

Technical Appendix 8.1: Ornithology

A8.1 Introduction

A8.1.1 This Technical Appendix presents the following information in support of Chapter 8: Ornithology of the Environmental Impact Assessment Report (EIAR) for Scienteuch Wind Farm (the Proposed Development):

- Existing ornithological records within a 10 km radius of the Proposed Development Area held by the Royal Society for the Protection of Birds (RSPB);
- The methods employed by Natural Power to provide baseline information on target bird species present within the Survey Area. Timings, surveyors, and duration of survey work are provided for each survey type. Details of weather conditions during survey can be provided on request;
- Details of target and non-target species flights recorded during Vantage Point (VP) surveys undertaken between September 2018 and February 2021;
- Details of target raptor flights recorded during breeding raptor surveys in 2020 and 2021;
- Details of target and non-target species recorded during breeding bird surveys in 2020 and 2021; and
- Calculations of the theoretical collision risk to target species (where a sufficient number of flights was recorded) using the Band Model¹ as advocated by NatureScot².

A8.2 Latin Names

A8.2.1 Latin names of all bird species referred to in Chapter 8: Ornithology and this technical appendix are given in Table A8.1 below.

Table A8.1: Latin names of bird species referred to in Chapter 8

Scientific name	Common name
<i>Branta canadensis</i>	Canada goose
<i>Anser anser</i>	Greylag goose
<i>Anas platyrhynchos</i>	Mallard
<i>Lyrurus tetrix</i>	Black grouse

<i>Mergus merganser</i>	Goosander
<i>Lyrurus tetrix</i>	Black grouse
<i>Lagopus lagopus</i>	Red grouse
<i>Phasianus colchicus</i>	Pheasant
<i>Ardea cinerea</i>	Grey heron
<i>Accipiter gentilis</i>	Goshawk
<i>Circus cyaneus</i>	Hen harrier
<i>Milvus milvus</i>	Red kite
<i>Accipiter nisus</i>	Sparrowhawk
<i>Buteo buteo</i>	Buzzard
<i>Haematopus ostralegus</i>	Oystercatcher
<i>Vanellus vanellus</i>	Lapwing
<i>Pluvialis apricaria</i>	Golden plover
<i>Numenius arquata</i>	Curlew
<i>Gallinago gallinago</i>	Snipe
<i>Chroicocephalus ridibundus</i>	Black-headed gull
<i>Larus canus</i>	Common gull
<i>Larus marinus</i>	Great black-backed gull
<i>Larus argentatus</i>	Herring gull
<i>Larus fuscus</i>	Lesser black-backed gull
<i>Cuculus canorus</i>	Cuckoo
<i>Tyto alba</i>	Barn owl
<i>Falco tinnunculus</i>	Kestrel
<i>Falco peregrinus</i>	Peregrine
<i>Corvus corone</i>	Carrion crow
<i>Corvus corax</i>	Raven
<i>Periparus ater</i>	Coal tit
<i>Poecile montana</i>	Willow tit
<i>Alauda arvensis</i>	Skylark
<i>Riparia riparia</i>	Sand martin
<i>Hirundo rustica</i>	Swallow
<i>Phylloscopus trochilus</i>	Willow warbler
<i>Phylloscopus collybita</i>	Chiffchaff
<i>Locustella naevia</i>	Grasshopper warbler
<i>Regulus regulus</i>	Goldcrest
<i>Sturnus vulgaris</i>	Starling
<i>Turdus merula</i>	Blackbird
<i>Turdus philomelos</i>	Song thrush

¹ SNH. (2007) Band, W., Madders, M. & Whitfield, D.P. Developing field and analytical methods to assess avian collision risk at wind farms. In de Lucas, M., Janss, G. & Ferrer, M. (eds.) Birds and Wind Power. Quercus, Madrid.

