survey dates were:

- May 26th;
- June 15th;
- July 2nd; and
- July 24th.

Two breeding bird surveys were undertaken during the spring/summer months of 2021, as shown in Table 3 below.

¹ Surveys commenced using a bearing of 135°; from November 2020 they were carried out using a view bearing of 120°. The difference in viewshed coverage is minimal between these two bearings. The difference occurred due to the VP location being known in November 2020 but not the bearing that had been used prior to this.

Table 3: Summary of breeding bird surveys 2021

Visit Date	Visit No.	Observer	Start	End	Temperature (0C)	Visibility (kilometres)
22/04/2021	1	M. Christie	09:30	15:00	6	>2 km
28/07/2021	2	R. McRory	09:54	16:06	15-17	>2 km
29/07/2021	2	A. Francis	13:50	18:05	14-19	>2 km
30/07/2021	2	A. Francis	13:08	14:10	16	>2 km

The behaviour and location of species were recorded on 1:10,000 scale maps, using standard BTO codes and nomenclature.

Once surveys were complete, analysis of territories was undertaken. The following definitions were used as a general guide but particularly for the 2021 surveys, given the limited surveys carried out a more precautionary approach was adopted to account for the under-recording of territories and effectively a lower standard of evidence was used to assign probable and possible territories:

- Confirmed territory – nest was found or adults seen carrying food (unless raptors) or nesting materials. Presence of juvenile birds on the site;
- Probable territory – bird(s) were seen in the same location on more than one occasion, or, where breeding behaviour was observed on at least one occasion (e.g. courtship, display or singing, pairs in suitable habitat, territorial disputes);
- Possible territory – birds observed only once in one location, in suitable habitat but without strong evidence of breeding (as above) observed; and
- Non-breeding – bird was observed but was unlikely to breed in the habitat in which it was observed.

3.4 Breeding Raptor Surveys

A transect survey incorporating vantage point 'stand watches' was followed, as described in Hardey et al (2013)². The transect route followed aimed to ensure the best possible coverage of the Survey Area which included a two kilometre buffer, providing a representative sample of the habitats present. The surveyor recorded the position of each raptor seen and heard, along with notes on behaviour observed. Due to the rugged nature of the terrain, the transect route incorporated fixed duration 'stand-watches' at vantage points on elevated locations (hilltops).

Raptor surveys were carried out at the Proposed Development between May 2020 and August 2020. Surveys were carried out over the western extension area plus a 2 kilometre buffer. Dates of survey were

- May 29th & June 2nd;
- June 17th & 19th;
- July 14th, 16th & 21st; and
- August 6th, 7th & 13th.

² Hardey, J, Crick, H., Wernham, C., Riley, H., Etheridge, B. and Thompson, D. (2013) Raptors: A Field Guide for Surveys and Monitoring, Scottish Natural Heritage Third Edition.

In 2021, the Proposed Development area was extended to include the northern extension area (Figure 3-1; Figure 7-2), but construction of the Sandy Knowe Wind Farm had also commenced. Access into buffer areas was also limited and as a result limited surveys were carried out in the early part of the season. Table 4 shows the dates and times of 2021 surveys.

Table 4: Summary of breeding raptor surveys 2021

Visit Date	Visit No.	Observer	Start	End	Temperature (°C)	Visibility (km)
11/06/2021	1	RM	09:30	15:30	15	>2
29/06/2021	2	RM	09:30	16:40	21	>2
30/06/2021	2	RM	09:30	15:40	18	>2
01/07/2021	2	RM	10:30	15:30	20	>2
02/07/2021	2	RM	09:15	16:00	19	>2
30/07/2021	3	RM	10:10	17:15	15	>2
30/07/2021	3	AF	14:10	17:55	16-21	>2
09/08/2021	4	RM	15:30	18:50	13	>2
10/08/2021	4	RM	10:45	12:20	14	>2
11/08/2021	4	RM	16:30	20:30	13	1-2km

3.5 Winter Bird Surveys

Winter bird surveys were carried out in the winter of 2019/2020 with three visits carried out:

- November 18th 2019;
- February 2nd 2020; and
- March 6th 2020.

No winter bird surveys were carried out in 2020/2021 as following NS guidance, no requirement for them was identified.

3.6 Limitations

3.6.1 Breeding bird surveys

In 2020, the Covid pandemic meant that surveys were not able to be carried out in April, meaning that surveys were condensed over a shorter period and therefore early season activity may have been missed.

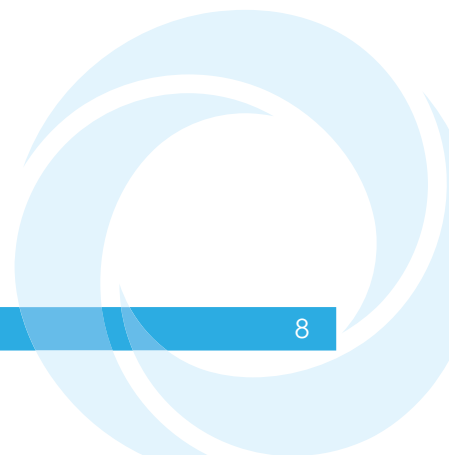
In 2021, a restricted number of surveys was carried out which made it more likely breeding activity could have been missed. As a result, territory analysis was carried out in a more precautionary way, with reduced evidence required to assign probable or possible territories.

3.6.2 Breeding raptor surveys

In 2020, the Covid pandemic meant that surveys were not able to be carried out in April, meaning that surveys were condensed over a shorter time period. This does mean that there is potential that early season breeding activity may have been missed.

In 2021 a combination of the increased area over which surveys had to be undertaken, combined with the commencement of the construction of Sandy Knowe Wind Farm mean that access was not available until mid-way through the season, and even then, access was not fully complete.

This meant that early season activity could also have been missed; however through this period vantage point surveys were ongoing on and around the Proposed Development which would ameliorate the risk of this.



4 Survey Results

4.1 Desk Study

4.1.1 Designated sites

The Muirkirk and North Lowther Uplands SPA lies approximately 4km to the north of the Proposed Development (Figure 7-3). The features for which this site was designated are shown in Table 5.

Table 5: Qualifying species of the Muirkirk and North Lowther Uplands SPA

Designated Feature	2015 Condition	Latest Assessed Condition
Breeding populations:		
Golden plover <i>Pluvialis apricaria</i> (minimum breeding population of 155 pairs in 1999)	Favourable Maintained	Unfavourable Declining
Hen harrier <i>Circus cyaneus</i> (mean of 29.2 breeding females 1994-1998)	Unfavourable Declining	Unfavourable Declining
Merlin <i>Falco columbarius</i> (mean of 9 breeding pairs 1989-1998)	Unfavourable No change	Unfavourable No change
Peregrine <i>Falco peregrinus</i> (mean of 6 breeding pairs 1992-1996)	Unfavourable No change	Unfavourable No change
Short-eared owl <i>Asio flammeus</i> (26 breeding pairs 1997-1998)	Favourable Maintained	Favourable Maintained
Non-breeding population:		
Hen harrier (mean of 12 individuals 1991-1995)	Unfavourable Declining	Unfavourable Declining

The SPA in this area is underlain by two SSSIs.

Muirkirk Uplands SSSI, which lies, at closest, just over 4km to the north of the Proposed Development boundary, is designated for a number of qualifying features including Hen harrier (both breeding and wintering), Short-eared owl (breeding) and an upland breeding bird assemblage.

