



Dalfad Wind Farm

Collision Risk Modelling

Technical Appendix 7.3

Brockwell Energy

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Basis of Report

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1.0 Input Data

The Collision Risk Analysis Area (CRAA) was created using a 500 metre (m) buffer from the proposed turbine locations (**Figure 7.2**). Using the larger 500 m area around the turbines accounts for possible inaccuracies in the recording of flightlines and ensures the assessment is precautionary.

As recommended in NatureScot guidance (NS 2025aⁱ), the aim of baseline flight activity surveys should be to achieve maximum visual coverage of proposed turbines and associated CRAA from Vantage Point (VP) viewsheds using the minimum number of VPs. However, in practice complete (100%) coverage is often unachievable as a result of the topography of the site, presence of mature forestry and access permissions outwith site boundaries.

For the Proposed Development, although some small areas of the CRAA remain ‘invisible’ at 20 m above ground level (**Figure 7.2**). The habitats within these areas are however of sufficient similarity to that ‘seen’ within the VP viewsheds in the CRAA, such that the survey data collected over the course of flight activity surveys and subsequently assessed for potential collision mortality risks, is considered to be representative of the whole CRAA and therefore appropriate for the purposes of estimating collision mortality risks using the NatureScot Collision Risk Model (CRM) (Band et al. 2007ⁱⁱ, Band 2024ⁱⁱⁱ).

In the use of the NatureScot CRM, flying time at risk height (secsHahr⁻¹) for each species is calculated as a single mean activity rate within the entirety of the CRAA.

Table 7-3-1, Table 7-3-2, Table 7-3-3 and Table 7-3-4 present the parameters which apply to each Collision Risk Model (CRM).

Table 7-3-1: Wind farm parameters for 132 m rotor diameter turbines

Size of wind farm envelope	660.56		hectares (ha)
Number of turbines	14		turbines
Rotor diameter	132	162	metres (m)
Hub height	83.9	119	m
Max. rotor depth	1.087	1.1129	m (at 15° pitch angle)
Max. chord	4.2	4.3	m
Pitch	15		degrees (°)
Rotation period	4.2857	4.9586	seconds (secs)
Turbine operation time	85		percent (%)
Risk height: highest	149.9	200	m
Risk height: lowest	17.9	38	m
Flight risk volume	871932747	1070099280	m3

Table 7-3-2: CRM parameters per species

Species	Length (m)	Wingspan (m)	Assumed flight speed, v (ms ⁻¹)	Avoidance rate	Probability of collision (V132)	Bird transit time (secs) (V132)	Probability of collision (V162)	Bird transit time (secs) (V162)
Curlew	0.6	1	13	0.98	0.0766	0.1298	0.0661	0.1318
Golden plover	0.28	0.72	17.9	0.98	0.0518	0.0764	0.0440	0.0778
Greylag goose	0.825	1.635	17.1	0.998	0.0760	0.1118	0.0649	0.1133
Hen harrier	0.48	1.1	12	0.99	0.0747	0.1306	0.0644	0.1327

Species	Length (m)	Wingspan (m)	Assumed flight speed, v (ms ⁻¹)	Avoidance rate	Probability of collision (V132)	Bird transit time (secs) (V132)	Probability of collision (V162)	Bird transit time (secs) (V162)
Herring gull	0.64	1.5	12.8	0.98	0.0810	0.1349	0.0698	0.1369
Lapwing	0.31	0.87	11.9	0.98	0.0652	0.1174	0.0510	0.1071
Merlin	0.28	0.56	13	0.98	0.0592	0.1052	0.0734	0.1485
Osprey	0.58	1.7	11.4	0.98	0.0851	0.1462	0.0641	0.1316
Peregrine falcon	0.48	1.1	12.1	0.98	0.0743	0.1295	0.0595	0.1033
Pink-footed goose	0.675	1.525	17.3	0.998	0.0698	0.1019	0.0753	0.1477
Red kite	0.66	1.95	12	0.99	0.0875	0.1456	0.0401	0.0673
Ringed plover	0.2	0.57	19.5	0.98	0.0473	0.0660	0.0566	0.1148
Short-eared owl	0.38	1.02	13	0.98	0.0658	0.1128	0.0888	0.1525
Whooper swan	1.525	2.305	17.3	0.995	0.1037	0.1510	0.0661	0.1318