² SNH. (2010) Use of Avoidance Rates in the SNH Wind Farm Collision Risk Model. SNH Avoidance Rate Information and Guidance Note. Scottish Natural Heritage. <http://www.snh.gov.uk/docs/B721137.pdf>

<i>Turdus viscivorus</i>	Mistle thrush
<i>Muscicapa striata</i>	Spotted flycatcher
<i>Erithacus rubecula</i>	Robin
<i>Saxicola rubetra</i>	Whinchat
<i>Saxicola rubicola</i>	Stonechat
<i>Oenanthe oenanthe</i>	Wheatear
<i>Prunella modularis</i>	Dunnock
<i>Motacilla alba</i>	Pied wagtail
<i>Anthus pratensis</i>	Meadow pipit
<i>Acanthis cabaret</i>	Lesser redpoll
<i>Loxia sp.</i>	Crossbill species
<i>Spinus spinus</i>	Siskin
<i>Emberiza schoeniclus</i>	Reed bunting

A8.3 Survey Methods

Desk Based Review

A8.3.1 To provide background information pertaining to the baseline status of ornithological species in the local environment, records of relevant data recorded in the vicinity of the Proposed Development within the last ten years (2011-2021) were requested from the RSPB, the South Strathclyde Raptor Study Group (SSRSG) and the local biological records centre (South-west Scotland Environmental Information Centre (SWSEIC)).

Field Surveys

A8.3.2 Baseline ornithological surveys were carried out between September 2018 and February 2021 to quantify the use of the Proposed Development Area by breeding and non-breeding birds, and to allow an estimate of the theoretical risk of bird collision with turbine rotors.

A8.3.3 Baseline ornithological surveys comprised:

- Vantage Point (VP) flight activity surveys;
- Breeding raptor surveys;
- Breeding bird surveys (BBS); and
- Black grouse surveys.

A8.3.4 All ornithology surveys were undertaken by experienced ornithological surveyors:

- Adam Anderson (AA);
- Gus Keys (GK);
- Helen Allinson (HA); and
- Jack Bell (JB).

A8.3.5 The survey methods are described in detail below.

Vantage Point Surveys

A8.3.6 VP surveys were undertaken during:

- Non-breeding season 2018/19 (September 2018 - February 2019);
- Breeding season 2020 (late February 2020 (early start) - August 2020); and
- Non-breeding season 2020/21 (September 2020 - February 2021).

A8.3.7 This accounted for 19 months of baseline monitoring. These surveys were used to record the flight activity of target species within the vicinity of the Proposed Development. The flight activity of secondary species was also recorded.

A8.3.8 In the non-breeding season 2018/19 two vantage points (with 3 km viewsheds) were used to carry out the VP surveys covering the Proposed Development (VP1) and an area to the east of it (VP2):

- VP1 was located on the west of Turgeny, looking north-west, at National Grid Reference (NGR) 242050 605709; and
- VP2 was located on Green Hill, looking south-west, at NGR 244104 609033.

A8.3.9 In 2020 and 2021 the VP surveys covered the Proposed Development and were conducted from a single location (VP1) with a 3 km viewshed (this was agreed with NatureScot).

A8.3.10 The VP locations were carefully selected to obtain maximum visibility based on viewshed analysis and a ground-truthing visit prior to surveys commencing.

A8.3.11 Following NatureScot guidance³ a minimum of 36 hours of survey effort was undertaken at each VP during the breeding season and two non-breeding seasons (Table). During goose migration periods and the core raptor breeding season, additional survey effort was undertaken.

A8.3.12 The weather conditions during each survey were recorded every hour, full details of survey dates, times and weather conditions during VP surveys can be provided upon

³ SNH. (2017) Recommended bird survey methods to inform impact assessment of onshore wind farms. SNH, Battleby.

request. As recommended in NatureScot guidance³, a minimum of 36 hours per VP were carried out in conditions of good or better visibility (≥ 3 km).

