Millennium East Wind Farm

Environmental Impact Assessment (EIA) Report

Technical Appendix 7.2: Collision Risk Model Analysis

avianecology

CONTENTS

1 INTRODUCTION

1.1.1 This Technical Appendix has been prepared to accompany **Chapter 7: Ornithology** of the Environmental Impact Assessment (EIA) Report for Millenium East Wind Farm (the Proposed Development), an extension to the operational Millennium Wind Farm.

1.1.2 This Technical Appendix presents details of the Collision Risk Modelling (CRM) calculations undertaken to ascertain the potential impact of collision mortality upon relevant ornithological interests, as a result of the Proposed Development.

1.1.3 This Technical Appendix should be read in conjunction with **Technical Appendix 7.1: Ornithology**, in **Volume 3** of the EIA Report, which provides full details of baseline survey methods and results, including those that informed the CRM calculations.

2 METHODOLOGY

2.1 Background

2.1.1 Baseline ornithology surveys undertaken for the Proposed Development included Vantage Point (VP) flight activity surveys, which recorded flight activity of 'target species' in the vicinity of proposed turbine locations (see further details in **Technical Appendix 7.1**). The results of the VP flight activity surveys have been used to estimate potential collision mortality risk using CRM analysis.

2.1.2 NatureScot advocate use of model devised by Band *et al*. (2007) and which has recently been updated (Band, 2024). It should be noted that the CRM analysis reported upon herein was undertaken based on the original model (Band *et al*,. 2007), and so does not fully follow the methodology set out in Band (2024). However, the main aim of the updated guidance is to standardise the approach to CRM and the previous approach is still considered valid. Band (2024) states that the methods are 'mathematically equivalent' and that the estimates produced from the updated approach 'should not differ substantially from those deriving from… earlier SNH [now NatureScot] guidance'.

2.1.3 The NatureScot CRM calculates collision mortality risks in three stages:

- Stage 1: estimation of the number of birds passing through the rotor swept volume of the wind farm, using observed flight activity data, and based on:
    - The amount of flight activity recorded in the vicinity of the wind farm;
    - The area watched (VP-specific viewsheds); and
    - The time spent watching the surveyed area (survey effort per VP per month);
- Stage 2: estimation of collision likelihood, i.e. the probability of a bird flying through the rotor swept volume being hit, based on bird and wind farm parameters (where all collisions are assumed to be fatal). This provides an estimate of how many fatal collisions could occur, in theory, should birds take no avoiding action; and
- Stage 3: application of appropriate avoidance factors, whereby it is assumed birds take action to avoid collision.

2.2 Wind Farm Parameters

2.2.1 The Proposed Development comprises eight turbines, with five turbines of 180 m maximum tip height, 102.5 m hub height, and three turbines of 200 m maximum tip height, 122.5 m hub height. For both

turbine tip heights, maximum rotor diameter is 155 m. Therefore, rotor swept height would be between 25 m and 200 m. All flights recorded in a height band that overlaps with this height range (see **Section 2.5**) are considered to represent flight activity at potential collision height (PCH).

2.2.2 For the purposes of CRM analysis, the flight risk volume (Vw) has been calculated based on applying a single, continuous 300 m buffer around the outermost turbine locations and with a height determined by the PCH. Any flights that passed through the 300 m buffer (the 'collision risk zone' (CRZ)) at PCH were considered to be 'at-risk' flights.

2.2.3 The 300 m buffer around the turbine envelope used to determine the CRZ is considered to be a precautionary approach, as in reality only flight activity within rotor radius of proposed turbines (77.5 m) would be at-risk flights. The 300 m buffer (rotor radius rounded up to 100 m plus an additional 200 m) more than compensates for any small mapping errors that may have inadvertently occurred during field recording and also allows for turbine micro-siting during the design process without need to rerun the CRM analysis. The area within the CRZ equates to a total of 268.84 ha.

2.2.4 Turbine parameters are summarised in **Table 2.1.** The final turbine model will be dependent on a procurement process and has not yet been confirmed. For the purposes of this assessment, the candidate turbine is the Siemens Gamesa 'SGRE 155', and parameters for this turbine have been considered.

2.2.5 Calculations have assumed an operational downtime for turbines of 15 %.

Table 2.1: Turbine parameters.

