



Avian Collision Risk Report

Lissinagroagh Wind Farm

FuturEnergy Ireland DAC

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Basis of Report

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Executive Summary

The aim of this report is to describe the collision risk modelling process undertaken for the Lissinagroagh Wind Farm project in Co. Leitrim, and to provide outputs such that any potentially significant collision-related effects on birds can be identified in the accompanying Environmental Impact Assessment (EIA) and Natura Impact Statement (NIS) reports. Modelling was undertaken based on ornithological data collected by MKO over the period from September 2020 to September 2025 for 12 bird species and one candidate turbine model, the Nordex N163-7.2. The model chosen was a random (i.e. non-directional) model and was implemented following NatureScot (2024) best-practice guidance. In general, the probability of collision risk for the candidate turbine model was highest for common snipe, followed by common kestrel. The probability of collision risk was relatively low for other species such as hen harrier and white-tailed eagle. While the model outputs provide a theoretical estimate of collision risk, they do not directly reflect whether collision is likely to have significant effects on avian populations, which is addressed within the accompanying EIA and NIS reports. Furthermore, the modelling is subject to various limitations and qualifications, which are discussed in the report.



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Acronyms and Abbreviations

CIEEM	Chartered Institute of Ecology and Environmental Management
CRM	Collision Risk Model
EIA	Environmental Impact Assessment
FEI	FuturEnergy Ireland DAC
GIS	Geographical Information Systems
HB	Height Band
MW	Megawatt
NIS	Natura Impact Statement
NS	NatureScot
PCH	Potential Collision Height
SCI	Special Conservation Interest
SPA	Special Protection Area
The Project	Lissinagroagh Wind Farm
VP	Vantage Point
WP	Wind Farm Polygon



1.0 Introduction

This report presents the results of Collision Risk Modelling (CRM) undertaken for 12 bird species to inform the assessment of potential ornithological impacts relating to the proposed Lissinagroagh Wind Farm (hereafter “the Project”), which has a layout comprising 14 turbines in one array.

As agreed with FuturEnergy Ireland DAC (hereafter “FEI”), modelling was based on the use of one turbine model: the Nordex N163 7.2 MW turbine type with a rotor diameter of 163 m, tip height of 185 m, and hub height of 103.5 m. This turbine was chosen as it represents the worst-case of the various candidate turbine models under consideration in that it has the longest rotor, lowest ground clearance and equal highest tip height.

The CRM was undertaken in accordance with current NatureScot (NS) (formerly Scottish Natural Heritage) guidance¹, which is recognised as standard best practice guidance through the UK and Ireland to inform impact assessment for onshore wind farms. Further details regarding the methodology used, including details of assumptions used and any corrections applied, are provided in section 2.0. The modelling results are presented in section 3.0 and copies of the modelling calculations for each species modelled are included in Appendix A.

¹ NatureScot (2024). Guidance on using an updated collision risk model to assess bird collision risk at onshore wind farms. NatureScot, Battleby, Scotland.



2.0 Methods

2.1 Statement of Authority

The modelling and report writing were conducted by Dr Jonathon Dunn MCIEEM. Jonathon is an Associate Ornithologist with SLR and has over 10 years' experience in the environmental sector and has completed CRM training delivered by the Chartered Institute of Ecology and Environmental Management (CIEEM). He has conducted CRMs for several onshore wind farms in Ireland.

Quality assurance and technical review were provided by Michael Austin MCIEEM. Michael is an Associate Ornithologist with SLR and has over 10 years' experience undertaking CRM. He was trained in CRM at RPS and has taken a lead role in CRM at SLR having conducted many CRMs for onshore wind farms in the UK and Ireland.

The approval review was undertaken by Duncan Watson CEnv, MCIEEM. Duncan is a Technical Director with SLR and has over 27 years' experience with ecological impact assessments for renewable energy projects, with a particular focus on ornithology. He has managed, undertaken or technically reviewed the assessments at over 90 proposed wind farms, ensuring robust CRM as part of the review process, where relevant.

2.2 Primary Target Species

Target species for the surveys were defined by legal and/ or conservation status and vulnerability to impacts caused by wind turbines, as defined in NS (2025) guidance². Bird species of high conservation importance are those which are Annex I species and other species of high conservation importance which are potentially vulnerable to impacts from wind farm developments. The following species were therefore considered relevant as primary target species:

- Annex I raptor species;
- All red-listed non-passerine species; and
- Special Conservation Interests (SCIs) of Special Protection Areas (SPAs) within 20 km of the Project.

2.3 Overview of CRM Process

As per current NS guidance, the updated Band CRM (Band 2024³) was used to estimate collision risk based on recorded primary target species activity levels and flight behaviour, proposed turbine numbers and specifications, and the relevant species biometrics and flight characteristics. Modelling collision risk under the Band CRM³ is summarised below:

- Stage A uses bird survey data to establish the density of flying birds in the vicinity of the turbines, and the proportion flying at a risk height, between the lowest and highest points of the rotors;
- Stage B provides an estimate, based on the bird density and proportion at risk height, of the potential number of bird passages through rotors in the period in question;

² NatureScot (2025). Recommended Bird Survey Methods to Inform Impact Assessment of Onshore Wind Farms. Version 2. Note that the 2017 version of this guidance was used to determine target species at the time of survey, but the text on the definition of target species remains the same in the 2025 update.

³ Band, W. 2024. Using a collision risk model to assess bird collision risks for onshore wind farms. NatureScot Research Report 909.



- Stage C calculates the probability of collision during a single bird rotor transit;
- Stage D estimates the potential collision rate for a bird species, assuming current levels of bird use of the site, allowing for the proportion of time that turbines are not operational; and
- Stage E takes account of the proportion of birds likely to avoid the wind farm or its turbines, either because they have been displaced from the site or because they take evasive action or are attracted to the wind farm, e.g. in response to changing habitats.

A full description of the different stages of the CRM is given in NS (2024)¹ guidance.

We have employed a non-directional (i.e. randomly distributed flights) CRM. The alternative modelling approach would be a directional (i.e. non-randomly distribute flights) CRM. The difference between the two modelling approaches depends on flight distributions and bird behaviours. Thus, if birds are regularly making flights along a defined axis, e.g. between nesting and foraging grounds, or as part of migration, then a directional CRM is appropriate. As we have no evidence of this for the Project, a non-directional CRM is the correct choice of model.

The modelling was carried out using the spreadsheet supplied with the NS (2024)¹ guidance.

The data used for the different stages of CRM are outlined below.

2.4 Stage A

2.4.1 Viewshed Data

Four vantage points (VPs) were used for flight activity surveys.

Viewshed data, i.e., the area visible from each VP within the wind farm polygon (WP)⁴, are summarised in Table 2-1. These VP locations and viewshed data are shown within the accompanying EIA report.

For the Nordex N163, based on an offset of 22 m (i.e. the lowest height swept by the turbine rotors), the combined viewshed area (minus overlap) from VPs 1 - 4 (6,994,217 m²) represents 78.7% of the WP (8,884,205 m²) (Table 2-1).

Table 2-1: VP Viewshed Data

VP / Viewshed Number	ITM Coordinates (x,y)	Area of visibility ⁵ (m ²)
VP 1	592932, 842222	1,792,183
VP 2	592617, 842416	2,890,444
VP 3	593500, 843676	2,118,268
VP 4	590414, 840986	1,086,620
VPs 1-4 viewshed combined (minus overlap)		6,994,217

⁴ The wind farm polygon (WP) includes the area within 500 m plus rotor blade length, extending from within the centre of each turbine tower, also known as 'the turbine envelope'. Thus, the size of the WP considers both rotor blade length and potential spatial errors in flight recording accuracy.

⁵ Areas calculated in GIS using an offset of 22 m above ground level for the Nordex 163 candidate turbine



2.4.2 Seasonal Definitions

The periods used in the flight activity survey design broadly equate to the breeding and non-breeding season periods for most bird species, defined by NatureScot (2025) guidance² as April – August (breeding season) and September – March (non-breeding season). There was a slight discrepancy in that the MKO surveys considered September part of the breeding season and are included this way in their baseline bird reports; however, for the purposes of this CRM, we have considered September's survey effort and flight activity results as part of the non-breeding season.

For golden plover *Pluvialis apricaria*, there was evidence of raised flight activity during migration periods. Consequently, the spring and autumn migration seasons were also considered for this species, with spring defined as March to May inclusive, and autumn as September to November inclusive.

2.4.3 Flight Activity Survey Data

Flight activity data from the four VPs described in Section 2.4.1 were collected during baseline surveys carried out by MKO over a period of five years, between September 2020 to September 2025. Survey data comprise five complete breeding periods and two complete non-breeding periods, plus four additional partially completed non-breeding seasons (i.e. September 2022, September 2023, September 2024 and September 2025).

The total number of hours of survey at each VP are as shown in Table 2-2 (MKO, 2025⁶; MKO, 2025⁷; MKO, 2023⁸; MKO, 2023⁹; MKO, 2024¹⁰; MKO, 2025¹¹; MKO, 2025¹²), which are far in excess of the minimum of 144 hours per VP over a two-year period required by NS guidance². It is acknowledged that the number of survey hours for each individual breeding season falls short of the 36 hours per season requirement. This is because September's survey effort and flight activity results have been considered as part of the non-breeding season for the purposes of the CRM (see Section 2.4.2). Overall, however, survey coverage during the breeding season greatly exceeds the minimum of 72 hours per VP per season required by the same NS guidance.

Consequently, September 2022, 2023, 2024 and 2025 are the only survey months for the non-breeding seasons in those survey years. The flight activity data from these months are not representative of full non-breeding seasons; however, when non-breeding seasons comprising September only were excluded from the subsequent analysis, the resulting average CRM estimates were virtually identical, and so the data are presented to provide a fuller picture of flight activity across the entire survey period.

⁶ MKO (2025). Lissinagroagh Wind Farm, Co. Leitrim. Winter Season 2020-2021. MKO, Galway, Ireland.

⁷ MKO (2025). Lissinagroagh Wind Farm, Co. Leitrim. Breeding Season 2021. MKO, Galway, Ireland.

⁸ MKO (2023). Lissinagroagh Wind Farm, Co. Leitrim. Winter Bird Survey Report 2021/22. MKO, Galway, Ireland.

⁹ MKO (2023). Lissinagroagh Wind Farm, Co. Leitrim. Breeding Bird Survey Report 2022. MKO, Galway, Ireland.

¹⁰ MKO (2024). Lissinagroagh Wind Farm, Co. Leitrim. Breeding Bird Survey Report 2023. MKO, Galway, Ireland.

¹¹ MKO (2025). Lissinagroagh Wind Farm, Co. Leitrim. Breeding Bird Survey Report 2024. MKO, Galway, Ireland.

¹² MKO (2025). Lissinagroagh Wind Farm, Co. Leitrim. Breeding Bird Survey Report 2025. MKO, Galway, Ireland.



Table 2-2: VP Surveys undertaken at the Project Site, Sep 2020 to Sep 2025

VP Number	Hours of Survey Completed per Survey Period											Total
	Sep 2020 – Mar 2021	Apr – Aug 2021	Sep 2021 – Mar 2022	Apr – Aug 2022	Sep 2022	Apr – Aug 2023	Sep 2023	Apr – Aug 2024	Sep 2024	Apr – Aug 2025	Sep 2025	
1	42	30	42	27	6	30	6	31	0	30.5	6	250.50
2	42	30	42	31	9	30	6	30	0	25	6	251.00
3	43	30	48	30	6	27	6	30	6	25	6	257.00
4	42	30	42	27	6	30	6	30	0	25	6	244.00

The raw number of flight lines (i.e. including those inside and outside the WP, and those within, below and above potential collision height (PCH)), cumulative number of birds and flying time in each height category (also known as ‘height band’ or HB, see Section 2.4.6) per VP for each survey period is shown in Table 2-3. Note that only data for survey periods and VPs where flight activity was recorded for the relevant species are shown for brevity. Survey periods have been abbreviated, such that ‘B’ = breeding season and ‘NB’ = non-breeding season, with survey year given by the suffix.