Table 7-3-3: Visible area within the CRAA per vantage point

VP	Area (ha)
1	145.7113
2	251.3502
3	52.0731
4	241.4620
5	198.1472

Birds are assumed to be active during all the daylight hours and this is estimated by calculating the number of hours per day between sunrise and sunset (adjusting for correct latitude) for the survey seasons as defined in Table 7-3-4 below.

Table 7-3-4: Season definitions per species/species group

Species	Breeding season			Non-breeding season		
	Start date	End date	Hours presumed present	Start date	End date	Hours presumed present
Golden plover	15th March	31st August	1969	1st September	14th March	2527
Geese and swans	15th May	31st August	1792	1st September	14th May	2703
Gulls	15th March	31st August	2645	1st September	14th March	1851
Raptors	15th March	31st August	2645	1st September	14th March	1851
Waders	1st April	31st July	1969	1st August	31st March	2526



2.0 Output Summary

Only flightlines identified to be within the CRAA and recorded within the 2 km viewshed of the associated VP were considered to be 'at-risk' for the purposes of the collision risk modelling.

- 'At-risk' is defined as – a flight having at least part of its duration (i) at Potential Collision Height (PCH)¹; (ii) within the CRAA; and (iii) recorded within the 2 km viewshed of the associated VP.
- PCH is defined as – the altitude between the minimum and maximum blade height² (taken to be from 17.9 m to 149.9 m for the V132 turbine model, or 38 m to 200 m for the V162 turbine model).

Full survey results detailing the findings from each survey visit (including target species' flightlines considered not 'at-risk' and secondary species information) can be found within **Technical Appendix 7.1**. Only bird seconds for observations identified as 'at-risk' were then input into a Collision Risk Model (CRM) to calculate the predicted collision rates per season. **Table 7-3-5 to Table 7-3-8** provide the estimated collision rates and number of seasons per collision for each species.

Table 7-3-5: Estimated collision rates for V132 turbine model

Species	2023 breeding season	2023/2024 non-breeding season	2024 breeding season	2024/2025 non-breeding season	Mean breeding	Mean non-breeding	Mean annual
Curlew	0.1501	0.0046	0.1215	0	0.1358	0.0023	0.1381
Golden plover	0	0	3.9430	16.7491	1.9715	8.3745	10.3460
Greylag goose	0.0405	0	0	0	0.0203	0	0.0203
Hen harrier	0.0092	0.0755	0.0123	0.0041	0.0107	0.0398	0.0506
Herring gull	0.1337	0.2592	0	0.0947	0.0668	0.1769	0.2438
Lapwing	0.0006	0	0.0003	0	0.0005	0	0.0005
Merlin	0	0.0030	0	0.0023	0	0.0027	0.0027
Osprey	0.0039	0	0	0	0.0019	0	0.0019
Peregrine falcon	0.1819	0.0214	0.0401	0.0100	0.1110	0.0157	0.1267
Pink-footed goose	0	0.4548	0	0	0	0.2274	0.2274
Red kite	0.0264	0	0.1445	0.1341	0.0854	0.0671	0.1525
Ringed plover	0	0	0.0013	0	0.0006	0	0.0006
Short-eared owl	0	0.0052	0.0359	0	0.0180	0.0026	0.0206
Whooper swan	0	0.0141	0	0	0	0.0070	0.0070