- A8.3.13 Surveys were carried out at various times of day, ensuring that a representative sample of times between dawn and dusk were surveyed. VP surveys were 3 hours in duration (unless aborted due to unsuitable weather conditions), with a minimum resting period of 30 minutes between surveys, in line with the most recent NatureScot guidance³.
- A8.3.14 A summary of VP survey effort for each VP is shown A8.2. Observers were AA, GK, HA and JB.
- A8.3.15 Focal sampling was carried out for target species. The area in view was scanned until a target species was observed, at which point it was followed until it had ceased flying or had flown out of sight. The flight lines of target bird species observed were recorded onto 1:10,000 scale maps. Following NatureScot guidance³ the time and duration of the flight were recorded, and the altitude of the target bird(s) was recorded at the start of the observation and at 15 second intervals thereafter into one of four height bands, (1) <25 m, (2) 25-150 m, (3) 150-220 m, (4) >220 m.
- A8.3.16 A map showing the flight lines for each target species was compiled in a Geographic Information System (QGIS), with each flight line linked to its associated flight duration and height information held in an Excel spreadsheet.
- A8.3.17 The information collected on key target species flying over the Survey Area and the adjacent airspace was used to estimate the number of individuals per species predicted to collide with the turbine rotors. The collision risk modelling (CRM) methods are described in the main ornithology chapter in Section 8.5 and parameters used in the calculations are presented in Section 5 of this appendix.
- A8.3.18 All secondary species were recorded using five-minute summaries. Each VP survey was sub-divided into five-minute periods. At the end of each five-minute period, the number and activity of all secondary species observed was recorded. The number of birds recorded in a five-minute period was the minimum number of individuals that could account for the activity observed. Observation of target species took priority over the recording of secondary species.

Table A8.2: Vantage Point survey effort

Month (year)	VP1 hours	VP2 hours
September (2018)	6	6
October (2018)	18	18
November (2018)	12	12
December (2018)	6	6
January (2019)	6	6
February (2019)	6	6
Total non-breeding season 2018/19	54	54
February (2020) - early start	6	
March (2020)	18	
April (2020)	12	
May (2020)	12	
June (2020)	3	
July (2020)	15	
August (2020)	6	
Total breeding season 2020	72	
September (2020)	12	
October (2020)	11	
November (2020)	13	
December (2020)	6	
January (2021)	6	
February (2021)	6	
Total non-breeding season 2020/21	54	

Breeding Raptor Surveys

- A8.3.19 Dedicated breeding raptor surveys covered the Main Study Area in 2020, and the Access Track Study Area in 2021. The surveys in 2021 also included barn owl surveys.
- A8.3.20 The nature of these surveys was determined by the target species recorded during the VP surveys and breeding bird surveys and by those species considered to have the potential to breed within the survey area, based upon the available habitat. Surveys involved walkovers and short VP watches to identify breeding sites and, where appropriate, productivity. Surveys were undertaken by experienced surveyors holding a Schedule 1 Licence. Species-specific survey methods were informed by the

methods outlined in Gilbert *et al.* (1998)⁴ and Hardey *et al.* (2013)⁵.

A8.3.21 All raptor and owl species encountered were recorded. This included all observations of secondary raptor species such as buzzard, kestrel and sparrowhawk.

A8.3.22 The raptor survey effort is summarised in A8.3, full details of weather conditions during raptor surveys can be provided upon request.

Table A8.3: Raptor survey effort

Year	Date	Survey effort (hours)
2020	6 March	12
2020	23 March	3.75
2020	25 March	2
2020	31 March	5.5
2020	7 April	6
2020	13 April	7
2020	21 April	3
2002	23 April	4
2020	20 May	12
2020	12 June	2.5
2020	31 July	6
Total		63.75
2021	24 March	5.66
2021	1 April	6.5
2021	13 April	6
2021	22 April	3
2021	14 May	7
2021	30 June	5
2021	7 July	7
Total		40.16

Breeding Bird Surveys

A8.3.23 Breeding bird surveys were undertaken in 2020 and 2021, following standard NatureScot guidance³. These surveys covered areas of open moorland ground: in 2020 within the Main Study Area, and in 2021 within the Access Track Study Area.

A8.3.24 The surveys followed the widely used Brown & Shepherd (1993)⁶ methodology, but utilising four survey visits, as is currently recommended (Calladine *et al.*, 2009)⁷. All surveys were carried out by experienced surveyors in suitable weather conditions.