Table 2-3: Details of Raw Flight Lines Recorded, both Inside and Outside the WP

Species	Survey Period	VP No.	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)			
						HB1	HB2	HB3	HB4
Black-headed gull <i>Chroicocephalus ridibundus</i>	B22	VP3	1	28	210	0	0	90	120
	B23	VP1	3	91	3835	350	3010	475	0
		VP4	5	190	1510	20	460	1040	0
	NB23_24	VP3	3	24	535	0	85	450	0
	B24	VP2	1	3	95	0	0	80	15
		VP4	1	13	55	0	10	45	0
	B25	VP2	1	3	240	0	0	240	0
NB25_26	VP4	1	3	50	0	0	50	0	
Cormorant <i>Phalacrocorax carbo</i>	B23	VP4	1	3	250	0	0	250	0
	B24	VP3	1	2	90	0	0	70	20
	B25	VP4	1	1	42	0	0	42	0
Golden plover	NB20_21	VP3	1	6	20	0	0	20	0
	B21	VP1	4	194	1901	0	715	1186	0
	NB21_22	VP1	7	345	806	8	35	763	0
		VP2	4	110	52	52	18	0	34
		VP3	1	12	15	0	15	0	0
	VP1	2	22	435	40	100	295	0	



Species	Survey Period	VP No.	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)			
						HB1	HB2	HB3	HB4
	NB22_23	VP4	1	8	75	0	0	75	0
	B24	VP2	1	15	140	0	90	50	0
	NB24_25	VP3	1	12	18	0	0	18	0
Hen harrier <i>Circus cyaneus</i>	NB20_21	VP2	2	2	30	30	0	0	0
		VP3	2	2	82	75	7	0	0
		VP4	1	1	18	18	0	0	0
	B21	VP1	8	8	604	361	223	20	0
		VP3	14	14	1645	622	668	325	30
	NB21_22	VP1	2	2	80	0	50	30	0
		VP2	21	36	1862	489	713	710	0
		VP3	2	2	93	93	0	0	0
		VP4	7	7	676	203	130	343	0
	B22	VP1	6	6	502	437	65	0	0
		VP2	5	6	1002	631	116	105	150
		VP3	12	12	567	387	180	0	0
	NB22_23	VP1	1	1	160	150	10	0	0
	B23	VP1	12	12	1526	46	180	1000	180
		VP2	13	13	3345	1515	1280	550	0
		VP3	1	1	110	90	20	0	0
		VP4	8	8	330	42	268	20	0
	B24	VP1	5	5	400	295	95	10	0
		VP2	11	11	1845	1045	440	360	0
		VP3	1	1	55	0	55	0	0
B25	VP1	3	3	193	64	40	89	0	
	VP3	1	1	110	0	0	30	80	
NB25_26	VP1	1	1	66	30	15	21	0	
	VP3	2	2	32	12	2	18	0	
Herring gull <i>Larus argentatus</i>	B23	VP1	2	23	1025	0	0	1025	0
	B23	VP3	1	1	40	0	10	30	0
	NB23_24	VP4	1	7	320	0	0	320	0
	B25	VP2	2	2	290	35	255	0	0
Kestrel <i>Falco tinnunculus</i>	NB20_21	VP1	1	1	170	0	60	110	0
		VP2	1	1	190	0	160	30	0



Species	Survey Period	VP No.	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)				
						HB1	HB2	HB3	HB4	
	B21	VP3	3	3	630	430	150	50	0	
	NB21_22	VP2	3	3	265	5	93	167	0	
		VP3	4	4	1038	61	339	643	0	
	B22	VP1	2	2	350	100	250	0	0	
		VP2	4	5	803	190	243	310	60	
		VP3	1	1	240	0	60	180	0	
	NB22_23	VP2	1	1	60	0	60	0	0	
		VP3	1	1	36	16	20	0	0	
		VP4	1	1	200	25	105	70	0	
	B23	VP2	1	1	590	60	180	250	0	
		VP3	1	1	350	40	260	50	0	
		VP4	3	3	1110	130	420	560	0	
	NB23_24	VP1	1	1	30	0	20	10	0	
		VP2	1	1	100	0	0	100	0	
		VP4	1	1	475	0	350	125	0	
	B24	VP1	10	10	2510	135	1005	1290	0	
		VP2	11	11	5075	315	1370	3390	0	
		VP3	2	2	390	5	85	300	0	
		VP4	5	5	4135	70	1615	2450	0	
	B25	VP1	5	5	69	38	31	0	0	
		VP2	2	2	175	45	80	50	0	
		VP3	4	4	65	5	55	5	0	
	NB25_26	VP1	4	4	806	55	135	566	50	
		VP4	1	1	7	7	0	0	0	
	Lesser black-backed gull <i>Larus fuscus</i>	B21	VP3	1	2	28	3	25	0	0
			VP4	1	4	51	0	0	51	0
		B22	VP1	1	6	470	0	230	140	0
			VP2	2	7	60	0	20	40	0
VP3			2	45	900	70	380	370	80	
VP4			3	34	565	0	50	515	0	
B23		VP1	6	71	4522	420	2782	1360	60	
		VP2	4	26	805	68	97	640	0	
		VP3	3	44	1120	0	200	920	0	
		VP4	3	11	611	0	51	360	200	
NB23_24		VP3	3	62	800	0	180	620	0	



Species	Survey Period	VP No.	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)			
						HB1	HB2	HB3	HB4
	B24	VP1	7	29	975	15	225	710	25
		VP2	9	45	705	0	130	575	0
		VP3	1	2	80	0	0	80	0
		VP4	10	30	590	0	50	540	0
	B25	VP1	2	5	155	0	0	45	110
		VP3	5	14	330	0	100	210	20
VP4		8	38	765	0	70	250	445	
Little egret <i>Egretta garzetta</i>	B23	VP3	2	5	320	0	170	150	0
Mallard <i>Anas platyrhynchos</i>	B23	VP4	1	13	320	0	0	320	0
	NB25_26	VP4	1	3	14	0	14	0	0
Merlin <i>Falco columbarius</i>	NB20_21	VP3	1	1	9	9	0	0	0
	NB22_23	VP4	1	1	28	28	0	0	0
	B23	VP4	1	1	130	60	70	0	0
	B24	VP3	5	5	635	535	100	0	0
	B25	VP3	3	3	85	65	20	0	0
Peregrine falcon <i>Falco peregrinus</i>	NB20_21	VP2	1	1	60	0	0	40	20
	B25	VP2	1	1	135	0	0	135	0
		VP3	1	1	50	0	0	20	30
Red grouse <i>Lagopus lagopus hibernica</i>	NB22_23	VP3	1	1	8	8	0	0	0
Snipe <i>Gallinago gallinago</i>	B21	VP1	1	1	7	7	0	0	0
	NB21_22	VP1	4	5	68	0	18	50	0
		VP2	2	2	11	5	6	0	0
		VP3	3	4	17	10	7	0	0
		VP4	1	1	3	0	3	0	0
	B22	VP4	4	18	460	35	410	15	0
	NB22_23	VP1	1	2	45	0	45	0	0
		VP3	1	6	27	10	17	0	0
	B23	VP1	2	6	200	35	145	20	0
		VP4	2	17	1150	150	720	260	0
NB23_24	VP3	2	8	120	80	35	0	0	



Species	Survey Period	VP No.	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)			
						HB1	HB2	HB3	HB4
	B24	VP1	18	45	2390	440	510	1440	0
		VP2	6	10	1630	85	415	1130	0
		VP3	34	87	2210	295	465	1460	0
		VP4	16	27	4105	25	1190	2895	0
	B25	VP1	9	20	2595	20	315	860	1400
		VP2	9	16	3105	35	245	2275	550
		VP3	22	68	7066	171	850	4855	1190
		VP4	9	13	2640	0	820	1690	130
	NB25_26	VP1	1	6	46	0	0	46	0
		VP3	1	1	5	2	3	0	0
	White-tailed eagle <i>Haliaeetus albicilla</i>	B23	VP2	1	1	1050	0	0	450
B24		VP2	1	1	670	0	0	270	400
B25		VP1	2	2	820	0	700	120	0
Whooper swan <i>Cygnus cygnus</i>	NB21_22	VP1	1	8	50	0	0	50	0
Woodcock <i>Scolopax rusticola</i>	NB20_21 ¹³	VP4	4	-	-	-	-	-	-
	NB21_22	VP4	3	3	13	5	8	0	0
	B22	VP3	1	1	5	5	0	0	0
	B23	VP4	1	1	5	0	5	0	0

2.4.4 Flight Selection for CRM

To select flights liable to incur a potential risk of collision, i.e., within the areas occupied by proposed turbines, the CRM used only observations collected within the WP⁴. It is known that bird detection rates vary between species. To ensure the CRM used robust measures of flight activity, a 2 km distance truncation was used in the viewshed from each VP, i.e., only flights within 2 km of each VP were included (as per NS 2025 guidance²).

Analysis in Excel and GIS identified those flights described in Table 2-3 that were within the WP.

Where flights occurred both within and outside the WP, the proportion of each flight line inside vs. outside the WP was also calculated using GIS.

This was undertaken for all primary target species regardless of the number of flight lines or cumulative numbers of birds.

¹³ Flight details were not recorded. These flight lines were outside of the WP so were not at collision risk, so the lack of details does not affect the CRM assessment.



2.4.5 Bird Density

Flying time estimated to occur within each of the survey recording height bands was used to determine the period that target species were at risk of collision with the rotors.

This was undertaken as follows. First, the time spent flying was estimated from interval data for flight lines that entered the WP. Second, these flight times were then multiplied by the proportion of each flight line length within the WP. Third, these flight times were then multiplied by the total number of individuals recorded per flight line to identify the total flying time in bird-seconds.

The total flying time (aggregated across all survey height bands) of species taken forward to CRM is given in Table 2-4, split by survey period and VP number. As this step only involves flights within the WP, there may be some differences in Table 2-4 vs. Table 2-3, which displays all flights, regardless of whether they were within the WP or not. This step resulted in the removal of little egret, mallard, whooper swan and woodcock from further consideration, none of which were recorded within the WP. Collision risk for these species, based on the recorded flight data, is therefore zero.

2.4.5.1 Total Flying Time

Table 2-4: Total Flying Time within the WP

Species	Survey Period	VP No.	Total Flying Time within the WP (bird-secs)
Black-headed gull	B23	VP1	2707.97
		VP4	885.43
	NB23_24	VP3	1795.94
	B24	VP2	153.70
		VP4	43.59
Cormorant	B23	VP4	250.89
Golden plover	NB21_22	VP1	405.26
		VP2	1151.73
	NB22_23	VP1	1985.50
	B24	VP2	858.74
	NB24_25	VP3	68.29
Hen harrier	NB20_21	VP2	30.00
		VP4	3.98
	B21	VP1	140.70
		VP2	2698.64
		VP3	810.20
		VP4	1095.22
	NB21_22	VP1	8.99
		VP2	3405.69
		VP4	93.39
	B22	VP1	247.52



Species	Survey Period	VP No.	Total Flying Time within the WP (bird-secs)
		VP2	345.32
		VP3	248.53
	B23	VP1	583.03
		VP2	398.62
		VP4	127.07
	B24	VP1	171.39
		VP2	1522.27
		VP3	55.00
	B25	VP1	33.85
	NB25_26	VP1	9.92
Herring gull	B23	VP1	1175.23
	B25	VP2	158.83
Kestrel	B21	VP3	22.87
	NB21_22	VP2	257.39
		VP3	183.27
	B22	VP2	742.64
	NB22_23	VP2	60.00
		VP3	36.00
	B23	VP2	490.00
	B24	VP1	22.59
		VP2	79.78
		VP3	1001.41
B25	VP2	4264.51	
NB25_26	VP1	9.02	
Lesser black-backed gull	B22	VP1	588.88
		VP2	178.90
		VP4	185.14
	B23	VP1	5684.64
		VP2	2760.06
		VP3	987.45
	B24	VP1	662.83
		VP2	609.54
		VP4	286.31
	B25	VP1	155.91
VP3		287.52	



Species	Survey Period	VP No.	Total Flying Time within the WP (bird-secs)
		VP4	75.98
Merlin	NB20_21	VP3	1.54
	B24	VP3	61.18
Peregrine falcon	B25	VP2	135.00
		VP3	22.34
Red grouse	NB22_23	VP3	0.57
Snipe	B21	VP1	7.00
		VP2	9.00
	NB21_22	VP1	28.07
		VP2	11.00
		VP3	0.12
	B22	VP3	207.72
	NB22_23	VP1	80.01
	B23	VP1	125.91
		VP2	360.02
		VP3	29.24
		VP4	700.62
	B24	VP1	576.38
		VP2	3200.62
		VP3	74.19
	B25	VP1	2513.26
		VP2	14472.77
		VP3	62.89
	NB25_26	VP1	0.05
		VP3	7.00
	White-tailed eagle	B23	VP2
B24		VP2	408.44
B25		VP1	171.33

2.4.5.2 Bird Density Results

Next, bird density was calculated by dividing flying time by the period of the watch in seconds multiplied by the area of the WP visible within each viewshed. This was undertaken using the flight time data in Table 2-4, the total survey effort given in Section 2.4.3 and viewshed data given in Section 2.4.1.

