Mynydd Llanhilleth Wind Farm
Technical Appendix 9B: Collision Risk Modelling
edp6367_r015

1. Introduction

1.1. This Technical Appendix has been written as a supplement to the Ornithology Chapter of the Environmental Statement for the proposed wind farm at Mynydd Llanhilleth (hereafter referred to as the 'Proposed Development'). It explains the process and results of the Collision Risk Modelling (CRM), which estimates the wind turbine collision risk to select bird species based on flight data from two years of Vantage Point (VP) surveys.

1.2. The CRM methodology is based on Band *et al*. (2007[1]) as recommended by Natural Scotland (previously known as Scottish Natural Heritage, (SNH)) (SNH 2017[2]). The model requires various data (turbine specification, species biometrics and flight characteristics and data on flights within the Collision Risk Zone (CRZ)) to calculate a theoretical collision rate by season, year and over the lifetime of the project to inform the assessment of potentially significant adverse effects. The ability of species to avoid turbines is also factored in (SNH 2017[3]).

2. Methodology

2.1. Worst-case parameters for the wind turbine model selected for the Proposed Development and used for the CRM are shown in **2.1**.

Table EDP 2.1: Turbine dimensions used in the CRM.

Parameter	Value
Model	Vestas V150 - 4.5 Megawatts (MW)
Number of turbines	8
Number of blades	3
Blade diameter (m)	150
Blade high point (m)	180
Blade low point (m)	30
Maximum blade depth (m)	4.2
Flight risk area (m^2)	2,992,700
Flight risk volume (m^3)	448,905,000

[1] 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 (*pp. 259-275)*. Quercus, Madrid.

[2] Scottish Natural Heritage (2017) *Recommended Bird Survey Methods to Inform Impact Assessment of Onshore Wind Farms*. (online) Available at: https://www.nature.scot/sites/default/files/2018-06/Guidance Note - Recommended bird survey methods to inform impact assessment of onshore windfarms.pdf. Last accessed 04/07/22.

[3] Scottish Natural Heritage (2017) Avoidance Rates for the onshore SNH Wind Farm Collision Risk Model.

2.2. A total of three VP locations were used, covering a combined area of approximately 300 hectares. **Table EDP 1.2** shows the number of survey hours per VP location per season.

Table EDP 1.2: Survey hours per VP location per season

Season	Hours per survey	Number of surveys	Total number of hours per VP location	Total number of hours surveying
Breeding 2020	3	12	36	108
Non-breeding 2020-21	3	12	36	108
Breeding 2021	3	12	36	108
Non-breeding 2021-22	3	23	69	207*

*Survey effort increased in response to scoping response from Natural Resources Wales to increase (NRW) migratory coverage.

2.3. The CRM was completed separately for breeding (April to August) and non-breeding (September to March) seasons, covering two years from the 2020 breeding season through to the non-breeding season of 2021-22. Early April 2022 data was also included under the non-breeding season data following some survey postponements due to unsuitable weather.

2.4. Based on the flight data recorded, target species were selected for CRM. This included herring gull (*Larus argentatus*), lesser black-backed gull (*Larus fuscus*), goshawk (*Accipiter gentilis*), peregrine (*Falco peregrinus*), red kite (*Milvus milvus*) and kestrel (*Falco tinnunculus*). Owing to the number of raven (*Corvus corax*) and buzzard (*Buteo buteo*) flights recorded within the Survey Boundary and Study Area and in light of the scoping response from NRW requesting that, subject to results, they not be scoped out of the assessment, these species were also subject to CRM despite their favourable conservation status.

2.5. As none of these species were flying across the Survey Boundary and Study Area in any sort of regular way, the "Random Model" technique was used1. The model takes into account the time that birds of each species were observed flying at the height of the turbine rotors (CRZ), as well as the time in which birds could be active, i.e. the number of daylight hours per month.

