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CRUACH CLENAMACRIE WIND FARM

APPENDIX 11.1 ORNITHOLOGICAL TECHNICAL REPORT

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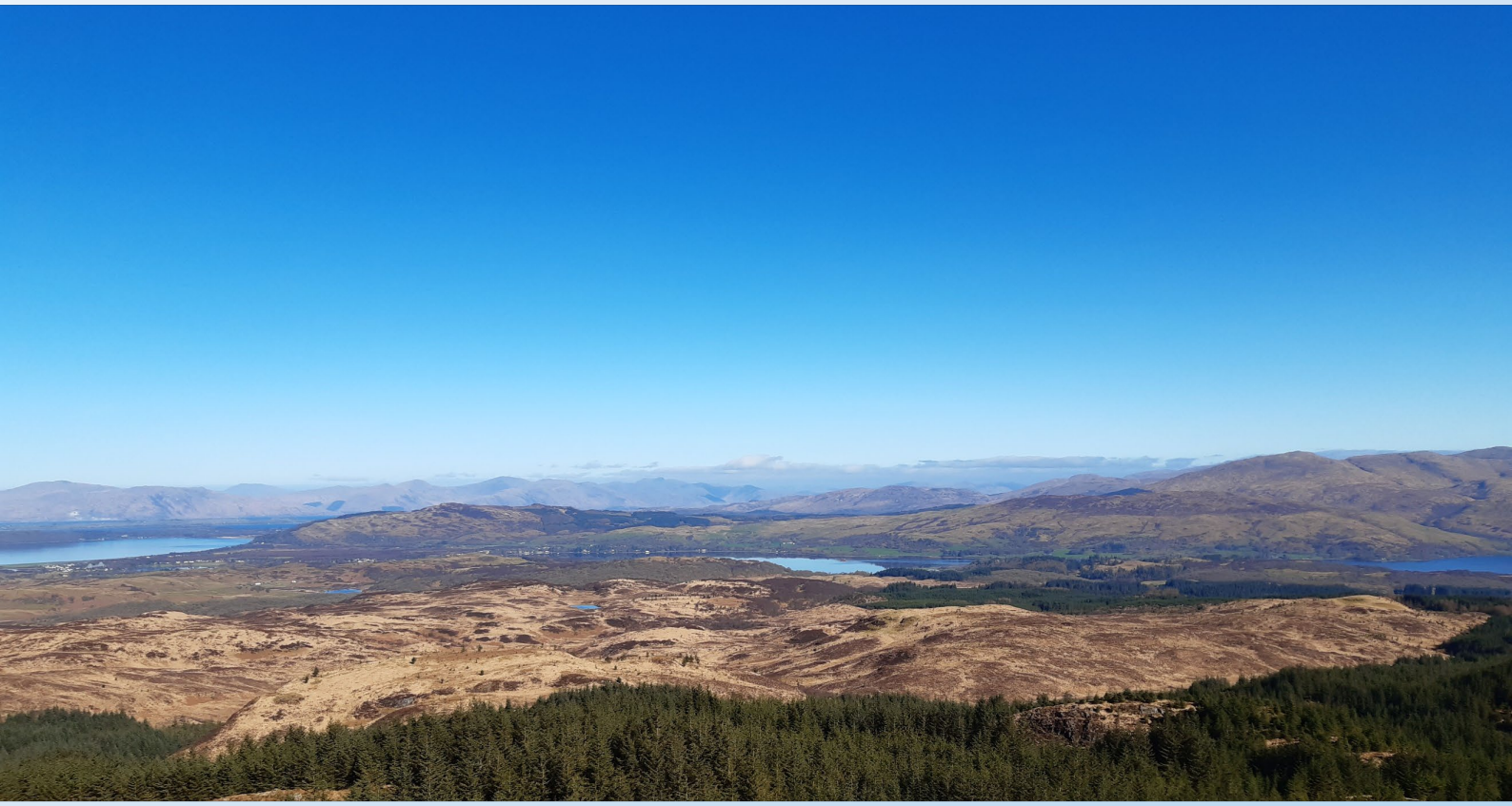
Appendix 11.1: Ornithological Technical Report



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CRUACH CLENAMACRIE WIND FARM

Appendix 11.1: Ornithological Technical Report

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CRUACH CLENAMACRIE WIND FARM

Appendix 11.1: Ornithological Technical Report

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1 INTRODUCTION

1.1 BACKGROUND

WSP UK Ltd (WSP) was commissioned by Voltalia UK Ltd (the Applicant) to undertake a programme of ornithological surveys to inform an Environmental Impact Assessment (EIA) in support of Cruach Clenamacrie Wind Farm (the Proposed Development), located approximately 7km east of Oban (Central Ordnance Survey Grid Reference: NM 94036 29966). The Proposed Development comprises six wind turbines along with their associated hard standings, a substation, control building, battery storage facility and a network of access tracks including a forest access track connecting the proposed wind farm site to the A85. The Site Application Boundary is shown in **EIA Figure 1.1**.

A bird survey programme comprising over three years of breeding and non-breeding seasons commenced in April 2021 and was completed in July 2024. A consultation exercise with ornithological interest groups and relevant land management organisations was also undertaken to gather third-party data to inform surveys and support the findings of the survey programme. All surveys were carried out in line with the latest NatureScot's wind farm bird survey guidance (Scottish Natural Heritage (SNH), 2017)[1] and agreed through ongoing consultation with NatureScot.

This Ornithological Technical Report provides details of the methods and results of the ornithological field surveys and data consultation exercise conducted to inform the EIA for the Proposed Development. The report concentrates on target species recorded in and around the Site which fall into at least one the following categories:

- Birds listed on Annex I of the EU Birds Directive[2];
- Birds listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended)[3];
- Birds that are qualifying features of European designates sites of nature conservation importance for birds (i.e., Special Protection Areas (SPAs) and Wetlands of International Importance (Ramsar Sites)) in proximity or potentially connected to the Site; and
- Red-listed Birds of Conservation Concern (BoCC) (Stanbury et al., 2021)[4].

Other species which are typically recognised as being potentially vulnerable to the effects of windfarm developments, but which do not fall under any of the above categories, such as certain waders and waterfowl species were also recorded as target species (e.g. snipe, oystercatcher, and mute swan). Passerines (songbirds) are not typically considered as target species as it is generally accepted that they are not significantly impacted by wind farm developments.

Sensitive information pertaining to the nest and lek sites locations of rare and vulnerable species, particularly those which may be at risk of persecution, has been omitted from this report and is instead presented in **Appendix 11.2: Confidential Ornithological Information**.

[1] SNH (2017). Recommended bird survey methods to inform impact assessment of onshore windfarms. v2. SNH Guidance. SNH, Battleby.

[2] EU Birds Directive: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0147

[3] Schedule 1-listed birds.

[4] 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.

2 DESK STUDY

2.1 DESIGNATED SITES

A desk study was undertaken at the outset of the survey programme to identify statutory ornithological designated sites of nature conservation interest located within, in close proximity to, or potentially connected to the Site.

The extent of searches conducted for statutory European / International designated sites (i.e., SPAs and Ramsar Sites) was dependent on their proximity and/or potential connectivity to the Site. This included direct connectivity, such as via watercourses, or indirect connectivity, such as through the potential use of habitats within the Site by qualifying species of designated sites in the wider surrounding area based on those species' recognised foraging/commuting ranges (e.g. as detailed in NatureScot (2016)[5]). A minimum search area of 10km from the Application Boundary was applied to account for the ranging distances of the majority of qualifying species affiliated with SPAs and Ramsar Sites in Scotland. However, the search area was extended to 20km for sites designated for pink-footed geese and greylag geese based on these species' larger recognised commuting distance.

Searches for all other designated sites with ornithological features of interest (including Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNRs) and Local Nature Reserves (LNRs)) extended to 2km from the Application Boundary. Searches were conducted using the following sources:

- NatureScot Sitelink database website[6]; and
- Joint Nature Conservation Committee (JNCC) website[7].

2.2 PROTECTED AND NOTEABLE SPECIES OF CONSERVATION CONCERN

To help inform the ornithological survey programme and the EIA, a consultation exercise was also undertaken to request records of protected and notable species of conservation concern (i.e., records of target species from the past 10 years (2014-2024 inclusive) within at least 2km of the Application Boundary. This was extended to 10km for records of golden eagle and white-tailed eagle. The following land management organisations and ornithological interest groups were consulted for any relevant data they may hold:

- Argyll Raptor Study Group (ARSG);
- Royal Society for the Protection of Birds (RSPB) Conservation Data Management Unit;
- Forestry and Land Scotland; and
- Argyll Biological Records Centre.