Table 7-3-6: Estimated collision rates for V162 turbine model

Species	2023 breeding season	2023/2024 non-breeding season	2024 breeding season	2024/2025 non-breeding season	Mean breeding	Mean non-breeding	Mean annual
Curlew	0.1003	0.0005	0.0545	0	0.0774	0.0002	0.0776
Golden plover	0	0	3.6324	12.1012	1.8162	6.0506	7.8668
Greylag goose	0.0425	0	0	0	0.0212	0	0.0212
Hen harrier	0.0002	0.0139	0.0012	0.0001	0.0007	0.0070	0.0077
Herring gull	0.0860	0.2664	0	0.0623	0.0430	0.1644	0.2073
Merlin	0	0.0003	0	0.0020	0	0.0011	0.0011
Osprey	0.0004	0	0	0	0.0002	0	0.0002
Peregrine falcon	0.2033	0.0359	0.0234	0.0135	0.1133	0.0247	0.1380
Pink-footed goose	0	0.5834	0	0	0	0.2917	0.2917
Red kite	0.0475	0	0.2160	0.0709	0.1318	0.0354	0.1672
Ringed plover	0	0	0.0001	0	0.0001	0	0.0001
Short-eared owl	0	0	0.0007	0	0.0004	0	0.0004
Whooper swan	0	0.0148	0	0	0	0.0074	0.0074

Table 7-3-7: Estimated number of seasons per collision for V132 turbine model

Species	2023 breeding season	2023/2024 non-breeding season	2024 breeding season	2024/2025 non-breeding season	Mean breeding	Mean non-breeding	Mean annual
Curlew	6.66	218	8.23	n/a	7.44	109	116
Golden plover	n/a	n/a	0.25	0.06	0.13	0.03	0.16
Greylag goose	24.7	n/a	n/a	n/a	12.3	n/a	12.3
Hen harrier	109	13.2	81	241	95	127	222
Herring gull	7.48	3.86	n/a	10.6	3.74	14.4	18.2
Lapwing	1643	n/a	2939	n/a	2291	n/a	2291
Merlin	n/a	335	n/a	428	n/a	382	382
Osprey	259	n/a	n/a	n/a	129	n/a	129
Peregrine falcon	5.50	47	25.0	100	15.2	73	88
Pink-footed goose	0	2.20	n/a	n/a	n/a	1.10	1.10
Red kite	38	n/a	n/a	n/a	n/a	3.73	26.1
Ringed plover	n/a	n/a	778	n/a	389	n/a	389
Short-eared owl	n/a	192	27.8	n/a	13.9	96	110
Whooper swan	n/a	71	n/a	n/a	n/a	36	36

¹ In some cases, only part of a total flight duration was recorded at PCH, and it is assumed that this proportion is applicable for that part of the flight within the CRAA and 2 km viewshed area.

² Where the actual rotor blade altitude differs from the pre-defined survey height bands, the collision risk model accounts for this difference on the assumption of an even flight distribution within each particular survey height band, and an adjustment can be made to estimate total flight duration at actual rotor blade altitude.



Table 7-3-8: Estimated number of seasons per collision for V162 turbine model

Species	2023 breeding season	2023/2024 non-breeding season	2024 breeding season	2024/2025 non-breeding season	Mean breeding	Mean non-breeding	Mean annual
Curlew	10.0	2057	18.4	-	14.2	1029	1043
Golden plover	-	-	0.28	0.08	0.14	0.04	0.18
Greylag goose	23.5	-	-	-	11.8	-	11.8
Hen harrier	5352	72	823	7411	3088	3742	6829
Herring gull	11.6	3.75	-	16.1	5.82	9.90	15.7
Merlin	-	3513	-	512	-	2012	2012
Osprey	2448	-	-	-	1224	-	1224
Peregrine falcon	4.92	27.9	43	74	23.8	51	75
Pink-footed goose	-	1.71	-	-	-	0.86	0.86
Red kite	21.0	-	4.63	14.1	12.8	7.05	19.9
Ringed plover	-	-	7481	-	3740	-	3740
Short-eared owl	-	-	1342	-	671	-	671
Whooper swan	-	68	-	-	-	34	34

Detailed outputs for the CRM for the following species scoped in to the assessment are presented in the following section below: curlew, hen harrier, lapwing, peregrine falcon and red kite.