Parameter	Value	Unit
Wind farm survey area *(300 m turbine buffer)*	268.84	ha
No. of rotors	8	-
No. of blades	3	-
Height to tip	180 - 200	metres
Hub height	102.5 – 122.5	metres
Rotor diameter	155	metres
Rotor radius	77.5	metres
Max chord	4.5	metres
Pitch	15	degrees
Rotation period	5.4	seconds

2.3 Viewsheds

2.3.1 Flight activity data of target species, for use in the CRM analysis, have been obtained using baseline surveys from three VP locations per year (see **Technical Appendix 7.1**).

2.3.2 The visible survey areas from the VP locations utilised during baseline surveys, using a 2 km viewshed radius (detection distance) and a 20 m above the ground cut-off are illustrated in **Figure 7.2a** (September 2021 to August 2022, Year 1) and **Figure 7.2b** (September 2022 to August 2023, Year 2).

2.3.3 The arrangement of VPs changed between baseline survey years, as the Proposed Development layout evolved. These changes in survey effort across the baseline survey period are incorporated into the CRM analysis. Note, given these alterations to the Proposed Development layout none of the visible

area within the CRZ (300 m buffer around turbines) is visible from VP1a, and thus VP1a is not considered in the CRM analysis.

2.3.4 Details of the VPs used during the flight activity surveys are presented in **Table 2.2**; this includes the area of viewshed visibility within the CRZ for each VP, as well as the time period in which each VP was surveyed.

2.3.5 For limitations in survey coverage please see **Technical Appendix 7.1**. Although it is acknowledged that viewshed coverage of all turbine locations and a surrounding buffer was not fully achieved for all locations and for all months (in accordance with NatureScot guidance (SNH, 2017)), there are considered not to be any substantive limitations with the data.

Table 2.2: VP locations and visibility.

VP iterations	Grid reference	Visible area within wind farm (ha) - (CRZ) turbine envelope + 300 m buffer	Time period covered
VP1a	NH 29283 06091	0	September 2021 to August 2022 (Year 1)
VP2a	NH 31554 08545	57.69	September 2021 to August 2022 (Year 1)
VP3a	NH 29085 09664	152.12	September 2021 to August 2022 (Year 1)
VP1b	NH 29917 06387	1.58	September 2022 to August 2023 (Year 2)
VP2b	NH 30329 09986	117.71	September 2022 to August 2023 (Year 2)
VP3b	NH 27449 08042	138	September 2022 to August 2023 (Year 2)

2.3.6 Given the very limited overlap between VP viewsheds (see **Figures 7.2a** and **7.2b**), and because those with the highest (albeit still very modest) degree of viewshed overlap were not surveyed at the same time, no viewsheds were snipped for consideration in the CRM analysis.

2.4 Vantage Point Survey Effort

2.4.1 Flight activity per unit of time is a component of the calculations.

2.4.2 This requires the inclusion of survey effort (hours completed per VP), as summarised in **Table 2.3**.

Table 2.3: VP flight activity survey effort (hours)

Year 1 (2021-2022)													Total VP hours
VP	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	
1a	6	6	9	6	6	0	12	6	6	6	6	6	**75**
2a	6	6	6	6	6	6	6	6	6	0	12	6	**72**
3a	6	6	9	6	6	0	12	6	6	6	6	6	**75**
Year 2 (2022-2023)													**Total VP hours**
VP	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	
1b	3	9	6	6	6	6	6	6	6	6	6	6	**72**
2b	6	6	6	6	6	6	6	6	6	6	6	6	**72**
3b	3	3	6	9	6	6	3	6	6	6	6	6	**66**

2.5 Identification of 'At-Risk' Flight Activity

2.5.1 Full details of all target species flights recorded during the VP flight activity surveys are presented in **Technical Appendix 7.1**. However, only those flights considered to be at-risk are included in the CRM analysis.

2.5.2 During baseline surveys, flight activity of target species was recorded using the following height bands (HT):

- HT1: 0-20 m;
- HT2: 20-50 m;
- HT3: 50-160 m;
- HT4: 160-180 m;
- HT5: 180-230 m; and
- HT6: >230 m.

2.5.3 All target species flights recorded in a height band that overlaps with rotor swept height (25-200m) have been taken to represent flight activity at PCH. Flights recorded at HT2 to HT5 have accordingly been considered as at PCH. This approach may have led to the inclusion of some flights that were actually below (flights at HT2: 20-50 m), or above at-risk height (flights at HT5: 180-230 m, with tip height 180-200 m) but this precautionary approach is considered appropriate and allows for small errors in estimation of height during field surveys.