The breeding bird assemblage is listed as including Teal *Anas crecca*, Buzzard *Buteo buteo*, Merlin, Peregrine, Red grouse *Lagopus lagopus*, Dunlin *Calidris alpina*, Snipe *Gallinago gallinago*, Curlew *Numenius arquata*, Redshank *Tringa totanus*, Whinchat *Saxicola rubetra*, Stonechat *Saxicola rubicola*, Wheatear *Oenanthe oenanthe* and Ring ouzel *Turdus torquatus*.

North Lowther Uplands SSSI, which lies just over 4km to the north of the Proposed Development is designated for breeding Hen harrier and also an upland breeding bird assemblage.

The breeding bird assemblage includes Hen harrier, Short-eared owl, Merlin, Peregrine, Golden plover, Red grouse, Raven *Corvus corax*, Dunlin, Snipe, Teal, Curlew, Redshank, Whinchat and Wheatear.

4.1.2 Other available data

RSPB data request

Information was received from the RSPB in September 2021. Data was received concerning two species; Black grouse and Swift *Apus apus*. Because Swift are not considered at risk from wind farms and so are not considered further. Records for Black grouse were provided for five records of Black grouse, one of which was outwith the Proposed Development and the other four were within or adjacent to it. More information is included within Confidential Technical Appendix 7-2.

Raptor study group

Data was requested from the Dumfries and Galloway Raptor Study Group in 2021. This data spanned from 2013 until 2021 but all information is provided in Confidential Technical Appendix 7-2.

4.2 Vantage Point Surveys

4.2.1 Vantage Point Surveys 2011-2012

Seven target species were recorded between April 2011 and March 2012 (Table 6). This list is not exhaustive (as discussed below).

Table 6: Target Species Flights April 2011 -March 2012

Common Name	Scientific Name	Max no. of birds	No. of flights	Sum of total flying time Birds*seconds	Total Flight Time at Risk Height	Designations
Hen harrier	<i>Circus cyaneus</i>	2	17	7470	0	Annex I, Schedule 1, SBL, BoCC red
Merlin	<i>Falco columbarius</i>	1	1	10	0	Annex I, Schedule 1, SBL, BoCC red
Peregrine	<i>Falco peregrinus</i>	1	1	25	25	Annex I, Schedule 1, SBL
Black grouse	<i>Lyrurus tetrix</i>	2	6	290	35	SBL, BoCC red
Golden plover	<i>Pluvialis apricaria</i>	53	10	23100	21455	Annex I, SBL
Long-eared owl	<i>Asio otus</i>	1	1	75	0	
Pink-footed goose	<i>Anser brachyrhynchos</i>	51	4	29840	28970	BoCC amber

Hen Harrier was seen on seventeen occasions between August 2011 and November 2011 with two birds together on 08/09/2011. None of these flights would pass within 500

m of the proposed turbines in the west of the site but seven of these flights pass within 500 m of the proposed turbines, in the north east, T29 and T30. All but one of the flights (seen flying over the access track to the east) pass within 500 m of existing turbine placements clustered in a triangle between T1 in the north, T23 in the south east and T8 in the south west. The data appear to indicate a greater concentration of flight records in the vicinity of development that is already consented.

A single Merlin flight was seen on 20/12/2011 in the south east of the site between the present position of consented turbines T21 and T22 and over a kilometre from the nearest proposed turbine.

A single Peregrine flight was recorded on the 24/02/2011 flying within 500 m of the proposed turbines T26, T27 and T28 in the south west of the site.

Black grouse are on the SBL and the red list of Bird of Conservation Concern. Six flights were recorded from VP with about 90% of the flight time being spent at below 10 m.

There were ten flights of Golden plover recorded, eight of which were in April 2012, including the largest flock of 53 birds and the remainder, in October and December 2001, also being outside of the breeding season. The majority of flights were recorded in the north and the west of the survey area in the vicinity of Polhote Burn, the majority within 500 m of the proposed turbines 25 to 28 and with over 90% at collision risk height.

Some further species for which data was recorded, which are currently regarded as sensitive to wind farm developments, were not regarded as such at the time and were not reported in as much detail as may be expected at the present day. These included:

- Curlew – 26 flights recorded, but little further information available. Flights were predominantly in the east of the survey area.
- Redshank – two flights were recorded.

4.2.2 Vantage Point Surveys 2019-2020

Table 7: Target Species Flights September 2019 – August 2020

Common name	Scientific name	Max no. of birds	No. of Flights	Total Flight Time (secs)	Total Flight Time at Risk Height
Hen harrier	<i>Circus cyaneus</i>	2	9	755	130
Black grouse	<i>Lyrurus tetrix</i>	1	1	30	0
Curlew	<i>Numenius arquata</i>	1	1	65	30
Golden plover	<i>Pluvialis apricaria</i>	25	4	7850	4100
Pink-footed goose	<i>Anser brachyrhynchus</i>	71	7	15330	750

Nine flights of Hen harrier with totalling eleven birds were seen with all but one observation being of male birds. All flights from vantage points were outside the breeding season with eight flights on the same day, 30/09/2019 including two different males and a female. Flight activity was primarily concentrated to the south and east of

the line between proposed turbines T25 and T28 and three of the seven flights passed within 500 m of these turbines.

Golden plover is an Annex I species as well as being listed on the SBL. All flight lines were recorded outside the breeding season with the biggest flock being of 25 birds, observed twice on 30/09/2019. A flock of five birds was seen twice on the 28/11/2019, five birds were seen on 28/11/2019 and a single bird was seen 07/02/2019. Flight lines were widely distributed over the survey area and included some flight activity within 200m of turbines.

Black Grouse is on the SBL and is red listed on BOCC4. A single flight was recorded, a male on 16/06/2020, flying for 30 seconds below collision risk height, flying north to south briefly within 500 m of proposed turbine 26 and closer to consented turbines 6, 7 and 8.

Curlew is on the SBL and red listed on BOCC4. A single flight line was recorded, on 16/06/2020, more than 500 m away from the proposed turbines 25 to 28, close to the location of consented turbine 6, and with 30 seconds of flight at risk height.

Pink-footed geese were recorded on seven occasions with a maximum flock size of 71 birds. The majority of flight activity was above collision risk height. There was no evidence of regular flights thorough the site. Five flight lines were on a single day, 30/09/2019, and all are likely to have been migrants rather than commuting flights between roosting and feeding areas.

4.2.3 Vantage Point Surveys 2020-2021

Eight target species were recorded during the VP surveys over the period November 2020 – October 2021 (Full details are provided in Appendix E). Table 8 below provides a summary of the target species recorded and the flights observed.

Flightlines of raptors and wildfowl are shown in Figure 7-5

Flightlines of waders and Black grouse are shown in Figure 7-6.