These data were calculated for each month, VP number and survey period per species. They were then averaged across all VPs, as outlined in NS (2024) guidance¹ for each species, season and month, to provide a mean figure of bird density per month, per season, along with the standard deviation.



As there were significant differences in the area covered by the VPs, with the viewshed from VP4 covering a much smaller area than those for other VPs (see Table 2-1), the mean density figure was weighted by the area observed and the duration of the VP watches as recommended by NS (2024) guidance¹.

This was calculated using the following formula where b_i = the number of flight seconds from each vantage point, t_i = the time in seconds that the vantage point was watched and A_i was the area of the vantage point viewshed in km^2 :

$$\frac{\sum b_i \cdot \frac{\sqrt{t_i \cdot A_i}}{t_i \cdot A_i}}{\sum \sqrt{t_i \cdot A_i}}$$

In most instances, this only resulted in relatively minor differences in bird density compared to those given by the straight mean.

There were no notable differences between underlying habitats in each VP viewshed (i.e. variations of conifer plantation, improved agricultural and wet grasslands and peatland habitats were present in all viewsheds), so a turbine-weighted average bird density was not used.

The results of this process are given in Table 2-5. Note that months are represented numerically from 1 (January) to 12 (December), and that only months with a mean density of >0 birds/ km^2 are shown for brevity.

Table 2-5: Bird Density Results

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	Standard Deviation	Weighted Mean
Black-headed gull	B23	5	0.00577323	0.011546461	0.004347777
		8	0.019317223	0.03393302	0.016588289
	NB23_24	9	0.009812879	0.019625759	0.010318023
	B24	4	0.000615437	0.001230874	0.000755919
		7	0.000464321	0.000928642	0.000349677
Cormorant	B23	5	0.002672377	0.005344754	0.002012548
Golden plover	NB21_22	3	0.000944253	0.001888506	0.000913249
		10	0.000492259	0.000607549	0.000502767
		11	0.00429999	0.008599979	0.005281524
		12	0.001492508	0.002985016	0.001443502
	NB22_23	9	0.012822516	0.025645033	0.011600898
	B24	4	0.003438612	0.006877225	0.004223525
	NB24_25	9	0.001492593	0	0.001492593
Hen harrier	NB20_21	1	0.00016247	0.000226562	0.000179437
	B21	4	0.015838306	0.014290584	0.015178728
		5	0.0034729	0.003704201	0.003714045
		6	0.00344351	0.005844399	0.00412242
		7	0.004092997	0.003379653	0.003751847



Species	Survey Period	Month	Bird Density (birds / km ²)		
			Mean	Standard Deviation	Weighted Mean
		8	0.000959575	0.00125771	0.000824578
	NB21_22	3	0.000892877	0.001634682	0.000684841
		9	0.013797126	0.027169566	0.016870545
	B22	5	0.000250368	0.000350243	0.000236164
		6	0.001778032	0.002400829	0.002216307
		7	0.000449023	0.000835207	0.000466028
		8	0.001505624	0.003011247	0.00142122
	B23	5	0.000133154	0.000266309	0.000163549
		6	0.015061026	0	0.015061026
		7	0.003423637	0.003130454	0.00352949
	B24	4	0.002952957	0.003259696	0.003366295
		5	0.003738453	0.006671496	0.004510408
		6	0.000811477	0.001622954	0.000977766
	B25	6	0.000126154	0.000252308	0.000118348
		7	0.000207334	0	0.000207334
		8	3.7464883124 6462e-05	7.4929766249 2923e-05	3.6234738224 3621e-05
	NB25_26	9	0.000125649	0.000145144	0.000126716
Herring gull	B23	8	0.00758973	0.01517946	0.006455684
	B25	5	7.5933343547 683e-05	0.000151867	9.3266219366 2064e-05
		6	0.000516976	0.001033952	0.000641064
Kestrel	B21	8	0.000124946	0.000249893	0.000131378
	NB21_2	11	0.001763767	0.002073692	0.001989337
		12	0.000268285	0.00053657	0.000329525
	B22	7	0.000748602	0.001497204	0.000899492
		8	0.001265588	0.002531177	0.00163871
	NB22_23	9	0.000356872	0.000416376	0.000418866
	B23	8	0.001962085	0.00392417	0.002119458
	B23_24	9	0.000465346	0.000607512	0.000533477
	B24	4	0.000777645	0.00155529	0.000955154
		5	0.013086502	0.02225801	0.015671746
		6	0.001852504	0.002108459	0.002093208
		7	0.004680376	0.005828078	0.005312112
		8	0.003074996	0.004554962	0.003147378
B25	4	0.000480511	0.000961021	0.000590194	



Species	Survey Period	Month	Bird Density (birds / km ²)		
			Mean	Standard Deviation	Weighted Mean
		8	0.000203293	0.000406586	0.000249697
	NB25_26	9	0.001683931	0.003367863	0.00162864
Lesser black-backed gull	B22	5	0.000716351	0.001432703	0.001006672
		7	0.000788824	0.001577649	0.000649738
		8	0.00380303	0.007606061	0.003589838
	B23	8	0.051360818	0.066266752	0.047238626
	B24	4	0.002995965	0.003582047	0.002516014
		5	0.003540231	0.004102569	0.003913869
		6	9.3386460768 0467e-05	0.000186773	0.000112523
		7	0.002515983	0.002332409	0.002419019
		8	0.0006255	0.001250999	0.000471059
	B25	4	0.001568422	0.001951653	0.001396719
		5	0.000425469	0.000504457	0.000373434
		6	0.001286126	0.002572251	0.001365283
Merlin	NB20_21	2	8.4233398534 3477e-06	1.6846679706 8695e-05	8.8569531090 8465e-06
	B24	4	0.000192103	0.000384205	0.000201991
		5	7.4482438693 6652e-05	0.000148965	7.8316615313 9441e-05
		7	6.7697086548 5728e-05	0.000135394	7.1181969576 8135e-05
Peregrine falcon	B25	4	0.000122067	0.000244133	0.00012835
		8	0.000498992	0.000997983	0.000612894
Red grouse	NB22_23	9	3.1341343925 302e-06	6.2682687850 604e-06	3.0827282931 8076e-06
Snipe	B21	4	8.1244902946 1459e-05	9.5000704236 1925e-05	8.7986819118 7035e-05
	NB21_22	2	6.5159684735 3766e-07	1.3031936947 0753e-06	6.8513948427 3141e-07
		3	2.4025528411 7058e-05	4.8051056823 4115e-05	2.9509700199 4659e-05
		10	0.000181263	0.000362525	0.000158097
		12	2.0021273676 4215e-05	4.0042547352 8429e-05	2.4591416832 8883e-05
	B22	8	0.001134955	0.00226991	0.001164724
	NB22_23	9	0.000516727	0.001033453	0.000467497
	B23	5	0.007462586	0.014925172	0.005620019



Species	Survey Period	Month	Bird Density (birds / km ²)		
			Mean	Standard Deviation	Weighted Mean
		8	0.002361279	0.002690143	0.002369528
	B24	4	0.001096465	0.001515622	0.001270211
		5	0.012012764	0.024025528	0.01475485
		7	0.003834544	0.006632272	0.003742817
	B25	4	0.074236754	0.10940276	0.086935091
		5	0.000290366	0.000580733	0.000305314
	NB25_26	9	2.5813855903 4482e-07	5.1627711806 8964e-07	2.7142691056 0043e-07
White-tailed eagle	B23	8	0.002078354	0.004156708	0.002245053
	B24	8	0.00163551	0.003271019	0.002008838
	B25	8	0.001021378	0.002042755	0.000987841

2.4.6 Proportion of Birds Flying at Risk Height

The baseline surveys prior to the breeding 2023 season utilised the following four height bands:

1. 0-10 m;
2. 10 – 25 m;
3. 25 – 175 m; and
4. >175 m.

All subsequent surveys, i.e. from the breeding season 2023 onwards, used the following height bands:

1. 0-15 m;
2. 15 – 25 m;
3. 25 – 175 m; and
4. >175 m.

The potential collision height (PCH) for the Nordex N163 turbine is 22 m to 185 m, based on a tip height of 185 m, hub height of 103.5 m and rotor diameter of 163 m. As such, all flight lines with a PCH of 22 to 185 m must be included for CRM.

To account for a rotor diameter of 163 m, the model adjusted the occupancy by rotor diameter as a proportion of survey risk height as described in NS (2024) guidance¹. This assumes that in each of the height ranges within which flight height was classified, flight heights were distributed uniformly.

Thus, the proportion of flights within each of the relevant height bands within the WP that are considered to have occurred at PCH has been calculated, as shown in Table 2-6.

For example, using the set of height bands for all surveys prior to the 2023 breeding season, 3 m of the 22-185 m PCH span falls within the 10-25 m height range (height band 2), so 3/15 of birds flying within that height range would be at rotor risk height. All of the 150 m height range for height band 3 falls with PCH. The remaining 10 m of the PCH span is within the >175 m height range (height band 4). As this height band does not have an upper limit it is not possible to determine the proportion of flights occurring within the range 175 m – 185 m



using an even distribution of flights. The difference between 175 m and 185 m is very small and likely to be indeterminable in the field, even to the best surveyors. Therefore, for the CRM, flights above 175 m were treated as flights above 185 m (see Section 3.1 for further discussion on this as a limitation), i.e. none of the birds flying >175 m were assumed to be at PCH. As none of the PCH span falls within the 0-10 m height range (height band 1), none of the birds flying within that height range would be at PCH.

The proportion of birds flying at PCH was calculated differently for the breeding 2023 season onwards, as height bands 1 and 2 changed from 0-10 m and 10-25 m to 0-15 m and 15-25 m, respectively.

Note that data have been aggregated by year and season as has been done in NS (2024) guidance¹. Only seasons where flight time is >0 have been included in Table 2-6 for brevity.