A8.3.25 A single surveyor walked a pre-determined route ensuring that all parts of the survey area were approached to within 100 m. A handheld GPS unit was used to ensure that the survey route was maintained. The location and behaviour of all birds encountered during the survey visits were recorded in the field on 1:15,000 scale maps. Standard British Trust for Ornithology (BTO) behaviour and species codes were used on field forms.

A8.3.26 Following completion of the survey season, territory analysis was carried out for waders species and red grouse (species targeted during the BBS). Territories were identified using a cluster analysis method, as outlined in Bibby *et al.*⁸. This method used the following principles:

- For resident bird species and summer migrants alike, a minimum of two registrations from two separate visits were required to generate a 'cluster'. This cluster was considered to represent a territory;
- Where a nest with eggs or young chicks was recorded, this record on its own constituted a breeding territory;
- Species were considered to be breeding if any of the following behaviour was observed during a single visit:
 - Song, courtship or territorial display;
 - Territorial dispute;
 - Nest building and nest-hole excavation;
 - Agitated behaviour by adult bird(s) indicating the presence of a nearby nest or young (e.g. repetitive alarm calling, distraction display);

⁴ Gilbert, G., Gibbons, D.W. & Evans, J. (1998). Bird Monitoring Methods. RSPB, Sandy.

⁵ Hardey, J., Crick, H., Wernham, C., Riley, H., Etheridge, B. & Thompson, D. (2013). Raptors: a field guide to survey and monitoring. 3rd Edition. The Stationery Office, Edinburgh.

⁶ Brown, A. F. & Shepherd, K. B. (1993). A method for censusing upland breeding waders. Bird Study, 40: 189-195.

⁷ Calladine, J., Garner, G., Wernham, C. & Thiel, A. (2009). The influence of survey frequency on population estimates of moorland breeding birds. Bird Study, 56, 381-388.

⁸ Bibby, C.J., Burgess, N.D., Hill, D.A. and Mustoe, S., (2000) Bird census techniques. Elsevier.

- Adult(s) carrying food; and
- Juveniles with parents in attendance;
- Where there were too few records to generate a cluster, with no evidence of any breeding behaviour, the individuals were not included in estimates for number of territories.

A8.3.27 The BBS effort is summarised in Table A8.4, full details of weather conditions during BBS surveys can be provided upon request

Table A8.4: Breeding bird survey effort

Year	Visit	Date	Survey effort (hours)
2020	1	21 April	4
2020	2	12 May	4.5
2020	3	2 June	3
2020	4	14 July	3
Total			
2021	1	21 April	4.5
2021	2	19 May	4.5
2021	3	24 June	5
2021	4	8 July	4.5
Total			

Black Grouse Surveys

A8.3.28 Dedicated black grouse surveys were carried out in 2020 and 2021, covering suitable habitats within the Main Study Area and Access Track Study Area (in respective years). The survey followed methods outlined in The National Black Grouse Survey Instructions (Etheridge and Baines, 1995)⁹; summarised in Gilbert *et al.* 1998)⁴.

A8.3.29 Three survey visits were undertaken in 2020, but only two in 2021 as the first preparatory visit to locate suitable lekking habitat was not required in the second year. Survey dates and effort are shown in Table A8.5.

Table A8.5: Black grouse survey effort

Year	Date	Survey effort (hours)
2020	6 March	6
2020	23 April	2
2020	12 May	2
Total		10
2021	22 April	3
2021	23 April	2.5
Total		5.5

A8.4 Results

Desk-based Review

A8.4.1 The RSPB provided data of bird species recorded within a 10 km radius of the Proposed Development Area Table A8.6 lists all protected bird species and/or birds of conservation concern (BoCC¹⁰ Red or Amber listed), excluding passerines, for which there were records from between 2011 and 2021 in the data provided by the above sources.