Data obtained from the above sources was used to inform the field surveys as and when it became available (e.g., to locate recent historical raptor nest sites or black grouse lek sites).

[5] SNH (2016). Assessing Connectivity with Special Protection Areas (SPAs). Version 3 – June 2016.
[6] SNH Sitelink database website (https://sitelink.nature.scot/home).
[7] JNCC Website (https://jncc.gov.uk/).

2.3 GOLDEN EAGLE TOPOGRAPHIC AND SATELLITE TAG DATA

2.3.1 GOLDEN EAGLE TOPOGRAPHY MODEL

The Golden Eagle Topography (GET) model data was developed using GPS telemetry data obtained from tagged juvenile eagles in Scotland to identify, and hence subsequently predict areas of air space used by golden eagles based on the underlying topographic features, as described in Fielding et al (2019[8]). The GPS telemetry data revealed that eagles preferred to use air space above slopes greater than 10° in gradient, at an altitude greater than 300m above sea level and within 300m of ridges. These topographic features create air currents which provide the lift which golden eagles, and other large raptors, rely on for energy-efficient flight.

Based on the GPS telemetry data the GET model predicts air space use based on the underlying presence of the preferred topographic features and categorises those areas using a standardised preference index (SPI) score ranging from the lowest predicted use, SPI 1, to the highest predicted use SPI 10. SPI scores of less than 6 (GET 5-) would mean that the corresponding area is likely to be unsuitable for, and therefore used rarely by golden eagles. Conversely, areas with SPI scores greater than 6 (GET 6+) are reasonably assumed as being likely to be used by eagles, at least in the regions where the species is known to occur, with areas with SPI scores of 8 and above being likely to experience high levels of use. The model does not, however, account for habitat features which golden eagles would not typically use, such as extensive forestry or operational wind farm developments, which may nonetheless have suitable underlying topography. As such, these features require to be imported manually from land cover data, wind farm layout data or digitised from aerial imagery to represent these features within the landscape and against GET data. The GET model also does not predict territorial extents for eagle territories as an accurate prediction of territory extents is only possible by tracking territorial birds, not juvenile birds, upon which the GET model was developed.

2.3.2 GOLDEN EAGLE SATELLITE DATA

Satellite tag data was obtained from Natural Research Ltd. which have conducted extensive studies on the range use of territorial golden eagles by trapping and tagging several territory-holding birds across Scotland and monitoring the spatial distribution of the received satellite tag transmissions. Coincidentally for the Proposed Development, this includes birds affiliated with the nearest golden eagle territory; G/LAW1. Two birds from the G/LAW1 territory have been tagged in recent years:

- **Bird 1 (Tag #996)**: a male golden eagle tagged over a nine month period between 20 February 2021 until its death on 02 December 2021;
- **Bird 2 (Tag #1157)**: a female golden eagle tagged on 07 February 2021. While this bird is still alive and the tag is still transmitting, data from this tag was provided for the 36-month period up until 31 January 2024 when the data was last processed.

Depending on the available power to connect with GPS satellites from the solar-charged batteries (and hence on available sunlight) daily transmissions of data can vary from tens of ‘fixes’ per day, to many hundreds of ‘fixes’ per day. The data recorded includes horizontal location, vertical height and speed.

[8] Fielding, A, H., Haworth, P, F., Anderson, D., Benn, S., Dennis, R., Weston, E and Whitfield, A, P (2019). A simple topographical model to predict Golden Eagle Aquila chrysaetos space use during dispersal. IBIS, 162(2), 400-415.

The satellite tag data from these two birds from the G/LAW1 territory has been used to determine their distribution, frequency of flight activity and general occurrence in proximity to the Site relative to their wider territory. While only one bird from a territory holding pair is typically tagged, it is understood that the range use of the other untagged bird from the territorial pair would broadly be consistent with that of the tagged birds. Thus the distribution and range use of the tagged birds is confidently assumed to be reflective of the territorial pair.

The extent of the G/LAW1 golden eagle's core range was determined based on a 95% kernal density analysis of the satellite tag fixes. This was then used to identify the extent to which their range overlapped with the Site, if at all. The satellite tag data was then used in combination with the GET model data to determine the extent to which the development of the Proposed Development may result in the effective loss of suitable habitat (displacement) from within the local golden eagle's territory range.

The satellite tag data has also been used to represent the frequency with which the different parts of the core range are used by creating a heat map which ranks areas by their frequency of use, and hence their inferred importance to golden eagles, by the frequency of satellite tag fixes occurring across their core range. This is refined by applying a 100m x 100m square grid across the area over which the satellite tag fixes are distributed in order to provide a degree of spatial resolution to the ranking of land throughout.

The satellite tag data from both tagged birds was also used to identify roost site locations within the wider territory, and their frequency of use, by analysing the time-stamps of the tag data to identify locations where repeat registrations were returned from the same location between sunset and sunrise over the same night.

3 ORNITHOLOGICAL FIELD SURVEYS

The ornithology survey programme was developed based on the particular ornithological sensitivities which were anticipated to occur in and around the Site and was devised following NatureScot's survey guidance for assessing onshore wind farms (SNH, 2017)[1].

It is important to note that the Survey Area covering the wind farm part of the Site throughout the ornithological survey programme were based upon an initial boundary, which was slightly smaller than that of the final Application Boundary. However, the Survey Area still covered the Proposed Development's final layout and the relevant survey buffers, and so adequately covered all areas which may potentially be affected by the Proposed Development.

3.1.1 FLIGHT ACTIVITY SURVEYS

These surveys were designed to record flight activity of birds utilising the airspace over the Site. The data collected allow the total flight activity and bird numbers involved to be estimated over a given timeframe (e.g., breeding season, non-breeding season, or year), as well as showing spatial and temporal flight activity patterns. In turn, this information is used to undertake collision risk modelling (CRM) for key species using the standard Band *et al.* (2007)[9] method to predict potential mortality rates and collisions.

In order to collect flight activity data, surveys are conducted from elevated vantage points (VPs) which offer as wide and unrestricted a view as possible of the Site and a surrounding buffer of 500m (the Flight Activity Survey Area). For the Proposed Development, the Flight Activity Survey Area was based on a 500m buffer surrounding the initial boundary, as referred to above. A single VP was identified to adequately cover the Flight Activity Survey Area. The VP overlooked most of the Survey Area and the majority of the turbine envelope[10] at rotor height in accordance with NatureScot guidelines, which for the turbine models under consideration ranges from 23m to 200m above ground level. The VP was located at Grid Reference NM 94664 28667 (Deadh Choimhead), the location and 2km and 180° viewshed from 20m above ground level (as per Band *et al.,* 2007) is shown in **Figure 11.1.1 (Appendix A)**.

NatureScot's guidance requires that a minimum of 36 hours of survey effort is carried out at each VP in each relevant survey season (i.e., breeding and non-breeding). Importantly though, it also requires that the minimum required 36 hours of survey effort is captured within the specific breeding and non-breeding seasons of each of the key species/groups of conservation concern which are most likely to occur over or in the vicinity of the Site. For the Proposed Development, key species that were identified at the outset of the survey programme as having the potential to occur over or around the Site were lower altitude moorland breeding raptors such as hen harrier, merlin and short-eared owl whose breeding seasons extend from March/April to mid-August (NatureScot, 2024[11]). Consequently, the flight activity survey programme for the Proposed Development was devised to cover the generic breeding and non-breeding seasons (taken as March to August and September to February respectively). It should be noted that because the survey programme was not commissioned until April

[9] Band W, Madders M, and Whitfield DP. (2007). Developing field and analytical methods to assess avian collision risk at wind farms. In: Janss G, de Lucas M, and Ferrer M. (eds.) Birds and Wind Farms. Quercus, Madrid.

[10] The turbine envelope is the area enclosed by the tips of the outermost turbines.

[11] NatureScot (2024). Breeding Season Dates for Key Breeding Species in Scotland. Available at: Bird breeding season dates in Scotland | NatureScot.

2021 the flight activity surveys during the initial 2021 breeding season only covered the period April to August.

The VP was subject to 36 hours of survey effort across each individual season. Survey effort was spread throughout the daytime period where daylight hours best represent temporal flight activity patterns. Each survey was undertaken by a single observer in good conditions (i.e., visibility of at least 2km) and was limited to a maximum of three hours by a single observer, with a minimum half an hour break between any two consecutive surveys.