2.6 Identification of Ornithological Features for Analysis

2.6.1 The following target species were recorded as having potential at-risk flights (within the CRZ at PCH), with full details of these flights provided in **Annex 1**:

- Black grouse.
- Greenshank.

- Grey heron.
- Pink-footed goose.
- Merlin.
- Golden eagle.

2.6.2 Collision mortality risk estimates have only been calculated for ornithological interests for which there is a potential for a significant effect. For species with few at-risk flights and recorded in very low numbers during baseline surveys, it can reasonably be predicted that the risk of collision mortality would be very small (negligible impact at any population level) and no significant effect can be concluded for these ornithological interests without the requirement for undertaking a detailed assessment.

2.6.3 For the purposes of the CRM analysis, a target species qualified for CRM analysis if there were three or more at-risk flights (or ten or more individuals) within the two-year baseline survey period. The species that met these criteria was only **golden eagle**.

2.6.4 Note, that pink-footed goose also met the criteria (two at-risk flights comprising 244 birds), although one of the flights was recorded entirely in HT5, and thus highly likely to have been above PCH (and the second flight was predominantly within HT5). In accordance with NatureScot guidance (2024), CRM analysis is only undertaken for this species where a site is considered to have connectivity with a protected area with pink-footed goose as a qualifying feature. The wintering foraging range of pink-footed goose is 15-20 km (SNH, 2016) and there are no designated sites with pink-footed goose as a listed species within this distance from the Site. Furthermore, the Site is not located within a known foraging area (in reference to Mitchell (2012)). The pink-footed geese flights recorded during baseline surveys are best considered part of the 'wider countryside' non-breeding population (i.e. not associated with any specific designated site). Accordingly, CRM analysis for pink-footed goose was not undertaken.

2.7 Species Parameters

2.7.1 The CRM analysis uses parameters for the species to calculate collision risk. The parameters used for golden eagle are presented in **Table 2.4**. Parameters are taken from Snow and Perrins (1998) (length) and Alerstam *et al*. (2007) (wingspan and flight speed), which are recommended sources (see Provan and Whitfield, 2006), with avoidance rates taken from NatureScot guidance (SNH, 2018). Biometrics (bird length and wingspan) are average measurements.

Table 2.4: Target species parameters.

Species	Length (m)	Wingspan (m)	Flight Speed (m/s)	'Gliding' or 'flapping' flight	Avoidance Rate (%)
Golden eagle	0.82	2.03	11.9	Gliding	99.0

2.7.2 Golden eagle was classed as having 'gliding' flights for the purpose of analysis. This is considered to be a precautionary approach as not all flights recorded for eagles will have been gliding (flapping flights produce a lower collision risk estimate).

2.7.3 Based on the flightlines recorded, golden eagle was classified as having 'non-directional' (random) flights, as opposed to directional flights which refer to birds regularly commuting on a straight path across a site.

2.7.4 The time period in which golden eagle is likely to be present in the vicinity of the Proposed Development is considered in the CRM analysis, with mortality estimates presented for each season (breeding and non-breeding), where applicable. The time periods used are species-specific breeding and non-breeding seasons, taken from NatureScot guidance (SNH, 2014). These time periods differ from the more generic breeding and non-breeding seasons used to determine overall survey effort for the VP flight activity surveys.

2.7.5 The seasons used in the calculations for golden eagle are February to August for the breeding season and September to January for the non-breeding season.

2.7.6 For golden eagle, the potential number of active hours within each season has been calculated following Forsythe *et al*. (1995), using a latitude of 57.140766 (the approximate latitude of the central part of the Site). Active hours per month were calculated, noting that 28 days were applicable to February 2022 and 2023.

2.7.7 For golden eagle, 'active hours' correspond with daylight hours, given eagles are diurnal and go to roost at night.

2.7.8 Previous NatureScot guidance (based on Band *et al*., 2007), used a 'collision probability' value for inclusion in the calculations and this is the approach that has been used in this CRM analysis. This value has been calculated using the previously available NatureScot spreadsheet, which gave the following output for golden eagle that has been used in the CRM analysis:

- Golden eagle – 7.8 %.

2.7.9 The collision probability calculation is presented in **Annex 2**.

3 COLLISION MORTALITY RISKS

3.1.1 The collision mortality risk calculations are provided in **Annex 3**.

3.1.2 **Table 3.1** presents a summary of the annual collision mortality estimates calculated for golden eagle following CRM analysis. Shaded cells represent seasons when no at-risk flights were recorded (and collision mortality risk calculations were not carried out).