Table A8.6: Desk study data from RSPB

Common name	Number of records	Last recorded	BoCC list	Biodiversity lists
Mallard	2	2016	Amber	
Teal	1	2016	Amber	
Black grouse	4	2017	Red	SBL
Curlew	5	2016	Red	SBL
Snipe	9	2016	Amber	
Swift	15	2021	Amber	SBL

A8.3.30 SSRSG and SWSEIC did not respond to data requests.

Field Surveys

A8.4.2 A summary of the ornithology results is presented in Chapter 8: Ornithology of the EIAR. Further details of these results are provided below, full non-confidential survey results data can be provided on request.

⁹ Etheridge, B. & Baines, D. (1995). Instructions for the Black Grouse Survey 1995/6: a Joint RSPB/GCT/JNCC/SNH Project. Unpublished.

¹⁰ Stanbury, A., Eaton, M., Aebischer, N., Balmer, D., Brown, A., Douse, A., Lindley, P., McCulloch, N., Noble, D., and Win I. (2021) The status of our bird populations: the fifth Birds of Conservation Concern in the United Kingdom, Channel Islands and Isle of Man and second IUCN Red List assessment of extinction risk for Great Britain. *British Birds* 114: 723-747.

Vantage Point Surveys

A8.4.3 A summary of target species flights recorded during the non-breeding season surveys in 2018-2019 are presented in Table A8.7. Those recorded during the breeding season 2020 are presented in Table A8.8, and those recorded during the non-breeding season 2020-2021 are presented in Table A8.9. Incidental observations of target species recorded during VP surveys from 2018 to 2021 breeding and non-breeding seasons are summarised in

A8.4.4 Table A8.10. These include birds that were not in flight, birds that were heard but not seen and birds that were observed well beyond the survey area. Secondary species observed are summarised in Table A8.11.

Table A8.7: Results of non-breeding season vantage point surveys in 2018/2019

Species	No. flights	No. individuals	Legally protected species	BoCC list	Biodiversity lists
Greylag goose	3	10			
Goosander	1	2			
Goshawk	6	6	WCA-Sch1		
Hen Harrier	4	4	BirdsDir-A1, WCA-Sch1	Red	SBL
Red kite	3	3	BirdsDir-A1, WCA-Sch1		SBL
Golden plover	3	18		Amber	
Snipe	5	7		Amber	
Common gull	2	9		Amber	
Great black-backed gull	3	5		Amber	
Herring gull	6	24		Red	SBL
Lesser black-backed gull	5	5		Amber	
Unidentified gull	7	28			
Unidentified large gull	2	2			
Peregrine	2	2	BirdsDir-A1, WCA-Sch1		SBL

Table A8.8: Target species recorded during the breeding season 2020 vantage point surveys

Species	No. flights	No. individuals	Legally protected species	BoCC list	Biodiversity lists
Goshawk	12	13	WCA-Sch1		
Red kite	2	2	BirdsDir-A1, WCA-Sch1		
Curlew	8	9		Red	SBL
Great black-backed gull	14	17		Amber	
Common gull	1	1		Amber	
Herring gull	2	3		Red	SBL
Lesser black-backed gull	1	1		Amber	

Table A8.9: Results of non-breeding season vantage point surveys in 2020/2021

Species	No. flights	No. individuals	Legally protected species	BoCC List	Biodiversity lists
Goshawk	1	1	WCA-Sch1		
Hen Harrier	1	1	BirdsDir-A1, WCA-Sch1	Red	SBL
Red kite	1	1	BirdsDir-A1, WCA-Sch1		SBL
Great black-backed gull	4	7		Amber	
Barn owl	1	1	WCA-Sch1		SBL

Table A8.10: Summary of incidental records of target species recorded during VP surveys

Year	Species	Season	No. records/flights	No. individuals	Legally protected species	BoCC	Biodiversity lists
2018	Hen harrier	Non-breeding	1	1	BirdsDir-A1, WCA-Sch1	Red	SBL
2018	Snipe	Non-breeding	2	3		Amber	
2020	Snipe	Breeding	2	2		Amber	

Table A8.11: Summary of secondary species recorded during all VP surveys

Species	No. flights recorded	No. individuals recorded
Buzzard	140	248
Canada goose	7	26
Grey heron	1	1
Kestrel	18	18
Mallard	1	1
Raven	161	259
Red grouse	1	1
Sparrowhawk	11	12
Tawny owl	1	2

Breeding Raptor Surveys

A8.4.5 One unoccupied nest and four target species flights were recorded during raptor surveys. Records from 2020 and 2021 raptor surveys are shown in Confidential Figure 8.6. Target species recorded in 2020 and 2021 are shown in Table A8.12, secondary species recorded are in Table A8.13.