During each survey, when a bird or flock was detected, it was observed until it had landed or flown out of sight. The paths of all observed flights (flight lines) were drawn directly onto 1:10,000 OS maps or on digital data capture devices while the following associated flight data was also recorded:

- Flight start time;
- Species (where identification was uncertain, observations were identified to species group level at a minimum);
- Number of birds / flock size;
- Flight duration;
- Bird(s) occupancy across three height bands above ground level corresponding to heights below, at and above the rotor swept heights of the indicative turbine design[12] for each 15 second flight time interval; and
- Behaviour (including territorial or nesting behaviour).

In addition to flights by target species, the presence and behaviour of any other notable species which may be potentially vulnerable to the effects of wind turbines (so-called secondary species) were also recorded.

Forty-eight flight activity surveys were undertaken at the VP between April 2021 and February 2023 totalling 144 hours of survey effort. **Table 3-1** presents a summary of the flight activity survey effort undertaken throughout the survey programme, further details of which are provided in **Appendix B, Table B-1**.

Table 3-1 – Summary of Flight Activity Survey Effort

VP	Survey Effort				
	Year 1 (2021-2022)		Year 2 (2022-2023)		Total effort
	Breeding season	Non-breeding season	Breeding season	Non-breeding season	
1	36hrs	36hrs	36hrs	36hrs	144hrs

Collision Risk Modelling

The Collision Risk Modelling (CRM) methodology followed that described by Band *et al.* (2007)[9] which is recommended by SNH (2018[13]), further details of which are provided in **Appendix C**. This involves a three-step process as follows:

[12] Height bands were: HB1 = <50m, 2 = 50-200m, 3 = >200m.
[13] SNH (2018). Use of Avoidance Rates in the SNH Wind Farm Collision Risk Model. SNH, September 2018 v2.

Stage 1: using flight activity survey results as a sample to estimate the number of flights likely to take place at rotor height during a certain period of time (usually either a year or during the breeding or non-breeding season), then calculate what proportion of these would take place within the total rotor swept area of the wind farm, assuming no avoidance actions, thus placing a bird at risk of collision.

Stage 2: calculate the probability that, if a flight does pass within the rotor swept area of a turbine, that bird would be struck by a rotating blade. This probability is multiplied by the number of at-risk flights for that species estimated in Stage 1.

Stage 3: account for the birds likely ability to avoid colliding with turbines in the vast majority of occasions, by behavioural actions either close to individual rotors or by avoiding the wind farm as a whole. This avoidance rate (typically 98% and up to 99.8% for geese - SNH, 2018[13]) is then multiplied by the figure calculated at Stage 2 to give an overall estimate of the collision rate.

For each target species recorded in sufficient numbers (i.e. three or more "at risk" flights as defined in **Appendix C**) at the Site, separate collision rates for the breeding and non-breeding season (where relevant) were predicted using either a directional or non-directional (random) version of the model. The choice of model for each target species was based on its pattern of flight behaviour within the study area. The directional model is appropriate when a species tends to move across the wind farm area in a particular direction. This type of flight behaviour is characteristic of species on migration or making regular movements between feeding and roosting sites and SNH[13] advocates using it for groups such as geese, swans, divers and ducks. A non-directional model is more appropriate where the flights of a particular species are not predominantly in any direction. This is usually the case for birds moving around within a breeding or hunting territory that is wholly or partly within the site of interest. This approach, which assumes that the direction of flights is random, is usually appropriate for breeding and non-breeding raptors and waders.

The Risk Zone within which birds were considered to be at risk of collision was taken to be the area enclosed by the tips of the outermost turbine rotors, plus a 500m buffer to allow for surveyor error when mapping flightlines, in line with the SNH (2017[1]) survey guidance.

3.1.2 SCARCE BREEDING BIRD SURVEYS

The Scarce Breeding Bird Surveys (SBBS) amalgamated two methodologies:

- Moorland breeding bird surveys which targeted breeding waders within the Site and a surrounding buffer of 500m, where access permitted, using a modified version of the Brown and Shepherd (1993)[14] methodology as summarised in Gilbert *et al.* (1998)[15]; and
- Scare breeding raptor surveys covering the Site and a surrounding buffer of up to 2km, where access permitted. Survey protocols broadly followed the standard methodologies for assessing raptor populations set out by Hardey *et al.* (2013)[16] and Gilbert *et al.* (1998)[15].

These survey methods were combined for efficiency in consideration of a lack of breeding wader activity noted during the initial surveys. Within the Site and surrounding 500m buffer the moorland breeding bird survey methodology was applied with the additional recording of scarce breeding raptors. Between 500m and 2km from the Site boundary, only the scarce breeding raptor survey

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

[15] Gilbert, G., Gibbons D.W., and Evans, J. (1998). Bird Monitoring Methods. RSPB, Sandy.

[16] Hardey, J.; Crick, H.; Wernham, C.; Riley, H.: Ethridge, B. and Thompson, D. (2013). Raptors. A Field Guide for Surveys and Monitoring. SNH, Inverness.

methodology was applied. The moorland breeding bird and scarce breeding raptor survey areas are shown in **Figure 11.1.2**.

Surveys involved monthly visits conducted between April and July in both the 2021 and 2022 breeding seasons, with an additional survey visit in March 2022 aimed at detecting early season display activity, particularly by hen harrier. The surveys involved walkovers and short, ad-hoc VP watches focussing on areas of suitable breeding raptor habitat such as heather moorland, craggy rock faces, cliffs and steep slopes, as well as the extensive forestry plantation to the south and east of the Site.

All observations and flight lines of raptor species and the locations of any nest sites or nesting/territorial activity were mapped and recorded as were any signs of raptor activity such as prey remains, faecal splashing, plucking posts, and pellets. All surveys were undertaken by Schedule 1-licensed surveyors with care being taken not to disturb active nest sites.

During the 2022 SBBS, a series of focal hen harrier watches were undertaken from several different locations. These surveys aimed to locate and monitor activity into and out of suspected, and subsequently confirmed hen harrier nest sites.

To inform the ornithological baseline conditions associated with the proposed Forest Access Track, an additional programme of scarce breeding bird surveys was conducted during the 2024 breeding season. These surveys covered the proposed Forest Access Track plus a surrounding buffer of up to 750m. This corresponds to the typical upper-range disturbance distance for the species most likely to occur in this part of the Site based on NatureScot's disturbance guidance (Goodship and Furness, 2022[17]). This Survey Area included the extensive commercial forestry plantation of Fearnoch Forest as well as the adjacent moorland edge habitats to the east. However, as the proposed Forest Access Track passes through Fearnoch Forest and is situated several hundred metres from the forest edge there was no likely risk of potential impacts upon moorland breeding waders. Consequently, these surveys only focussed on scarce breeding raptors.

Due to the extensive nature of the plantation throughout much of Fearnoch Forest, there were no locations which provided broad visibility over the forestry from which to conduct watches from, in order to locate the presence and activity of breeding raptors. Instead, watches were undertaken from elevated vantage points in the open moorland to the east of the forestry which provided sufficient visibility over the woodland from which to conduct these watches adequately.

Details of all Scarce Breeding Bird Surveys, including the focal hen harrier watches, are provided in **Appendix B, Table B-2**.

3.1.3 FOCAL EAGLE SURVEYS

In addition to the Scarce Breeding Raptor Surveys, dedicated eagle surveys were undertaken in April, June and July 2021 and March 2022 to detect the presence, distribution and activity patterns of golden and white-tailed eagles in the wider surrounding area (i.e. beyond the coverage of the SBBS). Watches were undertaken from the same hill as the Flight Activity Surveys (Deadh Choimhead) but looked due south, in the opposite direction from the Site, towards areas of habitat with the highest suitability for eagles, using a telescope to scan for the presence of birds up to 6km from the Site.

[17] Goodship, N.M. and Furness, R.W. (MacArthur Green) (2022). Disturbance Distances Review: An updated literature review of disturbance distances of selected bird species. NatureScot Research Report 1283.

Closer proximity surveys of these areas were not undertaken due to access restrictions in the wider surrounding area. All observations and flight lines of raptor species were recorded.

The eagle survey area is shown in **Figure 11.1.3**, while the details of these surveys are provided in **Appendix B, Table B-2**.

3.1.4 HEN HARRIER ROOST SURVEY

A programme of winter hen harrier roost surveys was undertaken between October 2023 and February 2024, broadly following the standard methodology set out in Gilbert *et al.* (1998)[15]. A survey was scheduled to take place in March 2024 but was cancelled due to access restrictions.