2.6. The Band (2007) model is a two-stage process. The first stage uses the flight data recorded on the VP surveys (**Table EDP 2.2**) to estimate the number of birds flying through the areas swept by the turbine rotor blades per year.

Table EDP 2.2: Flight observations for Stage 1 of CRM.

Species	Season	Total observed time (s)	Available hours for flight activity	Time at CRZ height (s)
Herring Gull	Breeding 2020 (April-August)	3390	2351.19	1575
	Non-breeding 2020-21 (September-March)	330	2130.25	90
	Breeding 2021 (April-August)	3180	2351.19	1770
	Non-breeding 2021-22 (September-March)	1305	2130.25	1020

Species	Season	Total observed time (s)	Available hours for flight activity	Time at CRZ height (s)
Lesser Black-backed Gull	Breeding 2020 (April-August)	1590	2351.19	1080
	Non-breeding 2020-21 (September-March)	975	2130.25	750
	Breeding 2021 (April-August)	3150	2351.19	1800
	Non-breeding 2021-22 (September-March)	1065	2130.25	810
Goshawk	Breeding 2020 (April-August)	75	2351.19	45
	Non-breeding 2020-21 (September-March)	195	2130.25	60
	Breeding 2021 (April-August)	75	2351.19	45
	Non-breeding 2021-22 (September-March)	90	2130.25	45
Peregrine	Breeding 2020 (April-August)	465	2351.19	285
	Non-breeding 2020-21 (September-March)	285	2130.25	120
	Breeding 2021 (April-August)	375	2351.19	315
	Non-breeding 2021-22 (September-March)	0	2130.25	0
Red Kite	Breeding 2020 (April-August)	3885	2351.19	1620
	Non-breeding 2020-21 (September-March)	4830	2130.25	3045
	Breeding 2021 (April-August)	2625	2351.19	1560
	Non-breeding 2021-22 (September-March)	9930	2130.25	7305
Kestrel	Breeding 2020 (April-August)	285	2351.19	225
	Non-breeding 2020-21 (September-March)	1500	2130.25	525
	Breeding 2021 (April-August)	180	2351.19	135
	Non-breeding 2021-22 (September-March)	5595	2130.25	4680
Raven	Breeding 2020 (April-August)	1740	2351.19	1155
	Non-breeding 2020-21 (September-March)	4380	2130.25	1740
	Breeding 2021 (April-August)	3060	2351.19	1440
	Non-breeding 2021-22 (September-March)	6765	2130.25	3405
Buzzard	Breeding 2020 (April-August)	4590	2351.19	1995
	Non-breeding 2020-21 (September-March)	7170	2130.25	3570
	Breeding 2021 (April-August)	7035	2351.19	5190
	Non-breeding 2021-22 (September-April)	18300	2130.25	14595

2.7. The flight risk area is defined as the area bounded by the extent of the outer-most turbines, plus a buffer of 75m in order to include the turbine blade radius. The flight risk volume is this area multiplied by the diameter of the turbine blades.

2.8. The area of visibility was calculated using Quantum Geographic Informaiton System software (QGIS), using a viewshed of 180° from each of the three VP locations, limited to a radius of 2km. It covers the area visible 25m above ground level, assuming an observer height of 1.75m, a woodland height of 18m, and a 5m digital terrain model. The overlapping areas were removed to give a total area visible.

2.9. The second stage then estimates the probability of these birds actually being hit by the moving rotors. The results of this stage can be seen in **Table EDP 2.3**. This stage uses data of bird wingspan and body length (BTO 2022[4]) and flight speeds (Alerstam *et al*. 2007[5] and Bruderer & Boldt 2001[6]), which have been provided in **Table EDP 2.4**. These two numbers are multiplied together to produce an estimate of bird casualties over a year, assuming that birds will take no measures to avoid collisions.

Table EDP 2.3: Calculation of collision probabilities for birds passing through area swept by rotor blades.