Table 2-6: Proportion of Flights at PCH

Species	Season	Duration of flights observed within WP across all viewsheds (bird-secs)	% of flight durations observed within WP				% of flight durations at PCH (22 – 185 m) within WP
			Height band 1 (0 – 10 m pre-breeding 2023, and 0-15 m thereafter)	Height band 2 (10 – 25 m pre-breeding 2023, and 15 – 25 m thereafter)	Height band 3 (25 - 175 m)	Height band 4 (>175 m)	
Black-headed gull	B23	3593.40	0.00	53.20	46.80	0.00	62.76
	NB23_24	1795.94	0.00	16.12	83.88	0.00	88.72
	B24	197.29	0.00	4.02	83.68	12.30	84.89
Cormorant	B23	250.89	0.00	0.00	100.00	0.00	100.00
Golden plover	NB21_22	1556.99	6.80	0.00	93.20	0.00	93.20
	NB22_23	1985.50	0.72	1.79	97.49	0.00	97.85
	B24	858.74	0.00	64.29	35.71	0.00	55.00
	NB24_25	68.29	0.00	0.00	100.00	0.00	100.00
Hen harrier	NB20_21	33.98	100.00	0.00	0.00	0.00	0.00
	B21	4744.76	62.90	30.90	6.20	0.00	12.38
	NB21_22	3508.06	30.73	34.42	34.85	0.00	41.73
	B22	841.37	67.78	21.82	4.44	5.95	8.81
	B23	1108.72	4.01	26.48	55.03	14.48	62.98
	B24	1748.65	61.32	25.30	13.38	0.00	20.97
	B25	33.85	76.29	7.35	16.36	0.00	18.57
	NB25_26	15.21	0.00	21.26	78.74	0.00	85.12
Herring gull	B23	1175.23	0.00	0.00	100.00	0.00	100.00
	B25	158.83	14.34	85.66	0.00	0.00	25.70
Kestrel	B21	22.87	100.00	0.00	0.00	0.00	0.00
	NB21_22	440.66	1.13	52.38	46.48	0.00	56.96
	B22	742.64	37.04	35.99	23.79	3.18	30.98
	NB22_23	96.00	16.67	83.33	0.00	0.00	16.67



Species	Season	Duration of flights observed within WP across all viewsheds (bird-secs)	% of flight durations observed within WP				% of flight durations at PCH (22 – 185 m) within WP
			Height band 1 (0 – 10 m pre breeding 2023, and 0-15 m thereafter)	Height band 2 (10 – 25 m pre breeding 2023, and 15 – 25 m thereafter)	Height band 3 (25 - 175 m)	Height band 4 (>175 m)	
	B23	490.00	12.24	36.73	51.02	0.00	62.04
	NB23_24	102.37	0.00	14.71	85.29	0.00	89.70
	B24	5274.94	7.02	30.66	62.32	0.00	71.52
	B25	175.00	25.71	45.71	28.57	0.00	42.29
	NB25_26	260.75	6.08	15.70	68.33	9.89	73.04
Lesser black-backed gull	B22	952.92	0.00	39.44	60.56	0.00	68.45
	B23	9432.16	0.00	25.35	73.35	1.30	80.96
	B24	1558.69	0.42	12.36	85.21	2.01	88.92
	B25	519.41	0.00	53.12	19.48	27.40	35.42
Merlin	NB20_21	1.54	100.00	0.00	0.00	0.00	0.00
	B24	61.18	84.11	15.89	0.00	0.00	4.77
Peregrine falcon	B25	157.34	0.00	0.00	91.48	8.52	91.48
Red grouse	NB22_23	0.57	100.00	0.00	0.00	0.00	0.00
Snipe	B21	16.00	43.75	0.00	56.25	0.00	56.25
	NB21_22	39.19	12.76	15.62	71.62	0.00	74.75
	B22	207.72	20.00	80.00	0.00	0.00	16.00
	NB22_23	80.01	0.00	100.00	0.00	0.00	20.00
	B23	1215.79	12.77	67.67	19.56	0.00	39.86
	B24	3851.19	16.93	21.39	61.67	0.00	68.09
	B25	17048.92	0.44	7.93	67.47	24.16	69.85
	NB25_26	0.05	40.00	60.00	0.00	0.00	18.00
White-tailed eagle	B23	519.04	0.00	0.00	42.86	57.14	42.86
	B24	408.44	0.00	0.00	40.30	59.70	40.30
	B25	171.33	0.00	79.65	20.35	0.00	44.25

2.5 Stages B - D

For Stages B-D, the following parameters were entered into the NS (2024) guidance¹ modelling spreadsheet:

- Day time bird density for each month aggregated by each survey year, season and VP (taken from Section 2.4.5);
- The proportion of flights at risk height aggregated by each survey year and season (taken from Section 2.4.6);



- Species-specific bird parameters (Table 2-7); and
- Wind farm parameters (Table 2-8).

2.5.1 Bird Parameters

Measurements and flight speeds of the species for which CRM was undertaken were derived from British Trust for Ornithology (BTO)¹⁴, Cochran & Applegate (1986)¹⁵, Cramp & Simmons (1977-1994)¹⁶, Provan & Whitfield (2007)¹⁷, Bruderer & Boldt (2001)¹⁸ and Alerstram et al. (2007)¹⁹. The avoidance rates for these species are taken from NS (2025)²⁰. Where species do not have a defined avoidance rate, the default avoidance rate of 98% has been applied.

Flight type was determined based on knowledge of the bird and empirical data collected during surveys. In the absence of any additional data, flapping flights were selected as a precaution, as this option results in a higher probability of collision than gliding flight.

The theoretical time that birds could be active with potential for turbine collisions was assumed to be the period between sunrise and sunset within each survey period using the latitude of the Project and was calculated using NS's (2024) guidance¹ spreadsheet.

For waders (i.e., snipe and golden plover), which could be active nocturnally, an additional 25% of nocturnal hours were added to the daylight hours to give a more accurate representation of the available hours in which collision could occur for these species (as per Band, 2024³).

Details of these species-specific parameters are given in Table 2-7.

Table 2-7: Bird Biometrics, Flight Speed, Flight Type, Nocturnal Activity Factor and Avoidance Rates used in CRM

Common Name	Bird Length (m)	Wingspan (m)	Flight Speed (m/s)	Flight Type (0 or 1) ²¹	Nocturnal Activity Factor (1-5) ²²	Avoidance Rate (%)
Black-headed gull	0.355	1.05	11.9	0	1	99.2
Kestrel	0.34	0.755	12.7	0	1	95.0
Snipe	0.26	0.455	16.0	0	2	98.0

¹⁴ <https://www.bto.org/understanding-birds/birdfacts> [Accessed in November 2025].

¹⁵ William W. Cochran and Roger D. Applegate. (1986). The Condor 88:398-401 The Cooper Ornithological Society

¹⁶ Cramp, S. and Simmon, S.E.L. (197-1994). Birds of the Western Palearctic. Oxford University Press.

¹⁷ Provan, S. and Whitfield, D.P. (2007) Avian flight speeds and biometrics for use in collision risk modelling. Report to Scottish Natural Heritage.

¹⁸ Bruderer, B. and Bolt, A. (2001) Flight characteristics of birds: 1. Radar measurements of speeds, Ibis, 143. 178 – 204.

¹⁹ Alerstam T, Rosén M, Bäckman J, Ericson PG, Hellgren O. (2007). Flight speeds among bird species: allometric and phylogenetic effects. PLoS Biol.

²⁰ SNH (2025) Avoidance rates for the onshore SNH wind farm collision risk model.

<https://www.nature.scot/doc/wind-farm-impacts-birds-use-avoidance-rates-naturescot-wind-farm-collision-risk-model#:~:text=2.%20Recommended%20avoidance%20rates%20%20%20Species%20,%20SNH%20%282013%20> [Accessed in November 2025].

²¹ Key: 0=flapping and 1=gliding

²² Key: 1=0%, 2=25%, 3=50%, 4=75% and 5=100% of daytime activity



Common Name	Bird Length (m)	Wingspan (m)	Flight Speed (m/s)	Flight Type (0 or 1) ²¹	Nocturnal Activity Factor (1-5) ²²	Avoidance Rate (%)
Golden plover	0.275	0.715	13.7	0	2	98.0
Cormorant	0.9	1.45	14.5	0	1	98.0
Hen harrier	0.48	1.1	8	0	1	99.0
Herring gull	0.61	1.465	12.8	0	1	99.5
Lesser black-backed gull	0.6	1.45	13.1	0	1	99.5
Merlin	0.275	0.56	13.47	0	1	98.0
Peregrine falcon	0.42	1.025	12.1	0	1	98.0
Red grouse	0.395	0.605	12.5	0	1	98.0
White-tailed eagle	0.8	2.2	13.6	0	1	95.0

2.5.2 Wind Farm Parameters

The wind turbine parameters used in the CRM are detailed in Table 2-8, based on information provided by FEI.

The proportion of time turbines are predicted to be operational per month was calculated based on the proportion of time available multiplied by the proportion of time the turbines were expected to be above cut-in and below cut-out speeds, using values supplied by FEI.

The Project was not considered to be a large array²³ and so no 'large array correction' was applied.

Table 2-8: Wind Farm and Turbine Parameters

Parameter	Value
Wind farm width (km)	2
Number of turbines	14
Rotor radius / diameter (m)	81.5 / 163
Hub height (m)	103.5
Maximum blade chord width (m)	4.15
Blade pitch (°)	15

²³ There is no fixed numerical threshold defining a "large array" in NatureScot's collision-risk-modelling guidance. As a practical rule of thumb, wind farms with around 40 or more turbines are often treated as large arrays, while wind farms of 20–40 turbines may also fall into this category where multiple turbine rows are present and where the product of turbine number and per-turbine collision probability is sufficiently high that ignoring density-depletion effects would overestimate collision risk. This typically occurs where the layout creates a meaningful likelihood that birds encounter more than one rotor while traversing the site. As the current project comprises 14 turbines arranged without multiple turbine rows, it does not meet these conditions and should not be considered a large array.



Parameter	Value
Rotation speed (r.p.m)	8.8
Turbine operation time (%) (calculated per month but mean value over whole year given here)	86



3.0 Results

Table 3-1 summarises the predicted collision rates for the 12 species under consideration, using the avoidance rates and other parameters given in Table 2-7, for the candidate turbine model. Copies of the NS model calculations for each species are included in Appendix A.

In addition to collision risk estimates for each period of analysis, mean annual risk estimates have also been presented. For resident species, mean annual risk estimates are based on all breeding and non-breeding season data, and for non-resident species, mean annual risk estimates are based on all instances of the relevant season. For example, for lesser black-backed gull, which is predominantly a summer visitor, only the breeding seasons have been considered.

To calculate mean annual collision risk estimates for resident species, the modelled predictions were averaged for each season type (e.g. breeding vs. non-breeding season). These seasonal averages were then summed to create annual averages.

Note that the NS spreadsheet output is restricted to two decimal places for monthly collision estimates and one decimal place for aggregated collision risk estimates. Therefore, it is possible in some cases that collision estimates presented below as zero collisions per year are in fact negligible, non-zero values. Where possible we have summed the monthly collision estimates (two decimal places) to give the period of analysis collision estimate, rather than use the per period estimate given in the spreadsheet (one decimal place).

Table 3-1: Summary of CRM Outputs

Common Name	Collision Estimates Per Period			Mean (Standard Deviation) Collision Estimates Per Year		
	Period	Collisions Per Year	No. Years Per Collision	Period	Collisions Per Year	No. Years Per Collision
Black-headed gull	NB20_21	0.00	N/A	All breeding and non-breeding seasons	0.04 (0.09)	23.26 (10.65)
	B21	0.00	N/A			
	NB21_22	0.00	N/A			
	B22	0.00	N/A			
	NB22_23	0.00	N/A			
	B23	0.13	7.69			
	NB23_24	0.09	11.11			
	B24	0.01	100			
	NB24_25	0.00	N/A			
	B25	0.00	N/A			
	NB25_26	0.00	N/A			
Cormorant	NB20_21	0.00	N/A	All breeding and non-breeding seasons	0.02 (0.04)	55.56 (24.85)
	B21	0.00	N/A			
	NB21_22	0.00	N/A			
	B22	0.00	N/A			
	NB22_23	0.00	N/A			
	B23	0.09	11.11			



Common Name	Collision Estimates Per Period			Mean (Standard Deviation) Collision Estimates Per Year		
	Period	Collisions Per Year	No. Years Per Collision	Period	Collisions Per Year	No. Years Per Collision
	NB23_24	0.00	N/A			
	B24	0.00	N/A			
	NB24_25	0.00	N/A			
	B25	0.00	N/A			
	NB25_26	0.00	N/A			
Golden plover	NB20_21	0.00	N/A	All non-breeding seasons	0.10 (0.14)	10.34 (7.03)
	NB21_22	0.20	5.00			
	NB22_23	0.34	2.94			
	NB23_24	0.00	N/A			
	NB24_25	0.04	25.00			
	NB25_26	0.00	N/A			
	Autumn_20	0.00	N/A	All autumn seasons (September to November inclusive ²⁴)	0.09 (0.14)	11.54 (7.38)
	Autumn_21	0.14	7.14			
	Autumn_22	0.34	2.94			
	Autumn_23	0.00	N/A			
	Autumn_24	0.04	25.00			
	Autumn_25	0.00	N/A			
	Spring_21	0.00	N/A	All spring seasons (March to May inclusive) ²⁵	0.02 (0.03)	50.00 (32.44)
	Spring_22	0.03	33.33			
	Spring_23	0.00	N/A			
Spring_24	0.07	14.20				
Spring_25	0.00	N/A				
Hen harrier	NB20_21	0.00	N/A	All breeding and non-breeding seasons	0.06 (0.11)	16.30 (9.15)
	B21	0.05	20.00			
	NB21_22	0.08	12.50			
	B22	0.00	N/A			
	NB22_23	0.00	N/A			
	B23	0.18	5.56			
	NB23_24	0.00	N/A			
	B24	0.01	100.00			
NB24_25	0.00	N/A				