3.0 Detailed Species Outputs

3.1 Curlew (V132)

3.1.1 Breeding Season 2023

Table 7-3-9: Curlew flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	62	4079.92	9.16E-07
3	161.78	1405.97	2.39E-06
4	359.23	6519.47	5.31E-06

Table 7-3-10: Curlew mortality estimates

Mean activity in wind farm at rotor height	0.0057	hr ⁻¹
Total Combined rotor swept volume	323214.7388	m ³
Bird occupancy	11.2082	hrs/season
Bird occupancy of rotor swept volume	14.9571	bird-sec
No. of transits through rotors	115.2566	per season
Estimated collisions	8.8320	per season
Estimated collisions after correction for operation	7.5072	per season
Estimated collisions after avoidance factor	0.1501	per season

3.1.2 Non-Breeding Season 2023/2024

Table 7-3-11: Curlew flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
3	22.87	2343.29	2.05E-07

Table 7-3-12: Curlew mortality estimates

Mean activity in wind farm at rotor height	0.0001	hr ⁻¹
Total Combined rotor swept volume	323214.7388	m ³
Bird occupancy	0.3429	hrs/season
Bird occupancy of rotor swept volume	0.4576	bird-sec
No. of transits through rotors	3.5263	per season
Estimated collisions	0.2702	per season
Estimated collisions after correction for operation	0.2297	per season
Estimated collisions after avoidance factor	0.0046	per season

3.1.3 Breeding Season 2024

Table 7-3-13: Curlew flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	140.98	4371.34	2.24E-06
2	147.72	6032.40	2.35E-06
4	149.41	5795.09	2.37E-06

Table 7-3-14: Curlew mortality estimates

Mean activity in wind farm at rotor height	0.0046	hr ⁻¹
Total Combined rotor swept volume	323214.7388	m ³
Bird occupancy	9.0711	hrs/season
Bird occupancy of rotor swept volume	12.1051	bird-sec
No. of transits through rotors	93.2797	per season
Estimated collisions	7.1479	per season
Estimated collisions after correction for operation	6.0757	per season
Estimated collisions after avoidance factor	0.1215	per season



3.2 Curlew (V162)

3.2.1 Breeding Season 2023

Table 7-3-15: Curlew flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	33.20	4079.92	4.91E-07
3	144.78	1405.97	2.14E-06
4	190.08	6519.47	2.81E-06

Table 7-3-16: Curlew mortality estimates

Mean activity in wind farm at rotor height	0.0036	hr ⁻¹
Total Combined rotor swept volume	494294.1909	m ³
Bird occupancy	7.0758	hrs/season
Bird occupancy of rotor swept volume	11.7664	bird-sec
No. of transits through rotors	89.2992	per season
Estimated collisions	5.9001	per season
Estimated collisions after correction for operation	5.0151	per season
Estimated collisions after avoidance factor	0.1003	per season

3.2.2 Non-Breeding Season 2023/2024

Table 7-3-17: Curlew flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
3	2.29	2343.29	2.05E-08

Table 7-3-18: Curlew mortality estimates

Mean activity in wind farm at rotor height	1.36E-05	hr ⁻¹
Total Combined rotor swept volume	494294.1909	m ³
Bird occupancy	0.0343	hrs/season
Bird occupancy of rotor swept volume	0.0570	bird-sec
No. of transits through rotors	0.4328	per season
Estimated collisions	0.0286	per season
Estimated collisions after correction for operation	0.0243	per season
Estimated collisions after avoidance factor	0.0005	per season

3.2.3 Breeding Season 2024

Table 7-3-19: Curlew flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	49.38	4371.34	7.86E-07
2	81.91	6032.41	1.3E-06
4	54.32	5795.09	8.65E-07

Table 7-3-20: Curlew mortality estimates

Mean activity in wind farm at rotor height	0.0020	hr ⁻¹
Total Combined rotor swept volume	494294.1909	m ³
Bird occupancy	3.8429	hrs/season
Bird occupancy of rotor swept volume	6.3904	bird-sec
No. of transits through rotors	48.4991	per season
Estimated collisions	3.2044	per season
Estimated collisions after correction for operation	2.7237	per season
Estimated collisions after avoidance factor	0.0545	per season