Table 8: Target Species Flights November 2020-October 2021

Species	Scientific name	Max no. of birds	No. of Flights	Total Flight Time (secs)	Total Flight Time at Risk Height (secs)	Designations
Red kite	<i>Milvus milvus</i>	1	1	224	224	Annex I, Schedule 1, SBL
Whooper swan	<i>Cygnus cygnus</i>	28	4	4267	4057	Annex I, Schedule 1, SBL, BoCC amber
Black grouse	<i>Lyrurus tetrix</i>	1	1	41	41	SBL, BoCC red
Curlew	<i>Numenius arquata</i>	3	11	456	449	SBL, BoCC red
Lapwing	<i>Vanellus vanellus</i>	1	4	250	250	SBL, BoCC red
Golden plover	<i>Pluvius</i>	42	1	1638	1638	Annex I, SBL

Species	Scientific name	Max no. of birds	No. of Flights	Total Flight Time (secs)	Total Flight Time at Risk Height (secs)	Designations
	<i>apricaria</i>					
Greylag goose	<i>Anser anser</i>	2	1	192	192	BoCC amber
Pink-footed goose	<i>Anser brachyrhynchus</i>	82	6	27,299	0	BoCC amber

Whooper Swan was observed on four occasions in December 2020 and March 2021:

- December 2020: a flight of five birds seen before survey, flying SSW from the north of the site and going out of site beyond Polneul burn.
- March 2021: Three flights occurred on the same day. Firstly 14 birds circled about 500m south of VP2 and then flew north north west. Then there were two flights, firstly of 22 birds and then 28 birds, both flying north west from Libry Moor, close to VP2 and exiting the viewshed to the north. Red kite was observed only once, in October 2021 when a single bird flew from Libry Moor area, heading north over site.

A single flight of 42 Golden plover were observed on April 9th from VP 1 flying from the north east, crossing Polhote burn and leaving the viewshed just south of the VP. Pre-breeding or migratory flocks like these are not uncommon at this time of year and given the number recorded is not considered to represent evidence of breeding Golden plover.

There was a single male Black grouse recorded from VP 1, on the 22nd December 2020.

There were four flights of Curlew in March, three singles and a pair. A further two flights of single birds in April and a further five flights in May including a flight of three birds and a pair. These birds were generally north of proposed turbines 29 and 30 but passed through that area with some activity at collision risk height. One flight was to the north of these locations close to consented turbines 14, 20 and 22.

There were three flights of single Lapwings, two in March, with a bird displaying in the Rotton Sike area, and one in April.

Additionally there were six flights of migratory Pink-footed goose, summing to 329 birds and flying well above collision risk height all on the 5th October 2020. Two Greylag geese were recorded on the same day at collision risk height.

4.3 Breeding Bird Surveys

4.3.1 Breeding Bird Surveys 2011

Species of nature conservation concern which were recorded during surveys in 2011 are listed in Table 9. Conservation statuses reported in the table below are taken from BOCC4 where applicable. Territory likelihoods are based upon analysis at that time and are not

Table 9: Breeding Bird Records 2011

Common name	Scientific name	Conservation Status (SBL, Red, Amber, Schedule ,Annex I)	BTO Code	Definite	Likely
Curlew	Numenius arquata	SBL, red list	CU	0	2
Grasshopper Warbler	Locustella naevia	red list	GH	0	3
Reed bunting	Embriza schoeniclus	SBL	RB	0	3
Whinchat	Saxicola rubicola	red list	WC	2	0

Much of the support for the Curlew territories seems to have come from vantage point observation but breeding bird surveys probably support the contention that breeding did not appear to have been successful as no young birds were observed in June or July 2011. One pair is said to have established on White Knowe and a second in the south west of the study area near Polnagrie Burn. A third territory, not mentioned in the data table is said to have been abandoned by May 2011.

Five Grasshopper warbler territories were identified with four identifiable on the map provided, of these three of the territories is on the eastern margin of the close to the forestry with two of these on Polmeur Burn, one at Polbroc Burn and the remaining territory on Polneul Burn.

Three Reed bunting territories were identified, with two on Polmeur Burn and the other on Polneul Burn.

Two Whinchat territories were identified with one about 500m SE of Nether Cairn and another between consented turbine 1 and proposed turbine 29, on Polneul Burn.

4.3.2 Breeding Bird Surveys 2020

The most significant breeding records regarded waders. There were single breeding records for Curlew, just north of the A76 in the 50 0m buffer and a Snipe breeding 300 m south east of the site boundary high up on White Hill.

A female Black Grouse was flushed during the fourth breeding bird walkover.

The following passerine species were recorded, Skylark *Alauda arvensis* Stonechat *Saxicola rubicola*, Cuckoo *Cuculus canorus*, Grey wagtail, Lesser redpoll *Acanthis flammea*, Mistle thrush *Turdus viscivorus*, Song thrush *Turdus philomelos*, Spotted flycatcher *Muscicapa striata* and Whinchat are all on the red list of BOCC4. Meadow pipit *Anthus pratensis*, Bullfinch *Pyrrhula pyrrhula*, Dunnock *Prunella Modularis*, House martin *Delichon urbicum* and Reed bunting are all on the Amber list.

4.3.3 Breeding Bird Surveys 2021

Table 10 shows the results of territory analysis, primarily of breeding bird surveys although vantage point and raptor survey results also informed some of the territory classifications for such species as Curlew, Lapwing, Buzzard and Kestrel *Falco tinnunculus*. A total of

31 species were identified as breeding on the development and buffer area in 2020 with designated species shown below. The results are shown in Figure 7.7

Table 10: Breeding bird records 2021

Name	Scientific Name	Designations	BTO Code	Confirmed	Probable	Possible
Curlew	<i>Numenius arquata</i>	SPL, BOCC4 red list	CU		1	1
Dunnock	<i>Prunella modularis</i>	SPL, BOCC4 amber list	D.		2	1
Grasshopper warbler	<i>Locustella naevia</i>	SPL, BOCC4 red list	GH			1
Grey wagtail	<i>Motacilla cinerea</i>	BOCC4 red list	GL		1	
House martin	<i>Delichon urbica</i>	BOCC4 amber list	HM			3
Kestrel	<i>Falco tinnunculus</i>	SPL, BOCC4 amber list	K.		1	
Lapwing	<i>Vanellus vanellus</i>	SPL, BOCC4 red list	L.		1	
Lesser redpoll	<i>Acanthis cabaret</i>	SPL, BOCC4 red list	LR			2
Linnet	<i>Linaria cannabina</i>	SPL, BOCC4 red list	LI			1
Mallard	<i>Anas platyrhynchos</i>	BOCC4 amber list	MA		1	
Reed bunting	<i>Emberiza schoeniclus</i>	SPL, BOCC4 amber list	RB		2	
Siskin	<i>Carduelis spinus</i>	SPL	SK		1	
Skylark	<i>Alauda arvensis</i>	SPL, BOCC4 red list	S.		42	9
Song thrush	<i>Turdus philomelos</i>	SPL, BOCC4 red list	ST		1	1
Willow warbler	<i>Phylloscopus trochilus</i>	BOCC4 amber list	WW		7	3

Lapwing and Curlew territories were identified from display behaviour observed from vantage points. Territories of raptors, namely Buzzard and Kestrel, whilst counted in the table above, are discussed in section 4.4.3.

4.4 Breeding Raptor Surveys

4.4.1 Breeding Raptor Surveys 2012

No Schedule 1 or Annex I raptors were found breeding during the 2012 surveys.

A single Barn owl *Tyto alba*, was flushed during a raptor survey on 24.04.2012 from a derelict livestock shed close to the junction of the main A76 road near Crockroy Cottage. Owl pellets were located then, and again in May 2012 but the surveyor concluded that there was no nest within the building.

4.4.2 Breeding Raptor Surveys 2020

There was no evidence of any Annex 1 or Schedule 1 species breeding within the survey area in 2020. However, see Confidential Technical Appendix 7-2 for further discussion of Peregrine sightings during raptor surveys in 2020.

4.4.3 Breeding Raptor Surveys 2021

There was no evidence of any Annex 1 or Schedule 1 species breeding within the survey area in 2021.

The following species were recorded breeding on site:

- Buzzard, with two probable and one possible territory; and
- Kestrel, with one probable territory.