3.1.3 Mortality risks for both the breeding and non-breeding seasons are provided, and these are then summed to provide an annual estimate. Estimates were calculated for both survey years (Year 1: September 2021 to August 2022 and Year 2: September 2022 to August 2023) and an average is also presented.

3.1.4 The mortality estimates are considered to be precautionary, based on the approach that has been used, and which is set out in this Technical Appendix.

3.1.5 The collision mortality risk estimates should also not be concluded as the number of bird deaths that will definitely occur as a result of the Proposed Development. The estimates are best treated as an indication as to the relative level of risk.

Table 3.1: Collision mortality estimates.

Species	Occupancy	Collision Mortality Estimate		
		Year 1	Year 2	Average
Golden eagle	Breeding season	0.045	0.046	0.046
	Non-breeding season	0.002	0.000	0.001

Species	Occupancy	Collision Mortality Estimate		
		Year 1	Year 2	Average
	Annual estimate	0.047	0.046	0.047

4 REFERENCES

Alerstam T., Rosén M., Bäckman J., Ericson P.G.P., and Hellgren O. (2007). Flight speeds among bird species: allometric and phylogenetic effects. *PLoS Biol*, 5, 1656-1662.

Band, W., Madders, M. and Whitfield, D.P. (2007). *Developing field and analytical methods to assess avian collision risk at wind farms.* In De Lucas, M., Janss, G. and Ferrer, M. (eds) 'Birds and Wind Power'. Quercus Editions, Madrid, 259-275.

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 (Accessed 09/01/2025).

Forsythe, W.C., Rykiel, Jr., E.J., Stahl, R.S., Wu, H. and Schoolfield, R.M. (1995). A Model Comparison for Daylength as a Function of Latitude and Day of the Year. *Ecological modelling*, 80, 87-95.

Provan, S. and Whitfield, D.P. (2006). *Avian Flight Speeds and Biometrics for Use in Collision Risk Modelling.* Unpublished Report to Scottish Natural Heritage.

Mitchell, C. (2012), *Mapping the distribution of feeding Pink-footed and Iceland Greylag Geese in Scotland*. Wildfowl & Wetlands Trust / Scottish Natural Heritage Report. WWT Slimbridge.

NatureScot (2024). *Wind farm impacts on birds*. Available at: https://www.nature.scot/professional-advice/planning-and-development/planning-and-development-advice/renewable-energy/onshore-wind-energy/wind-farm-impacts-birds (Accessed 13/02/2025).

SNH (2014). *Breeding season dates for key breeding species in Scotland.* Available at: https://www.nature.scot/sites/default/files/2017-07/A303080%20-%20Bird%20Breeding%20Season%20Dates%20in%20Scotland.pdf (Accessed 13/02/2025).

SNH (2016). *Assessing connectivity with Special Protection Areas (SPAs). Guidance.* Version 3 - June 2016. Inverness.

SNH (2017) *Recommended bird survey methods to inform impact assessment of onshore wind farms. Scottish Natural Heritage (SNH)*, Guidance.

SNH (2018). *Avoidance rates for the onshore SNH wind farm collision risk model.* September 2018, v2.

Snow, D. W. & Perrins, C. M. (1998). *The Birds of the Western Palearctic. Concise Edition*. Oxford University Press.

ANNEX 1 – 'AT RISK' FLIGHT ACTIVITY

Table A1.1 presents at risk target species flight activity recorded over the full baseline survey period (September 2021 to August 2023). These were those flights that passed into the CRZ (within 300 m wind farm area) at PCH (HT2 to HT5) for at least some of the time.

The species, number of individuals, total flight duration (in seconds) and duration spent at each height band (recorded at 15 second intervals) is presented.

At-risk flight activity input into the CRM analysis is calculated as a proportional duration for each flight, based on flock size, flock length and duration at collision risk height.

*The following British Trust for Ornithology (BTO) codes[1] used in **Table A1.1** are used to denote species: EA - Golden eagle, PG - Pink-footed goose, BK – Black grouse, ML - Merlin, H. - Grey heron, and GK - Greenshank.*

Table A1.1: At risk flight activity.