3.3 Hen Harrier (V132)

3.3.1 Breeding Season 2023

Table 7-3-21: Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	77.95	5245.61	8.71E-07

Table 7-3-22: Hen harrier mortality estimates

Mean activity in wind farm at rotor height	0.0006	hr ⁻¹
Total Combined rotor swept volume	300224.3124	m ³
Bird occupancy	1.5215	hrs/season
Bird occupancy of rotor swept volume	1.8860	bird-sec
No. of transits through rotors	14.4425	per season
Estimated collisions	1.0784	per season
Estimated collisions after correction for operation	0.9167	per season
Estimated collisions after avoidance factor	0.0092	per season



3.3.2 Non-Breeding Season 2023/2024

Table 7-3-23: Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	604.79	5245.61	6.76E-06
2	299.11	9048.61	3.34E-06
3	13.57	1874.63	1.52E-07

Table 7-3-24: Hen harrier mortality estimates

Mean activity in wind farm at rotor height	0.0068	hr ⁻¹
Total Combined rotor swept volume	300224.3124	m ³
Bird occupancy	12.5319	hrs/season
Bird occupancy of rotor swept volume	15.5339	bird-sec
No. of transits through rotors	118.9549	per season
Estimated collisions	8.8824	per season
Estimated collisions after correction for operation	7.5500	per season
Estimated collisions after avoidance factor	0.0755	per season

3.3.3 Breeding Season 2024

Table 7-3-25: Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	104.62	5245.61	1.17E-06

Table 7-3-26: Hen harrier mortality estimates

Mean activity in wind farm at rotor height	0.0008	hr ⁻¹
Total Combined rotor swept volume	300224.3124	m ³
Bird occupancy	2.0420	hrs/season
Bird occupancy of rotor swept volume	2.5312	bird-sec
No. of transits through rotors	19.3830	per season
Estimated collisions	1.4473	per season
Estimated collisions after correction for operation	1.2302	per season
Estimated collisions after avoidance factor	0.0123	per season

3.3.4 Non-Breeding Season 2024/2025

Table 7-3-27: Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	59.75	5245.61	5.51E-07
2	1.26	9048.61	1.16E-08
5	0.07	7133.30	6.3E-10

Table 7-3-28: Hen harrier mortality estimates

Mean activity in wind farm at rotor height	0.0004	hr ⁻¹
Total Combined rotor swept volume	300224.3124	m ³
Bird occupancy	0.6886	hrs/season
Bird occupancy of rotor swept volume	0.8536	bird-sec
No. of transits through rotors	6.5365	per season
Estimated collisions	0.4881	per season
Estimated collisions after correction for operation	0.4149	per season
Estimated collisions after avoidance factor	0.0041	per season

3.4 Hen Harrier (V162)

3.4.1 Breeding Season 2023

Table 7-3-29: Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	1.50	5245.61	1.68E-08

Table 7-3-30: Hen harrier mortality estimates

Mean activity in wind farm at rotor height	1.1071E-05	hr ⁻¹
Total Combined rotor swept volume	459666.0487	m ³
Bird occupancy	0.0293	hrs/season
Bird occupancy of rotor swept volume	0.0453	bird-sec
No. of transits through rotors	0.3411	per season
Estimated collisions	0.0220	per season
Estimated collisions after correction for operation	0.0187	per season
Estimated collisions after avoidance factor	0.0002	per season



3.4.2 Non-Breeding Season 2023/2024

Table 7-3-31: Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	35.44	5245.61	3.96E-07
2	123.87	9048.61	1.38E-06

Table 7-3-32: Hen harrier mortality estimates

Mean activity in wind farm at rotor height	0.0012	hr ⁻¹
Total Combined rotor swept volume	459666.0487	m ³
Bird occupancy	2.1760	hrs/season
Bird occupancy of rotor swept volume	3.3650	bird-sec
No. of transits through rotors	25.3497	per season
Estimated collisions	1.6337	per season
Estimated collisions after correction for operation	1.3886	per season
Estimated collisions after avoidance factor	0.0139	per season

3.4.3 Breeding Season 2024

Table 7-3-33: Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	9.75	5245.61	1.09E-07