²⁴ Only in 2020 and 2021; otherwise, September only

²⁵ Only in 2021 and 2022; otherwise, April to May



Common Name	Collision Estimates Per Period			Mean (Standard Deviation) Collision Estimates Per Year		
	Period	Collisions Per Year	No. Years Per Collision	Period	Collisions Per Year	No. Years Per Collision
	B25	0.00	N/A			
	NB25_26	0.00	N/A			
Herring gull	NB20_21	0.00	N/A	All breeding and non-breeding seasons	0.01 (0.02)	100.00 (44.72)
	B21	0.00	N/A			
	NB21_22	0.00	N/A			
	B22	0.00	N/A			
	NB22_23	0.00	N/A			
	B23	0.05	20.00			
	NB23_24	0.00	N/A			
	B24	0.00	N/A			
	NB24_25	0.00	N/A			
	B25	0.00	N/A			
	NB25_26	0.00	N/A			
Kestrel	NB20_21	0.00	N/A	All breeding and non-breeding seasons	0.34 (0.64)	2.96 (1.56)
	B21	0.00	N/A			
	NB21_22	0.06	16.67			
	B22	0.05	20.00			
	NB22_23	0.00	N/A			
	B23	0.08	12.50			
	NB23_24	0.03	33.33			
	B24	1.39	0.72			
	NB24_25	0.00	N/A			
	B25	0.03	33.33			
	NB25_26	0.08	12.50			
Lesser black-backed gull	B21	0.00	N/A	All breeding seasons	0.08 (0.12)	12.50 (8.30)
	B22	0.03	33.33			
	B23	0.29	3.45			
	B24	0.07	14.29			
	B25	0.01	100.00			
Merlin	NB20_21	0.00	N/A	All breeding and non-breeding seasons	0.00	N/A
	B21	0.00	N/A			
	NB21_22	0.00	N/A			
	B22	0.00	N/A			
	NB22_23	0.00	N/A			



Common Name	Collision Estimates Per Period			Mean (Standard Deviation) Collision Estimates Per Year		
	Period	Collisions Per Year	No. Years Per Collision	Period	Collisions Per Year	No. Years Per Collision
	B23	0.00	N/A			
	NB23_24	0.00	N/A			
	B24	0.00	N/A			
	NB24_25	0.00	N/A			
	B25	0.00	N/A			
	NB25_26	0.00	N/A			
Peregrine falcon	NB20_21	0.00	N/A	All breeding and non-breeding seasons	0.00 (0.00)	500.00 (223.61)
	B21	0.00	N/A			
	NB21_22	0.00	N/A			
	B22	0.00	N/A			
	NB22_23	0.00	N/A			
	B23	0.00	N/A			
	NB23_24	0.00	N/A			
	B24	0.00	N/A			
	NB24_25	0.00	N/A			
	B25	0.01	100.00			
	NB25_26	0.00	N/A			
Red grouse	NB20_21	0.00	N/A	All breeding and non-breeding seasons	0.00	N/A
	B21	0.00	N/A			
	NB21_22	0.00	N/A			
	B22	0.00	N/A			
	NB22_23	0.00	N/A			
	B23	0.00	N/A			
	NB23_24	0.00	N/A			
	B24	0.00	N/A			
	NB24_25	0.00	N/A			
	B25	0.00	N/A			
	NB25_26	0.00	N/A			
Snipe	NB20_21	0.00	N/A	All breeding and non-breeding seasons	0.54 (0.89)	1.87 (1.12)
	B21	0.00	N/A			
	NB21_22	0.00	N/A			
	B22	0.01	100.00			
	NB22_23	0.00	N/A			
	B23	0.11	9.09			



Common Name	Collision Estimates Per Period			Mean (Standard Deviation) Collision Estimates Per Year		
	Period	Collisions Per Year	No. Years Per Collision	Period	Collisions Per Year	No. Years Per Collision
	NB23_24	0.00	N/A			
	B24	0.46	2.17			
	NB24_25	0.00	N/A			
	B25	2.10	0.47			
	NB25_26	0.00	N/A			
White-tailed eagle	NB20_21	0.00	N/A	All breeding and non-breeding seasons	0.04 (0.04)	25.00 (24.62)
	B21	0.00	N/A			
	NB21_22	0.00	N/A			
	B22	0.00	N/A			
	NB22_23	0.00	N/A			
	B23	0.09	11.11			
	NB23_24	0.00	N/A			
	B24	0.07	14.29			
	NB24_25	0.00	N/A			
	B25	0.04	25.00			
	NB25_26	0.00	N/A			

3.1 Limitations and Uncertainty in Outputs

It should be acknowledged that there are several limitations and uncertainties in the collision risk outputs. While the results presented here are ‘best estimates’, there is natural variability in the data, with collision risk estimates differing per period of analysis for many species. To this end we have presented measures of variability (standard deviation) for our collision risk estimates for each species.

Some likely sources of variability or uncertainty in the data are as follows:

- Uncertainty in flight activity data including imprecision on flight height estimates and lack of detailed knowledge regarding night-time behaviour for some species; and
- Inherent limitations within the collision-risk model itself including the variability of bird dimensions and flight speed, and the simplification in shape of a bird and turbine blades.

Finally, it should be acknowledged that the collision risk outputs presented here do not directly identify whether collision is likely to have significant effects on avian populations. Further assessment to contextualise the outputs presented here is provided in the EIAR and NIS.





Appendix A NatureScot Spreadsheets – Nordex N163

Avian Collision Risk Report

Lissinagroagh Wind Farm

FuturEnergy Ireland DAC

SLR Project No.: 501.065072.00001

26 January 2026

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

	Value	Units		Value	Units		Value	Units
Bird data			Windfarm data			Turbine data		
Species name	Black-headed gull		Site name	Lissinagroagh		Model	N163	
Bird length	L	0.355	Latitude	54.33493	degrees	Hub height	103.5	m
Wingspan	W	1.05	No of turbines	T	14	Rotor radius	R	81.5
Bird flight speed	v	11.9	Width of windfarm	w	3	No of blades	b	3
Flight type, flapping or gliding		flapping				Rotation speed	Ω	8.8
% of flights upwind/downwind		50%				Max blade width	C	4.15
Nocturnal activity ranking 1-5		1				Blade pitch	λ	15
Nocturnal activity factor	f_{night}	0%				Risk height range		22-185
								m

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_A	birds/km ²												0.0017
Proportion at rotor risk height	Q_{2R}	62.76%												
At latitude 54.3		246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14												
Rotor radius	R	81.5 m												
		Total rotor frontal area m ² 292141												
Nocturnal activity factor	f_{night}	0%												
Bird flight speed	v	11.9 m s ⁻¹												
		0.0	0.0	0.0	0.0	103.9	0.0	0.0	369.4	0.0	0.0	0.0	0.0	473
		Projected number of rotor transits												

Stage C														
No of blades	b	3		Bird length	l	0.355 m								
Rotation speed	Ω	8.8 rpm		Wingspan	w	1.05 m								
Rotor radius	R	81.5 m		Bird flight speed	v	11.9 m s ⁻¹								
Max blade width	C	4.15 m		Flight type		flapping								
Pitch	λ	15 degrees		% of flights upwind/downwind		50%								
Blade profile		see Blade profile sheet												
		Single transit risk		upwind	6.74%									
				downwind	2.88%									
				weighted mean	4.81%									

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	0.00	4.07	0.00	0.00	12.58	0.00	0.00	0.00	0.00	17
		year total												

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?		No												
Width of windfarm	w	3 km		large array correction										
		Collision rates allowing for avoidance												
Avoidance rates modelled		0.00	0.00	0.00	0.00	4.07	0.00	0.00	12.58	0.00	0.00	0.00	0.00	16.6
		0.00	0.00	0.00	0.00	4.07	0.00	0.00	12.58	0.00	0.00	0.00	0.00	16.6
		0.00	0.00	0.00	0.00	4.07	0.00	0.00	12.58	0.00	0.00	0.00	0.00	16.6
		0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.1

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

	Value	Units		Value	Units		Value	Units
Bird data			Windfarm data			Turbine data		
Species name	Black-headed gull		Site name	Lissinagroagh		Model	N163	
Bird length	L	0.355	Latitude	54.33493	degrees	Hub height	103.5	m
Wingspan	W	1.05	No of turbines	T	14	Rotor radius	R	81.5
Bird flight speed	v	11.9	Width of windfarm	w	3	No of blades	b	3
Flight type, flapping or gliding		flapping				Rotation speed	Ω	8.8
% of flights upwind/downwind		50%				Max blade width	C	4.15
Nocturnal activity ranking 1-5		1				Blade pitch	λ	15
Nocturnal activity factor	f _{night}	0%				Risk height range		22-185
								m

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Daytime bird density	D _A	birds/km ²												0.0009	
Proportion at rotor risk height	Q _{2R}	88.72%												0.010318	
At latitude 54.3		Daylight hours per month	246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		Nighttime hours per month	497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
No of turbines	T	14													
Rotor radius	R	81.5 m													
		Total rotor frontal area m ² 292141													
Nocturnal activity factor	f _{night}	0%													
Bird flight speed	v	11.9 m s ⁻¹													
		Projected number of rotor transits	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	269.4	0.0	0.0	0.0	269

Stage C														
No of blades	b	3		Bird length	l	0.355 m								
Rotation speed	Ω	8.8 rpm		Wingspan	w	1.05 m								
Rotor radius	R	81.5 m		Bird flight speed	v	11.9 m s ⁻¹								
Max blade width	C	4.15 m		Flight type		flapping								
Pitch	λ	15 degrees		% of flights upwind/downwind		50%								
Blade profile		see Blade profile sheet												
		Single transit risk	upwind	6.74%										
			downwind	2.88%										
			weighted mean	4.81%										

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.18	0.00	0.00	0.00	11

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?		No												
Width of windfarm	w	3 km												
		large array correction												
Avoidance rates modelled		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
		99.20%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.18	0.00	0.00	0.00	11.2
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.18	0.00	0.00	0.00	11.2
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.18	0.00	0.00	0.00	11.2
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.1

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

	Value	Units		Value	Units		Value	Units
Bird data			Windfarm data			Turbine data		
Species name	Golden plover		Site name	Lissinagroagh		Model	N163	
Bird length	L	0.275	Latitude	54.33493	degrees	Hub height	103.5	m
Wingspan	W	0.715	No of turbines	T	14	Rotor radius	R	81.5
Bird flight speed	v	13.7	Width of windfarm	w	3	No of blades	b	3
Flight type, flapping or gliding		flapping				Rotation speed	Ω	8.8
% of flights upwind/downwind		50%				Max blade width	C	4.15
Nocturnal activity ranking 1-5		2				Blade pitch	λ	15
Nocturnal activity factor	f_{night}	25%				Risk height range		22-185
								m

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_A	birds/km ²												0.0005
Proportion at rotor risk height	Q_{2R}	93.20%												0.000503
At latitude 54.3		246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14												
Rotor radius	R	81.5 m												
		Total rotor frontal area m ² 292141												
Nocturnal activity factor	f_{night}	25%												
Bird flight speed	v	13.7 m s ⁻¹												
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.9	162.3	0.0	180
		Projected number of rotor transits												

Stage C		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Bird length 0.275 m												
		Wingspan 0.715 m												
		Bird flight speed 13.7 m s ⁻¹												
		Flight type 50%												
		% of flights upwind/downwind 50%												
		Single transit risk upwind 5.95%												
		downwind 2.43%												
		weighted mean 4.19%												

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	6.32	0.00	7

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?		No												
Width of windfarm	w	3 km												
		large array correction												
Avoidance rates modelled		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	6.32	0.00	7.0
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	6.32	0.00	7.0
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.00	0.1
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.0

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

	Value	Units		Value	Units		Value	Units
Bird data			Windfarm data			Turbine data		
Species name	Golden plover		Site name	Lissinagroagh		Model	N163	
Bird length	L	0.275	Latitude	54.33493	degrees	Hub height	103.5	m
Wingspan	W	0.715	No of turbines	T	14	Rotor radius	R	81.5
Bird flight speed	v	13.7	Width of windfarm	w	3	No of blades	b	3
Flight type, flapping or gliding		flapping				Rotation speed	Ω	8.8
% of flights upwind/downwind		50%				Max blade width	C	4.15
Nocturnal activity ranking 1-5		2				Blade pitch	λ	15
Nocturnal activity factor	f _{night}	25%				Risk height range		22-185
								m