Kestrel probably bred at the north of the site in woodland close to the A76, close to a probable Buzzard breeding site where adults were alarm calling. The vicinities of other Buzzard territories were harder to characterise and regard repeated observations of Buzzards, including pairs, in areas of plantation woodland around the periphery of the study area. A disused buzzard nest was found on the first of July in the ravine of Polneul Burn below White Knowe, the ecological clerk of works for the site confirmed that it hadn't been used in 2021.

Full details are shown on Figure 7-7.

4.5 Winter Bird Surveys

4.5.1 Winter Bird Walkover 2011-2012

Forty bird species were recorded during three different winter walkover surveys conducted between October 2011 and February 2012.

However, since these surveys were undertaken, the requirement to carry them out has been removed from guidance except under particular circumstances which are not met at the Proposed Development. As such, this section focuses only on Annex I species, Schedule 1 species and species at risk from windfarms.

Of these species two songbirds are on Schedule 1 of the wildlife and countryside act 1981, Crossbill and Fieldfare. Crossbill, which is also an Annex I species, is associated with forestry land around the development and is likely to breed in this forestry. There were 50 birds recorded throughout the season, primarily in February. Fieldfare is a common winter visitor, designated on Schedule 1 due to its rarity as a breeder in the UK and is also on BOCC4. The largest recorded flock was of 41 birds and 188 birds were seen over the period.

Golden plover is on Annex I and the SBL. The only birds seen were five in October.

Lapwing and Herring gull *Larus argentatus*, are both on the SBL and BOCC4 red list. A flock of 40 Lapwing were observed over open pasture in Libry Moor Plantation in the north-east of the study area during the first walk over. Two herring gulls were seen flying over the study area in December 2011.

Song thrush is on the SBL and BOCC4. Eight were recorded during the February walkover survey.

Lesser redpoll, Linnet, Mistle thrush and Starling are all on the BOCC4 red list. Lesser redpoll was recorded in October with 20 birds, Linnet in December and February, totalling 15 birds. Starling were recorded on every visit, totalling 68, of which 44 were in December.

Kestrel, Bullfinch and Reed bunting are all on the SBL and BOCC4 red list. Four records of Kestrel were spread across each visit. There were 14 records of Bullfinch in December and three in February and seven records of Reed bunting in December and 12 in February.

Mallard, Teal, Goldeneye, Common gull *Larus canus*, Dunnock and Meadow pipit are all on BOCC4 amber list. There were 10 records of Mallard, three records of Teal and one record of Goldeneye although it is not clear if these were on water, potentially on the small water body near consented turbine 24, or flying over.

Table 11: Winter walkover species list

Species	Scientific Name	Designations	October	December	February
Bullfinch	<i>Pyrrhula pyrrhula</i>	SBL, BOCC4 amber list		14	3
Common gull	<i>Larus canus</i>	BOCC4 amber list			1
Dunnock	<i>Prunella modularis</i>	BOCC4 amber list		2	2
Fieldfare	<i>Turdus pilaris</i>	Schedule 1, BOCC4 red list	83	63	42
Golden plover	<i>Pluvialis apricaria</i>	Annex I, SBL	5		
Goldeneye	<i>Bucephala clangula</i>	BOCC4 amber list	1		
Herring gull	<i>Larus argentatus</i>	SBL, BOCC4 red list		2	
Kestrel	<i>Falco tinnunculus</i>	SBL, BOCC4 amber list	2	1	1
Lapwing	<i>Vanellus vanellus</i>	SBL, BOCC4 red list	40		
Lesser redpoll	<i>Acanthis cabaret</i>	BOCC4 red list		7	8
Linnet	<i>Linaria cannabina</i>	BOCC4 red list	20		
Mallard	<i>Anas platyrhynchos</i>	BOCC4 amber list		6	4
Meadow pipit	<i>Anthus pratensis</i>	BOCC4 amber list	1		3
Mistle thrush	<i>Turdus viscivorus</i>	BOCC4 red list	5	3	2
Reed bunting	<i>Emberiza schoeniclus</i>	SBL, BOCC4 amber list		7	12
Song thrush	<i>Turdus philomelos</i>	SBL, BOCC4 red list			8
Starling	<i>Sturnus vulgaris</i>	BOCC4 red list	3	44	21

Species	Scientific Name	Designations	October	December	February
Teal	<i>Anas crecca</i>	BOCC4 amber list		2	1
Crossbill	<i>Loxia curvirostra</i>	Annex I, Schedule 1, SBL		4	46

4.5.2 Winter Bird Walkover 2019-2020

The monthly surveys recorded relatively low activity, with Buzzards and Ravens recorded on every walkover, Sparrowhawk in November and February and Snipe in March.

4.6 Black Grouse Surveys

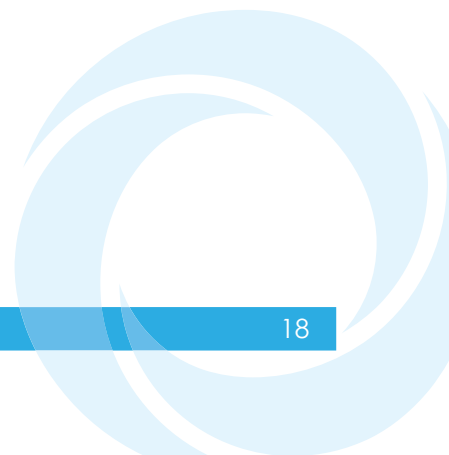
Data was available for surveys carried out in 2012 and 2019. Data provided by RSPB with respect to this species is provided in Appendix 7-2: Confidential Appendix.

4.6.1 Black Grouse Surveys 2012

On 29/03/2012 a single lekking male was observed on Hay Knowe, to the north-east of White Hill (269514 , 610645) close to the future placement of consented turbine 10. On 12/04.2012 a single male was lekking to the north of Hay Knowe on the west bank of Polneul Burn (269503 , 611894) over 700m from any of the proposed turbine placements. Shortly later five females flew south east across the site and landed at 270277, 610164, close to the met mast and to future turbine placement 19. Neither the leks nor the landing point of the five female black grouse were within 500m of any of the proposed turbine locations.

4.6.2 Black Grouse Surveys 2019

Single male Black grouse were noted lekking at 269359, 601790 and 270377, 611480. The northernmost leks in 2012 and 2019 were about 1 kilometre apart, the southernmost leks were about 200m apart. The northern Lek was about 500m to the north of proposed Turbines 29 and 30 and about 200m north of the location of a record disclosed by the RSPB. The southern Lek was about 100m from consented turbine 10.



5 Collision risk Modelling

Collision risk activity for all species was relatively limited and not assessed as sufficient to give rise to significant impacts. One species, Whooper swan did however have an increased level of at risk flight activity and so a precautionary approach was taken and CRM was carried out for this species.

All flights recorded at collision risk height during the VP survey times were included in the CRM calculations, and a worked example is presented in Appendix G.

The proposed turbines involve two different turbine dimensions, with tip heights up to 149.9 m. For modelling purposes the parameters used in Table 12 were used; however, all flight activity recorded up to 160 m in height was used to take account of the presence of the taller turbines as well.

A model (Forsythe et al. 1995) was used to calculate the daytime length as a function of latitude (55° 22' N, 4° 04'W for the centre of the proposed Sandy Knowe Extension Wind Farm) and date (2020-21). Table 12, below, presents the turbine parameters used for this model.