The surveys comprised of two VP locations overlooking areas of suitable habitat (i.e. areas of reedbed, rough grassland and heathland) within the Site and a surrounding buffer of up to 2km. Both VPs were located on the ridge of Cruach Clenamacrie, with one looking north and east across the Site and the wooded slopes towards Black Lochs and its surrounding marshlands (VP1: grid reference NM9318 2990) and the other looking due southwest towards the moorland slopes on the opposite side of Glen Lonan (VP2: grid reference NM 3922 2925) (see **Figure 11.1.4**).

Surveys took place between an hour to an hour and a half before sunset to half an hour after sunset (or until it became too dark to see), during which surveyors scanned suitable habitats for the presence of hen harriers and in particular any birds descending into particular locations to roost. Other species of conservation concern observed during these surveys were also recorded.

The details of these surveys are provided in **Appendix B, Table B-4**.

3.1.5 BLACK GROUSE SURVEYS

Black grouse surveys were completed in the springs of 2021 and 2022 following the standard methodology set out in Gilbert *et al.* (1998)[15]. These involved walkover surveys of all areas of suitable habitat (e.g., areas of short grassland such as pastures or moorland particularly near young or open forest edges) within the Site and a surrounding buffer of 1.5km and were conducted between late March and mid-May. Their aim was to determine the presence of black grouse and locate any lek (display) sites.

Surveys were undertaken from up to an hour before sunrise to approximately two hours after dawn in dry and calm conditions with good visibility. Surveyors sought to cover all areas to within 500m in search of lekking male black grouse and any attending females. Any identified leks were observed from suitable VPs to avoid disturbance and the number of males (not just displaying birds) and females seen in the lekking area were recorded on each visit. The grid reference and details of any observations or signs of black grouse were also recorded. Leks located 200m or more apart were considered to be separate.

In order to inform the potential impacts on black ground from the proposed Forest Access Track, an additional black grouse survey was conducted during the 2024 spring lekking season. This survey covered the moorland edge habitats to the east of Fearnoch Forest located within 750m of the proposed Forest Access Track, as this corresponds to the upper-range disturbance distance for lekking black grouse based on NatureScot's disturbance guidance (Goodship and Furness, 2022[17]) The surveys followed the same methods as those detailed above.

Details of these surveys are provided in **Appendix B, Table B-3**. The black grouse survey area is shown in **Figure 11.1.2**.

4 DESK STUDY RESULTS

4.1 DESIGNATED SITES

There are four internationally designated sites of ornithological interest were identified within 20km of the Application Boundary. Details of each of these sites are presented in Table 4-1 while their locations and distribution in relation to the Site are shown in Figure 11.1.5. There are no other designated sites with ornithological features of interest within 2km of the Site.

Table 4-1 – Internationally Designated Sites with Ornithological Interest within 20km of the Site

Site Name	Qualifying Features	Distance to Nearest Point of the Site
Glen Etive and Glen Fyne SPA	Glen Etive and Glen Fyne SPA qualifies under Article 4.1 by regularly supporting a population of European importance of the Annex 1 species golden eagle *Aquila chrysaetos* (19 active territories in 2003, more than 4.2% of the GB population).	~8.5km to the east of the wind farm Site. ~6.6km to the east of the access track.

4.2 PROTECTED AND NOTABLE SPECIES OF CONSERVATION CONCERN

A summary of records derived from data sources using the methodology described in **Section 3** is provided in Table 4-2. Details concerning the nest and lek site locations of rare and vulnerable species of conservation concern are restricted to **Figure 11.2.1** in **Appendix 11.2: Confidential Ornithological Information**.

Table 4-2 – Summary of Recent Historical Records of Species of Conservation Concern

Species	Summary of Data Provided	Date(s)	Provider(s)
Golden eagle	One nest site is located within 6km but over 2km from the Proposed Development Site, which corresponded with the G/LAW1territory referred to in consultation with NatureScot (see Table 11.1). Nest site locations for a further two territories located over 6km from the Site were also provided.	2020-2022	ARSG
	A recorded roost site located to the west of the Site during surveys for the proposed Beinn Ghlas Wind Farm Repowering Project.	2022	Natural Research
White-tailed eagle	One nest site is located within 6km but over 2km from the Site, and a further five nest sites are located over 6km from the Site.	2017-2022	ARSG, FLS
Osprey	One nest site is located within 2km of the Site.	2020-2021	ARSG, FLS
Black Grouse	One lek site comprising two males from 2018 is located within the Site, and a further two lek sites are located within 2km of the Site, one from 2014 comprising an undefined number of males and the other from 2017 comprising two males. Sighting records were also provided from within and immediately to the east of the Site.	2014-2022	RSPB, FLS

In addition to the recent historical records presented in **Table 4-2**, the following notable historical records were also provided:

- Hen harrier: two nest site records from 2010; one located within the Site and the other located over 2km from the Site; and
- Black grouse: a lek site comprising seven males located within the Site from 2012.

4.3 GOLDEN EAGLE TOPOGRAPHY MODELLING AND SATELLITE TAG DATA

Due to the sensitivity of some of the data it contains, full details of the GET model and satellite tag data are presented in **Appendix 11.2: Confidential Ornithological Information**. In summary, the GET model data demonstrate that the Site and immediately surrounding area (i.e. up to 1km) represents moderately suitable habitat for golden eagle with a reasonable proportion of land corresponding to GET 6+ suitability. This is interspersed with smaller pockets of unsuitable (GET 5-) habitat such as lower lying ground as well as being partially surrounded to the south, east and west by closed canopy forestry. More extensive suitable (GET 6+) land exists in the wider surrounding area, particularly over 2km to the south of the Proposed Development associated with Beinn Ghlas hill and the affiliated higher ground. Much more extensive and consistently suitable habitat exists over 6km to the east of the Proposed Development, either side of Loch Etive where the land is predominantly classed as GET 8+. This land corresponds with Glen Etive and Glen Fyne SPA, which is designated for golden eagles as detailed in **Table 4-1**.

Meanwhile, the satellite tag data from the birds associated with the G/LAW1 territory shows that their distribution is concentrated around the higher ground associated with Beinn Ghlas located over 3km to the south of the Proposed Development, stretching from Glen Feochan in the west to the Pass of Brander and the southern slopes of Ben Cruachan in the east. Southerly distribution extends across the open hills towards Loch Scammadale and Glen Nant, while to the north the birds range across Glen Lonan to use higher ground associated with the Site, including in particular Deadh Choimhead immediately to the south. Using kernel density analysis to identify the area within which 95% of the satellite tag fixes occur, the core range of the G/LAW1 territory encompasses an area of 111.15ha centred around the higher ground associated with Beinn Ghlas extending to the named locations to the north, south, east and west as referenced above (i.e. Glen Feochan and the southern slopes of Ben Cruachan etc).

When compared with the GET model data, the core range of the G/LAW1 golden eagles shows a very strong correlation with the areas where GET 6+ land predominates, as is associated with Beinn Ghlas and the affiliated higher ground. In total there is 58.56ha of suitable (GET 6+) golden eagle habitat within the core G/LAW1 golden eagle range, which represents 52.68% of the core range.

Additionally, the heat mapping exercise which the satellite tag data has also been used to represent the frequency with which the different parts of the core range are used, and hence their inferred importance to golden eagles, clearly shows that the higher ground located to the south of the Proposed Development, on the opposite side of Glen Lonan and associated with Beinn Ghlas, is occupied most frequently and represents the most intensively utilised part of the range. Meanwhile, the peripheral areas of the core range, which include land within which the Site is located, are occupied much less frequently.

Meanwhile, with regards to interpretation of the satellite tag data to identify overnight roost sites, analysis of the data revealed there to be over 100 locations where G/LAW1 golden eagles roost throughout their core territory. Some of these are clustered into broader roosting areas presumably with multiple roosting crags or trees. Further analysis into the frequency with which each location/area is used, identified two regularly used, traditional roost sites and one frequently used site as well as over 100 occasional or infrequently used roost sites. The three regular and frequently used roost sites were all over 2km from the Site and distributed throughout the golden eagles' wider core territory. Of the remaining occasional to infrequently used roost sites/areas, five are located within 1km of the Site, all but one of which are located over 500m from the development footprint. Notably, there are several roost sites located within 500m of the existing Beinn Ghlas Wind Farm site.

It is worth noting that none of the roost sites identified by the satellite tag data corresponded with the roost location provided by Natural Research to the west of the Proposed Development (see **Table 4-2**). This suggests that that observation will have been of a non-tagged bird, either a non-territorial bird or the un-tagged bird from the territorial pair.