Species (in flapping flight)	p(collision) Upwind (%)	p(collision) Downwind (%)	Mean (%)
Herring Gull	17.0	11.5	14.3
Lesser Black-backed Gull	16.6	11.0	13.8
Goshawk	20.4	14.7	17.6
Peregrine	16.3	10.7	13.5
Red Kite	18.3	12.7	15.5
Kestrel	18.1	12.5	15.3
Raven	15.9	10.3	13.1
Buzzard	16.0	10.5	13.3

Note: upwind and downwind probabilities are different due to wind speed affecting time taken to pass through the area swept by the rotor blades. These are therefore combined to give an average collision probability.

[4] British Trust for Ornithology (2022) *Birdfacts* (online) Available at: https://www.bto.org/understanding-birds/birdfacts. Last accessed 04/07/22.
[5] 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.
[6] Bruderer, B. & Boldt, A. 2001. *Flight characteristics of birds 1: radar measurement of speeds*. Ibis 143 (2): 178-204.

2.10. In reality, birds will avoid collisions if possible, so this assumption is unrealistic. Therefore SNH (2018[7]) have calculated avoidance rates based on observations of different species in the field, which are then applied to the bird collision risk estimate to provide a more realistic estimate. Furness (2019[8]) updated the avoidance rates of herring gull and lesser black-backed gull. The avoidance rates used are shown in **Table EDP 2.4**.

Table EDP 2.4: Bird biometrics and avoidance rates.

Species	Body length (m)	Wingspan (m)	Assumed flight speed (m/s)	Avoidance rate (%)
Herring Gull	0.60	1.44	12.8	99.5
Lesser Black-backed Gull	0.58	1.42	13.1	99.5
Goshawk	0.55	1.10	10.0	98.0
Peregrine	0.42	1.02	12.1	98.0
Red Kite	0.63	1.85	12.0	99.0
Kestrel	0.34	0.76	10.1	95.0
Raven	0.64	1.35	14.3	98.0
Buzzard	0.54	1.20	13.3	98.0

Note: assumed flapping flight.

Limitations and assumptions

2.11. The CRM assumes that the turbines will be operational at all times, and therefore accounts for the worst-case scenario. In reality, mechanical faults/maintenance and low wind speed will likely mean that operational time is more like 85-90%. If the rotors are not spinning, this would result in lower numbers of bird collisions than projected here.

2.12. No data was available on the wind turbine blade pitch angle which is used in the collision risk calculations. It was left as the default value of 30°. Band (2012[10]) considers 25-30° to be a reasonable assumption for a typical large turbine.

2.13. No data was available for the rotation period of the wind turbines, so this was left at the default value of 2.97 seconds per rotation (20.2 rotations per minute).

[7] Scottish Natural Heritage (2018) *Avoidance Rates for the Onshore SNH Wind Farm Collision Risk Model*. (online) Available at: https://www.nature.scot/sites/default/files/2018-09/Wind farm impacts on birds - Use of Avoidance Rates in the SNH Wind Farm Collision Risk Model.pdf. Last accessed 04/07/22.

[8] Furness, R.W. (2019) *Avoidance rates of herring gull, great black-backed gull and common gull for use in the assessment of terrestrial wind farms in Scotland*. Scottish Natural Heritage Research Report No. 1019.

[10] Band, B. (2012). *Using a Collision Risk Model to Assess Bird Collision Risks for Offshore Wind Farms*. Report by British Trust for Ornithology (BTO). Report for The Crown Estate. (online) Accessed at https://www.bto.org/sites/default/files/u28/downloads/Projects/Final_Report_SOSS02_Band1ModelGuidance.pdf. Last accessed 25/08/22.

3. Results

3.1 The results of the CRM, showing seasonal, annual, and longer-term collision risks, are shown in **Table EDP 3.1**.

Table EDP 3.1: Projected seasonal, annual, and longer-term collision risk.