Table 7-3-34: Hen harrier mortality estimates

Mean activity in wind farm at rotor height	7.1979E-05	hr ⁻¹
Total Combined rotor swept volume	459666.0487	m ³
Bird occupancy	0.1904	hrs/season
Bird occupancy of rotor swept volume	0.2944	bird-sec
No. of transits through rotors	2.2176	per season
Estimated collisions	0.1429	per season
Estimated collisions after correction for operation	0.1215	per season
Estimated collisions after avoidance factor	0.0012	per season

3.4.4 Non-Breeding Season 2024/2025

Table 7-3-35: Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	1.88	5245.61	1.73E-08

Table 7-3-36: Hen harrier mortality estimates

Mean activity in wind farm at rotor height	1.1425E-05	hr ⁻¹
Total Combined rotor swept volume	459666.0487	m ³
Bird occupancy	0.0211	hrs/season
Bird occupancy of rotor swept volume	0.0327	bird-sec
No. of transits through rotors	0.2463	per season
Estimated collisions	0.0159	per season
Estimated collisions after correction for operation	0.0135	per season
Estimated collisions after avoidance factor	0.0001	per season

3.5 Lapwing (V132)

3.5.1 Breeding Season 2023

Table 7-3-37: Lapwing flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	0.93	4079.92	1.38E-08
2	2.10	6786.46	3.1E-08

Table 7-3-38: Lapwing mortality estimates

Mean activity in wind farm at rotor height	2.9631E-05	hr ⁻¹
Total Combined rotor swept volume	267654.5417	m ³
Bird occupancy	0.0583	hrs/season
Bird occupancy of rotor swept volume	0.0645	bird-sec
No. of transits through rotors	0.5492	per season
Estimated collisions	0.0358	per season
Estimated collisions after correction for operation	0.0304	per season
Estimated collisions after avoidance factor	0.0006	per season



3.5.2 Breeding Season 2024

Table 7-3-39: Lapwing flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	1.58	4371.34	2.51E-08

Table 7-3-40: Lapwing mortality estimates

Mean activity in wind farm at rotor height	1.65625E-05	hr ⁻¹
Total Combined rotor swept volume	267654.5417	m ³
Bird occupancy	0.0326	hrs/season
Bird occupancy of rotor swept volume	0.0360	bird-sec
No. of transits through rotors	0.3070	per season
Estimated collisions	0.0200	per season
Estimated collisions after correction for operation	0.0170	per season
Estimated collisions after avoidance factor	0.0003	per season

3.6 Peregrine Falcon (V132)

3.6.1 Breeding Season 2023

Table 7-3-41: Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	137.96	5245.61	1.54E-06
2	241.33	9048.61	2.70E-06
3	265.60	1874.63	2.97E-06
4	126.30	8692.63	1.41E-06

Table 7-3-42: Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.0057	hr ⁻¹
Total Combined rotor swept volume	300224.3124	m ³
Bird occupancy	15.0529	hrs/season
Bird occupancy of rotor swept volume	18.6589	bird-sec
No. of transits through rotors	144.0761	per season
Estimated collisions	10.6986	per season
Estimated collisions after correction for operation	9.0938	per season
Estimated collisions after avoidance factor	0.1819	per season

3.6.2 Non-Breeding Season 2023/2024

Table 7-3-43: Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	21.17	9048.61	2.37E-07
4	108.78	8692.63	1.22E-06

Table 7-3-44: Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.0010	hr ⁻¹
Total Combined rotor swept volume	300224.3124	m ³
Bird occupancy	1.7751	hrs/season
Bird occupancy of rotor swept volume	2.2003	bird-sec
No. of transits through rotors	16.9899	per season
Estimated collisions	1.2616	per season
Estimated collisions after correction for operation	1.0724	per season
Estimated collisions after avoidance factor	0.0214	per season

3.6.3 Breeding Season 2024

Table 7-3-45: Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
3	106.61	1874.63	1.19E-06
4	63.33	8692.63	7.08E-07