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Daytime bird density	D _A	birds/km ²												0.0010	
Proportion at rotor risk height	Q _{2R}	97.85%													
At latitude 54.3		Daylight hours per month	246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		Nighttime hours per month	497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
No of turbines	T	14													
Rotor radius	R	81.5 m													
		Total rotor frontal area m ² 292141													
Nocturnal activity factor	f _{night}	25%													
Bird flight speed	v	13.7 m s ⁻¹													
		Projected number of rotor transits	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	469.1	0.0	0.0	0.0	469

Stage C														
No of blades	b	3		Bird length	l	0.275 m								
Rotation speed	Ω	8.8 rpm		Wingspan	w	0.715 m								
Rotor radius	R	81.5 m		Bird flight speed	v	13.7 m s ⁻¹								
Max blade width	C	4.15 m		Flight type		flapping								
Pitch	λ	15 degrees		% of flights upwind/downwind		50%								
Blade profile		see Blade profile sheet												
		Single transit risk	upwind	5.95%										
			downwind	2.43%										
			weighted mean	4.19%										

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.95	0.00	0.00	0.00	17

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
Allow for large array correction?		No													
Width of windfarm	w	3 km													
		large array correction													
Avoidance rates modelled		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
		98.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
		99.80%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
		Collision rates allowing for avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.95	0.00	0.00	0.00	16.9
			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.95	0.00	0.00	0.00	16.9
			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.3
			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.0

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

	Value	Units		Value	Units		Value	Units
Bird data			Windfarm data			Turbine data		
Species name	Golden plover		Site name	Lissinagroagh		Model	N163	
Bird length	L	0.275	Latitude	54.33493	degrees	Hub height	103.5	m
Wingspan	W	0.715	No of turbines	T	14	Rotor radius	R	81.5
Bird flight speed	v	13.7	Width of windfarm	w	3	No of blades	b	3
Flight type, flapping or gliding		flapping				Rotation speed	Ω	8.8
% of flights upwind/downwind		50%				Max blade width	C	4.15
Nocturnal activity ranking 1-5		2				Blade pitch	λ	15
Nocturnal activity factor	f _{night}	25%				Risk height range		22-185
								m

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D _A	0.000913												0.0007
Proportion at rotor risk height	Q _{2R}	93.20%												
At latitude 54.3		246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14												
Rotor radius	R	81.5 m												
		Total rotor frontal area m ² 292141												
Nocturnal activity factor	f _{night}	25%												
Bird flight speed	v	13.7 m s ⁻¹												
		0.0	0.0	34.6	0.0	0.0	0.0	0.0	0.0	0.0	17.9	162.3	42.7	257
		Projected number of rotor transits												

Stage C														
No of blades	b	3		Bird length	l	0.275	m							
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.715	m							
Rotor radius	R	81.5	m	Bird flight speed	v	13.7	m s ⁻¹							
Max blade width	C	4.15	m	Flight type		flapping								
Pitch	λ	15	degrees	% of flights upwind/downwind		50%								
Blade profile		see Blade profile sheet												
		Single transit risk		upwind	5.95%									
				downwind	2.43%									
				weighted mean	4.19%									

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	1.32	0.00	0.00	0.00	0.00	0.00	0.00	0.68	6.32	1.61	10

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?		No												
Width of windfarm	w	3 km												
		large array correction												
Avoidance rates modelled		0.00	0.00	1.32	0.00	0.00	0.00	0.00	0.00	0.00	0.68	6.32	1.61	9.9
		0.00	0.00	1.32	0.00	0.00	0.00	0.00	0.00	0.00	0.68	6.32	1.61	9.9
		0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.03	0.2
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.0

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units				
Species name	Golden plover		Site name	Lissinagroagh		Model	N163				
Bird length	L	0.275	m	Latitude	54.33493	degrees	Hub height	103.5	m		
Wingspan	W	0.715	m	No of turbines	T	14	Rotor radius	R	81.5	m	
Bird flight speed	v	13.7	m s ⁻¹	Width of windfarm	w	3	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%						Max blade width	C	4.15	m
Nocturnal activity ranking 1-5		2						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	25%						Risk height range		22-185	m

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Daytime bird density	D _A	birds/km ²												0.0010	
Proportion at rotor risk height	Q _{2R}	97.85%												0.011601	
At latitude 54.3		Daylight hours per month	246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		Nighttime hours per month	497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
No of turbines	T	14													
Rotor radius	R	81.5 m													
		Total rotor frontal area m ² 292141													
Nocturnal activity factor	f _{night}	25%													
Bird flight speed	v	13.7 m s ⁻¹													
		Projected number of rotor transits	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	469.1	0.0	0.0	0.0	469

Stage C		Bird length	Wingspan	Bird flight speed	Flight type	% of flights upwind/downwind
No of blades	b	3				
Rotation speed	Ω	8.8 rpm				
Rotor radius	R	81.5 m				
Max blade width	C	4.15 m				
Pitch	λ	15 degrees				
Blade profile		see Blade profile sheet				
		Single transit risk	upwind	5.95%	downwind	2.43%
			weighted mean	4.19%		

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.95	0.00	0.00	0.00	17

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
Allow for large array correction?	w	No													
Width of windfarm		3 km													
		large array correction													
Avoidance rates modelled		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
		98.00%	99.80%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
		Collision rates allowing for avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.95	0.00	0.00	0.00	16.9
			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.95	0.00	0.00	0.00	16.9
			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.3
			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.0

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
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Value				Units				Value				Units			
Bird data				Windfarm data				Turbine data							
Species name	Golden plover			Site name	Lissinagroagh			Model	N163						
Bird length	L	0.275	m	Latitude	54.33493			Hub height	103.5			m			
Wingspan	W	0.715	m	No of turbines	T	14		Rotor radius	R	81.5		m			
Bird flight speed	v	13.7	m s ⁻¹	Width of windfarm	w	3		No of blades	b	3					
Flight type, flapping or gliding	flapping							Rotation speed	Ω	8.8		rpm			
% of flights upwind/downwind	50%							Max blade width	C	4.15		m			
Nocturnal activity ranking 1-5	2							Blade pitch	λ	15		degrees			
Nocturnal activity factor	f _{night}	25%						Risk height range	22-185			m			

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
Daytime bird density	D _A	birds/km ²	0												0.0004	
Proportion at rotor risk height	Q _{2R}	55.00%	0.004224												0	
At latitude 54.3			Daylight hours per month	246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
			Nighttime hours per month	497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14													
Rotor radius	R	81.5 m													
	Total rotor frontal area m ²		292141												
Nocturnal activity factor	f _{night}	25%													
Bird flight speed	v	13.7 m s ⁻¹													
	Projected number of rotor transits		0.0	0.0	0.0	101.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	102

Stage C			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	8.8 rpm													
Rotor radius	R	81.5 m													
Max blade width	C	4.15 m													
Pitch	λ	15 degrees													
Blade profile	see Blade profile sheet														
	Single transit risk		upwind		5.95%										
			downwind		2.43%										
			weighted mean		4.19%										

Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave
Proportion of time operational	Q _{op}		90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
	Collision rates before avoidance		0.00	0.00	0.00	3.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4

Stage E			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm	w	3 km													
	large array correction														
Avoidance rates modelled			Collision rates allowing for avoidance		0.00		3.72		0.00		0.00		0.00		3.7
					0.00		3.72		0.00		0.00		0.00		3.7
	98.00%				0.00		0.07		0.00		0.00		0.00		0.1
	99.80%				0.00		0.01		0.00		0.00		0.00		0.0

COLLISION RISK MODEL

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Value				Units				Value				Units			
Bird data				Windfarm data				Turbine data							
Species name	Herring gull			Site name	Lissinagroagh			Model	N163						
Bird length	L	0.61	m	Latitude	54.33493			Hub height	103.5			m			
Wingspan	W	1.465	m	No of turbines	T	14		Rotor radius	R	81.5		m			
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	3		No of blades	b	3					
Flight type, flapping or gliding	flapping							Rotation speed	Ω	8.8		rpm			
% of flights upwind/downwind	50%							Max blade width	C	4.15		m			
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15		degrees			
Nocturnal activity factor	f _{night}	0%						Risk height range	22-185			m			

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Daytime bird density	D _A	birds/km ²	0.006456											0.0005		
Proportion at rotor risk height	Q _{2R}	100.00%														
At latitude 54.3			Daylight hours per month	246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
			Nighttime hours per month	497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14													
Rotor radius	R	81.5 m													
	Total rotor frontal area m ²		292141												
Nocturnal activity factor	f _{night}	0%													
Bird flight speed	v	12.8 m s ⁻¹													
	Projected number of rotor transits		0.0	0.0	0.0	0.0	0.0	0.0	0.0	246.4	0.0	0.0	0.0	0.0	246

Stage C			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	8.8 rpm													
Rotor radius	R	81.5 m													
Max blade width	C	4.15 m													
Pitch	λ	15 degrees													
Blade profile	see Blade profile sheet														
	Single transit risk		upwind		7.42%										
			downwind		3.74%										
			weighted mean		5.58%										

Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}		90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
	Collision rates before avoidance		0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.73	0.00	0.00	0.00	0.00	10

Stage E			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	No														
Width of windfarm	w	3 km													
	large array correction														
Avoidance rates modelled	100.00%		Collision rates allowing for avoidance		0.00		0.00		0.00		9.73		0.00		9.7
	100.00%				0.00		0.00		0.00		9.73		0.00		9.7
	100.00%				0.00		0.00		0.00		9.73		0.00		9.7
	99.50%				0.00		0.00		0.00		0.05		0.00		0.0

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
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Value				Units				Value				Units			
Bird data				Windfarm data				Turbine data							
Species name	Hen harrier			Site name	Lissinagroagh			Model	N163						
Bird length	L	0.48	m	Latitude	54.33493			Hub height	103.5			m			
Wingspan	W	1.1	m	No of turbines	T	14		Rotor radius	R	81.5		m			
Bird flight speed	v	8	m s ⁻¹	Width of windfarm	w	3		No of blades	b	3					
Flight type, flapping or gliding	flapping							Rotation speed	Ω	8.8		rpm			
% of flights upwind/downwind	50%							Max blade width	C	4.15		m			
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15		degrees			
Nocturnal activity factor	f _{night}	0%						Risk height range	22-185			m			

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave
Daytime bird density	D _A	birds/km ²	0.015179 0.003714 0.004122 0.003752 0.000825												0.0023
Proportion at rotor risk height	Q _{2R}	12.38%													
At latitude 54.3	Daylight hours per month		246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
	Nighttime hours per month		497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14													
Rotor radius	R	81.5 m													
	Total rotor frontal area m ²		292141												
Nocturnal activity factor	f _{night}	0%													
Bird flight speed	v	8 m s ⁻¹													
	Projected number of rotor transits		0.0	0.0	0.0	40.8	11.8	13.5	12.4	2.4	0.0	0.0	0.0	0.0	81

Stage C			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	8.8 rpm													
Rotor radius	R	81.5 m													
Max blade width	C	4.15 m													
Pitch	λ	15 degrees													
Blade profile	see Blade profile sheet														
		Bird length	l	0.48 m											
		Wingspan	w	1.1 m											
		Bird flight speed	v	8 m s ⁻¹											
		Flight type	flapping												
		% of flights upwind/downwind	50%												
		Single transit risk	upwind	8.97%											
			downwind	4.32%											
			weighted mean	6.64%											

Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave
Proportion of time operational	Q _{op}		90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance	0.00	0.00	0.00	2.37	0.64	0.79	0.53	0.11	0.00	0.00	0.00	0.00	4

Stage E			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	No														
Width of windfarm	w	3 km													
		large array correction													
Avoidance rates modelled	100.00%		Collision rates allowing for avoidance												
	100.00%		0.00	0.00	0.00	2.37	0.64	0.79	0.53	0.11	0.00	0.00	0.00	0.00	4.4
	100.00%		0.00	0.00	0.00	2.37	0.64	0.79	0.53	0.11	0.00	0.00	0.00	0.00	4.4
	99.00%		0.00	0.00	0.00	2.37	0.64	0.79	0.53	0.11	0.00	0.00	0.00	0.00	4.4
	100.00%		0.00	0.00	0.00	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.0