Table 12: Turbine parameters

Parameter		Unit
Number of turbines	6	
Blades per turbine	3	
Hub height	69	metres
Rotor radius	56	metres
Maximum chord	4.2	metres
Pitch	15	degrees
Rotation period	4	seconds
Proportion operational	0.85	

5.1 Random Collision Risk Model

The general methodology used to predict collision risk for birds using the Wind Farm airspace is provided by SNH (SNH 2009b). Given the lack of regular movements of Whooper swan across the Proposed Development and the few number of flights which were recorded on a limited number of occasions, then random model was considered the appropriate model to use.

In summary, the following steps were followed for random bird movements for species being assessed:

- Digitise all flight lines and record relevant characteristics (including species, number of birds, start time of flight and time within each height band) in a database;
- Review the flight line data, which in this instance indicated that a random collision analysis should be conducted for each species;
- Identify all flights for each species that are at any point within the 'at risk' height band and sum the total 'at risk' flight duration for each VP, multiplying any flight at risk time by the number of birds observed, where more than one bird is recorded per flight line;

- Calculate an 'occupancy rate' for each vantage point, defined as the observed 'at risk' activity levels divided by total observation time and area observed, giving the occupancy per unit time and unit area for each VP;
- Average the occupancy rate across the VPs using an un-weighted mean approach;
- Apply the average occupancy rate to the wind development site, based on the site area, risk volume and total turbine rotor volume, applying a factor to estimate the total time that the birds could theoretically be active during the year, based on an algorithm for calculating day length (Forsythe et al. 1995); thus determining the total predicted time spent by the individual species within air space that could be swept by turbine blades;
- Run the collision model with relevant turbine and ornithological parameters to calculate the theoretical probability of transits resulting in a collision assuming no avoiding action;
- Multiply the number of transits by the collision rate, avoidance factor and operating parameters of the proposed wind farm to estimate the theoretical number of collisions per year; and
- Avoidance rates used were in accordance with SNH guidance (SNH 2017).

The predicted mortality through collision is dependent on a number of variables, including flight activity within the turbine envelope, the species' physiology, nocturnal flight behaviour and flight velocity, weather conditions, the predicted avoidance rate, the number, rotational speed and dimensions of the turbines, and the proportion of the time that the turbines are operational throughout the year.

The following assumptions were made for the various species:

- A daylight calculator was used to produce figures for the total daylight period at the Proposed Development Site;
- Biometric data (bird length and wingspan) for the various species were obtained from the BTO webpage; and
- An assessment was made on the months active at the site for each species, with some species resident and others seasonal visitors. All species were considered active during the day only.

Table 13: Random CRM Biometric parameters

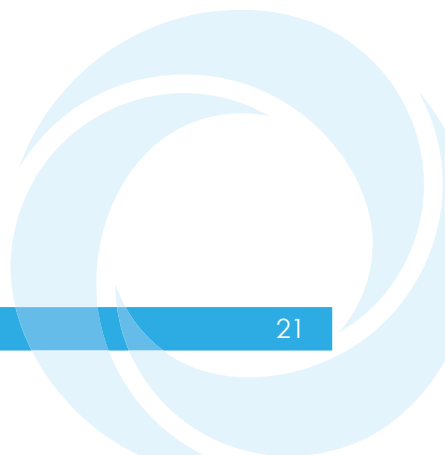
Species	Bird length (m)	Wingspan (m)	Bird speed (m/s)	Avoidance rate	Months active	Daylight hours	Nocturnal hours	Total hours	Assumed activity period	Flapping / gliding
Whooper swan	1.52	2.30	17.3	0.95	Sep - Mar	2406	n/a	2406	Daylight only	Flapping

Table 14 presents the results of the random model. This represents the annual rate based upon both years of data. Worked examples for the model are included in Appendix G.

Data is presented in Table 14 showing the collisions over a 25 year period. This is the typical way such data is presented, based upon the typical lifespan for a wind farm. However the proposed Development will have a lifespan of 40 years; this would equate to a predicted loss of 9.52 Whooper swan over the lifespan of the Proposed Development.

Table 14: Random CRM results

Species	Annual Collision risk	Years per collision	Collisions over 25 years
Whooper Swan	0.238	4.2	5.944



6 References

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- WSP (2012) Appendix 7.1 Ornithology Technical Report

Appendices

Appendix A. Figures

Figure 7-1 – Viewsheds and bearings

Figure 7-2 – Survey areas

Figure 7-3 - Ornithology receptors within 10 km

Figure 7-4 – Vantage point results 2019-2020

Figure 7-5 - Vantage point results 2020-21 raptors and wildfowl

Figure 7-6 - Vantage point results 2020-21 waders and Black grouse

Figure 7-7 – Breeding bird survey results

Figure 7-8 – Confidential Black grouse lek locations

Figure 7-9 – Confidential Goshawk nest location

Appendix B. Vantage Point Survey Visit Details September 2019 - August 2020

Table 15: Timing and Duration of Surveys (September 2019 -August 2020)

Date	Start	Time	Duration	Stratification (external source)
30/09/2019	11:00	14:00	3	Diurnal
30/09/2019	14:30	17:30	3	Diurnal
22/10/2019	08:00	11:00	3	Diurnal
22/10/2019	11:30	14:30	3	Diurnal
28/11/2019	09:24	12:24	3	Diurnal
28/11/2019	12:54	15:54	3	Diurnal
07/02/2020	07:58	10:58	3	Diurnal
07/02/2020	11:28	14:28	3	Diurnal
05/03/2020	11:00	14:00	3	Diurnal
05/03/2020	14:30	17:30	3	Diurnal
19/03/2020	11:55	14:55	3	Diurnal
19/03/2020	15:30	18:30	3	Dusk
28/05/2020	12:45	15:45	3	Diurnal
28/05/2020	16:15	19:15	3	Diurnal
16/06/2020	04:33	07:33	3	Dawn
16/06/2020	08:03	11:03	3	Diurnal
01/07/2020	15:20	18:20	3	Diurnal
16/07/2020	18:46	21:46	3	Dusk
31/07/2020	08:30	11:30	3	Diurnal
31/07/2020	12:00	15:00	3	Diurnal
14/08/2020	05:40	08:40	3	Diurnal
14/08/2020	09:10	12:10	3	Diurnal

Date	Start	Time	Duration	Stratification (external source)
26/08/2020	13:50	16:50	3	Diurnal
26/08/2020	15:20	20:20	5	Diurnal

Appendix C. Vantage Point Survey Visit Details November 2020 - October 2021

Table 16: Timing and Duration of Surveys (November 2020 – October 2021)

Survey Date	Start Time	Finish Time	Duration	Surveyor	VP Type	VP Number
05/11/2020	09:40	12:40	03:00:00	Stephen McNee	Diurnal	1
05/11/2020	12:51	15:51	03:00:00	Stephen McNee	Diurnal	1
22/12/2020	09:35	12:35	03:00:00	Stephen McNee	Diurnal	1
22/12/2020	12:35	15:35	03:00:00	Stephen McNee	Diurnal	1
15/01/2021	09:50	12:50	03:00:00	Michael Christie	Diurnal	1
15/01/2021	13:00	16:00	03:00:00	Michael Christie	Diurnal	1
20/01/2021	09:40	12:40	03:00:00	Michael Christie	Diurnal	1
20/01/2021	12:50	15:50	03:00:00	Michael Christie	Diurnal	1
22/02/2021	09:00	12:00	03:00:00	Michael Christie	Diurnal	1
22/02/2021	12:10	15:10	03:00:00	Michael Christie	Diurnal	1
11/03/2021	09:10	11:10	02:00:00	Michael Christie	Diurnal	1
24/03/2021	10:10	13:10	03:00:00	Michael Christie	Diurnal	1
24/03/2021	13:30	14:30	01:00:00	Michael Christie	Diurnal	1
30/03/2021	09:10	12:10	03:00:00	Michael Christie	Diurnal	2
30/03/2021	12:30	15:30	03:00:00	Michael Christie	Diurnal	2
09/04/2021	09:45	12:45	03:00:00	Michael Christie	Diurnal	1
09/04/2021	12:50	15:50	03:00:00	MC	Diurnal	1
16/04/2021	08:30	11:30	03:00:00	MC	Diurnal	2
16/04/2021	11:45	14:45	03:00:00	MC	Diurnal	2
19/05/2021	10:30	13:30	03:00:00	Roisin McGrory	Diurnal	1
19/05/2021	14:00	17:00	03:00:00	Roisin	Diurnal	1