Date	VP	Species	No. of Birds	Start Time (24h)	Duration (s)	HT1	HT2	HT3	HT4	HT5	HT6	Notes
24/11/2021	3a	BK	1	09:51	52	22	30	0	0	0	0	-
31/01/2022	2a	EA	1	12:02	171	120	51	0	0	0	0	Adult, moving steadily west. Low flight throughout.
01/03/2022	3a	ML	1	11:56	105	0	105	0	0	0	0	-
27/04/2022	3a	PG	144	11:13	247	0	0	0	0	247	0	-
27/04/2022	3a	EA	1	16:06	82	7	15	30	15	15	0	Adult female.
24/04/2023	3b	EA	1	18:15	230	200	30	0	0	0	0	Adult.
26/04/2023	1b	PG	100	07:00	195	0	0	0	30	165	0	-
05/05/2023	2b	EA	1	07:47	93	45	48	0	0	0	0	Adult. Female. Hunting. Mobbed by corvid.
05/05/2023	2b	H.	1	07:55	149	74	75	0	0	0	0	Landed.
05/05/2023	2b	GK	1	08:24	156	36	90	30	0	0	0	Displaying.
05/05/2023	2b	GK	1	09:50	203	23	75	105	0	0	0	Same bird. Displaying.
05/05/2023	2b	EA	1	12:10	192	162	30	0	0	0	0	Adult. Hunting, low flight.
22/06/2023	3b	EA	1	12:19	453	0	0	108	105	90	150	Immature seemed to depart in response to appearance of adult

[1] Available at https://www.bto.org/sites/default/files/u16/downloads/forms_instructions/bto_bird_species_codes.pdf (Accessed 13/02/2025).

Date	VP	Species	No. of Birds	Start Time (24h)	Duration (s)	HT1	HT2	HT3	HT4	HT5	HT6	Notes
22/06/2023	3b	EA	1	12:24	419	0	0	0	30	135	254	Adult moved directly to Immature bird. In flight, displayed.

ANNEX 2 – COLLISION PROBABILITY CALCULATION

Golden eagle

K: [1D or [3D] (0 or 1)	**1**		**Calculation of alpha and p(collision) as a function of radius**									
No. Blades	**3**						Upwind:				Downwind:	
Max Chord	**4.5**	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	**15**		radius	chord	alpha	length	p (collision)	from radius r	length	p (collision)	from radius r
Bird Length	**0.82**	m	0.025	0.575	5.28	20.68	0.97	0.00121	19.35	0.90	0.00113
Wingspan	**2.03**	m	0.075	0.575	1.76	7.34	0.34	0.00257	6.00	0.28	0.00210
F: Flapping (0) or gliding (+1)	**1**		0.125	0.702	1.06	5.40	0.25	0.00315	3.77	0.18	0.00220
			0.175	0.860	0.75	4.80	0.22	0.00392	2.79	0.13	0.00228
Bird speed	**11.9**	m/sec	0.225	0.994	0.59	4.45	0.21	0.00468	2.13	0.10	0.00224
Rotor Diam	**155**	m	0.275	0.947	0.48	3.70	0.17	0.00475	1.49	0.07	0.00192
Rotation Period	**5.40**	sec	0.325	0.899	0.41	3.16	0.15	0.00479	1.06	0.05	0.00161
			0.375	0.851	0.35	3.11	0.15	0.00545	1.13	0.05	0.00198
			0.425	0.804	0.31	2.84	0.13	0.00564	0.97	0.05	0.00192
			0.475	0.756	0.28	2.61	0.12	0.00579	0.85	0.04	0.00189
Bird aspect ratio: β	0.40		0.525	0.708	0.25	2.42	0.11	0.00593	0.87	0.04	0.00213
			0.575	0.660	0.23	2.25	0.10	0.00603	0.93	0.04	0.00250
			0.625	0.613	0.21	2.10	0.10	0.00612	0.97	0.05	0.00283
			0.675	0.565	0.20	1.96	0.09	0.00617	1.00	0.05	0.00314
			0.725	0.517	0.18	1.83	0.09	0.00620	1.01	0.05	0.00343
			0.775	0.470	0.17	1.71	0.08	0.00620	1.02	0.05	0.00369
			0.825	0.422	0.16	1.60	0.07	0.00618	1.02	0.05	0.00392
			0.875	0.374	0.15	1.50	0.07	0.00613	1.01	0.05	0.00413
			0.925	0.327	0.14	1.40	0.07	0.00606	1.00	0.05	0.00431
			0.975	0.279	0.14	1.31	0.06	0.00596	0.98	0.05	0.00446
				Overall p(collision) =			**Upwind**	**10.3%**		**Downwind**	**5.4%**
								Average	**7.8%**		