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

Value				Units				Value				Units			
Bird data				Windfarm data				Turbine data							
Species name	Hen harrier			Site name	Lissinagroagh			Model	N163						
Bird length	L	0.48	m	Latitude	54.33493			Hub height	103.5			m			
Wingspan	W	1.1	m	No of turbines	T	14		Rotor radius	R	81.5		m			
Bird flight speed	v	8	m s ⁻¹	Width of windfarm	w	3		No of blades	b	3					
Flight type, flapping or gliding	flapping							Rotation speed	Ω	8.8		rpm			
% of flights upwind/downwind	50%							Max blade width	C	4.15		m			
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15		degrees			
Nocturnal activity factor	f _{night}	0%						Risk height range	22-185			m			

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Daytime bird density	D _A	birds/km ²	0.000685										0.0015			
Proportion at rotor risk height	Q _{2R}	41.73%	0.016871													
At latitude 54.3			Daylight hours per month	246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
			Nighttime hours per month	497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14													
Rotor radius	R	81.5 m													
	Total rotor frontal area m ²		292141												
Nocturnal activity factor	f _{night}	0%													
Bird flight speed	v	8 m s ⁻¹													
	Projected number of rotor transits		0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	139.3	0.0	0.0	0.0	145

Stage C															
No of blades	b	3	Bird length	l	0.48 m										
Rotation speed	Ω	8.8 rpm	Wingspan	w	1.1 m										
Rotor radius	R	81.5 m	Bird flight speed	v	8 m s ⁻¹										
Max blade width	C	4.15 m	Flight type	flapping											
Pitch	λ	15 degrees	% of flights upwind/downwind	50%											
Blade profile	see Blade profile sheet														
	Single transit risk		upwind	8.97%											
			downwind	4.32%											
			weighted mean	6.64%											

Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}		90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
	Collision rates before avoidance		0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	7.99	0.00	0.00	0.00	year total
			8												

Stage E			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	No														
Width of windfarm	w	3 km													
	large array correction														
Avoidance rates modelled	100.00%		Collision rates allowing for avoidance												
	100.00%		0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	7.99	0.00	0.00	0.00	8.3
	100.00%		0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	7.99	0.00	0.00	0.00	8.3
	99.00%		0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	7.99	0.00	0.00	0.00	8.3
	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.1

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

Value				Units				Value				Units			
Bird data				Windfarm data				Turbine data							
Species name	Kestrel			Site name	Lissinagroagh			Model	N163						
Bird length	L	0.34	m	Latitude	54.33493			Hub height	103.5			m			
Wingspan	W	0.755	m	No of turbines	T	14		Rotor radius	R	81.5		m			
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	3		No of blades	b	3					
Flight type, flapping or gliding	flapping							Rotation speed	Ω	8.8		rpm			
% of flights upwind/downwind	50%							Max blade width	C	4.15		m			
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15		degrees			
Nocturnal activity factor	f _{night}	0%						Risk height range	22-185			m			

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Daytime bird density	D _A	birds/km ²		0.000899												0.001639	0.0002
Proportion at rotor risk height	Q _{2R}	30.98%															
At latitude 54.3	Daylight hours per month			246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7	
	Nighttime hours per month			497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3	

Stage B				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14														
Rotor radius	R	81.5 m														
	Total rotor frontal area m ²			292141												
Nocturnal activity factor	f _{night}	0%														
Bird flight speed	v	12.7 m s ⁻¹		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
	Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	11.8	19.2	0.0	0.0	0.0	0.0	31

Stage C															
No of blades	b	3		Bird length	l	0.34 m									
Rotation speed	Ω	8.8 rpm		Wingspan	w	0.755 m									
Rotor radius	R	81.5 m		Bird flight speed	v	12.7 m s ⁻¹									
Max blade width	C	4.15 m		Flight type	flapping										
Pitch	λ	15 degrees		% of flights upwind/downwind	50%										
Blade profile	see Blade profile sheet														
	Single transit risk			upwind	6.35%										
				downwind	2.65%										
				weighted mean	4.50%										

Stage D				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}			90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
	Collision rates before avoidance			0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.61	0.00	0.00	0.00	0.00	1

Stage E				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	No															
Width of windfarm	w	3 km														
	large array correction															
Avoidance rates modelled	100.00%			Collision rates allowing for avoidance												
	100.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.61	0.00	0.00	0.00	0.00	1.0
	100.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.61	0.00	0.00	0.00	0.00	1.0
	95.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.61	0.00	0.00	0.00	0.00	1.0
	100.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	0.00	0.00	0.0

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

Value				Units				Value				Units			
Bird data				Windfarm data				Turbine data							
Species name	Kestrel			Site name	Lissinagroagh			Model	N163						
Bird length	L	0.34	m	Latitude	54.33493			Hub height	103.5			m			
Wingspan	W	0.755	m	No of turbines	T	14		Rotor radius	R	81.5		m			
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	3		No of blades	b	3					
Flight type, flapping or gliding	flapping							Rotation speed	Ω	8.8		rpm			
% of flights upwind/downwind	50%							Max blade width	C	4.15		m			
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15		degrees			
Nocturnal activity factor	f _{night}	0%						Risk height range	22-185			m			

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D _A	birds/km ²		0.002119												0.0002
Proportion at rotor risk height	Q _{2R}	62.04%														
At latitude 54.3	Daylight hours per month			246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
	Nighttime hours per month			497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14														
Rotor radius	R	81.5 m														
	Total rotor frontal area m ²			292141												
Nocturnal activity factor	f _{night}	0%														
Bird flight speed	v	12.7 m s ⁻¹														
	Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.8	0.0	0.0	0.0	50

Stage C															
No of blades	b	3		Bird length	l	0.34 m									
Rotation speed	Ω	8.8 rpm		Wingspan	w	0.755 m									
Rotor radius	R	81.5 m		Bird flight speed	v	12.7 m s ⁻¹									
Max blade width	C	4.15 m		Flight type	flapping										
Pitch	λ	15 degrees		% of flights upwind/downwind	50%										
Blade profile	see Blade profile sheet														
	Single transit risk			upwind	6.35%										
				downwind	2.65%										
				weighted mean	4.50%										

Stage D				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}			90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
	Collision rates before avoidance			0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0.00	0.00	2

Stage E				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	No															
Width of windfarm	w	3 km														
	large array correction															
Avoidance rates modelled	100.00%			Collision rates allowing for avoidance												
	100.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0.00	1.6
	100.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0.00	0.00	1.6
	95.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.1

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
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Value				Units				Value				Units			
Bird data				Windfarm data				Turbine data							
Species name	Kestrel			Site name	Lissinagroagh			Model	N163						
Bird length	L	0.34	m	Latitude	54.33493			Hub height	103.5			m			
Wingspan	W	0.755	m	No of turbines	T	14		Rotor radius	R	81.5		m			
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	3		No of blades	b	3					
Flight type, flapping or gliding	flapping							Rotation speed	Ω	8.8		rpm			
% of flights upwind/downwind	50%							Max blade width	C	4.15		m			
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15		degrees			
Nocturnal activity factor	f _{night}	0%						Risk height range	22-185			m			

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D _A	birds/km ²		0.000955 0.015672 0.002093 0.005312 0.003147												0.0023
Proportion at rotor risk height	Q _{2R}	71.52%														
At latitude 54.3	Daylight hours per month			246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
	Nighttime hours per month			497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14														
Rotor radius	R	81.5 m														
	Total rotor frontal area m ²			292141												
Nocturnal activity factor	f _{night}	0%														
Bird flight speed	v	12.7 m s ⁻¹														
	Projected number of rotor transits			0.0	0.0	0.0	23.5	455.5	63.0	160.5	85.2	0.0	0.0	0.0	0.0	788

Stage C				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3														
Rotation speed	Ω	8.8 rpm														
Rotor radius	R	81.5 m														
Max blade width	C	4.15 m														
Pitch	λ	15 degrees														
Blade profile	see Blade profile sheet															
	Single transit risk															
	upwind			6.35%												
	downwind			2.65%												
	weighted mean			4.50%												

Stage D				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}	90.2%		94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%	
	Collision rates before avoidance															
				0.00	0.00	0.00	0.93	16.72	2.50	4.63	2.72	0.00	0.00	0.00	0.00	27

Stage E				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	No															
Width of windfarm	w	3 km														
	large array correction															
Avoidance rates modelled	100.00%			Collision rates allowing for avoidance												
	100.00%			0.00	0.00	0.00	0.93	16.72	2.50	4.63	2.72	0.00	0.00	0.00	0.00	27.5
	100.00%			0.00	0.00	0.00	0.93	16.72	2.50	4.63	2.72	0.00	0.00	0.00	0.00	27.5
	95.00%			0.00	0.00	0.00	0.05	0.84	0.13	0.23	0.14	0.00	0.00	0.00	0.00	1.4

COLLISION RISK MODEL

Required input data is in orange boxes
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	Value	Units		Value	Units		Value	Units
Bird data			Windfarm data			Turbine data		
Species name	Kestrel		Site name	Lissinagroagh		Model	N163	
Bird length	L	0.34	Latitude	54.33493	degrees	Hub height	103.5	m
Wingspan	W	0.755	No of turbines	T	14	Rotor radius	R	81.5
Bird flight speed	v	12.7	Width of windfarm	w	3	No of blades	b	3
Flight type, flapping or gliding		flapping				Rotation speed	Ω	8.8
% of flights upwind/downwind		50%				Max blade width	C	4.15
Nocturnal activity ranking 1-5		1				Blade pitch	λ	15
Nocturnal activity factor	f_{night}	0%				Risk height range		22-185
								m

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_A	birds/km ²												0.0002
Proportion at rotor risk height	Q_{2R}	56.96%												
At latitude 54.3		246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14												
Rotor radius	R	81.5 m												
		Total rotor frontal area m ² 292141												
Nocturnal activity factor	f_{night}	0%												
Bird flight speed	v	12.7 m s ⁻¹												
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.9	3.5	27
		Projected number of rotor transits												

Stage C														
No of blades	b	3		Bird length	l	0.34	m							
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.755	m							
Rotor radius	R	81.5	m	Bird flight speed	v	12.7	m s ⁻¹							
Max blade width	C	4.15	m	Flight type		flapping								
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%							
Blade profile		see Blade profile sheet												
		Single transit risk		upwind	6.35%									
				downwind	2.65%									
				weighted mean	4.50%									

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.14	1

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?		No												
Width of windfarm	w	3 km												
		large array correction												
Avoidance rates modelled		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.14	1.1
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.14	1.1
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.14	1.1
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.1

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units				
Species name	Kestrel		Site name	Lissinagroagh		Model	N163				
Bird length	L	0.34	m	Latitude	54.33493	degrees	Hub height	103.5	m		
Wingspan	W	0.755	m	No of turbines	T	14		Rotor radius	R	81.5	m
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	3	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%						Max blade width	C	4.15	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						Risk height range		22-185	m

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Daytime bird density	D _A	birds/km ²												0.0001	
Proportion at rotor risk height	Q _{2R}	73.04%												0.001693	
At latitude 54.3		Daylight hours per month	246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		Nighttime hours per month	497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
No of turbines	T	14													
Rotor radius	R	81.5 m													
		Total rotor frontal area m ² 292141													
Nocturnal activity factor	f _{night}	0%													
Bird flight speed	v	12.7 m s ⁻¹													
		Projected number of rotor transits	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.8	0.0	0.0	0.0	39

Stage C		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Bird length	0.34 m											
		Wingspan	0.755 m											
		Bird flight speed	12.7 m s ⁻¹											
		Flight type	flapping											
		% of flights upwind/downwind	50%											
		Single transit risk	upwind 6.35%											
			downwind 2.65%											
			weighted mean 4.50%											

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.51	0.00	0.00	0.00	year total 2

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?		No												
Width of windfarm	w	3 km												
		large array correction												
Avoidance rates modelled		100.00%												
		100.00%												
		100.00%												
		95.00%												
		Collision rates allowing for avoidance												
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.51	0.00	0.00	0.00	1.5
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.51	0.00	0.00	0.00	1.5
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.51	0.00	0.00	0.00	1.5
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.1