Survey Date	Start Time	Finish Time	Duration	Surveyor	VP Type	VP Number
				McGrory		
20/05/2021	09:35	12:35	03:00:00	RM	Diurnal	2
20/05/2021	13:12	15:02	01:50:00	RM	Diurnal	2
04/06/2021	11:40	14:40	03:00:00	Roisin McGrory	Diurnal	1
29/07/2021	10:30	13:30	03:00:00	Roisin McGrory	Diurnal	2
29/07/2021	14:15	17:15	03:00:00	Roisin McGrory	Diurnal	2
10/08/2021	13:35	16:35	03:00:00	Roisin McGrory	Diurnal	1
05/10/2021	10:10	13:10	03:00:00	Michael Christie	Diurnal	1
05/10/2021	13:20	16:20	03:00:00	Michael Christie	Diurnal	1
06/10/2021	09:50	12:50	03:00:00	Michael Christie	Diurnal	2
06/10/2021	13:10	16:10	03:00:00	Michael Christie	Diurnal	2
05/11/2020	09:40	12:40	03:00:00	Stephen McNee	Diurnal	1

Appendix D. Vantage Point Survey Summary of Weather Conditions

Table 17: VP weather summary (November 2020 – October 2021)

Survey Date	VP Number	VP Type	Mean Cloud Cover (eights)	Modal Visibility	Modal Precipitation	Mean Temperature (°C)	Mean Wind Speed (Beaufort Scale)	Modal Wind Direction
05/11/2020	1	Diurnal	7	1km - 2km	None	11	1	W
			8	200m - 1km	Light Intermittent	9	1	W
22/12/2020	1	Diurnal	5	1km - 2km	None	5	0	W
			6	1km - 2km	Light Persistent	5	0	W
15/01/2021	1	Diurnal	7	> 2km	None	1	1	SE
			7	> 2km	None	1	3	SE
20/01/2021	1	Diurnal	8	1km - 2km	None	1	1	N
			8	> 2km	None	1	1	N

Survey Date	VP Number	VP Type	Mean Cloud Cover (eights)	Modal Visibility	Modal Precipitation	Mean Temperature (°C)	Mean Wind Speed (Beaufort Scale)	Modal Wind Direction
22/02/2021	1	Diurnal	3	> 2km	None	6	1	SW
			2	> 2km	None	7	2	SW
11/03/2021	1	Diurnal	8	> 2km	Light Persistent	5	2	W
24/03/2021	1	Diurnal	5	> 2km	None	7	2	SW
			5	> 2km	None	8	2	SW
30/03/2021	2	Diurnal	6	> 2km	None	10	1	SE
			5	> 2km	None	11	2	SE
09/04/2021	1	Diurnal	2	> 2km	None	4	1	NW
			5	> 2km	None	5	1	NW
16/04/2021	2	Diurnal	5	> 2km	None	8	1	S
			1	> 2km	None	4	1	ESE
19/05/2021	1	Diurnal	4	> 2km	None	11	2	WNW
			5	> 2km	None	13	2	WNW
20/05/2021	2	Diurnal	8	1km - 2km	Light Persistent	7	4	SE
			8	> 2km	Heavy Persistent	8	6	SE
04/06/2021	1	Diurnal	5	> 2km	None	14	4	SSW
29/07/2021	2	Diurnal	7	> 2km	None	14	3	W
			6	> 2km	None	15	3	W
10/08/2021	1	Diurnal	6	> 2km	None	16	2	WNW
05/10/2021	1	Diurnal	6	> 2km	None	9	3	NW
			7	> 2km	None	10	3	W
06/10/2021	2	Diurnal	1	> 2km	None	9	1	S
			6	> 2km	None	11	2	S

Appendix E. Vantage Point Survey Target Species Flights

Table 18: VP Flight Line Details (November 2020 – October 2021)

Date	Species	VP No.	Time First Observed	No. of Birds	Height_Band	Time in Height Band (s)	Seconds at collision risk height	Mean Height † (m)
22/12/2020	Black grouse	1	11:36:00	1	B: At risk height	41	41	35
30/03/2021	Lapwing	2	09:19:00	1	B: At risk height	96	96	60
30/03/2021	Curlew	2	09:20:00	1	B: At risk height	17	17	70
30/03/2021	Curlew	2	09:51:00	1	B: At risk height	65	65	80
30/03/2021	Curlew	2	10:08:00	2	B: At risk height	38	76	10
30/03/2021	Curlew	2	10:13:00	1	B: At risk height	79	79	50
30/03/2021	Whooper swan	2	10:23:00	14	B: At risk height	66	924	100
30/03/2021	Whooper swan	2	10:23:00	14	C: Above risk height	15	NA	200
30/03/2021	Whooper swan	2	10:48:00	22	B: At risk height	40	880	100
30/03/2021	Whooper swan	2	10:59:00	28	B: At risk height	76	2128	100
30/03/2021	Lapwing	2	11:01:00	1	B: At risk height	35	35	80
16/04/2021	Lapwing	2	12:43:00	1	B: At risk height	84	84	70
16/04/2021	Curlew	2	14:21:00	1	B: At risk height	21	21	10
16/04/2021	Curlew	2	14:27:00	1	A: Below risk height	7	NA	6
20/05/2021	Curlew	2	11:28:00	2	B: At risk height	41	82	60
20/05/2021	Curlew	2	11:43:00	1	B: At risk height	18	18	10
20/05/2021	Curlew	2	11:44:00	3	B: At risk height	2	6	30
20/05/2021	Curlew	2	11:44:00	3	B: At risk height	9	27	30
20/05/2021	Curlew	2	14:06:00	2	B: At risk height	19	38	30
20/05/2021	Curlew	2	14:06:00	2	B: At risk height	3	6	30
20/05/2021	Curlew	2	14:50:00	1	B: At risk height	12	12	30
20/05/2021	Curlew	2	14:50:00	1	B: At risk height	2	2	30
05/10/2021	Pink-footed goose	1	10:25:00	57	C: Above risk height	124	NA	300
05/10/2021	Pink-footed goose	1	10:54:00	72	C: Above risk height	81	NA	250
05/10/2021	Pink-footed goose	1	11:24:00	55	C: Above risk height	78	NA	200

Date	Species	VP No.	Time First Observed	No. of Birds	Height_Band	Time in Height Band (s)	Seconds at collision risk height	Mean Height (m)
05/10/2021	Pink-footed goose	1	11:36:00	20	C: Above risk height	99	NA	200
05/10/2021	Greylag goose	1	12:27:00	2	B: At risk height	96	192	100
05/10/2021	Pink-footed goose	1	13:06:00	82	C: Above risk height	64	NA	250
05/10/2021	Pink-footed goose	1	14:16:00	43	C: Above risk height	67	NA	200
06/10/2021	Red kite	2	11:15:00	1	B: At risk height	224	224	50
06/10/2021	Golden plover	2	11:51:00	42	B: At risk height	39	1638	60