Herring Gull		**Year 1**	**Year 2**	**Average**
Breeding Season (April-August)	Predicted collisions per year	0.04	0.05	0.04
	Predicted collisions over 30 years	1.17	1.44	1.30
Non-breeding Season (September-March)	Predicted collisions per year	0.00	0.01	0.01
	Predicted collisions over 30 years	0.06	0.39	0.23
Annual total	Predicted collisions per year	0.04	0.06	0.05
	Predicted collisions over 30 years	1.23	1.83	1.53
Lesser Black-backed Gull		**Year 1**	**Year 2**	**Average**
Breeding Season (April-August)	Predicted collisions per year	0.03	0.05	0.04
	Predicted collisions over 30 years	0.79	1.45	1.12
Non-breeding Season (September-March)	Predicted collisions per year	0.02	0.01	0.01
	Predicted collisions over 30 years	0.50	0.31	0.40
Annual total	Predicted collisions per year	0.04	0.06	0.05
	Predicted collisions over 30 years	1.29	1.75	1.52
Goshawk		**Year 1**	**Year 2**	**Average**
Breeding Season (April-August)	Predicted collisions per year	0.00	0.00	0.00
	Predicted collisions over 30 years	0.13	0.14	0.13
Non-breeding Season (September-March)	Predicted collisions per year	0.01	0.00	0.00
	Predicted collisions over 30 years	0.15	0.07	0.11
Annual total	Predicted collisions per year	0.01	0.01	0.01
	Predicted collisions over 30 years	0.28	0.21	0.24
Peregrine		**Year 1**	**Year 2**	**Average**
Breeding Season (April-August)	Predicted collisions per year	0.03	0.03	0.03
	Predicted collisions over 30 years	0.76	0.92	0.84
Non-breeding Season (September-March)	Predicted collisions per year	0.01	0.00	0.00
	Predicted collisions over 30 years	0.29	0.00	0.14
Annual total	Predicted collisions per year	0.03	0.03	0.03
	Predicted collisions over 30 years	1.04	0.92	0.98

Red Kite		**Year 1**	**Year 2**	**Average**
Breeding Season (April-August)	Predicted collisions per year	0.08	0.09	0.08
	Predicted collisions over 30 years	2.44	2.58	2.51
Non-breeding Season (September-March)	Predicted collisions per year	0.14	0.19	0.16
	Predicted collisions over 30 years	4.18	5.71	4.93
Annual total	Predicted collisions per year	0.22	0.28	0.25
	Predicted collisions over 30 years	6.60	8.29	7.45
Kestrel		**Year 1**	**Year 2**	**Average**
Breeding Season (April-August)	Predicted collisions per year	0.05	0.03	0.04
	Predicted collisions over 30 years	1.41	0.93	1.17
Non-breeding Season (September-March)	Predicted collisions per year	0.10	0.51	0.30
	Predicted collisions over 30 years	2.98	15.18	9.08
Annual total	Predicted collisions per year	0.15	0.54	0.34
	Predicted collisions over 30 years	4.38	16.10	10.24
Raven		**Year 1**	**Year 2**	**Average**
Breeding Season (April-August)	Predicted collisions per year	0.12	0.16	0.14
	Predicted collisions over 30 years	3.51	4.79	4.15
Non-breeding Season (September-March)	Predicted collisions per year	0.16	0.18	0.17
	Predicted collisions over 30 years	4.79	5.36	5.07
Annual total	Predicted collisions per year	0.28	0.34	0.31
	Predicted collisions over 30 years	8.29	10.15	9.22
Buzzard		**Year 1**	**Year 2**	**Average**
Breeding Season (April-August)	Predicted collisions per year	0.19	0.54	0.37
	Predicted collisions over 30 years	5.71	16.28	10.99
Non-breeding Season (September-March)	Predicted collisions per year	0.31	0.72	0.51
	Predicted collisions over 30 years	9.25	21.64	15.45
Annual total	Predicted collisions per year	0.50	1.26	0.88
	Predicted collisions over 30 years	14.96	37.92	26.44