5 ORNITHOLOGICAL FIELD SURVEY RESULTS

5.1.1 FLIGHT ACTIVITY SURVEYS

A total of 76 flights by ten target species were recorded over and around the Site between April 2021 and August 2022. **Table 5-1** presents a summary of the flight activity survey results for the entire survey programme and a breakdown for each season as well as identifying the 'at-risk' flight time for each target species. Full details of the flight activity survey observations are provided in **Appendix D, Table D-1**. **Figures 11.1.6.a-b** and **11.1.7.a-b** show the distribution of target raptors and waterfowl bird flight activity during Year 1 (2021-22) and Year 2 (2022-23) respectively.

Table 5-1 – Details of Recorded Flight Activity by Target Species

Species (Season[18])	Total No. of Flights (No. of Birds)	Year	No. of Flights (No. of Birds)	Cumulative Flight Duration (secs)	No. of "At Risk" Flights (No. of Birds)	Cumulative Flight Duration "At Risk" (secs)
Hen harrier	53 (58)	Yr1 (2021/22)	18 (20)	990	9 (9)	112
		Yr2 (2022/23)	35 (38)	6060	20 (22)	1231
Golden eagle	9 (11)	Yr1 (2021/22)	3 (3)	547	0	0
		Yr2 (2022/23)	6 (8)	1652	5 (6)	192
White-tailed eagle	3 (3)	Yr1 (2021/22)	2 (2)	863	2 (2)	469
		Yr2 (2022/23)	1 (1)	400	0	-
Pink-footed goose[19]	4 (451)	Yr1 (2021/22)	1 (180)	150	0	0
		Yr2 (2022/23)	3 (271)	378	-	-
Greylag goose	2 (21)	Yr1 (2021/22)	2 (21)	135	1 (1)	15
		Yr2 (2022/23)	0	-	-	-
Merlin	1	Yr1 (2021/22)	1 (1)	1	0	0
		Yr2 (2022/23)	0	-	-	-

[18] Species-specific breeding and non-breeding seasons taken from SNH (2014) Breeding season dates for key breeding species in Scotland, unless otherwise stated.

[19] Breeding and non-breeding seasons taken from SNH (2017) Recommended bird survey methods to inform impact assessment of onshore windfarms. SNH Guidance. SNH, Battleby.

Species (Season[18])	Total No. of Flights (No. of Birds)	Year	No. of Flights (No. of Birds)	Cumulative Flight Duration (secs)	No. of "At Risk" Flights (No. of Birds)	Cumulative Flight Duration "At Risk" (secs)
Osprey	1	Yr1 (2021/22)	1 (1)	165	0	0
		Yr2 (2022/23)	0	-	-	-
Peregrine	1	Yr1 (2021/22)	1 (1)	60	0	0
		Yr2 (2022/23)	0	-	-	-
Red-throated diver	1	Yr1 (2021/22)	1 (1)	180	0	0
		Yr2 (2022/23)	0	-	-	-
Whooper Swan	1 (6)	Yr1 (2021/22)	1 (6)	315	0	0
		Yr2 (2022/23)	0	-	-	-

- **Hen harrier:** A total of 53 flights comprising 58 birds were recorded throughout the 2021-22 survey programme. Eighteen of those flights relating to 20 birds were recorded in 2021, the majority of which were recorded in June and July, with flights observed in July 2021 predominantly involved juvenile birds. Throughout the 2021 breeding season flights were distributed around the Site with a concentration in the southern-central part of the Site and related to a breeding pair located within 2km of the Site. Only a single hen harrier flight was observed during the 2021/22 non-breeding season. This involved a male bird observed flying along the Site's southern boundary in September.

  In 2022 twice the number of flights (35 comprising 38 birds) were recorded and related to at least five different birds; two breeding pairs located within 2km of the Site and an additional second calendar year male bird. Although flights occurred across the Site, there was a concentration of activity over the moorland and adjacent forestry to the north east of the Site. As in the 2021/22 surveys, only a single hen harrier flight was observed during the 2022/23 non-breeding season. This also involved a male bird observed, this time flying due south over the VP hill, Deadh Choimhead, in the September.

  As expected, based on this species' hunting behaviour, the majority of flights occurred at low levels although a number of flights, particularly display flights during the early part of the breeding season were at greater heights.

- **Golden eagle:** A total nine flights by 11 birds were recorded throughout the 2021-22 survey programme. Three flights were recorded during the surveys in 2021/22; one during the breeding season and two during the non-breeding season, with six flights occurring during the 2022/23 surveys, all of which were recorded during the breeding season. However, four of the six flights recorded during the season years surveys were by the same two birds (a male and a sub-adult female) recorded on the same day over a period of 30 minutes.

Flights involved both adult and sub-adult birds, including the male and a sub-adult female pair mentioned above, and were predominantly distributed over the higher ground within the west (Cruach Clenamacrie) and south of the Site, as well as around the VP hill, Deadh Choimhead, to the south of the Site.

- **White-tailed eagle:** three separate flights, all by immature birds, were observed throughout the 2021-22 survey seasons. One bird was observed flying due south over the Site during the 2021 breeding season, the second was over the western part of the Site during the 2021/22 non-breeding season and the third was flying to the east of the Site during the 2022 breeding season.
- **Osprey**: one flight by a single bird was recorded passing high over the Site due north-east towards Loch Etive during the 2021 breeding season.
- **Merlin:** one flight by single small raptor which was only observed very briefly but suspected to be a merlin, was recorded in the south-west corner of the Site during the 2021 breeding season.
- **Peregrine:** a single flight by an individual bird was observed flying due east over the forestry and VP hill to the south of the Site during the 2021 breeding season.
- **Red-throated diver:** a single flight by an individual bird was observed flying due south to the west of the Site during the 2021 breeding season.
- **Greylag goose:** two flights by 21 birds; one flight north very high over the Site were birds expected to have been on spring migration.
- **Pink-footed goose:** four flights comprising 451 birds, with two flocks of between 180 and 190 birds. Two of the flights were recorded in the April of 2021 and 2022 at the end of the spring migration period, while the other two were recorded in September 2022 at the start of the autumn migration period.
- **Whooper swan**: A flock of six whooper swans passing due north over the Site during the 2021/22 non-breeding season.

Collision Risk Modelling Output

As detailed in the methods section, in order for CRM results to be meaningful a minimum of three "at risk" flights are required. The flight activity survey results therefore meant that there were only sufficient at-risk flights to undertake CRM for two species: golden eagle and hen harrier. A summary of the output from the CRM based on the recorded flight activity by these species in each year is presented in **Table 5-2** below.

Table 5-2 – Collision Risk Modelling Output

Species	Avoidance Rate	Year	No. of "At Risk" Flights (No. of birds)	Cumulative Flight Duration "At Risk" (secs)	Number of Predicted Collisions per Year	Time for One Collision to Occur (years)
Hen harrier	99%	Year 1 (2021/22)	9 (9)	112	0.01	170
		Year 2 (2022/23)	20 (22)	1231	0.06	15.5

Species	Avoidance Rate	Year	No. of "At Risk" Flights (No. of birds)	Cumulative Flight Duration "At Risk" (secs)	Number of Predicted Collisions per Year	Time for One Collision to Occur (years)
Golden eagle	99%	Year 1 (2021/22)	1 (1)	0	Insufficient number of 'at risk' flights	
		Year 2 (2022/23)	5 (6)	192	0.02	66.5

5.1.2 SCARCE BREEDING BIRD SURVEYS

Seven species of scarce raptor and one species of breeding wader were recorded during the 2021 and 2022 scarce breeding bird surveys, the frequency, distribution and activity of which is summarised below. **Figures 11.1.8a** and **11.1.8b** show the distribution of scarce breeding raptors recorded in 2021 and 2022 respectively, excluding eagles, while nest locations are presented in **Figures 11.2.7.a** and **11.2.7.b** in **Appendix 11.2 Confidential Ornithological Information** for 2021 and 2022 respectively. Meanwhile **Figures 11.1.9a** and **11.1.9b** show the distribution of the eagle observations from 2021 and 2022 respectively, as well as any other scarce raptors observed outwith the 2km scarce raptor survey area. Records of breeding waders (for which greenshank was the only species) are presented on **Figure 11.1.10** only.

No scarce raptors were recorded during the surveys undertaken for the proposed Forest Access Track.

- **Hen harrier:** Due to its sensitivity, details relating to hen harrier are restricted to **Appendix 11.2 Confidential Ornithological Information**.
- **Golden eagle:** During the dedicated eagle watch in April 2021 a single golden eagle was observed flying east over high ground approximately 4km south east of the Site, east of Beinn Ghlas Wind Farm. No golden eagle activity was recorded in June 2021 but in the July an adult bird was observed flying due east past Beinn Ghlas Wind Farm.