Appendix F. Conservation Status of all Recorded Bird Species

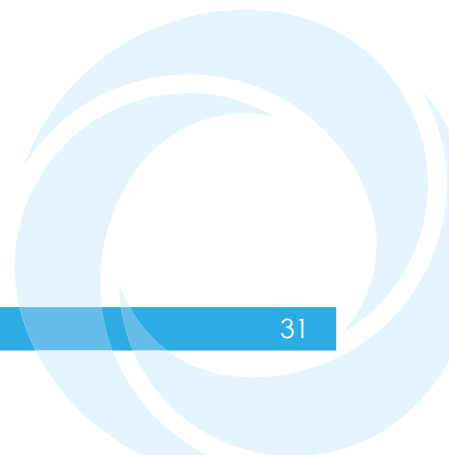
Table 19: Conservation Status for Birds Recorded

Common name	Scientific name	BTO code	Annex I	Schedule 1	SBL	BoCC 4 Red	At risk from windfarms
Barn owl	<i>Tyto alba</i>	BO		X	X		
Black grouse	<i>Lyrurus tetrix</i>	BK			X	Red	X
Blackbird	<i>Turdus merula</i>	B.					
Blue tit	<i>Cyanistes caeruleus</i>	BT					
Brent goose	<i>Branta bernicla</i>	BG					X
Bullfinch	<i>Pyrrhula pyrrhula</i>	BF			X	Amber	
Buzzard	<i>Buteo buteo</i>	BZ					
Carrion crow	<i>Corvus corone</i>	C.					
Chaffinch	<i>Fringilla coelebs</i>	CH					
Coal tit	<i>Periparus ater</i>	CT					
Common gull	<i>Larus canus</i>	CM				Amber	
Cuckoo	<i>Cuculus canorus</i>	CK			X	Red	
Curlew	<i>Numenius arquata</i>	CU			X	Red	X
Dunlin	<i>Calidris alpina</i>	DN	X			Amber	X

Common name	Scientific name	BTO code	Anne x I	Schedule 1	SBL	BoCC 4 Red	At risk from windfarms
Duncock	<i>Prunella modularis</i>	D.			X	Amber	
Goldcrest	<i>Regulus regulus</i>	GC					
Golden plover	<i>Pluvialis apricaria</i>	GP	X		X		X
Goosander	<i>Mergus merganser</i>	GD					
Grasshopper warbler	<i>Locustella naevia</i>	GH			X	Red	
Great spotted woodpecker	<i>Dendrocopos major</i>	GS					
Grey wagtail	<i>Motacilla cinerea</i>	GL				Red	
Greylag goose	<i>Anser anser</i>	GJ				Amber	X
Hen harrier	<i>Circus cyaneus</i>	HH	X	X	X	Amber	X
Herring gull	<i>Larus argentatus</i>	HG			X	Red	
House martin	<i>Delichon urbicum</i>	HM				Amber	
Kestrel	<i>Falco tinnunculus</i>	K.			X	Amber	
Lapwing	<i>Vanellus vanellus</i>	L.			X	Red	
Lesser black-backed gull	<i>Larus fuscus</i>	LB				Amber	
Lesser redpoll	<i>Acanthis cabaret</i>	LR			X	Red	
Linnet	<i>Linaria cannabina</i>	LI			X	Red	
Long-eared owl	<i>Asio otus</i>	LE					
Magpie	<i>Pica pica</i>	MG					
Mallard	<i>Anas platyrhynchos</i>	MA				Amber	
Meadow pipit	<i>Anthus pratensis</i>	MP				Amber	
Merlin	<i>Falco columbarius</i>	ML	X	X	X	Red	X
Mistle thrush	<i>Turdus viscivorus</i>	M.				Red	
Oystercatcher	<i>Haematopus ostralegus</i>	OC				Amber	
Peregrine	<i>Falco peregrinus</i>	PE	X	X	X		X
Pied Wagtail	<i>Motacilla alba yarrellii</i>	PW					

Common name	Scientific name	BTO code	Annex I	Schedule 1	SBL	BoCC 4 Red	At risk from windfarms
Pink-footed goose	<i>Anser brachyrhynchus</i>	PG				Amber	X
Raven	<i>Corvus corax</i>	RN					
Red grouse	<i>Lagopus lagopus</i>	RG			X	Amber	
Red kite	<i>Milvus milvus</i>	KT	X	X	X		X
Redshank	<i>Tringa totanus</i>	RK				Amber	
Reed bunting	<i>Emberiza schoeniclus</i>	RB			X	Amber	
Ring ouzel	<i>Turdus torquatus</i>	RZ			X	Red	
Robin	<i>Erithacus rubecula</i>	R.					
Sedge warbler	<i>Acrocephalus schoenobaenus</i>	SW					
Short-eared owl	<i>Asio flammeus</i>	SE	X		X	Amber	X
Siskin	<i>Spinus spinus</i>	SK					
Skylark	<i>Alauda arvensis</i>	S.			X	Red	
Snipe	<i>Gallinago gallinago</i>	SN				Amber	
Song thrush	<i>Turdus philomelos</i>	ST					
Sparrowhawk	<i>Accipiter nisus</i>	SH					
Spotted flycatcher	<i>Muscicapa striata</i>	SF			X	Red	
Stonechat	<i>Saxicola rubicola</i>	SC					
Tawny owl	<i>Strix aluco</i>	TO				Amber	
Teal	<i>Anas crecca</i>	T.				Amber	
Wheatear	<i>Oenanthe oenanthe</i>	W.					
Whinchat	<i>Saxicola rubetra</i>	WC				X	
Whooper swan	<i>Cygnus cygnus</i>	WS	X	X	X	Amber	X
Willow warbler	<i>Phylloscopus trochilus</i>	WW				Amber	
Woodpigeon	<i>Columba palumbus</i>	WP					
Wren	<i>Troglodytes troglodytes</i>	WR					

Appendix G. Examples of CRM Calculations



Collision Risk Model Calculations for Whooper swan (September - March 1900)

Stage 1: Number of birds flying through the rotors per year

Calculate the time the site was observed for and how long birds (as a % area-time activity) were seen in the observation area during this time and bird activity for each vantage point

The survey period for this species is taken as September - March.