ANNEX 3 – COLLISION RISK MODEL CALCULATIONS

Golden Eagle (Year 1; Non-breeding season)

VP	Watch data			Flying time (s)	Flying time hahr-1	Weighted flying time ha hr^-1	
	Area (ha)	Time (hrs)	HaHr	Risk height	Risk height	Weighting	Risk height
2a	57.7	30.0	1730.7	14	0.0000021736	0.256374932	0.000000557
3a	152.1	33.0	5020.0	0	0.0000000000	0.743625068	0.000000000
Totals	209.8	63.0	6750.7	14	0.0000010868	1.000000000	0.000000557
Mean activity hr^-1 in wind farm				**WIND FARM DATA**			
Risk height	0.00015	0.0150 %		**Wind farm area (ha)**	268.84		

Daylight hours	1,463.6				
Downtime	15	0.85		**D**	155.0
Vw =	416702000			**L + d**	5.32
Vr =	803073	**No. of turbines**	8	**R**	77.5
Vr/Vw =	0.0019272				
Speed	11.9				
Vw Occupancy =	0.2202	792.8			
Vr Occupancy =	0.0004	1.5			
Transit time =	0.4471				
Transits =	3.418				
Collision probability from Annex 2	0.078				
Collisions with no avoidance	0.267	**Collisions with 99% avoidance & downtime**			0.002
Collisions with 99% avoidance	0.003	**Years for 1 death**			441.32

Golden Eagle (Year 1; Breeding season)

VP	Watch data			Flying time (s)	Flying time hahr-1	Weighted flying time ha hr^-1	
	Area (ha)	Time (hrs)	HaHr	Risk height	Risk height	Weighting	Risk height
2a	57.7	42.0	2423.0	0	0.0000000000	0.274963062	0.000000000
3a	152.1	42.0	6389.0	172	0.0000074665	0.725036938	0.000005413
Totals	209.8	84.0	8812.0	172	0.0000037332	1.000000000	0.000005413

Mean activity hr^-1 in wind farm				WIND FARM DATA	
Risk height	0.00146	0.1455 %		Wind farm area (ha)	268.84

Daylight hours	3007.4					
Downtime	15	0.85		D	155.0	
Vw =	416702000			L + d	5.32	
Vr =	803073	No. of turbines	8	R	77.5	
Vr/Vw =	0.0019272					
Speed	11.9					
Vw Occupancy =	4.3768	15756.6				
Vr Occupancy =	0.0084	30.4				
Transit time =	0.4471					
Transits =	67.925					
Collision probability from Annex 2	0.078					
Collisions with no avoidance	5.298	Collisions with 99% avoidance & downtime			0.045	
Collisions with 99% avoidance	0.053	Years for 1 death			22.21	

Golden Eagle (Year 2; Non-breeding season)

No at-risk flights.

Golden Eagle (Year 2; Breeding season)

VP	Watch data			Flying time (s)	Flying time hahr-1	Weighted flying time ha hr^-1	
	Area (ha)	Time (hrs)	HaHr	Risk height	Risk height	Weighting	Risk height
1b	1.6	42.0	66.4	0	0.0000000000	0.006385571	0.000000000
2b	117.7	42.0	4943.8	10	0.0000005542	0.475725016	0.000000264
3b	138.0	39.0	5382.0	197	0.0000101492	0.517889413	0.000005256
Totals	257.3	123.0	10392.2	207	0.0000035678	1.000000000	0.000005520

Mean activity hr^-1 in wind farm				**WIND FARM DATA**			
Risk height	0.00148	0.1484 %		**Wind farm area (ha)**	268.84		
Daylight hours			3007.4				
Downtime			15	0.85		**D**	155.0
Vw =			416702000			**L + d**	5.32
Vr =			803073	**No. of turbines**	8	**R**	77.5
Vr/Vw =			0.0019272				
Speed			11.9				
Vw Occupancy =			4.4628	16066.2			
Vr Occupancy =			0.0086	31.0			
Transit time =			0.4471				
Transits =			69.259				
Collision probability from Annex 2			0.078				
Collisions with no avoidance			5.402	**Collisions with 99% avoidance & downtime**			0.046
Collisions with 99% avoidance			0.054	**Years for 1 death**			21.78