  In contrast to the 2021 dedicated eagle watch, there was a marked increase in flights during the surveys in 2022, with a total of 13 golden eagle flights recorded in the March. Most flight activity was located over 3km from the Site, with only one flight from a single adult passing around the southern and eastern peripheries of the Site. Most of the activity related to up to two adults, presumed to be a territorial pair, in an area around Beinn Ghlas Wind Farm over 4km south of the Site. In July, a single bird was seen perched and in flight in the western half of the Site.
- **White-tailed eagle:** During the dedicated 2021-22 eagle watches, four white-tailed eagle flights were recorded. Two flights by single white-tailed eagles were observed at least 4km south east of the Site along the ridge associated with Beinn Ghlas Wind Farm before a pair of adult birds were observed drifting and circling due north from the direction of Beinn Ghlas Wind Farm passing over the eastern part of the Site before continuing due north. An adult white-tailed eagle was also observed passing high due north over the Site.
  Six white-tailed eagle flights were recorded during the 2022 surveys and related to sightings of one or more adult birds. Two of these were located just to the south of the Site circling over Glen Lonan, while a third was observed over Fearnoch Forest before drifting north east towards Loch Etive. The

remaining three flights were located over 3km south of the Site, to the west of Beinn Ghlas. No flights crossed the Site.

- **Osprey:** Details relating to osprey are restricted to **Appendix 11.2 Confidential Ornithological Information**.
- **Red kite:** Two flights by what were presumed to be the same single red kite were observed over 3km due south of the Site in the vicinity of Beinn Ghlas Wind Farm during the eagle surveys of April 2021. There were no observations of this species over or around the Site itself.
- **Merlin:** A male was disturbed from the southern area of the Application Boundary during surveys in April 2021 and observed in the same area in May of the same year. However, there was no indication of breeding by this species.
- **Peregrine**: A single peregrine was observed over the forestry to the south of the Site during one of the 2021 eagle watches. There were no other sightings of this species to indicate that there was a breeding site near to the Site.
- **Greenshank:** A single bird was observed briefly at the edge of Lochan na Creige Deirge to the north of the Site boundary in April 2021, before taking flight and departing the Site. There were no further observations of this species, and the record is presumed to have involved a passage bird. This was the only target wader species recorded during the scarce breeding bird surveys.

5.1.3 HEN HARRIER ROOST SURVEYS

The only hen harrier sighting made during the winter roost watches was of an adult male bird flying due north east over Cruach Clenamacrie in December. However, the bird was not seen descending into roost anywhere and there was no indication that it had gone into roost anywhere within the survey area.

Other birds observed during the hen harrier winter roost surveys included the following:

- **Golden eagle**: a pair of golden eagles observed flying over Deadh Choimhead and continuing on due south east over Glen Lonan during the January survey;
- **Short-eared owl**: a single bird observed hunting to the north of the Wind Farm Site during the November survey; and
- **Black grouse**: a male and female bird were observed flying over the northern end of Cruach Clenamacrie during the October survey, and a single female bird flushed also from the northern end of Cruach Clenamacrie during the January survey.

The location of these sightings is shown in **Figure 11.1.11**.

5.1.4 BLACK GROUSE

Black grouse were recorded lekking at four locations during the surveys of 2021 and 2022 (referred to as Leks A, B, C and D), the locations of which are illustrated on **Figure 11.2.8** in **Appendix 11.2 Confidential Ornithological Information**, while general flights and observations are shown on **Figures 11.1.12a-b** from 2021 and 2022 respectively. No black grouse were recorded during surveys in 2024 associated with the Forest Access Track.

Lek A is the only location at which lekking males were repeatedly observed both within and between survey years, with a peak count of three males being recorded in 2022. Three males and a single

female were observed at Lek B, but these birds were only observed on a single occasion in 2022, despite multiple visits to that part of the Site during dedicated black grouse surveys in both years. Furthermore, those birds were only observed to fly in and lek briefly (15-20 minutes) before flying away again (in from and away to the general direction of Lek A). Meanwhile, single birds were observed at Leks C and D on only single occasions in 2021 and 2022 respectively, with the bird at Lek D only lekking at that location for no more than five minutes.

Following further consideration and interpretation of the observations at Lek B, Lek C and Lek D, the behaviour observed is considered to be reflective of birds which exist at low densities, including that of sub-ordinate males which can display at the peripheries of and/or away from core lek sites while the dominant males are in attendance. Indeed, of the three birds observed at Lek A in 2022, one was noticeably located peripherally to the other two who were actively engaged in lekking display. This peripheral bird is believed to have been a sub-ordinate male and is likely to have been the same single bird observed at Leks C and D in both survey years. Meanwhile, the observed behaviour of three males and a single female briefly flying into and out of Lek B is interpreted to have been a competitive exchange, instigated by the presence of the female with the two dominant males chasing after her across the Site, lekking opportunistically where the female landed (irrespective of recognised/traditional lekking site) with the subordinate bird in tow, before flying off again a short time later. Overall, it is concluded that the Site supports three males (two dominant and one subordinate) and at least one female.

Based on the details above, and interpretation of these observations only Lek A is considered to be a core lek site, having consistently been attended in both years. Although birds were observed lekking at the other three locations they are not considered to be traditional/core lek sites and are simply concluded as having been a chance observation of competing males chasing a female (Lek B) and ad-hoc observations of an opportunistic subordinate male (Leks C and D).

Appendix A

FIGURES

Appendix B

ORNITHOLOGICAL SURVEY DETAILS

Table B-1 – Flight Activity Survey Effort (April 2021 – February 2023)

Date	VP	Surveyor*	Start Time	End Time	Duration (hh:mm)
02/04/21	1	TG	09:50	12:50	03:00
02/04/21	1	TG	13:20	16:20	03:00
19/05/21	1	RW	06:35	09:35	03:00
19/05/21	1	RW	10:05	13:05	03:00
25/05/21	1	GS	10:30	13:30	03:00
25/06/21	1	SM	10:55	13:55	03:00
25/06/21	1	SM	14:25	17:25	03:00
30/06/21	1	AL	14:15	17:15	03:00
31/07/21	1	AL	09:00	12:00	03:00
31/07/21	1	AL	12:30	15:30	03:00
23/08/21	1	IG/TG	11:00	14:00	03:00
23/08/21	1	IG/TG	14:30	17:30	03:00
28/09/21	1	IG	15:00	18:00	03:00
29/09/21	1	IG	10:15	13:15	03:00
28/10/21	1	AMN	10:45	13:45	03:00
28/10/21	1	AMN	14:15	17:15	03:00
25/11/21	1	AMN	09:35	12:35	03:00
25/11/21	1	AMN	13:05	16:05	03:00
09/12/21	1	MW	09:00	12:00	03:00
09/12/21	1	MW	12:30	15:30	03:00
27/01/22	1	PC	09:15	12:15	03:00
27/01/22	1	PC	12:45	15:45	03:00
24/02/22	1	SM	08:55	11:55	03:00
24/02/22	1	SM	12:25	15:25	03:00
22/03/22	1	TG	12:45	15:45	03:00
23/03/22	1	TG	09:40	12:40	03:00
21/04/22	1	GS	09:45	12:45	03:00
21/04/22	1	GS	13:15	16:15	03:00
12/05/22	1	GS	09:50	12:50	03:00
12/05/22	1	GS	13:20	16:20	03:00
16/06/22	1	GS	09:30	12:30	03:00
16/06/22	1	GS	13:00	16:00	03:00
13/07/22	1	IG	13:45	16:45	03:00
13/07/22	1	IG	17:15	20:15	03:00
04/08/22	1	IG	09:00	12:00	03:00

Date	VP	Surveyor*	Start Time	End Time	Duration (hh:mm)
04/08/22	1	IG	12:30	15:30	03:00
15/09/22	1	IG	10:00	13:00	03:00
15/09/22	1	IG	13:30	16:30	03:00
04/11/22	1	PC	09:00	12:00	03:00
04/11/22	1	PC	12:30	15:30	03:00
16/11/22	1	IG	12:30	15:30	03:00
17/11/22	1	IG	10:30	13:30	03:00
12/12/22	1	IG	12:00	15:00	03:00
13/12/22	1	IG	09:45	12:45	03:00
26/01/23	1	IG	10:45	13:45	03:00
27/01/23	1	IG	10:30	13:30	03:00
15/02/23	1	IG	12:50	15:50	03:00
16/02/23	1	IG	09:45	10:05	00:20
24/02/23	1	IG	11:30	14:10	02:40

* Surveyor: TG=Thomas Goater, IG=Iain Gilmore, RB=Robbie Watt, PC=Pete Carroll, GS=Graham Sparshott, AMN=Angus McNab, MW=M. Wood.