Table A8.12: Target species recorded during raptor surveys 2020 - 2021

Date	Record	Species	Sex/age	No. individuals	Sign	Notes
06/03/2020	Flight	Hen harrier	Female	1		Hunting.
23/03/2020	Flight	Hen harrier	Female			Mobbed by pair of great black-backed gulls.
23/03/2020	Flight	Hen harrier	Female			
23/03/2020	Flight	Hen harrier	Female			Hunting.
23/03/2020	Flight	Hen harrier	Female			
23/03/2020	Flight	Red kite	Adult			
23/03/2020	Flight	Red kite	Adult			
25/03/2020	Point	Owl			Pellets and droppings	Found on fence line.
25/03/2020	Point	Barn owl			Pellets	Barn owl pellet.
31/03/2020	Flight	Goshawk	Immature			
07/04/2020	Flight	Goshawk	Adult			Displaying, dropped into area around nest that

						was found during bat roost survey.
07/04/2020	Flight	Goshawk	Adult			Displaying, far side of power lines.
07/04/2020	Flight	Goshawk	Adult			Displaying next to power lines.
20/05/2020	Point	Goshawk			Plucking post	Plucking post with barn owl feathers.
30/06/2021	Flight	Goshawk	Female/Adult	1		Mobbed by single raven.

Table A8.13: Secondary species recorded during raptor surveys 2020 - 2021

Date	Species	Sex/age	No. individuals	Notes
23/03/2020	Great black-backed gull	Adult/Pair	2	Mobbed hen harrier.
23/03/2020	Curlew	Adult		Displaying.
23/03/2020	Great black-backed gull	Adult		
23/03/2020	Curlew	Adult		Displaying.
23/03/2020	Great black-backed gull	Adult		
23/03/2020	Curlew	Adult		
25/03/2020	Curlew		1	
31/03/2020	Curlew	Adult		
07/04/2020	Curlew	Adult/Pair	2	
07/04/2020	Great black-backed gull	Adult		
24/03/2021	Kestrel	Male/Adult	1	Male kestrel hunting along wall. Landed on telegraph poles and wall at multiple points. Dropped out of view.
24/03/2021	Buzzard	Pair	2	
24/03/2021	Buzzard	Adult	1	
24/03/2021	Sparrowhawk	Male	1	Flying low between mature forestry and young forestry blocks.
01/04/2021	Raven			Single feather.
01/04/2021	Sparrowhawk	Adult		Pigeon plucked, likely by sparrowhawk.
01/04/2021	Buzzard	Adult		Three pellets below post, highly likely to be buzzard.
01/04/2021	Red grouse			Individual calling.
01/04/2021	Buzzard	Adult		Small Scots pine copse - no nesting potential due to exposure. However,

				is being used as hunting post with multiple droppings and pellets.
14/05/2021	Buzzard		1	
14/05/2021	Buzzard	Adult	1	
07/07/2021	Buzzard	Adult	2	
07/07/2021	Buzzard	Adult	1	

Breeding Bird Surveys

A8.4.6 Birds detected during breeding bird surveys that did not undergo territory analysis (moorland passerines or other species where a lack of evidence of breeding was observed) are listed in Table A8.14.