Table 7-3-46: Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.0013	hr ⁻¹
Total Combined rotor swept volume	300224.3124	m ³
Bird occupancy	3.3169	hrs/season
Bird occupancy of rotor swept volume	4.1115	bird-sec
No. of transits through rotors	31.7472	per season
Estimated collisions	2.3574	per season
Estimated collisions after correction for operation	2.0038	per season
Estimated collisions after avoidance factor	0.0401	per season



3.6.4 Non-Breeding Season 2024/2025

Table 7-3-47: Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	63.43	9048.61	5.85E-07
5	10.21	7133.30	9.42E-08

Table 7-3-48: Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.0004	hr ⁻¹
Total Combined rotor swept volume	300224.3124	m ³
Bird occupancy	0.8302	hrs/season
Bird occupancy of rotor swept volume	1.0291	bird-sec
No. of transits through rotors	7.9465	per season
Estimated collisions	0.5901	per season
Estimated collisions after correction for operation	0.5016	per season
Estimated collisions after avoidance factor	0.0100	per season

3.7 Peregrine Falcon (V162)

3.7.1 Breeding Season 2023

Table 7-3-49: Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	126.66	5245.61	1.42E-06
2	472.25	9048.61	5.28E-06
3	203.04	1874.63	2.27E-06
4	12	8692.63	1.34E-07

Table 7-3-50: Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.0060	hr ⁻¹
Total Combined rotor swept volume	459666.0487	m ³
Bird occupancy	15.8875	hrs/season
Bird occupancy of rotor swept volume	24.5683	bird-sec
No. of transits through rotors	186.6235	per season
Estimated collisions	11.9585	per season
Estimated collisions after correction for operation	10.1647	per season
Estimated collisions after avoidance factor	0.2033	per season

3.7.2 Non-Breeding Season 2023/2024

Table 7-3-51: Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	20.50	9048.61	2.29E-07
4	184.68	8692.63	2.06E-06

Table 7-3-52: Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.0015	hr ⁻¹
Total Combined rotor swept volume	459666.0487	m ³
Bird occupancy	2.8025	hrs/season
Bird occupancy of rotor swept volume	4.3338	bird-sec
No. of transits through rotors	32.9201	per season
Estimated collisions	2.1095	per season
Estimated collisions after correction for operation	1.7930	per season
Estimated collisions after avoidance factor	0.0359	per season

3.7.3 Breeding Season 2024

Table 7-3-53: Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
3	11.14	1874.63	1.24E-07
4	82.55	8692.63	9.22E-07

Table 7-3-54: Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.0007	hr ⁻¹
Total Combined rotor swept volume	459666.0487	m ³
Bird occupancy	1.8287	hrs/season
Bird occupancy of rotor swept volume	2.8279	bird-sec
No. of transits through rotors	21.4812	per season
Estimated collisions	1.3765	per season
Estimated collisions after correction for operation	1.1700	per season
Estimated collisions after avoidance factor	0.0234	per season



3.7.4 Non-Breeding Season 2024/2025

Table 7-3-55: Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	77.46	9048.61	7.14E-07
5	16	7133.30	1.48E-07

Table 7-3-56: Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.0006	hr ⁻¹
Total Combined rotor swept volume	459666.0487	m ³
Bird occupancy	1.0537	hrs/season
Bird occupancy of rotor swept volume	1.6294	bird-sec
No. of transits through rotors	12.3774	per season
Estimated collisions	0.7931	per season
Estimated collisions after correction for operation	0.6742	per season
Estimated collisions after avoidance factor	0.0135	per season

3.8 Red Kite (V132)

3.8.1 Breeding Season 2023

Table 7-3-57: Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	99.22	9048.61	1.11E-06
4	92.31	8692.63	1.03E-06

Table 7-3-58: Red kite mortality estimates

Mean activity in wind farm at rotor height	0.0014	hr ⁻¹
Total Combined rotor swept volume	334709.9520	m ³
Bird occupancy	3.7384	hrs/season
Bird occupancy of rotor swept volume	5.1662	bird-sec
No. of transits through rotors	35.4852	per season
Estimated collisions	3.1035	per season
Estimated collisions after correction for operation	2.6380	per season
Estimated collisions after avoidance factor	0.0264	per season