Table B-2 – Scarce Breeding Bird Survey Effort (2021, 2022 and 2024)

Month/Year	Date	Surveyor*	Start Time	End Time	Duration (hh:mm)
April 2021	29/04/21+	TG	09:00	11:40	02:40
	29/04/21	TG	11:40	16:30	04:50
	28/04/21	RW	11:30	17:00	05:30
	29/04/21	RW	06:15	13:45	07:30
	30/04/21	RW	09:45	14:15	04:30
May 2021	20/05/21	RW	06:00	11:30	05:30
	22/05/21	GS	13:30	15:30	02:00
	27/05/21	GS	08:45	14:45	06:00
June 2021	25/06/21	PC	10:50	16:50	06:00
	30/06/21	KL	11:00	17:00	06:00
	30/06/21+	AL	11:15	14:15	03:00
July 2021	30/07/21	AL	09:45	15:45	06:00
	30/07/21	KL	09:45	15:45	06:00
	31/07/21+	KL	09:00	15:00	06:00
March 2022	18/03/22+	TG	09:30	14:00	04:30
	22/03/22+	TG	09:35	12:35	03:00
April 2022	30/04/22	AL	06:30	11:30	05:00
	30/04/22	KL	06:30	11:30	05:00

Month/Year	Date	Surveyor*	Start Time	End Time	Duration (hh:mm)
	21/04/22	TG	05:55	12:40	06:45
	22/04/22	TG	05:55	10:05	04:10
May 2022	19/05/22	CG	05:30	13:30	08:00
June 2022	30/06/22	IG	11:30	14:30	03:00
	30/06/22	IG	15:00	18:00	03:00
July 2022	01/07/22	IG	11:00	13:15	02:15
	07/07/22#	GS	09:00	15:30	05:30 (inc. 3hr hen harrier focal watch)
	14/07/22	IG	09:55	12:00	02:05
	21/07/22#	GS	08:15	15:15	07:00
August 2022	03/08/22#	IG	12:00	18:30	06:30
	04/08/22#	IG	09:00	15:30	06:30
Forest Access Track Surveys					
April 2024	25/04/24	IG	12:00	16:30	04:30
	26/04/24	IG	09:00	12:30	03:30
May 2024	10/05/24	IG	05:00	07:00	02:00
	23/05/24	IG	14:45	15:45	01:00
	24/05/24	IG	08:15	10:15	03:00
June 20224	06/06/24	IG	12:00	15:00	03:00
	07/06/24	IG	09:55	12:55	03:00
July 2024	16/07/24	IG	11:30	14:30	03:00
	17/07/24	IG	08:25	11:25	03:00

* Surveyor: TG=Thomas Goater, RB=Robbie Watt, GS=Graham Sparshott, IG=Iain Gilmore; PC=Pete Carroll, AL=A. Little, KL=K. Little, CG=C. Griffin.

+ Golden Eagle Survey; # Hen Harrier Focal Watch

Table B-3 – Lekking Black Grouse Survey Effort (late April – mid May 2021 and May 2022)

Month/Year	Date	Surveyor*	Sunrise Time	Start Time	End Time	Duration (hh:mm)
April 2021	29/04/21	RW	05:40	05:15	11:15	03:00
May 2021	19/05/21	RW	05:00	05:00	06:30	01:30
April 2022	21/04/22	TG	06:00	04:55	07:55	03:00
	22/04/22	TG	06:00	04:55	07:55	03:00
	30/04/22	AL	05:40	05:30	11:30	03:00
	30/04/22	KL	05:40	05:30	11:30	03:00
May 2022	19/05/22	CG	05:00	04:30	07:30	03:00
Forest Access Track Surveys						
May 2024	10/05/24	IG	04:47	03:30	06:00	02.50

* Surveyor: TG=Thomas Goater, RB=Robbie Watt, AL=A. Little, KL=K. Little, CG=C. Griffin.

Table B-4 – Hen Harrier Winter Roost Survey Effort (November 2023 - February 2024)

Month/Year	Date	VP No.	Surveyor*	Sunset Time	Start Time	End Time	Duration (hh:mm)
October 2023	30/10/23	1	IG	16:42	15:10	17:15	02:05
		2	RW				
November 2023	29/11/23	1	AR	15:52	14:55	16:35	01:40
		2	PC				
December 2023	19/12/21	1	SM	15:44	14:15	16:30	02:15
		2	ML				
January 2024	15/01/24	1	ML	16:16	14:45	17:05	02:20
		2	SM				
February 2024	21/02/24	1	PC	17:36	16:20	18:05	01:45
		2	LC				
March 2024	Survey cancelled due to access restrictions.						

* Surveyor: AR=A. Russell, PC= Pete Carroll, SM=Stuart MacDonald, ML=M. Lawson, LC=L. Carroll.

Appendix C

COLLISION RISK MODELLING METHODOLOGY

Introduction

This section contains details of the methods used for the estimation of turbine collision rates. All of the mapped flight data were collated in a GIS (ArcView), with each flight's attributes (e.g., date, number of birds, vantage point recorded) included in an attribute table. These data were used in collision risk models to predict the number of birds that would collide with the turbines of the Proposed Development based on the indicative candidate design specifications (hub height – 119m and blade radius – 81m) during each season or year.

Choice of Directional or Non-Directional Models

CRM followed the method of Band et al. (2007)[20]. For each target species for which sufficient flights were recorded at PCH within the wind farm polygon (see below), a seasonal or annual collision rate was predicted using either a directional or non-directional collision risk model. Three was taken to be the minimum number of individual 'at-risk' flight events required to justify undertaking CRM. The choice of model for each target species was based on its pattern of flight behaviour within the study area.

The directional model is appropriate when the flights of a species are predominantly regular, directional, transits across the wind farm area. This type of flight behaviour is characteristic of species on migration or making regular movements between feeding and roosting sites, as is frequently the case for groups such as geese, swans, divers and ducks.

A non-directional model is more appropriate where the flights of a particular species represent more general usage of the airspace in and around the wind farm area and are not predominantly regular transits through the site. This is usually the case where birds have breeding or hunting territories that are wholly or partly within the site of interest. This approach, which assumes that the direction of flights is random, is usually appropriate for breeding and non-breeding raptors and waders.

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

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

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

Definition of the Risk Zone: The Wind Farm Polygon

The zone within which birds were considered to be at risk of collision was defined as the area enclosed by the tips of the outermost turbine rotors (the turbine envelope), plus a 500m buffer to allow for a degree of surveyor error when mapping flight lines in the field. This area is referred to as the Wind Farm Polygon (WP). Any bird flying within the WP at PCH was considered to be "at risk" of passing through the airspace swept by a turbine rotor (i.e., a rotor transit).

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

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

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

1. A 'Risk Window' was defined as the area spanned by the rotors of the wind farm as presented to a particular species following its normal flight direction through the wind farm. The size of this area is determined by the distance between the outermost rotors in front of the birds, multiplied by the height of the rotors, taken as the distance between the upper and lower rotor swept heights.
2. The Rotor-swept Area is defined as the total area swept by all of the rotors in the wind farm.
3. The number of rotor transits was calculated from the number of birds passing through the Risk Window by applying the ratio of the Rotor-swept Area to the Risk Window. For example: 20 birds x (5,000 m^2 [rotor swept area] / 50,000 m^2 [Risk Window]) = 2 rotor transits.

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

The Modelling Process

Stage 1

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

For the Directional Model – Estimation of the Number Rotor Transits

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

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

1) Occur within the flight recording height bands which reflected turbine height, or actual PCH, which for the proposed turbine design is 38-200m above ground.
   - Three height bands were used during the flight activity surveys in order to accommodate various turbine design options from the outset of the survey programme (i.e. Height Bands 1 = <50m, 2 = 50-200m, 3 = 200m+). In order to accurately reflect bird flight activity and flight time relative to the proposed turbine design specifications, the identification of 'at risk' flights and associated flight time was adjusted to reflect actual PCH by multiplying the time of each flight recorded in each of the two height bands that were only partially encompassed by PCH (i.e. height bands 1 and 3) by the proportion of the height bands that were within actual PCH. Thus, for the proposed turbine design the

time of each flight recorded within Height Band 1 was multiplied by 0.24 (i.e. 24% of Height Band 1 corresponds to actual PCH).