VP	Area (Ha)	Time (hours)	Ha hours	Ha seconds (hours x 3600)	Flight time observed in risk window (s)	Bird Activity (flight time/ha-s)
1	334.59	48	16060.32	57817152.67	125	2.1620E-06
2	531.7158	12	6380.59	22970122.56	3932	1.7118E-04
Total	866.3058	60	51978.35	187122053.6	4057	1.7334E-04

Calculate the average bird observation activity in all areas and the percentage of time birds active within the overall observed area

Mean bird activity = Total bird activity / number of VPs

Mean bird activity = $0.000173340874555502/2 =$ **8.667E-05**

Overall area covered by VPs (excluding overlap) = 707.2947702559 ha

Proportion of time birds active in the area = Overall area (excluding overlaps) in ha x mean bird activity

Proportion of time birds active in area = $707.2947702559 \times 0.000086670437277751 =$ **6.1302E-02**

Correct for differences between the recording height band and the actual height swept by the rotors

Corrected bird activity = Proportion of actual height band x Proportion of time birds active in the area

Hub height = 69 m

Observed height band max = 160 m

Rotor radius = 56 m

Observed height band min = 25 m

Rotor max height = hub height + rotor radius

Rotor min height = hub height - rotor radius

Rotor max height = 125 m

Rotor min height = 13 m

Proportion of actual height band = $(\text{Rotor max height} - \text{rotor min height}) / (\text{observed height band max} - \text{observed height band min})$

Proportion of actual height band = $(125 - 13) / (160 - 25)$

Proportion of actual height band = 0.8296296

Corrected bird activity = **5.086E-02**

Calculate the number of hours per day the birds are potentially active over a year and the number of hours of bird occupancy in the airspace per year

Hours potentially active are taken as daylight hours only for September - March and then calculated where the day length is a function of latitude and day of the year[1]

Hours potentially active = 2062.37717725179

No. of hours of bird occupancy in the airspace per year = hours potentially active x bird activity

No. of hours of bird occupancy in the airspace per year = $2062.37717725179 \times 0.0508575797518716$

No. of hours of bird occupancy = 104.88751

Calculate the flight risk volume

Flight risk volume (Vw) = Overall area (ha) x 10000 x rotor radius (m) x 2
Vw = 707.2947702559 x 10000 x 56 x 2
Vw = 792170142.686608 m³

Calculate the combined rotor swept volume

Number of turbines = 6
Maximum chord = 4.2 m
Bird length = 1.52 m

Combined rotor swept volume (Vr) = number of turbines (N) x Pi x r² x (maximum chord + bird length)
Vr = 6 x Pi x 56 x 56 x (4.2 + 1.52)
Vr = 338121.826 m³

Calculate the bird occupancy in the rotor swept volume

No. of hours of bird occupancy (converted to seconds) x Combined rotor swept volume/Flight risk volume = n x (Vr/Vw)
Bird occupancy in rotor swept volume = 104.887511770523 x 3600 x 338121.83/792170142.686608
Bird occupancy in rotor swept volume = 161.168819

Calculate the bird transit time through the rotors and the potential number of transits per year

Bird speed = 17.3 m/s

Bird transit time through the rotors = (maximum chord + bird length) /bird speed
Bird transit time through the rotors = (4.2 + 1.52)/17.3
Bird transit time through the rotors = 0.330635838150289 s

No. of transits = bird occupancy in the rotor swept volume/bird transit time
No. of transits = 161.168819/0.330635838150289

No. of transits = 487.45115

Stage 2: Collision risk for bird passing through rotor area (assuming no avoidance)

Convert pitch of chord into radians

K: 1D or 3D (0 or 1)	1
No. of blades	3
Maximum chord	4.2 m
Pitch (degrees)	15
Rotor radius	56 m
Rotation Period	4 s

Pitch in radians = pitch (degrees) x Pi/180
Pitch in radians = 15 x Pi/180
Pitch in radians = 0.2618

Calculate the bird aspect ratio

Bird length	1.52 m
Wingspan	2.3 m
Bird speed	17.3 m/s
F:Flapping	1

Bird aspect ratio (b) = bird length/wingspan
Bird aspect ratio (b) = 1.52/2.3
Bird aspect ratio (b) = 0.6609

Calculation of alpha and p(collision) as a function of radius

r/R radius	c/C chord	a alpha	Upwind:			Downwind:			check area total
			collide length	p(collision)	contribution from radius r	collide length	p(collision)	contribution from radius r	
0.025	0.575	7.866801	37.0697	1	0.00125	35.82	1	0.00125	0.00125
0.075	0.575	2.622267	12.7733	0.5537538	0.00415315	11.523	0.4995589	0.00374669	0.0075
0.125	0.7015	1.57336	8.85892	0.3840574	0.00480072	7.3338	0.3179396	0.00397425	0.0125
0.175	0.8601	1.123829	7.44118	0.3225944	0.0056454	5.5713	0.2415283	0.00422674	0.0175
0.225	0.99435	0.874089	6.61735	0.2868793	0.00645478	4.4556	0.1931598	0.0043461	0.0225
0.275	0.94665	0.715164	5.42048	0.2349917	0.00646227	3.3624	0.1457681	0.00400862	0.0275
0.325	0.89895	0.605139	4.7041	0.2039349	0.00662788	2.7497	0.1192071	0.00387423	0.0325
0.375	0.85125	0.524453	4.2565	0.1845305	0.00691989	2.4058	0.1042985	0.00391119	0.0375
0.425	0.80355	0.462753	3.90203	0.169163	0.00718943	2.155	0.0934267	0.00397064	0.0425
0.475	0.75585	0.414042	3.61126	0.1565574	0.00743648	1.968	0.085317	0.00405256	0.0475
0.525	0.70815	0.37461	3.366	0.1459248	0.00766105	1.8264	0.0791802	0.00415696	0.0525
0.575	0.66045	0.342035	3.15437	0.1367503	0.00786314	1.7185	0.0745016	0.00428384	0.0575
0.625	0.61275	0.314672	2.96831	0.1286841	0.00804276	1.6361	0.0709312	0.0044332	0.0625
0.675	0.56505	0.291363	2.80214	0.1214799	0.00819989	1.5737	0.0682228	0.00460504	0.0675
0.725	0.51735	0.271269	2.65173	0.1149593	0.00833455	1.527	0.066198	0.00479936	0.0725
0.775	0.46965	0.253768	2.51404	0.10899	0.00844673	1.547	0.0670673	0.00519772	0.0775
0.825	0.42195	0.238388	2.38675	0.1034718	0.00853643	1.5706	0.0680897	0.0056174	0.0825
0.875	0.37425	0.224766	2.26808	0.0983274	0.00860364	1.5856	0.0687384	0.00601461	0.0875
0.925	0.32655	0.212616	2.15664	0.093496	0.00864838	1.5933	0.0690739	0.00638933	0.0925
0.975	0.27885	0.201713	2.05131	0.0889297	0.00867064	1.5949	0.0691444	0.00674158	0.0975
Overall p(collision)			Upwind		0.13994723	Downwind		0.08960005	0.99875

Average probability of collision = (upwind collision total + downwind collision total)/2

Average probability of collision = (0.13994723305346 + 0.0896000541554241)/2

Average probability of collision = 0.114774

Annual collision risk for Whooper swan assuming no avoidance

Annual collision risk = no. of transits per year through the rotors x the average probability of collision

Annual collision risk = 487.451149834583 x 0.114774

Annual collision risk = 55.946545 birds

Corrected annual collision risk assuming avoidance

Whooper swan avoidance rate = 0.995

Annual collision risk, with avoidance = annual collision risk x (1 - avoidance rate)

Annual collision risk, with avoidance = 55.9465445456899 x (1 - 0.995)

Annual collision risk, with avoidance = 0.27973272272845 birds

Corrected for assumed operational downtime of the rotors

Proportion of time wind turbines operational = 0.85

Corrected annual risk = annual risk, with avoidance x proportion of time wind turbines operational

Corrected annual risk = 0.237773 birds

Calculate number of years per collision

Number of years per collision for Whooper swan = 1/corrected annual risk

Number of years per collision for Whooper swan = 1/0.237772814319182

Number of years per collision for Whooper swan = 4.2057

[1] Forsythe, W. C., Rykiel, E. J., Stahl, R. S., Wu, H. and Schoolfield, R. M., 1995. A model comparison for daylength as a function of latitude and day of year. *Ecological Modelling* Vol 80, Issue 1, 87-95