Table A8.14: Species recorded during breeding bird surveys in 2020 and 2021

Species	Recorded 2020	Recorded 2021
Red kite		Yes
Buzzard	Yes	Yes
Curlew	Yes	
Great black-backed gull	Yes	
Cuckoo	Yes	Yes
Carrion crow	Yes	
Raven	Yes	Yes
Coal tit	Yes	
Skylark	Yes	Yes
Sand martin		Yes
Swallow	Yes	
Willow warbler	Yes	
Chiffchaff	Yes	
Goldcrest	Yes	
Starling		Yes
Blackbird	Yes	
Song thrush	Yes	
Mistle thrush	Yes	
Robin	Yes	
Whinchat		Yes
Stonechat	Yes	
Wheatear	Yes	
Duncock	Yes	

¹¹ Band, W., Madders, M. & Whitfield, D.P. (2007) Developing field and analytical methods to assess avian collision risk at wind farms. In de Lucas, M., Janss, G. & Ferrer, M. (eds.) *Birds and Wind Farms: risk assessment and mitigation*. Quercus, Madrid.

Pied wagtail	Yes	
Meadow pipit	Yes	Yes
Chaffinch	Yes	
Lesser redpoll	Yes	
Siskin	Yes	

Black Grouse Surveys

A8.4.7 There were no black grouse recorded within the Proposed Development, including the Access Track Study Area, during dedicated surveys in 2020 and 2021.

A8.5 Collision Risk Modelling Parameters

A8.5.1 CRM was carried out for vantage point data collected at the Proposed Development between September 2018 and February 2019 inclusive and February 2020 to February 2021 inclusive from VP 1.

A8.5.2 Bird flights considered to represent a potential collision risk were those that passed within the collision risk zone (CRZ) - a 275 m buffer of the proposed turbine locations representing half the rotor diameter of the turbines to be used at the site plus a 200 m precautionary buffer zone. Since the height within which the proposed turbine blades will rotate (potential collision height - PCH) falls within height bands 2 and 3 (covering 25 - 220 m), only flights within these height bands were considered at potential collision risk. Although two different heights of turbines are being proposed across the site, the rotor-swept height for both fall within this range. A precautionary approach was taken in which it was assumed that all bird activity within the 25 - 220 m height range covered by height bands 2 and 3 were at rotor-swept height (30 m - 180 m and 50 - 200 m), although a small number of flights shall actually have been above or below rotor-swept height.

A8.5.3 Collision risk modelling was only run for birds for which at least 3 flights or 10 individuals were recorded within the CRZ at PCH.

A8.5.4 Collision risk modelling was carried out according to the Band *et al.* (2007)¹¹ Collision Risk Model recommended by NatureScot¹¹. Data collected during flight activity vantage point surveys were used to predict the number of individuals per species

expected to collide with the turbine rotors per season. Where turbine specifications were not available, representative values were used. Wind farm specifications used in the model are provided in Table A8.15.

Table A8.15: Wind turbine specifications used in CRM

Attribute	Value
Number of turbines	9
Number of blades	3
Maximum chord length (metres)	4.1*
Pitch (degrees)	52.5*
Rotor diameter (metres)	150
Rotation period (seconds)	7.5*

*Representative values

Species Collision Risk

A8.5.5 Species considered for CRM during the breeding season are shown in Table A8.16.

Table A8.17 shows species considered for CRM during the non-breeding seasons. Bird parameters used in the model are provided in Table A8.18.

Table A8.16: Number of flights and individuals observed passing through the turbine area collision risk height during the breeding season 2020

Species	No. flights	Flights in the CRZ	Individuals in the CRZ	CRM carried out
Goshawk	12	4	4	Yes
Red kite	3	0	0	No
Curlew	8	1	2	No
Common gull	1	0	0	No
Great black-backed gull	14	7	8	Yes
Herring gull	2	0	0	No
Lesser black-backed gull	1	1	1	No

Table A8.17: Number of flights and individuals observed passing through the turbine area at collision risk height during the non-breeding seasons 2018/2019 and 2020/2021

Species	No. flights	Flights in the CRZ	Individuals in the CRZ	CRM carried out
Goshawk	4	3	3	Yes
Hen harrier	4	0	0	No
Red kite	1	0	0	No
Golden plover	1	0	0	No
Snipe	4	0	0	No
Great black-backed gull	4	2	3	Yes
Lesser black-backed gull	2	0	0	No
Barn owl	1	0	0	No
Peregrine	1	0	0	No