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

	Value	Units		Value	Units		Value	Units
Bird data			Windfarm data			Turbine data		
Species name	Lesser black-backed gull		Site name	Lissinagroagh		Model	N163	
Bird length	L	0.6	Latitude	54.33493	degrees	Hub height	103.5	m
Wingspan	W	1.45	No of turbines	T	14	Rotor radius	R	81.5
Bird flight speed	v	13.1	Width of windfarm	w	3	No of blades	b	3
Flight type, flapping or gliding		flapping				Rotation speed	Ω	8.8
% of flights upwind/downwind		50%				Max blade width	C	4.15
Nocturnal activity ranking 1-5		1				Blade pitch	λ	15
Nocturnal activity factor	f_{night}	0%				Risk height range		22-185
								m

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_A	birds/km ²												0.001007
Proportion at rotor risk height	Q_{2R}	64.85%												0.00065
At latitude 54.3		246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		Daylight hours per month												
		Nighttime hours per month	497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14												
Rotor radius	R	81.5 m												
		Total rotor frontal area m ² 292141												
Nocturnal activity factor	f_{night}	0%												
Bird flight speed	v	13.1 m s ⁻¹												
		Projected number of rotor transits	0.0	0.0	0.0	0.0	27.4	0.0	18.4	90.9	0.0	0.0	0.0	137

Stage C														
No of blades	b	3		Bird length	l	0.6 m								
Rotation speed	Ω	8.8 rpm		Wingspan	w	1.45 m								
Rotor radius	R	81.5 m		Bird flight speed	v	13.1 m s ⁻¹								
Max blade width	C	4.15 m		Flight type		flapping								
Pitch	λ	15 degrees		% of flights upwind/downwind		50%								
Blade profile		see Blade profile sheet												
		Single transit risk	upwind	7.30%										
			downwind	3.67%										
			weighted mean	5.49%										

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	0.00	1.22	0.00	0.65	3.53	0.00	0.00	0.00	0.00	5

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?		No												
Width of windfarm	w	3 km		large array correction										
		Collision rates allowing for avoidance												
Avoidance rates modelled		0.00	0.00	0.00	0.00	1.22	0.00	0.65	3.53	0.00	0.00	0.00	0.00	5.4
		100.00%	100.00%	100.00%	100.00%	1.22	0.00	0.65	3.53	0.00	0.00	0.00	0.00	5.4
		100.00%	100.00%	100.00%	100.00%	1.22	0.00	0.65	3.53	0.00	0.00	0.00	0.00	5.4
		99.50%	100.00%	100.00%	100.00%	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.0

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

	Value	Units		Value	Units		Value	Units
Bird data			Windfarm data			Turbine data		
Species name	Lesser black-backed gull		Site name	Lissinagroagh		Model	N163	
Bird length	L	0.6	Latitude	54.33493	degrees	Hub height	103.5	m
Wingspan	W	1.45	No of turbines	T	14	Rotor radius	R	81.5
Bird flight speed	v	13.1	Width of windfarm	w	3	No of blades	b	3
Flight type, flapping or gliding		flapping				Rotation speed	Ω	8.8
% of flights upwind/downwind		50%				Max blade width	C	4.15
Nocturnal activity ranking 1-5		1				Blade pitch	λ	15
Nocturnal activity factor	f_{night}	0%				Risk height range		22-185
								m

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Daytime bird density	D_A	0.047239												0.0039	
Proportion at rotor risk height	Q_{2R}	80.96%													
At latitude 54.3		Daylight hours per month	246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		Nighttime hours per month	497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
No of turbines	T	14													
Rotor radius	R	81.5 m													
		Total rotor frontal area m^2 292141													
Nocturnal activity factor	f_{night}	0%													
Bird flight speed	v	13.1 $m s^{-1}$													
		Projected number of rotor transits	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1493.9	0.0	0.0	0.0	0.0	1494

Stage C														
No of blades	b	3		Bird length	l	0.6 m								
Rotation speed	Ω	8.8 rpm		Wingspan	w	1.45 m								
Rotor radius	R	81.5 m		Bird flight speed	v	13.1 $m s^{-1}$								
Max blade width	C	4.15 m		Flight type		flapping								
Pitch	λ	15 degrees		% of flights upwind/downwind		50%								
Blade profile		see Blade profile sheet												
		Single transit risk	upwind	7.30%										
			downwind	3.67%										
			weighted mean	5.49%										

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	58.03	0.00	0.00	0.00	0.00	58

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?		No												
Width of windfarm	w	3 km												
		large array correction												
Avoidance rates modelled		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	58.0
		99.50%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	58.0
									0.29	0.00	0.00	0.00	0.00	0.3

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Snipe		Site name	Lissinagroagh		Model	N163				
Bird length	L	0.26	m	Latitude	54.33493	degrees	Hub height	103.5	m		
Wingspan	W	0.455	m	No of turbines	T	14	Rotor radius	R	81.5	m	
Bird flight speed	v	16	m s ⁻¹	Width of windfarm	w	3	km	No of blades	b	3	
Flight type, flapping or gliding		flapping					Rotation speed	Ω	8.8	rpm	
% of flights upwind/downwind		50%					Max blade width	C	4.15	m	
Nocturnal activity ranking 1-5		2					Blade pitch	λ	15	degrees	
Nocturnal activity factor	f _{night}	25%					Risk height range		22-185	m	

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D _A	birds/km ²												0.0007
Proportion at rotor risk height	Q _{2R}	39.86%												
At latitude 54.3		246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14												
Rotor radius	R	81.5 m												
		Total rotor frontal area m ² 292141												
Nocturnal activity factor	f _{night}	25%												
Bird flight speed	v	16 m s ⁻¹												
		0.0	0.0	0.0	0.0	129.0	0.0	0.0	51.9	0.0	0.0	0.0	0.0	181

Stage C		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Single transit risk												
		upwind 5.42%												
		downwind 2.29%												
		weighted mean 3.86%												

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	0.00	4.05	0.00	0.00	1.42	0.00	0.00	0.00	0.00	5

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No												
Width of windfarm	w	3 km												
		large array correction												
		Collision rates allowing for avoidance												
Avoidance rates modelled		0.00	0.00	0.00	0.00	4.05	0.00	0.00	1.42	0.00	0.00	0.00	0.00	5.5
		0.00	0.00	0.00	0.00	4.05	0.00	0.00	1.42	0.00	0.00	0.00	0.00	5.5
		0.00	0.00	0.00	0.00	4.05	0.00	0.00	1.42	0.00	0.00	0.00	0.00	5.5
		0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.1

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Snipe		Site name	Lissinagroagh		Model	N163				
Bird length	L	0.26	m	Latitude	54.33493	degrees	Hub height	103.5	m		
Wingspan	W	0.455	m	No of turbines	T	14	Rotor radius	R	81.5	m	
Bird flight speed	v	16	m s ⁻¹	Width of windfarm	w	3	km	No of blades	b	3	
Flight type, flapping or gliding		flapping					Rotation speed	Ω	8.8	rpm	
% of flights upwind/downwind		50%					Max blade width	C	4.15	m	
Nocturnal activity ranking 1-5		2					Blade pitch	λ	15	degrees	
Nocturnal activity factor	f _{night}	25%					Risk height range		22-185	m	

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avege
Daytime bird density	D _A	birds/km ²												0.0016
Proportion at rotor risk height	Q _{2R}	68.09%												0.00127
At latitude 54.3		246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14												
Rotor radius	R	81.5 m												
		Total rotor frontal area m ² 292141												
Nocturnal activity factor	f _{night}	25%												
Bird flight speed	v	16 m s ⁻¹												
		0.0	0.0	0.0	44.2	578.7	0.0	150.7	0.0	0.0	0.0	0.0	0.0	774

Stage C		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Bird length 0.26 m												
		Wingspan 0.455 m												
		Bird flight speed 16 m s ⁻¹												
		Flight type flapping												
		% of flights upwind/downwind 50% 50%												
		Single transit risk upwind 5.42%												
		downwind 2.29%												
		weighted mean 3.86%												

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avege
Proportion of time operational	Q _{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	1.49	18.18	0.00	3.72	0.00	0.00	0.00	0.00	0.00	23

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No												
Width of windfarm	w	3 km												
		large array correction												
		Collision rates allowing for avoidance												
Avoidance rates modelled		0.00	0.00	0.00	1.49	18.18	0.00	3.72	0.00	0.00	0.00	0.00	0.00	23.4
		0.00	0.00	0.00	1.49	18.18	0.00	3.72	0.00	0.00	0.00	0.00	0.00	23.4
		0.00	0.00	0.00	1.49	18.18	0.00	3.72	0.00	0.00	0.00	0.00	0.00	23.4
		0.00	0.00	0.00	0.03	0.36	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.5

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units				
Species name	White-tailed eagle		Site name	Lissinagroagh		Model	N163				
Bird length	L	0.8	Latitude	54.33493	degrees	Hub height	103.5				
Wingspan	W	2.2	No of turbines	T	14	Rotor radius	R	81.5			
Bird flight speed	v	13.6	Width of windfarm	w	3	No of blades	b	3			
Flight type, flapping or gliding		flapping				Rotation speed	Ω	8.8			
% of flights upwind/downwind		50%				Max blade width	C	4.15			
Nocturnal activity ranking 1-5		1				Blade pitch	λ	15			
Nocturnal activity factor	f _{night}	0%				Risk height range		22-185			

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D _A	birds/km ²												0.0002
Proportion at rotor risk height	Q _{2R}	0.00209												0.0002
At latitude 54.3		246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14												
Rotor radius	R	81.5 m												
		Total rotor frontal area m ² 292141												
Nocturnal activity factor	f _{night}	0%												
Bird flight speed	v	13.6 m s ⁻¹												
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.8	0.0	0.0	0.0	0.0	33

Stage C		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Single transit risk												
		upwind 8.06%												
		downwind 4.53%												
		weighted mean 6.30%												

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.46	0.00	0.00	0.00	0.00	1

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No												
Width of windfarm	w	3 km												
		large array correction												
		Collision rates allowing for avoidance												
Avoidance rates modelled		0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.46	0.00	0.00	0.00	0.00	1.5
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.46	0.00	0.00	0.00	0.00	1.5
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.46	0.00	0.00	0.00	0.00	1.5
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.1

COLLISION RISK MODEL

Required input data is in orange boxes
 Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	White-tailed eagle		Site name	Lissinagroagh		Model	N163				
Bird length	L	0.8	Latitude	54.33493	degrees	Hub height	103.5	m			
Wingspan	W	2.2	No of turbines	T	14	Rotor radius	R	81.5	m		
Bird flight speed	v	13.6	Width of windfarm	w	3	No of blades	b	3			
Flight type, flapping or gliding		flapping				Rotation speed	Ω	8.8	rpm		
% of flights upwind/downwind		50%				Max blade width	C	4.15	m		
Nocturnal activity ranking 1-5		1				Blade pitch	λ	15	degrees		
Nocturnal activity factor	f _{night}	0%				Risk height range		22-185	m		

normal approach Set to 'normal approach' to use survey data on bird density
 Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D _A	birds/km ²												0.0001
Proportion at rotor risk height	Q _{2R}	44.25%												0.0001
At latitude 54.3		246.8	271.3	366.1	420.6	496.0	513.3	515.7	462.1	383.3	328.1	257.2	230.1	4490.7
		497.2	400.7	377.9	299.4	248.0	206.7	228.3	281.9	336.7	415.9	462.8	513.9	4269.3

Stage B		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	14												
Rotor radius	R	81.5 m												
		Total rotor frontal area m ² 292141												
Nocturnal activity factor	f _{night}	0%												
Bird flight speed	v	13.6 m s ⁻¹												
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.7	0.0	0.0	0.0	0.0	18

Stage C		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Single transit risk												
		upwind 8.06%												
		downwind 4.53%												
		weighted mean 6.30%												

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}	90.2%	94.1%	91.2%	87.3%	81.5%	88.2%	64.0%	70.8%	86.3%	91.2%	93.1%	90.2%	85.7%
		Collision rates before avoidance												
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	1

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No												
Width of windfarm	w	3 km												
		large array correction												
		Collision rates allowing for avoidance												
Avoidance rates modelled		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.8
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.8
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.8
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.0



Making Sustainability Happen