3.8.2 Breeding Season 2024

Table 7-3-59: Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
3	33.34	1874.63	3.72E-07
4	1015.46	8692.63	1.13E-05

Table 7-3-60: Red kite mortality estimates

Mean activity in wind farm at rotor height	0.0077	hr ⁻¹
Total Combined rotor swept volume	334709.9520	m ³
Bird occupancy	20.4715	hrs/season
Bird occupancy of rotor swept volume	28.2904	bird-sec
No. of transits through rotors	194.3197	per season
Estimated collisions	16.9950	per season
Estimated collisions after correction for operation	14.4457	per season
Estimated collisions after avoidance factor	0.1445	per season

3.8.3 Non-Breeding Season 2024/2025

Table 7-3-61: Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	265.13	9048.61	2.45E-06
4	1421.05	8692.63	1.31E-05

Table 7-3-62: Red kite mortality estimates

Mean activity in wind farm at rotor height	0.0103	hr ⁻¹
Total Combined rotor swept volume	334709.9520	m ³
Bird occupancy	19.0106	hrs/season
Bird occupancy of rotor swept volume	26.2715	bird-sec
No. of transits through rotors	180.4525	per season
Estimated collisions	15.7822	per season
Estimated collisions after correction for operation	13.4149	per season
Estimated collisions after avoidance factor	0.1341	per season



3.9 Red Kite (V162)

3.9.1 Breeding Season 2023

Table 7-3-63: Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	199.42	9048.61	2.23E-06
4	127.26	8692.63	1.42E-06

Table 7-3-64: Red kite mortality estimates

Mean activity in wind farm at rotor height	0.0024	hr ⁻¹
Total Combined rotor swept volume	511608.2620	m ³
Bird occupancy	6.3764	hrs/season
Bird occupancy of rotor swept volume	10.9746	bird-sec
No. of transits through rotors	74.2815	per season
Estimated collisions	5.5904	per season
Estimated collisions after correction for operation	4.7518	per season
Estimated collisions after avoidance factor	0.0475	per season

3.9.2 Breeding Season 2024

Table 7-3-65: Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
3	54.85	1874.63	6.13E-07
4	1430.35	8692.63	1.60E-05

Table 7-3-66: Red kite mortality estimates

Mean activity in wind farm at rotor height	0.0110	hr ⁻¹
Total Combined rotor swept volume	511608.2620	m ³
Bird occupancy	28.9896	hrs/season
Bird occupancy of rotor swept volume	49.8951	bird-sec
No. of transits through rotors	337.7141	per season
Estimated collisions	25.4161	per season
Estimated collisions after correction for operation	21.6037	per season
Estimated collisions after avoidance factor	0.2160	per season

3.9.3 Non-Breeding Season 2024/2025

Table 7-3-67: Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	211.47	9048.61	1.95E-06
4	632.30	8692.63	5.83E-06

Table 7-3-68: Red kite mortality estimates

Mean activity in wind farm at rotor height	0.0051	hr ⁻¹
Total Combined rotor swept volume	511608.2620	m ³
Bird occupancy	9.5130	hrs/season
Bird occupancy of rotor swept volume	16.3732	bird-sec
No. of transits through rotors	110.8220	per season
Estimated collisions	8.3404	per season
Estimated collisions after correction for operation	7.0893	per season
Estimated collisions after avoidance factor	0.0709	per season

ⁱ NatureScot (2025a) Recommended Bird Survey Methods to inform impact assessment of Onshore Windfarms. Available at: <https://www.nature.scot/doc/recommended-bird-survey-methods-inform-impact-assessment-onshore-windfarms>

ⁱⁱ Band, W., Madders, M., and 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. 259-275.

ⁱⁱⁱ Band, W. 2024. Using a collision risk model to assess bird collision risks for onshore wind farms. NatureScot Research Report 909. Available at: <https://www.nature.scot/doc/naturescot-research-report-909-using-collision-risk-model-assess-bird-collision-risks-onshore-wind>





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