Table A8.18: Bird specifications used in CRM

Species	Bird length (metres)	Wingspan (metres)	Bird speed (metres/second)	Estimated nocturnal activity*	Calculated individual collision risk
Goshawk	0.55	1.5	11.3	0	0.089
Great black-backed gull	0.71	1.58	13.7	0	0.079

A8.5.6 Details of calculations used to produce estimates for the collision risk model for goshawk in the breeding and non-breeding season are shown in Table A8.19. Details of calculations used to produce estimates for the collision risk model for great black-backed gull in the breeding and non-breeding season are shown in Table A8.20.

Table A8.19: CRM run for goshawk

Parameter	Unit	Breeding	Non-breeding
Occupancy of risk volume (a)	seconds	633	234
Survey effort (b)	hectare-minutes	818818	1222541
Observed occupancy rate for site (c = a / b)	seconds per hectare-minute	0.00077	0.00019
Daylight minutes (d)	minutes	167847	101844

Potentially active period ($e = d \cdot 1$)	minutes	167847	101844
Area of the wind farm polygon (f)	hectares	213.82	213.82
Total occupancy of risk volume during period of interest ($g = c \cdot e \cdot f$)	seconds	27759	4171
Rotor diameter (h)	metres	150	150
Risk volume ($l = f \cdot h \cdot 10,000$)	cubic metres	320732904	320732904
Number of turbines (j)	turbines	9	9
Rotor blade width (k)	metres	4.1	4.1
Length of bird of interest (l)	metres	0.55	0.55
Rotor-swept volume ($m = j \cdot \pi \cdot (h/2)^2 \cdot (k + l)$)	cubic metres	739551	739551
Bird occupancy of rotor-swept volume ($n = g \cdot m / i$)	seconds	64.0	9.6
Bird flight speed (o)	metres per second	11.3	11.3
Time taken for bird to transit rotor ($p = (k + l) / o$)	seconds	0.41	0.41
Number of rotor transits ($q = n / p$)	rotor transits	156	23
Probability of collision for a bird flying through rotors (estimated using SNH spreadsheet)		0.089	0.089
Predicted mortality with no avoidance - turbines operational 85% of the time ($y = q \cdot r \cdot 0.85$)	collisions per season	11.70	1.76

* Figures have been rounded for presentation purposes. Following the calculations using the rounded figures may yield slightly different results.

Table A8.20: CRM run for great black-backed gull

Parameter	Unit	Breeding	Non-breeding
Total number of birds flying through wind farm polygon (a)	birds	8	3
Mean survey effort (b)	minutes	4320	6450
Daylight during survey period, based on civil twilight	minutes	167847	101844
Estimate of nocturnal activity as a proportion of daytime activity (d)		0	0
Time of potential activity during survey period ($e = c \cdot (1+d)$)	minutes	167847	101844
Rate of birds recorded during survey period ($f = a/b$)	birds per minute	0.0019	0.0005
Estimate of number of birds during season ($g = e \cdot f$)	birds	310.83	47.37
Risk window length (h)	metres	2749.788818	2749.788818
Turbine blade length (i)	metres	75	75
Number of turbines (j)		9	9
Risk window ($k = h \cdot l \cdot 2$)	square metres	412468	412468
Rotor-swept area ($l = \pi \cdot i^2 \cdot j$)	square metres	159043	159043
Proportion of risk area that is rotor-swept ($m = l/k$)		0.386	0.386
Estimate of number of birds flying through rotor-swept area during season ($n = g \cdot m$)	birds	119.9	18.3
Probability of collision for a bird flying through rotors (estimated using SNH spreadsheet) (o)		0.079	0.079
Predicted mortality with no avoidance - turbines operational 85% of the time ($p = n \cdot o \cdot 0.85$)	collisions per season	8.05	1.23

* Figures have been rounded for presentation purposes. Following the calculations using the rounded figures may yield slightly different results.