2) Pass over the survey WP at any point.
3) Occur within 2km of the VP at some point.

The Risk Window was measured as the distance between the outermost turbine rotors that would be facing a bird (i.e. perpendicular) on its typical orientation through the proposed wind farm. For the purposes of assigning flights to the Risk Window, a 500m buffer extending from the turbine rotor tips was included. This buffer mitigates against a degree of observer error when drawing flightlines on the map in the field. However, the actual length of the Risk Window (without a buffer) was used when calculating collision risk.

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

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

The weighted flux values for each VP were then summed to give the total flux through the proposed wind farm during the surveys.

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

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

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

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

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

For the Directional Model – Estimating the Number Rotor Transits

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

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

For a bird (or flock) to be considered within the survey Risk Volume it had to satisfy three conditions:

1) Occur within the flight recording height bands which reflected turbine height, or actual PCH (with the same corrections applied as for the directional model, above).
2) Pass over the survey WP at any point.
3) Occur within 2km viewshed of the VP at some point.

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

The total occupancy of the survey Risk Volume during the period of interest was extrapolated from the overall occupancy rate, by multiplying the rate by the size of the Risk Area and the total number of minutes that the species was potentially active during the period.

The Risk Volume was determined by multiplying the area of the WP by the diameter of the rotors.

The rotor-swept volume of the proposed wind farm was determined as: N*πr2*(d+L), where N is the number of turbines, d is the width of the rotor blades at their widest point and L is the body length (in metres) of the bird species for which collision risk is being calculated.

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

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

Stage 2

The probability was calculated that a bird of the species for which collision risk is being estimated would collide with a turbine rotor if it passed through the Rotor-swept Area/Volume. This probability is a function of the dimensions and flight speed of the species and of various turbine-specific. The calculation is facilitated by use of a spreadsheet supplied by SNH (2000)[21]. The relevant species biometrics and turbine parameters were entered into this spreadsheet which then calculated the probability of collision. Average flight speed values were taken from Alerstam et al. (2007)[22] and Bruderer and Boldt (2001)[23], with other taxonomic data taken from the RSPB website[24].

[21] SNH (2000). Windfarms and birds: Calculating a theoretical collision risk assuming no avoiding action. SNH Guidance Note Series.
[22] Alerstam T., Rosén M., Bäckman J., Ericson P.G.P. & Hellgren, O. (2007). Flight Speeds among Bird Species: Allometric and Phylogenetic Effects. *PLoS Biol* 5(8): e197. DOI:10.1371/journal.pbio.0050197.
[23] Bruderer, B. and Boldt, A. (2001) Flight Characteristics of Birds: I. Radar Measurements of Speeds. Ibis 143, 178-204.
[24] RSPB. Find a Bird webpage. Available at https://www.rspb.org.uk/birds-and-wildlife/a-z. Accessed July 2024.

Stage 3

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

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

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

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

i. that turbines would not be operational all of the time, with the standard assumption of 85% operational time used; and
ii. a range of plausible avoidance rates applied from 98 – 99.8%, with emphasis placed upon the rate that is recommended for the species of interest by SNH (SNH, 2018[13]).

Appendix D

ORNITHOLGICAL SURVEY RESULT DETAILS

Table D-1 - Details of Flight Activity Survey Records

Date	Time	VP	Observer*	Species	No. of Birds	Flight Duration (secs)
02/04/21	10:10	1	TG	Greylag goose	20	120
02/04/21	12:12	1	TG	Pink-footed goose	180	150
02/04/21	13:33	1	TG	Greylag goose	1	15
02/04/21	14:02	1	TG	Hen harrier	1	180
02/04/21	15:41	1	TG	Merlin	1	1
02/04/21	16:02	1	TG	Osprey	1	165
25/06/21	12:24	1	SM	Hen harrier	1	45
25/06/21	12:36	1	SM	Golden eagle	1	224
25/06/21	14:31	1	SM	Hen harrier	1	90
25/06/21	15:52	1	SM	Hen harrier	1	60
25/06/21	16:22	1	SM	Hen harrier	1	45
30/06/21	14:44	1	AL	Hen harrier	1	135
31/07/21	11:06	1	AL	Hen harrier	1	30
31/07/21	11:10	1	AL	Hen harrier	2	30
31/07/21	11:12	1	AL	Hen harrier	1	15
31/07/21	11:20	1	AL	Hen harrier	1	30
31/07/21	11:58	1	AL	Hen harrier	1	30
31/07/21	12:00	1	AL	Hen harrier	1	30
31/07/21	12:41	1	AL	Hen harrier	1	30
31/07/21	12:43	1	AL	Hen harrier	1	135
31/07/21	14:01	1	AL	Hen harrier	1	30
31/07/21	14:09	1	AL	Hen harrier	2	15
31/07/21	15:06	1	AL	Hen harrier	1	30
23/08/21	12:19	1	IG/TG	Red-throated diver	1	180
23/08/21	16:31	1	IG/TG	White-tailed eagle	1	255
23/08/21	16:38	1	IG/TG	Peregrine	1	60
29/09/21	11:11	1	IG	Hen harrier	1	30
29/09/21	11:43	1	IG	Golden eagle	1	45

Date	Time	VP	Observer*	Species	No. of Birds	Flight Duration (secs)
28/10/21	13:38	1	AMN	Whooper swan	6	315
22/03/22	12:47	1	TG	Hen harrier	1	20
22/03/22	12:54	1	TG	Hen harrier	1	10
22/03/22	13:11	1	TG	Hen harrier	1	20
22/03/22	13:55	1	TG	Hen harrier	1	75
22/03/22	15:27	1	TG	Hen harrier	1	125
23/03/22	10:09	1	TG	Hen harrier	1	5
23/03/22	10:15	1	TG	Hen harrier	2	165
23/03/22	10:47	1	TG	Hen harrier	1	70
23/03/22	11:53	1	TG	Hen harrier	1	40
23/03/22	11:59	1	TG	Hen harrier	2	960
23/03/22	11:21	1	TG	Golden eagle	1	570
21/04/22	09:57	1	GS	Hen harrier	1	135
21/04/22	10:58	1	GS	Hen harrier	1	56
21/04/22	11:06	1	GS	Hen harrier	1	46
21/04/22	11:28	1	GS	Hen harrier	1	220
21/04/22	11:39	1	GS	Pink-footed goose	38	78
21/04/22	11:55	1	GS	Hen harrier	1	390
21/04/22	14:15	1	GS	Golden eagle	2	540
21/04/22	14:17	1	GS	White-tailed eagle	1	400
21/04/22	14:42	1	GS	Hen harrier	1	30
21/04/22	14:55	1	GS	Hen harrier	1	180
21/04/22	15:50	1	GS	Hen harrier	1	25
21/04/22	16:06	1	GS	Hen harrier	1	270
12/05/22	10:31	1	GS	Hen harrier	1	140
12/05/22	12:29	1	GS	Hen harrier	1	45
12/05/22	12:38	1	GS	Hen harrier	1	400
12/05/22	12:49	1	GS	Hen harrier	1	72
12/05/22	13:23	1	GS	Hen harrier	1	330
12/05/22	14:08	1	GS	Hen harrier	1	89

Date	Time	VP	Observer*	Species	No. of Birds	Flight Duration (secs)
12/05/22	15:45	1	GS	Hen harrier	1	103
16/06/22	11:20	1	GS	Hen harrier	1	55
16/06/22	13:40	1	GS	Golden eagle	1	62
16/06/22	13:45	1	GS	Hen harrier	1	780
16/06/22	14:00	1	GS	Golden eagle	1	360
16/06/22	14:07	1	GS	Golden eagle	1	60
16/06/22	14:10	1	GS	Golden eagle	2	60
16/06/22	14:47	1	GS	Hen harrier	2	130
16/06/22	15:35	1	GS	Hen harrier	1	130
13/07/22	18:33	1	IG	Hen harrier	1	240
13/07/22	19:12	1	IG	Hen harrier	1	180
13/07/22	19:57	1	IG	Hen harrier	1	15
15/09/22	14:01	1	IG	Pink-footed goose	40	120
15/09/22	14:52	1	IG	Hen harrier	1	120
15/09/22	17:19	1	IG	Pink-footed goose	193	180
13/07/22	16:05	1	IG	Hen harrier	1	300
24/02/22	10:31	1	SM	White-tailed eagle	1	608
24/02/22	13:48	1	SM	Golden eagle	1	278

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